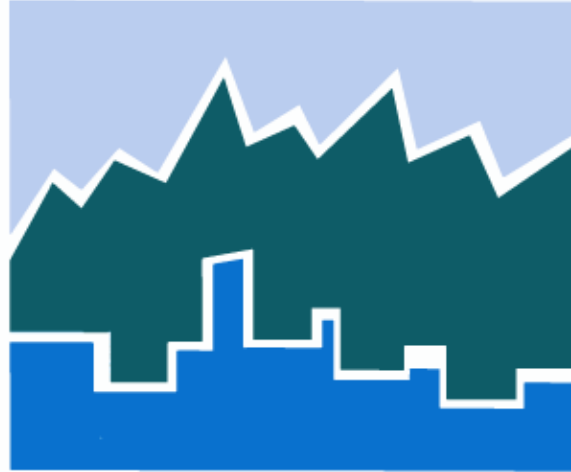


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**NHTS**



# **National Household Travel Survey**

## **Compendium of Uses**

January 2017 - December 2017

## **Introduction**

This compendium contains various uses and applications of the National Household Travel Survey (NHTS) data used in transportation planning and research from January 2017 to December 2017. Published journal articles and reports that cite the use of NHTS data were selected using the Transportation Research Board (TRB) Annual Meeting Online Portal <http://amonline.trb.org/>, Google Scholar <https://scholar.google.com/>, and Google Alerts, notification emails sent by Google when new search results matched predetermined search terms pertaining to NHTS data. The key word and search engine terms used for all online sources were the **National Household Travel Survey** and **NHTS**.

The research papers were grouped into 11 categories that were created based on the **Subject Areas** and index terms identified in each abstract as well as category titles used in previous NHTS compendium databases. The categories are as follows:

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

A short description of each paper is provided which includes the **Title, Authors, Abstract, Subject Areas, and Availability**.

Research articles and reports in this document 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 American Journal of Public Health, the International Journal of Behavioral Nutrition and Physical Activity, and the National Center for Transit Research. Several papers were also submitted by researchers and graduate students for presentation and publication to the Transportation Research Board 96<sup>th</sup> Annual Meeting and can be found in the 2017 TRB Annual Meeting Compendium of Papers. Please note that this 2017 compendium consists of approximately 412 research papers and articles. This document was updated on an on-going 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](mailto:Daniel.Jenkins@dot.gov).

Search and documentation support was provided by Aparna Banerjee (MacroSys), who also categorized and formatted the paper abstracts.

# TABLE OF CONTENTS

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## Contents

<b>1</b>	<b>Bicycle and Pedestrian Studies</b>	<b>20</b>
1.1	Title: Estimating Pedestrian Exposure for Small Urban and Rural Areas . . . .	20
1.2	Title: The Reach of Bicycling in Rural, Small, and Low-Density Places . . . .	21
1.3	Title: Differences in Behavior, Time, Location, and Built Environment Between Objectively Measured Utilitarian and Recreational Walking . . . . .	22
1.4	Title: Using Machine Learning Techniques to Estimate Non-motorized Trips for Rural Roadways . . . . .	23
1.5	Title: Trends in Walking and Cycling Safety: Recent Evidence From High-Income Countries, with a Focus on the United States and Germany . . . . .	24
1.6	Title: Perceived Barriers to Bicycling in an Urban U.S. Environment . . . . .	25
1.7	Title: Impact of Built Environment and Temporal Factors on Public Bike-Sharing	26
1.8	Title: Leading Pedestrian Interval Implementation as a Marginal Costs and Benefits Problem . . . . .	27
1.9	Title: Hail a Cab or Ride a Bike? A Travel Time Comparison of Taxi and Bicycle-sharing systems in New York City . . . . .	28
1.10	Title: Making Every Mode Count in Washington State . . . . .	29
1.11	Title: Exploring the Impact of Walk-bike Infrastructure, Safety Perception, and Built-Environment on Active Transportation Mode Choice: A Random Parameter Model using New York City Commuter Data . . . . .	30
1.12	Title: How Bicycling Sharing System usage is affected by Land Use and Urban Form: Analysis from System and User Perspectives . . . . .	31
1.13	Title: Estimating Walking and Bicycling at the State Level . . . . .	32
1.14	Title: No Need for Training Wheels: Ideas for Including Balance Bikes in Elementary Physical Education . . . . .	33
1.15	Title: Improving Walkability Through Control Strategies at Signalized Intersections . . . . .	34
1.16	Title: Cycling in Toronto: Route Choice Behavior and Implications to Infrastructure Planning . . . . .	35
1.17	Title: Spring Weather Brings Bicyclists out for the Season . . . . .	36
1.18	Title: Savannah celebrates National Bike to Work Day . . . . .	37
1.19	Title: Examining the Impact of Sample Size in the Analysis of Bicycle-Sharing Systems . . . . .	38
1.20	Title: Evaluation of an Electric Bike Pilot Project at Three Employment Campuses in Portland, Oregon . . . . .	39
1.21	Title: The Built Environment and Walking . . . . .	40

1.22	Title: Utah cyclists share why they ride in 200th Anniversary Year of the Bicycle's Invention . . . . .	41
1.23	Title: Bicycle Rodeo in Poughkeepsie Focuses on Skills, Safety and Comfort . . . . .	42
1.24	Title: On a Roll: Cycling is the Go-to Sport for Enjoying the Outdoors . . . . .	43
1.25	Title: Accessibility Evaluations for Nighttime Walking and Bicycling for Low-income Shift Workers . . . . .	44
1.26	Title: Grounding Urban Walking and Cycling Research in a Political Economy Framework . . . . .	45
1.27	Title: Bike-Sharing Systems and Congestion: Evidence from US Cities . . . . .	46
1.28	Title: The Routledge International Handbook of Walking . . . . .	47
1.29	Title: Bike Infrastructure for Multifamily Communities . . . . .	48
1.30	Title: Use of Technology to Improve Bicycle Mobility in Smart Cities . . . . .	49
1.31	Title: Travel and Built Environment: Evidence from 23 Diverse Regions of the United States . . . . .	50
1.32	Title: Planning for Cycling in Peterborough . . . . .	51
1.33	Title: Contextualizing Walkability: Do Relationships Between Built Environments and Walking Vary by Socioeconomic Context? . . . . .	52
1.34	Title: Are They Telling The Truth? Revealing Hidden Traits of Satisfaction with a Public Bike-sharing Service . . . . .	53
1.35	Title: Pedaling Disaster: Citizen Bicyclists in Disaster Response - Innovative Solution or Unnecessary Effort? . . . . .	54
1.36	Title: Correlates of Bicycling for Recreation and Transportation: Ecological Approach . . . . .	55
1.37	Title: Pedestrian Crossing Behavior in College Students: Exploration Using the Theory of Planned Behavior . . . . .	56
1.38	Title: Increasing Winter Bikeability in Toronto Through Improved Bicycle Network Design . . . . .	57
1.39	Title: Talking the Walk: An Autoethnography of Pedestrianism in Chicagoland . . . . .	58
<b>2</b>	<b>Energy</b>	<b>59</b>
2.1	Title: Quantifying the Impacts of Electric Vehicle Travel Patterns on Battery Life Span . . . . .	59
2.2	Title: Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts . . . . .	60
2.3	Title: Estimating Household Travel Energy Consumption in Conjunction with a Travel Demand Forecasting Model . . . . .	61
2.4	Title: Modelling Electric Vehicles Use: A Survey on the Methods . . . . .	62
2.5	Title: On the Impact of Single-Phase Plug-in Electric Vehicles Charging and Rooftop Solar Photovoltaic on Distribution Transformer Aging . . . . .	63
2.6	Title: Socially Optimal Replacement of Conventional with Electric Vehicles for the U.S. Household Fleet . . . . .	64
2.7	Title: Are Consumers Poorly-Informed about Fuel Economy? Evidence from Two Experiments . . . . .	65
2.8	Title: Reliability Assessment of Power Grid Supporting Sustainable Transportation . . . . .	66

2.9	Title: On the Effects of a Routing and Reservation System on the Electric Vehicle Public Charging Network . . . . .	67
2.10	Title: Intelligent Charge Rate Optimization of PHEVs Incorporating Driver Satisfaction and Grid Constraints . . . . .	68
2.11	Title: Energy Demand Model for Residential Sector: A First Principles Approach	69
2.12	Title: The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the U.S.: A Retrospective and Prospective Analysis	70
2.13	Title: Experiences and Applications of Electric and Plug-in Hybrid Vehicles in Power System Networks . . . . .	71
2.14	Title: A Review of Literature on Espousal of Electric and Hybrid Vehicle . . .	72
2.15	Title: San Francisco's 2030 District: Performance and Implications for Urban Energy Efficiency . . . . .	73
2.16	Title: A Dynamic Stochastic Optimization for Recharging Plug-in Electric Vehicles . . . . .	74
2.17	Title: A Data-Driven Optimization-Based Approach for Siting and Sizing of Electric Taxi Charging Stations . . . . .	75
2.18	Title: Model-Based Analysis of V2G Impact on Battery Degradation . . . . .	76
2.19	Title: Environmentally-friendly Demand Response for Residential Plug-in Electric Vehicles . . . . .	77
2.20	Title: Distribution System Planning to Accommodate Distributed Energy Resources and PEVs . . . . .	78
2.21	Title: Optimal Design of Electric Vehicle Charging Stations Considering Various Energy Resources . . . . .	79
2.22	Title: Reliability Studies of Modern Distribution Systems Integrated with Renewable Generation and Parking Lots . . . . .	80
2.23	Title: A MPC-Based PEV Charging Scheduling . . . . .	81
2.24	Title: Decentralized Electric Vehicle Charging Strategies for Reduced Load Variation and Guaranteed Charge Completion in Regional Distribution Grids .	82
2.25	Title: Development of a Control System for a Series-Parallel Plug-In Hybrid Electric Vehicle . . . . .	83
2.26	Title: Opportunistic Energy Sharing Between Power Grid and Electric Vehicles: A Game Theory-Based . . . . .	84
2.27	Title: Energy Efficiency Mandates Are Worse for Poor Americans Than Energy Taxes . . . . .	85
2.28	Title: Smart Operation of Four-Quadrant Electric Vehicle Chargers in Distribution Grids . . . . .	86
2.29	Title: A Second Order Cone Programming Model for Planning PEV Fast-Charging Stations . . . . .	87
2.30	Title: Robust Frequency Regulation Capacity Scheduling Algorithm for Electric Vehicles . . . . .	88
2.31	Title: Mitigation of the Impact of High Plug-in Electric Vehicle Penetration on Residential Distribution Grid Using Smart Charging Strategies . . . . .	89
2.32	Title: Modeling of Plug-in Electric Vehicle Travel Patterns and Charging Load Based on Trip Chain Generation . . . . .	90
2.33	Title: Optimal allocation for electric vehicle charging stations using Trip Success Ratio . . . . .	91

2.34	Title: Estimating the Benefits of Fuel Economy Information: An Analysis, Update and Recommendations for Enhancing ORNL’s Methodology . . . . .	92
2.35	Title: A Cost Efficiency Analysis for Private Vehicles: Determinants for Households’ Choices of Vehicles Using a Household-Level Commute Data Approach	93
2.36	Title: A New Model of Charging Demand Related to Plug-in Hybrid Electric Vehicles Aggregation . . . . .	94
2.37	Title: Optimal Scheduling of the Plug-in Electric Vehicles Aggregator Energy and Regulation Services Based on Grid to Vehicle . . . . .	95
2.38	Title: Performance Evaluation of Distribution Network in Presence of Plug-in Electric Vehicles through a New Index . . . . .	96
2.39	Title: Modelling Probabilistic Transmission Expansion Planning in the Presence of Plug-in Electric Vehicles Uncertainty by Multi-State Markov Model .	97
2.40	Title: Battery Aging Studies Based on Real-World Driving . . . . .	98
2.41	Title: Distributed Control of PEV Charging Based on Energy Demand Forecast	99
2.42	Title: Balanced Charging Strategies for Electric Vehicles on Power Systems .	100
2.43	Title: Robust Online Algorithms for Peak-Minimizing EV Charging under Multi-Stage Uncertainty . . . . .	101
2.44	Title: Analysis on the Operation of a Charging Station with Battery Energy Storage System . . . . .	102
2.45	Title: Analyzing The Impacts of Plug-in EVs on the California Power Grid using Quadratic Programming and Fixed-Point Iteration . . . . .	103
2.46	Title: Plug-in Hybrid Electric Vehicle Load Profile Estimation with Opportunity Charging . . . . .	104
2.47	Title: Trip Energy: Estimating Personal Vehicle Energy Consumption Given Limited Travel Survey Data . . . . .	105
2.48	Title: Modeling Framework and Results to Inform Charging Infrastructure Investments . . . . .	106
2.49	Title: Plug-in Fuel Cell Electric Vehicles: A California Case Study . . . . .	107
2.50	Title: Exploiting PHEV to Augment Power System Reliability . . . . .	108
2.51	Title: U.S. Light-duty Vehicle Air Conditioning Fuel Use and the Impact of Four Solar/Thermal Control Technologies . . . . .	109
2.52	Title: A Stochastic Game Approach for PEV Charging Station Operation in Smart Grid . . . . .	110
2.53	Title: Comparison of EV Smart Charging Strategies from Multiple Stakeholders’ Perception . . . . .	111
2.54	Title: Optimal Energy Management Scheme for Electric Vehicle Integration in Microgrid . . . . .	112
2.55	Title: National Plug-In Electric Vehicle Infrastructure Analysis . . . . .	113
2.56	Title: Analysis of Electric Vehicle Charging Impact on Grid Voltage Regulation	114
2.57	Title: Statistical Analysis And Modeling of Plug-In Electric Vehicle Charging Demand in Distribution Systems . . . . .	115
2.58	Title: A Novel Markov-based temporal- <i>SoC</i> Analysis for Characterizing PEV Charging Demand . . . . .	116
2.59	Title: Understanding the Heterogeneous Effects of Gasoline Taxes Across Income and Location . . . . .	117

2.60	Title: Cost-Effective and Ecofriendly Plug-In Hybrid Electric Vehicle Charging Management . . . . .	118
2.61	Title: Vehicle Activity Patterns and Electrification Potential . . . . .	119
2.62	Title: With and Without the Tracks: How Railroad Access Impacts Gas Price Elasticity . . . . .	120
2.63	Title: Modeling Electric Taxis' Charging Behavior Using Real-World Data . .	121
2.64	Title: Refueling and Infrastructure Costs of Expanding Access to E85 in Pennsylvania . . . . .	122
2.65	Title: Optimal Planning of Charging for Plug-In Electric Vehicles Focusing on Users' Benefits . . . . .	123
2.66	Title: Boosting the Adoption and the Reliability of Renewable Energy Sources: Mitigating the Large-Scale Wind Power Intermittency through Vehicle to Grid Technology . . . . .	124
2.67	Title: Toward a Sustainable Neighborhood: Examining the Impact of Mixed-use Development on Neighborhood Energy Consumption . . . . .	125
2.68	Title: Energy Scheduling of a Technical Virtual Power Plant in Presence of Electric Vehicles . . . . .	126
2.69	Title: Coordinated Charging Methods of Electric Vehicles . . . . .	127
2.70	Title: A Survey on PEV Charging Infrastructure: Impact Assessment and Planning . . . . .	128
2.71	Title: Study on the Impact of Electric Vehicle Charging Load on Nodal Voltage Deviation . . . . .	129
2.72	Title: Multi-Party Energy Management for Networks of PV-Assisted Charging Stations: A Game Theoretical Approach . . . . .	130
2.73	Title: Mileage Electrification Potential of Different Electric Vehicles in Germany	131
2.74	Title: A Model of Charging Service Demand for the Czech Republic . . . . .	132
2.75	Title: Simultaneous Inference of Partially Linear Error-in-Covariate Models: An Application to the U.S. Gasoline Demand . . . . .	133
2.76	Title: Powering the Driverless Electric Car of the Future . . . . .	134
2.77	Title: Multi-Area Self-Adaptive Pricing Control in Smart City With EV User Participation . . . . .	135
2.78	Title: Grid Load Contributions Through Electric Vehicles and Their Uncertainties	136
2.79	Title: Energy-saving Benefits from Plug-in Hybrid Electric Vehicles: Perspectives based on Real-World Measurements . . . . .	137
2.80	Title: Impact of Electric Vehicles on the Expansion Planning of Distribution Systems considering Renewable Energy, Storage and Charging Stations . . . .	138
2.81	Title: Multi-Objective Scheduling of Microgrids to Harvest Higher Photovoltaic Energy . . . . .	139
2.82	Title: Distributed Optimization Operation Strategy for Charging Stations Under Demand Response . . . . .	140
2.83	Title: Multi-level Charging Control Algorithm of Electric Vehicle in EVs-grid System . . . . .	141
2.84	Title: Strategic Scheduling of PEV Charging Load: A Non-cooperative Game Model . . . . .	142
2.85	Title: Innovative Appraisalment of Smart Grid Operation Considering Large-Scale Integration of Electric Vehicles Enabling V2G and G2V Systems . . . .	143

2.86	Title: Plug-in Electric Vehicle Batteries Degradation Modeling for Smart Grid Studies: Review, Assessment and Conceptual Framework . . . . .	144
2.87	Title: Socio-economic Implications of Large-scale Electric Vehicle Systems . . . . .	145
2.88	Title: Water-filling Algorithm Based Approach for Management of Responsive Residential Loads . . . . .	146
2.89	Title: A Novel Parallel-Series Hybrid Meta-Heuristic Method for Solving a Hybrid Unit Commitment Problem . . . . .	147
2.90	Title: Smart Grid adds to Renewable Resources Hosting Capacity: Collaboration of Plug-in Hybrid Electric Vehicles in Volt/VAr Control . . . . .	148
2.91	Title: Electric Vehicle Battery Cycle Aging Evaluation in Real-World Daily Driving and Vehicle-to-Grid Services . . . . .	149
2.92	Title: Occupant-behavior Driven Appliance Scheduling for Residential Buildings	150
2.93	Title: Rural Areas Will Be Late Adaptors to EV Surge, Study Says . . . . .	151
2.94	Title: Cost-Benefit Analysis of V2G Implementation in Distribution Networks Considering PEVs Battery Degradation . . . . .	152
2.95	Title: Vehicle Technologies and Fuel Cell Technologies Office Research and Development Programs: Prospective Benefits Assessment Report for Fiscal Year 2018 . . . . .	153
2.96	Title: Multi-objective Electric Vehicle Scheduling Considering Customer and System Objectives . . . . .	154
<b>3</b>	<b>Environment</b>	<b>155</b>
3.1	Title: Greenhouse Gas and Air Quality Effects of Auto First-last Mile use with Transit . . . . .	155
3.2	Title: Regional Sky Transit III: The Primacy of Noise . . . . .	156
3.3	Title: Comparison of Gasoline Direct-Injection (GDI) and Port Fuel Injection (PFI) Vehicle Emissions: Emission Certification Standards, Cold-Start, Secondary Organic Aerosol Formation Potential, and Potential Climate Impacts . . . . .	157
3.4	Title: Hitting the Sweet Spot: Variability in Commute Lengths And Vehicle Emissions across a Diverse State . . . . .	158
3.5	Title: More connected Urban Roads reduce US GHG Emissions . . . . .	159
3.6	Title: The Unsustainability of Exurban Development in London and New York: Calculating Transport CO <sub>2</sub> Emissions . . . . .	160
3.7	Title: Travel Demand Management Policy Instruments, Urban Spatial Characteristics, and Household Greenhouse Gas Emissions from Travel in the US Urban Areas . . . . .	161
3.8	Title: The Impact of Metropolitan, County, and Local Land Use on Driving Emissions in US Metropolitan Areas: Mediator Effects Of Vehicle Travel Characteristics. . . . .	162
3.9	Title: The Public Transport and Urban Pollution. . . . .	163
3.10	Title: Household Accessibility to Heat Refuges: Residential Air Conditioning, Public Cooled Space, and Walkability. . . . .	164
3.11	Title: The Analysis of CO <sub>2</sub> Emissions by Private Cars in Chinese cities and International Comparison . . . . .	165



3.12	Title: Comparing On-road Real-time Simultaneous In-cabin and Outdoor Particulate and Gaseous Concentrations for a Range of Ventilation Scenarios . . .	166
3.13	Title: The Revenue Implications of a Carbon Tax . . . . .	167
3.14	Title: Toward Probabilistic Prediction of Flash Flood Human Impacts . . . . .	168
3.15	Title: The Role of State Policies under Federal Light-Duty Vehicle Greenhouse Gas Emissions Standards . . . . .	169
3.16	Title: Comparing Greenhouse Gas Reductions and Legal Implementation Possibilities for Pay-to-Save Transportation Price-shifting Strategies and EPA's Clean Power Plan . . . . .	170
3.17	Title: Sustainability of Self-Driving Mobility: An Analysis of Carbon Emissions between Autonomous Vehicles and Conventional Modes of Transportation	171
3.18	Title: Empirical Fuel Consumption and CO <sub>2</sub> Emissions of Plug-in Hybrid Electric Vehicles . . . . .	172
<b>4</b>	<b>Health</b>	<b>173</b>
4.1	Title: Estimating the Effect of Mobility and Food Choice on Obesity in a Rural, Northern Environment . . . . .	173
4.2	Title: Exploring Parental Perceptions of a Walking-School-bus Initiative in Northern Ontario . . . . .	174
4.3	Title: Using Public Transportation Reduces Obesity and Makes People Healthier	175
4.4	Title: Are Buffers around Home representative of Physical Activity Spaces among Adults? . . . . .	176
4.5	Title: Analyzing the Impact of Public Transit Usage on Obesity . . . . .	177
4.6	Title: Interrelationships of physical activity in different domains: Evidence from the Geographic Research on Wellbeing (GROW) study . . . . .	178
4.7	Title: Automobile Dependence and Physical Inactivity: Insights from the California Household Travel Survey . . . . .	179
4.8	Title: Mass Transit Linked to Lower Obesity Rates in Study . . . . .	180
4.9	Title: "Transit makes you short": On Health Impact Assessment of Transportation and the Built Environment . . . . .	181
4.10	Title: Geographic Variation in Transportation Concerns and Adaptations to Travel-Limiting Health Conditions in the United States . . . . .	182
4.11	Title: CTASS: A Framework for Contextualized Travel Behavior Advice to Cardiac Patients . . . . .	183
4.12	Title: Collaboration between Physical Activity Researchers and Transport Planners: A Qualitative Study of Attitudes to Data Driven Approaches . . . . .	184
4.13	Title: Essays on the Economics of Risky Health Behaviors . . . . .	185
<b>5</b>	<b>Policy and Mobility</b>	<b>186</b>
5.1	Title: U.S. Transportation and Health Tool: Data for Action . . . . .	186
5.2	Title: Exploring the Relationship between Vehicle Type Choice and Distance Traveled: A latent segmentation approach . . . . .	187
5.3	Title: The Driving Downturn: A Preliminary Assessment . . . . .	188
5.4	Title: Beyond Traffic: Trends and Choices 2045 - A National Dialogue About Future Transportation Opportunities and Challenges . . . . .	189

5.5	Title: Parking for Residential Delivery in New York City: Regulations and Behavior . . . . .	190
5.6	Title: Integrating Health and Transportation in Nashville, Tennessee, USA: From Policy to Projects . . . . .	191
5.7	Title: A New Route to Increasing Economic Growth: Reducing Highway Congestion with Autonomous Vehicles . . . . .	192
5.8	Title: Going Nowhere Fast: Urban Mobility and Employment Outcomes . . .	193
5.9	Title: Linking the 2016 NHTS to Emerging Applications, Uses and Policy Making . . . . .	194
5.10	Title: Change And Innovation in the NHTS: How it all adds up - The MPO Perspective . . . . .	195
5.11	Title: From Gallons to Miles: A Disaggregate Analysis of Automobile Travel and Externality Taxes . . . . .	196
5.12	Title: Intermodal Mobility . . . . .	197
5.13	Title: Understanding Changes in Youth Mobility . . . . .	198
5.14	Title: Change in Vehicle Occupancy Used in Mobility Monitoring Efforts . .	199
5.15	Title: Car-Less or Car-Free? Socioeconomic and Mobility Differences among Zero-Car Households . . . . .	200
5.16	Title: Affordable Housing in Transit-Oriented Developments: Impacts on Driving and Policy Approaches . . . . .	201
5.17	Title: Carless in California: Green Choice or Misery? . . . . .	202
5.18	Title: Smart Transportation Systems . . . . .	203
5.19	Title: Potential Fleet Size of Private Autonomous Vehicles in Germany and the US . . . . .	204
5.20	Title: On Demand Mobility Commuter Aircraft Demand Estimation . . . . .	205
5.21	Title: Smart City as a Tool for Sustainable Mobility and Transport Decarbonisation . . . . .	206
5.22	Title: Transportation Cost Index: A Comprehensive Performance Measure for Transportation and Land Use Systems and its Application in OR, FL, and UT . . . . .	207
5.23	Title: Autonomous or Driver-less Vehicles: Implementation Strategies and Operational Concerns . . . . .	208
5.24	Title: Estimating the Presence of People in Buildings using Call Detail Records . . . . .	209
5.25	Title: Introducing Urban Transportation . . . . .	210
5.26	Title: Social Equity and Urban Transportation . . . . .	211
5.27	Title: Joint Evaluation of Transportation Revenue Generation and Infrastructure Investment Policies with Benefits Redistribution Considerations . . . . .	212
5.28	Title: Advancements, Prospects, and Impacts of Automated Driving Systems . . . . .	213
5.29	Title: Towards Urban Mobility-based Activity Knowledge Discovery: Interpreting Motion Trajectories . . . . .	214
5.30	Title: Transitioning to a Connected and Automated Vehicle Environment: Opportunities for Improving Transportation . . . . .	216
5.31	Title: Factors Influencing the Use of Autonomous and Shared Autonomous Vehicles in Alberta . . . . .	218
5.32	Title: Application of Vehicle Dynamics in Design and Development of an Autonomous Vehicle for EcoPRT . . . . .	219

5.33	Title: The Impact of Geography and Labor upon the Size of Job Agglomerations in Memphis, Tennessee . . . . .	220
5.34	Title: Smart City in a Box: A Strategic Playbook for Igniting Civic Innovation	221
5.35	Title: Environmental and Policy Implications of Vehicle Automation and Electrification . . . . .	222
5.36	Title: Mobility in History through the Lens of Transport . . . . .	224
5.37	Title: A Decomposition Algorithm to Solve the Multi-hop Peer-to-Peer Ride-Matching Problem . . . . .	225
5.38	Title: Shared Automated Vehicles: Review of Business Models . . . . .	226
<b>6</b>	<b>Special Population Group</b>	<b>227</b>
6.1	Title: An Analysis of the Time-of-Day Choices of the Elderly for Non Work Travel . . . . .	227
6.2	Title: The Multimodal Behavior of Millennials: Differences in Travel Choices between Young Adults and Gen Xers in California . . . . .	228
6.3	Title: Driving Self-Regulation and Ride Service Utilization in a Multicommunity, Multistate Sample of U.S. Older Adults . . . . .	229
6.4	Title: Ethnic Neighborhoods, Social Networks, and Inter-Household Carpooling: A Comparison Across Ethnic Minority Groups . . . . .	230
6.5	Title: Hidden Costs of Carpooling in Family Life: Travel Behavior of Hispanic Families with Children in the USA . . . . .	231
6.6	Title: Achieving Mobility Access for Older Adults Through Group Travel Instruction . . . . .	232
6.7	Title: Driving the Poor into Debt? Automobile Loans, Transport Disadvantage, and Automobile Dependence . . . . .	233
6.8	Title: The Impact of Employment Status on the Travel Behaviour of Millennials: Assessing the Potential for Promoting Sustainable Transportation in the Greater Toronto and Hamilton Area . . . . .	234
6.9	Title: Commuting Patterns of Immigrant workers in Indian Eateries: Focusing on Latino and Indian Immigrants . . . . .	235
6.10	Title: What Explains the Decline in Driving Among Young People? . . . . .	236
6.11	Title: Multimodal Millennials? The Four Traveler Types of Young People in the United States in 2009 . . . . .	237
6.12	Title: Humboldt Bay Trail Could Use Your Support . . . . .	238
6.13	Title: Gender Differences in the Commute to School and Work through Time and Space in the Greater Toronto and Hamilton Area, Canada . . . . .	239
6.14	Title: Declining Function in Older Adults: Influencing not only Community Mobility Options but also Wellbeing . . . . .	240
6.15	Title: Does Economic Vulnerability Moderate the Association between Transportation Mode and Social Activity Restrictions in Later Life? . . . . .	242
6.16	Title: Elderly's Travel Patterns and Trends: The Empirical Analysis of Beijing	243
6.17	Title: Transportation Barriers and Use of Dental Services among Medicaid-Insured Adults . . . . .	244
6.18	Title: Understanding Immigrants' Mode Choice Behavior in Florida: Analysis of Neighborhood Effects and Cultural Assimilation . . . . .	245
6.19	Title: Measuring and Improving Seniors' Access to Medical Facilities . . . . .	246

6.20	Title: Reducing Vehicle Travel for the Next Generation: Lessons from the 2001 and 2009 National Household Travel Surveys . . . . .	247
6.21	Title: What Affects Millennials' Mobility? PART II: The Impact of Residential Location, Individual Preferences and Lifestyles on Young Adults' Travel Behavior in California . . . . .	248
6.22	Title: Changing Travel Behavior of Asian Immigrants in the U.S. . . . .	249
6.23	Title: Travel Patterns and Characteristics of Low-Income Subpopulation in New York State. . . . .	250
6.24	Title: The Decline in Active School Transportation (AST): A Systematic Review of the Factors Related to AST and Changes in School Transport Over Time in North America. . . . .	251
6.25	Title: A Cross-Sectional Study of Travel Patterns of Older Adults in the USA During 2015: Implications For Mobility and Traffic Safety. . . . .	252
6.26	Title: Characteristics and Travel Patterns of New York Residents: Foreign Born Subpopulations in New York State. . . . .	253
6.27	Title: (Millennial) Cities of Tomorrow. . . . .	254
6.28	Title: Carless or Car Later? Declining Car Ownership of Millennial Households in the Puget Sound Region, Washington State. . . . .	255
6.29	Title: Urban Revival in America, 2000 to 2010. . . . .	256
6.30	Title: Tired of Commuting? Relationships among Journeys to School, Sleep, and Exercise among American Teenagers . . . . .	257
6.31	Title: Does Transport Accessibility Increase Travel in Older Age? Analyzing Travel For Discretionary and Non-Discretionary Purposes in Aging Canadians	258
6.32	Title: What drives Sustainable Student Travel? Mode Choice Determinants in the Greater Toronto Area . . . . .	259
6.33	Title: Transportation, Accessibility, and Accommodation in Rural Communities	260
6.34	Title: Coping with the Costs Of Car Dependency: A System Of Expedients Used By Low-Income Households On the Outskirts Of Dijon and Paris . . . .	261
6.35	Title: Uber for Seniors? Exploring Transportation Options for the Future . . .	262
6.36	Title: Formal Alternative Transportation Options for Older Adults: An Assessment of Need . . . . .	263
6.37	Title: Factors Influencing Travel Mode Choice among Families With Young Children (aged 0-4): A Review of the Literature . . . . .	264
6.38	Title: Students Social Based Mobility Model for MANET-DTN Networks . .	265
6.39	Title: The Rising Value of Time and the Origin of Urban Gentrification . . . .	266
6.40	Title: A Dynamic Field: Transportation for Older Adults Who Don't Drive . .	267
6.41	Title: How will Millennials Impact Freight Flows in Texas? . . . . .	268
6.42	Title: Would Congestion Pricing Harm the Poor? Do Free Roads Help the Poor?	269
<b>7</b>	<b>Survey, Data Synthesis, and Other Applications</b>	<b>270</b>
7.1	Title: Applying Geographic-Based Demographic Targeting in Household Travel Survey Sampling Plans: Case Study from the Phoenix, Arizona Region . . . .	270
7.2	Title: Measuring the Spatial Dimension of Automobile Ownership and Its Associations with Household Characteristics and Land Use Patterns: A Case Study in Three Counties, South Florida (USA) . . . . .	271

7.3	Title: Testing Spatial Transferability of Activity-Based Travel Forecasting Models . . . . .	272
7.4	Title: Regional Differences in the Determinants of Oregon VMT . . . . .	273
7.5	Title: A Practical Method to Test the Validity of the Standard Gumbel Distribution in Logit-Based Multinomial Choice Models of Human Travel Behavior . . . . .	274
7.6	Title: Long-Term Impacts of the Universal Helmet Law Changes on Motorcyclist Fatal Crashes: Comparison Group and Empirical Bayes Approaches . . . . .	275
7.7	Title: Incorporating Activity Space and Trip Chaining onto Facility Siting for Accessibility Maximization . . . . .	276
7.8	Title: A Walk Trip Generation Model for Portland, OR . . . . .	277
7.9	Title: Commute Mode Diversity and Public Health: A Multivariate Analysis of 148 U.S. Cities . . . . .	278
7.10	Title: A Microsimulation Model of Population Heat Exposure . . . . .	279
7.11	Title: Surveillance Systems to Track and Evaluate Obesity Prevention Efforts . . . . .	280
7.12	Title: A Generative Model of Urban Activities from Cellular Data . . . . .	281
7.13	Title: National Data Sets: How to Choose Them, How to Use Them . . . . .	282
7.14	Title: Demographic Factors, Workplace Factors and Active Transportation Use in the USA: A Secondary Analysis of 2009 NHTS Data . . . . .	283
7.15	Title: Examining Multimodal Transportation in the El Paso, Texas, Region: Regional Transportation Survey Results . . . . .	284
7.16	Title: The Drive to Work : The Relationship between Transportation Access, Housing Assistance, and Employment among Participants in the Welfare to Work Voucher Program . . . . .	285
7.17	Title: Two Perspectives on Commuting: A Comparison of Home to Work Flows Across Job-Linked Survey and Administrative Files . . . . .	286
7.18	Title: Day Pattern Generation System for Jointly Modeling Tours and Stops: Bi-Level Multiple Discrete Continuous Probit Model . . . . .	287
7.19	Title: Designing the All-in-One Vermont Transportation Survey . . . . .	288
7.20	Title: Simulation, Numerical Approximation and Closed Forms for Joint Discrete Continuous Models with an Application to Household Vehicle Ownership and Use . . . . .	289
7.21	Title: Use of Smartphone Panels for Viable and Cost-Effective GPS Data Collection for Small and Medium Planning Agencies . . . . .	290
7.22	Title: Federal Highway Administration Research and Technology Evaluation: National Household Travel Survey Program Final Report . . . . .	291
7.23	Title: Introduction of Car Sharing into Existing Car Fleets in Microscopic Travel Demand Modelling . . . . .	292
7.24	Title: Modeling Green Vehicle Adoption: An Integrated Approach for Policy Evaluation . . . . .	293
7.25	Title: Estimating Freeway Route Travel Time Reliability from Data on Component Links and Associated Cost Implications . . . . .	294
7.26	Title: A Natural Experiment to Measure the Consequences of a Binding Interest Rate Cap . . . . .	295
7.27	Title: The Interaction between Land Use and Transportation in the Era of Shared Autonomous Vehicles: A Simulation Model . . . . .	296
7.28	Title: Improving the Fit of Structural Models of Congestion . . . . .	297

7.29	Title: Integration of the National Long Distance Passenger Travel Demand Model with the Tennessee Statewide Model and Calibration to Big Data . . .	298
<b>8</b>	<b>Traffic Safety</b>	<b>299</b>
8.1	Title: Linking Transportation and Population Health to Reduce Racial and Ethnic Disparities in Transportation Injury: Implications for Practice and Policy .	299
8.2	Title: Review of Regulatory Emphasis on Transportation Safety in the United States, 2002-2009: Public versus Private Modes . . . . .	300
8.3	Title: Safer or Cheaper? Traffic Safety, Vehicle Choices and the Effect of New Corporate Average Fuel Economy Standards . . . . .	301
8.4	Title: Advertising Spending and Media Bias: Evidence from News Coverage of Car Safety Recalls . . . . .	302
8.5	Title: Life-threatening Motor Vehicle Crashes in Bright Sunlight . . . . .	303
8.6	Title: Spatial Investigation of Aging-involved Crashes: A GIS-based Case Study in Northwest Florida . . . . .	304
8.7	Title: A New Spatial and Flexible Multivariate Random-Coefficients Model for the Analysis of Pedestrian Injury Counts by Severity Level . . . . .	305
8.8	Title: Texting and Driving: A Look at Self-Control, Social Learning Theory, Knowledge, and Adherence to the Law among Young Drivers . . . . .	306
8.9	Title: Crash Analysis and Road User Survey to Identify Issues and Countermeasures for Older Drivers in Kansas . . . . .	307
8.10	Title: The Effect of Passengers on Driver-Injury Severities in Single-Vehicle Crashes: A Random Parameters Heterogeneity-in-means Approach . . . . .	308
8.11	Title: Assessing Route Choice to Mitigate Older Driver Risk . . . . .	309
8.12	Title: Epidemiology of Injuries Sustained by Rear-Seat Passengers in Frontal Motor Vehicle Crashes . . . . .	310
8.13	Title: Comparison of US Metropolitan Region Pedestrian and Bicyclist Fatality Rates . . . . .	311
8.14	Title: Understanding the Role of Driver, Vehicle, Environment, and Policy Factors in Crash Injury Severity among Older Adults in the United States . . .	312
8.15	Title: Guidance to Support Vulnerable Road Users in the State of Alabama . .	313
8.16	Title: An On-Road Evaluation of the Impact of Explicit and Implicit Cognitive Training Protocols on Safety-Related Senior Driver Behaviors . . . . .	314
8.17	Title: Modeling Bicycle-Vehicle Crash Frequency on Urban Roads . . . . .	315
8.18	Title: Study suggests Investment pays off in Safety for Walkers, Bikers . . . .	316
8.19	Title: Driving in Search of Analyses . . . . .	317
8.20	Title: Characteristics of Single Vehicle Crashes with a Teen Driver in South Carolina, 2005 - 2008 . . . . .	318
8.21	Title: Risk-Exposure Density and Mileage Bias in Crash Risk for Older Drivers	320
8.22	Title: A Validation of the Low Mileage Bias Using Naturalistic Driving Study Data . . . . .	321
8.23	Title: Estimated Total Costs from Non-Fatal and Fatal Bicycle Crashes in the USA: 1997-2013 . . . . .	322
8.24	Title: Teens' Distracted Driving Behavior: Prevalence and Predictor . . . . .	323
8.25	Title: Climate Change, Weather and Road Deaths . . . . .	324

8.26	Title: Demographic Variation in the Injury Patterns of Adult Cyclists Admitted to a Large US Healthcare Network: A Five-Year Review . . . . .	325
8.27	Title: Social Inequalities in Child Pedestrian Traffic Injuries: Differences in Neighborhood Built Environments Near Schools in Austin, TX, USA . . . . .	326
8.28	Title: Risk Analysis of Autonomous Vehicles in Mixed Traffic Streams . . . . .	327
8.29	Title: Understanding International Road Safety Disparities: Why is Australia so much Safer than the United States? . . . . .	328
8.30	Title: Graduated Driver Licensing (GDL) in the United States in 2016: A Literature Review and Commentary . . . . .	329
8.31	Title: Development of Curriculum for the Virginia Driver’s Licensing Ceremony	330
8.32	Title: Statewide Analysis of Bicycle Crashes . . . . .	331
8.33	Title: Drivers’ Attitudes and Behaviors Toward Bicyclists: Intermodal Interactions and Implications for Road Safety . . . . .	332
8.34	Title: Crowdsourcing Data-driven Development of Bicycle Safety Performance Functions (SPFs): Microscopic and Macroscopic Scales . . . . .	333
<b>9</b>	<b>Transit Planning</b>	<b>334</b>
9.1	Title: Transit Corridor Livability: Realizing the Potential of Transportation and Land Use Integration . . . . .	334
9.2	Title: Risk and Resilience Analysis for Highway Assets . . . . .	335
9.3	Title: Modeling Vehicle Miles Traveled on Local Roads Using Classification Roadway Spatial Structure . . . . .	336
9.4	Title: Development of an Accessibility Formulation to Measure Customers’ Evaluations of Demand-Responsive Transit (DRT) Systems: Final Report . . . . .	337
9.5	Title: Doors Opening: An Analysis of Equity and Accessibility on Public Transportation Services in The United States . . . . .	338
9.6	Title: Transportation Inclusion and Community Wellbeing: Exploring Public Transit Accessibility of Winnipeg’s North End Neighbourhoods . . . . .	340
9.7	Title: Why Tiny Electric Planes and \$25 Tickets could be the Future of Regional Air Travel . . . . .	341
9.8	Title: Riding Transit Takes Almost Twice as Long as Driving . . . . .	342
9.9	Title: Uber’s Mildly Helpful Data Tool Could Help Cities Fix Streets . . . . .	343
9.10	Title: CatCharger: Deploying Wireless Charging Lanes in a Metropolitan Road Network through Categorization and Clustering of Vehicle Traffic . . . . .	344
9.11	Title: 18 Equity Analysis of California High-Speed Rail . . . . .	345
9.12	Title: Transit System Design and Vulnerability of Riders to Heat . . . . .	346
9.13	Title: Benchmarking a Transit System on Time-Constrained Trip Chain Access: A Comparative GIS Analysis of Two University Towns . . . . .	347
9.14	Title: First Mile-Last Mile, Intermodalism, and Making Public Transit More Attractive . . . . .	348
9.15	Title: Effects of Additional Capacity on Vehicle Kilometers of Travel in the U.S.: Evidence from National Household Travel Surveys . . . . .	349
9.16	Title: The CTPP Workplace Data for Transportation Planning: A Systematic Review . . . . .	350
9.17	Title: Utilizing Student Schedule Data to Develop Travel Matrices for Transit and Pedestrian Travel Demand Models . . . . .	351

9.18	Title: Conceptual Models of the Effect of Information and Communications Technology on Long-Distance Travel Demand . . . . .	352
9.19	Title: High-Speed Rail and Sustainability . . . . .	353
9.20	Title: Rail-transit-induced Gentrification and the Affordability Paradox of TOD	354
9.21	Title: How Does Transportation Affordability Vary Among TODs, TADs, and Other Areas? . . . . .	355
9.22	Title: Improving Last-Mile Connections to Transit: An Exploration of Data and Analysis Tools . . . . .	356
9.23	Title: Attitudinal Variables Influencing Transit Ridership: Measuring the Impact of Express Bus Service in Kingston, Ontario . . . . .	357
<b>10</b>	<b>Travel Behavior</b>	<b>358</b>
10.1	Title: Travel and the Built Environment: Insights Using Activity Densities, the Sprawl Index, and Neighborhood Type . . . . .	358
10.2	Title: Influence of Personal Concerns About Travel on Travel Behavior . . .	359
10.3	Title: Impacts of standardizing school start time on children and household workers - An examination with NHTS data . . . . .	360
10.4	Title: Neighborhood Density and Travel Mode: New Survey Findings for High Densities . . . . .	361
10.5	Title: School Transportation Mode, by Distance between Home and School, United States, Consumer Styles 2012 . . . . .	362
10.6	Title: Exploring the Influence of Built Environment on Travel Mode Choice Considering the Mediating Effects of Car Ownership and Travel Distance . .	363
10.7	Title: Active Travel Behavior in a Border Region of Texas and New Mexico: Motivators, Deterrents and Characteristics . . . . .	364
10.8	Title: Synergistic Neighborhood Relationships with Travel Behavior: An Analysis of Travel in 30,000 US Neighborhoods . . . . .	365
10.9	Title: The Role of Destination's Built Environment on Nonmotorized Travel Behavior: A Case of Long Beach, California . . . . .	366
10.10	Title: Determinants of Route Choice Behavior: A Comparison of Shop versus Work Trips using the Potential Path Area - Gateway (PPAG) algorithm and Path-Size Logit . . . . .	367
10.11	Title: Modeling the Choice of Time-of-day for Joint Social-Recreational Activities . . . . .	368
10.12	Title: A Largely Unnoticed Impact on Real Estate - Self-Driven Vehicles . . .	369
10.13	Title: Improving Trip Generation Methods for Livable Communities . . . . .	370
10.14	Title: Tour Complexity, Variability and Pattern using Longitudinal GPS Data .	371
10.15	Title: Zipf's Power Law in Activity Schedules and the Effect of Aggregation .	372
10.16	Title: Investigating the impacts of Built Environment on Vehicle Miles Traveled and Energy Consumption: Differences between Commuting and Non-Commuting Trips . . . . .	373
10.17	Title: Commuting in America; Developing a National Report from National Survey Sources . . . . .	374
10.18	Title: Investigating the Influence of Trip Distance on Travel Behaviour of Non-Motorized Transport (NMT) Users . . . . .	376



10.19	Title: Estimating Motorized Travel Mode Choice using Classifiers: An Application for High-Dimensional Multicollinear Data . . . . .	377
10.20	Title: Tracking a System of Shared Autonomous Vehicles across the Austin, Texas Network using Agent-Based Simulation 2 . . . . .	378
10.21	Title: Developing a Data Transferability Framework for Evaluating National-level Impacts of Connected Automated Vehicles . . . . .	379
10.22	Title: Understanding Travel Behavior: How Good Are Our Data Sources for Addressing Travel Behavior Information Needs? . . . . .	380
10.23	Title: Statewide Tourism Travel Demand Forecasting: A Behavior-Based Modeling Framework for the State of Florida . . . . .	381
10.24	Title: Tour-Based Mode Choice Study Through Support Vector Machine Classifiers . . . . .	382
10.25	Title: Unraveling the Effects of Land Use Planning and Energy Policy on Travel Behavior . . . . .	383
10.26	Title: Addressing the Joint Occurrence of Self-Selection and Simultaneity Biases in the Estimation of Program Effects Based on Cross-Sectional Observational Surveys: Case Study of Travel Behavior Effects in Carsharing . . . . .	385
10.27	Title: Do Young Children Affect Travel Behavior for Parents in Atlanta? . . . . .	386
10.28	Title: Why You Go Reveals Who You Know: Disclosing Social Relationship by Cooccurrence . . . . .	387
10.29	Title: Potentials of Using Social Media to Infer the Longitudinal Travel Behavior: A Sequential Model-Based Clustering Method . . . . .	388
10.30	Title: Telecommuting and Its Impact on Activity - Time Use Patterns of Dual-Earner Households . . . . .	389
10.31	Title: Analysis of the Effects of Connected-Automated Vehicle Technologies on Travel Demand . . . . .	390
10.32	Title: Evaluation of Ridesharing Impacts using an Integrated Transport Land-use Model: A Case Study for the Paris Region . . . . .	391
10.33	Title: The Impact of Demographic Shifts on Automobile Travel in the United States: Three Empirical Essays . . . . .	392
10.34	Title: Potential of Converting Short Car Trips to Active Trips: the Role of the Built Environment in Tour-Based Travel . . . . .	393
10.35	Title: Investigating the Use of Anonymous Cellular Data for Intercity Travel Patterns in Alberta . . . . .	394
10.36	Title: A Comparison of Domestic Passenger Demand for Intercity Travel by Rail and Air in the United States: The Rail Station a Case Study . . . . .	396
10.37	Title: Transportation Sustainability in the Urban Context: A Comprehensive Review . . . . .	397
10.38	Title: Structural Analysis on Activity-travel Patterns, Travel Demand, Socio-demographics, and Urban Form: Evidence from Cleveland Metropolitan Area . . . . .	398
10.39	Title: Impacts of Telecommuting on Nonmandatory Activity Participation: Role of Endogeneity . . . . .	400
10.40	Title: Land Use, Travel Behavior, and Disaggregate Travel Data . . . . .	401
10.41	Title: Development of a Neighborhood Commute Mode Share Model using Nationally-Available Data . . . . .	402
10.42	Title: Intertemporal Substitution and the Value of Leisure Time . . . . .	403

10.43	Title: Latent Class Analysis of Residential and Work Location Choices . . . . .	404
10.44	Title: Development and Application of Advanced Econometric Models for Exploring Activity-Travel Behavior . . . . .	405
10.45	Title: The Interactions Between Online Shopping and Personal Activity Travel Behavior: An Analysis with a GPS-Based Activity Travel Diary. . . . .	406
<b>11</b>	<b>Trend Analysis and Market Segmentation</b>	<b>407</b>
11.1	Title: SmartTrips Ithaca: Encouraging Sustainable Transportation Options Through a Personalized Educational Campaign . . . . .	407
11.2	Title: A Time-Dependent Stated Preference Approach to Measuring Vehicle Type Preferences and Market Elasticity of Conventional and Green Vehicles .	408
11.3	Title: Stochastic Programming Approach for Electric Vehicle Charging Network Design . . . . .	409
11.4	Title: Electricity Costs for a Level 3 Electric Vehicle Fueling Station Integrated with a Building . . . . .	410
11.5	Title: Essays on Regulation and its Impact on Industry and Taxation: Studies on Cafe Standards . . . . .	411
11.6	Title: CVaR-Constrained Optimal Bidding of Electric Vehicle Aggregators in Day-ahead and Real-time Markets . . . . .	412
11.7	Title: An Optimal Integrated Planning Method for Supporting Growing Penetration of Electric Vehicles in Distribution Systems . . . . .	413
11.8	Title: Effectiveness Evaluation for a Commercialized PV-Assisted Charging Station . . . . .	414
11.9	Title: Deployment and Utilization of Plug-in Electric Vehicles in Round-trip Carsharing Systems . . . . .	415
11.10	Title: Adequacy Assessment of Power Distribution Network with Large Fleets of PHEVs considering Condition-Dependent Transformer Faults . . . . .	416
11.11	Title: Economic Analysis of Different Electric Vehicle Charging Scenarios . .	417
11.12	Title: Innovative Transit Financing: Is the New Markets Tax Credit a Viable Financing Mechanism for Transit Projects? . . . . .	418
11.13	Title: Relationships between the Online and In-store Shopping Frequency of Davis, California Residents . . . . .	419
11.14	Title: Customer Data Driven PHEV Refuel Distance Modeling and Estimation	420
11.15	Title: Cash for Corollas: When Stimulus Reduces Spending. . . . .	421
11.16	Title: Nonparametric Estimation of a Nonseparable Demand Function under the Slutsky Inequality Restriction. . . . .	422
11.17	Title: Identifying Odometer Fraud In Used Car Market Data. . . . .	423
11.18	Title: Consumer Inattention and Demand for Energy Cost Savings . . . . .	424
11.19	Title: Incorporating Online Shopping into Travel Demand Modelling: Challenges, Progress, and Opportunities . . . . .	425
11.20	Title: Reliability-Based Design Optimization (RBDO) for Electric Vehicle Market Systems . . . . .	426
11.21	Title: Long-term Trends in Domestic US Passenger Travel: The Past 110 Years and the Next 90 . . . . .	427
11.22	Title: Comparative Analysis of Cast-in-place Post-tensioned and Steel-concrete Composite Bridge Bent Caps . . . . .	428

11.23	Title: Implications of Consumer Lifestyle Changes and Behavioral Heterogeneity on U.S. Energy Consumption and Policy . . . . .	429
11.24	Title: How Much Do Consumers Value Fuel Economy and Performance? . . . .	430
11.25	Title: Economical Staging Plan for Implementing Electric Vehicle Charging Stations . . . . .	431
11.26	Title: How does On-road Fuel Economy vary with Vehicle Cumulative Mileage and Daily Use? . . . . .	432
11.27	Title: Optimal Temporal-Spatial PEV Charging Scheduling in Active Power Distribution Networks . . . . .	433
11.28	Title: Optimal Scheduling of Unbalanced Distribution Networks to Improve the Contribution of Renewables and Network Balancing Performance . . . . .	434
11.29	Title: The Economic Impact of Electric Vehicle Routing and Charging Strategy on Traffic-Power Integrated Networks . . . . .	435
11.30	Title: Enabling Fast Charging - Infrastructure and Economic Considerations . .	436
11.31	Title: Adoption of Electric Vehicles in Commercial Fleets: Why do Car Pool Managers Campaign for BEV Procurement? . . . . .	437
11.32	Title: Design of Optimal Incentives for Smart Charging Considering Utility-Customer Interactions and Distribution Systems Impact . . . . .	438
11.33	Title: Optimal Electric Vehicle Scheduling: A Co-Optimized System and Customer Perspective . . . . .	439
11.34	Title: A Local Energy Market for Electricity and Hydrogen . . . . .	440
11.35	Title: Coordination of PEV Charging Across Multiple Stations in Distribution Networks using Aggregate PEV Charging Load Model . . . . .	441

## 1. Bicycle and Pedestrian Studies

### 1.1. Title: Estimating Pedestrian Exposure for Small Urban and Rural Areas

**Authors:** Jamali, A. and Wang, Y.

**Abstract:** Pedestrian exposure refers to a pedestrian's contact with vehicular traffic that can create opportunities for collisions. A myriad of metrics exist to estimate pedestrian exposure, but no consensus has been reached on what metrics should be adopted. Hence, this study attempted to synthesize previous studies and offer best practices for estimating pedestrian exposure (with a focus for rural and small urban areas). Four general types of exposure metrics emerged from area-based measures (e.g., zonal walk miles traveled), through more granular metrics at the point or segment level, to advanced metrics that utilize the behavioral attributes of walk trips (e.g., space-time prism and discrete choice). In addition, the study utilized home-based walk-only trips from nine states in the National Household Travel Survey (NHTS) (2009) data to estimate a household-level pedestrian exposure measure for rural and small urban settings. The model accounted for household characteristics (e.g., income and vehicle ownership), regional factor, and block-group-level attributes (e.g., population density and school density), with an overall goodness-of-fit of 0.41. The results can be used to infer number of walk trips at as small as the block group level or be inserted into four-step travel demand model to create point or segment-based measures where pedestrian network is defined.

**Subject Areas:** Pedestrian safety; Pedestrians and Bicyclists; Rural areas; Small cities; Operations and Traffic Management; Planning and Forecasting

**Availability:** Jamali, A. and Wang, Y., 2017. *Estimating Pedestrian Exposure for Small Urban and Rural Areas*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-06576).

<https://trid.trb.org/view.aspx?id=1439632>

## **1.2. Title: The Reach of Bicycling in Rural, Small, and Low-Density Places**

**Authors:** McAndrews, C., Okuyama, K. and Litt, J.S.

**Abstract:** Lessons derived from the urban experience of bicycling may not be broadly supportive of bicycling in what is called rural, small, and low-density (RSLD) places because of differences in built environment, social, and political contexts. In this study the authors investigated the hypothesis that bicycling is primarily an urban activity. The authors used binary logistic regression to compare the frequency of bicycling and the population characteristics of bicyclists across urban and RSLD places. The authors used multiple operational definitions of urban-rural continua to examine whether the results are sensitive to how RSLD places are defined. The data for bicycling are from the 2009 National Household Travel Survey (NHTS), which was designed to represent the population of the U.S. The authors found that bicycling is primarily-but not exclusively-an urban activity. Moreover, women and youth were more likely to bicycle in RSLD places compared to urban places. These findings suggest that an urban perspective on bicycling could limit the success of initiatives aiming to increase the diversity of populations that bicycle. Developing a base of empirical knowledge of bicycling in RSLD places is a necessary step toward developing more inclusive and effective multimodal transportation strategies.

**Subject Areas:** Pedestrians and Bicyclists; Planning and Forecasting; Bicycling; Built environment; Logistic regression analysis

**Availability:** McAndrews, C., Okuyama, K. and Litt, J.S., 2017. *The Reach of Bicycling in Rural, Small, and Low-Density Places*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-00697).

[http://careymcandrews.org/pdf/McAndrews\\_et\\_al\\_2017\\_TRR.pdf](http://careymcandrews.org/pdf/McAndrews_et_al_2017_TRR.pdf)

### **1.3. Title: Differences in Behavior, Time, Location, and Built Environment Between Objectively Measured Utilitarian and Recreational Walking**

**Authors:** Kang, B., Moudon, A.V., Hurvitz, P.M. and Saelens, B.E.

**Abstract:** Objectives: Utilitarian and recreational walking both contribute to physical activity. Yet walking for these two purposes may be different behaviors. We sought to provide operational definitions of utilitarian and recreational walking and to objectively measure their behavioral, spatial, and temporal differences in order to inform transportation and public health policies and interventions.

Methods: Data were collected 2008-2009 from 651 Seattle-King County residents, wearing an accelerometer and a GPS unit, and filling-in a travel diary for 7 days. Walking activity bouts were classified as utilitarian or recreational based on whether walking had a destination or not. Differences between the two walking purposes were analyzed, adjusting for the nested structure of walking activity within participants.

Results: Of the 4905 observed walking bouts, 87.4% were utilitarian and 12.6% recreational walking. Utilitarian walking bouts were 45% shorter in duration (-12.1 min) and 9% faster in speed (+0.3 km/h) than recreational walking bouts. Recreational walking occurred more frequently in the home neighborhood and was not associated with recreational land uses. Utilitarian walking occurred in areas having higher residential, employment, and street density, lower residential property value, higher area percentage of mixed-use neighborhood destinations, lower percentage of parks/trails, and lower average topographic slope than recreational walking.

Conclusion: Utilitarian and recreational walking are substantially different in terms of frequency, speed, duration, location, and related built environment. Policies that promote walking should adopt type-specific strategies. The high occurrence of recreational walking near home highlights the importance of the home neighborhood for this activity.

**Subject Areas:** GPS; Accelerometer; Home and non-home based walking; Pedestrian; Active transportation

**Availability:** Kang, B., Moudon, A.V., Hurvitz, P.M. and Saelens, B.E., 2017. *Differences in Behavior, Time, Location, and Built Environment Between Objectively Measured Utilitarian and Recreational Walking*. Transportation Research Part D: Transport and Environment, 57, pp.185-194.

<http://www.sciencedirect.com/science/article/pii/S1361920915301826>

#### **1.4. Title: Using Machine Learning Techniques to Estimate Non-motorized Trips for Rural Roadways**

**Authors:** Das, S., Dixon, K., Avelar, R.E. and Fitzpatrick, K.

**Abstract:** Non-motorized travel modes such as bicycling and walking are considered the green modes of traveling because of their environmental, ecological, and sustainability advantages. In recent years, the transportation profession has given increasing attention to the suitability of the roadway infrastructure for these non-motorized users. For rural roadways, the question of how many people actually use or will use non-motorized trips is a key concern. Developing a corridor for rural roadways that specifically addresses bicycle and pedestrian needs can be beneficial to both planners and users by optimizing available resources. To prioritize the selection of potential shoulder widening locations for safer non-motorized trip, there is a need to determine the number of predicted non-motorized trips per week. This study used National Household Travel Survey (NHTS) data to estimate non-motorized trips on rural roadways (two-lane and multi-lane) by applying a machine-learning tool support vector regression (SVR). Findings of this study will help the authority to logically rank the locations with more of these trips higher than locations without the prospect of any bicycle or pedestrian activity.

**Subject Areas:** Data and Information Technology; Highways; Pedestrians and Bicyclists; Planning and Forecasting

**Availability:** Das, S., Dixon, K., Avelar, R.E. and Fitzpatrick, K., 2017. *Using Machine Learning Techniques to Estimate Non-motorized Trips for Rural Roadways*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-03870).

<https://trid.trb.org/view.aspx?id=1438537>

**1.5. Title: Trends in Walking and Cycling Safety: Recent Evidence From High-Income Countries, with a Focus on the United States and Germany**

**Authors:** Buehler, R. and Pucher, J.

**Abstract:**

Objectives: To examine changes in pedestrian and cyclist fatalities per capita (1990-2014) and per kilometer (2000-2010) in selected high-income countries, and in fatalities and serious injuries per kilometer by age in the United States and Germany (2001-2009).

Methods: We used Organisation for Economic Cooperation and Development data to estimate 5-year annual averages of per-capita fatalities relative to the 1990-1994 average. To control for exposure, we divided fatalities and serious injuries by kilometers of walking or cycling per year for countries with comparable data from national household travel surveys.

Results: Most countries have reduced pedestrian and cyclist fatality rates per capita and per kilometer. The serious injuries data show smaller declines or even increases in rates per kilometer. There are large differences by age group in fatality and serious injury rates per kilometer, with seniors having the highest rates. The United States has much higher fatality and serious injury rates per kilometer than the other countries examined, and has made the least progress in reducing per-capita fatality rates.

Conclusions: The United States must greatly improve walking and cycling conditions. All countries should focus safety programs on seniors and children.

**Subject Areas:** Fatalities; Pedestrians and Bicyclists; Planning and Forecasting

**Availability:** Buehler, R. and Pucher, J., 2017. *Trends in Walking and Cycling Safety: Recent Evidence From High-Income Countries, with a Focus on the United States and Germany*. American Journal of Public Health, (0), pp.e1-e7.

<http://ajph.aphapublications.org/doi/full/10.2105/AJPH.2016.303546>



## 1.6. Title: Perceived Barriers to Bicycling in an Urban U.S. Environment

**Authors:** Fowler, S.L., Berrigan, D. and Pollack, K.M.

**Abstract:** Prior research has identified several barriers influencing decisions to bicycle, including infrastructure, safety, and environmental factors. There is scant research exploring how sex and ridership status correlate with perceived barriers, which is a known barrier to being physically active. A total of 1334 Baltimore City residents aged 18 to 75 participated in an online survey (February-March 2014) assessing the major barriers to bicycling in the city. Differences by sex and ridership status were examined independently and interactively. Most respondents were women (60%) and not regular riders (66%). Safety due to traffic was the biggest barrier for non-riding women (77%) and non-riding men (54%). Weather was the biggest barrier for riding women (55%) and riding men (51%), followed by safety due to drivers (45% and 33%, respectively). Sex and ridership differences were also found for barriers regarding preference and logistics of transport. For example, riders had lower odds than non-riders of rating biking as less comfortable than driving as a major barrier, OR=0.39,  $p<0.01$ . Furthermore, women had greater odds than men of rating it is difficult to carry things on a bike as a major barrier, OR=1.65,  $p<0.01$ . Interactions between sex and ridership status revealed that riding women had lower odds than riding men of rating a) needing others to travel, OR=0.32 and b) hygiene, OR=0.41, as major barriers,  $p$ 's $<0.05$ . We discuss these findings in the broader context of the literature, and offer strategies for addressing specific barriers to bicycling.

**Subject Areas:** Physical activity; Active transportation; Built environment; Ridership; Sex differences

**Availability:** Fowler, S.L., Berrigan, D. and Pollack, K.M., 2017. *Perceived Barriers to Bicycling in an Urban U.S. Environment*. Journal of Transport & Health.

<http://www.sciencedirect.com/science/article/pii/S2214140517301263>

## **1.7. Title: Impact of Built Environment and Temporal Factors on Public Bike-Sharing**

**Authors:** Sun, F. and Chen, P.

**Abstract:** As bicycling regaining popularity in U.S. cities, Seattle has implemented its own public bike-share system, Pronto, in October 13rd, 2014. After one-year operation, while the system is popularly used, it faces the challenge of bike unavailability and dock shortage at various stations. To deal with the problem, this paper seeks to understand the generation of public bike usage. Through compiling various sources of spatial and temporal data sets and linking them to the recent published Pronto bike trip data, this paper comprehensively investigates the effects of land use, transport infrastructure, demographics, weather, and events on hourly public bicycle pickups and returns at each docking station. To address temporal autocorrelation in the data, the paper implements a generalized linear mixed model by considering the joint effects of time metric and time-varying variables. Besides, the model also includes a spatial weight matrix and a location dummy variable to account for different levels of spatial autocorrelations. The paper estimates models on both the total counts and counts by gender groups. Results both confirm findings in previous studies and provide new insights. In particular, transport infrastructure, office land use, and employment density are found to have positive correlations with bicycle counts. Transit station density is found to have a substitutional effect with public bike system. Weather and time events are also correlated with bicycle counts. Moreover, the spatial and temporal effects vary between male and female customers. In conclusion, the paper also discusses the limitation of the modeling approach and future research directions.

**Subject Areas:** Bi-cycle; Bike-share System; Temporal autocorrelation

**Availability:** Sun, F. and Chen, P., 2017. *Impact of Built Environment and Temporal Factors on Public Bike-Sharing*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-05281).

<http://docs.trb.org/prp/17-05281.pdf>

### **1.8. Title: Leading Pedestrian Interval Implementation as a Marginal Costs and Benefits Problem**

**Authors:** Sharma, A., Smaglik, E., Kothuri, S., Smith, O., Koonce, P. and Huang, T.

**Abstract:** To improve the safety of people walking at particular signalized intersections, traffic signal engineers may implement leading pedestrian intervals (LPI) to provide pedestrians with a walk signal for a few seconds prior to the parallel vehicular green indication. Previous research using before-after studies and simple economic analyses shows that LPIs are low cost tools that can reduce vehicle-pedestrian conflicts and crashes at some signalized intersections. Despite this evidence, there is little guidance for municipalities on when to implement LPIs. This paper develops a marginal costs and benefits framework using quantitative metrics, extending the concept of traffic conflicts and marginal safety-delay tradeoffs to analyze the appropriateness of implementing an LPI at specific signalized intersections. The guidance provided by this method helps quantify the probability of a conflict happening, and provides direction on whether or not to implement an LPI at a given location based upon macroscopic level inputs, including turning movement counts, crash data, and geometry. A case study with sample data indicates that an LPI is cost effective for the scenario presented.

**Subject Areas:** Pedestrian; Safety; Leading Pedestrian Interval (LPI)

**Availability:** Sharma, A., Smaglik, E., Kothuri, S., Smith, O., Koonce, P. and Huang, T., 2017. *Leading Pedestrian Interval Implementation as a Marginal Costs and Benefits Problem*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-05116).  
<http://docs.trb.org/prp/17-05116.pdf>

### **1.9. Title: Hail a Cab or Ride a Bike? A Travel Time Comparison of Taxi and Bicycle-sharing systems in New York City**

**Authors:** Faghih-Imani, A., Anowar, S., Miller, E.J. and Eluru, N.

**Abstract:** In this paper, we examine the hypothesis that bicycles can compete with cars in terms of travel time in dense urban areas. We conduct a detailed investigation of the differences in observed travel times by taxi and a bicycle-sharing system (BSS) in New York City in 2014. The taxi trips with origins and destinations in proximity to BSS stations are identified and compared to BSS trips from the same origin and destinations. The travel time comparison is conducted along following dimensions: (a) all trips, (b) temporal dimension including different time periods of the day, weekday versus weekend, and seasonal variation, and (c) distance categories. It is found that during weekdays' AM, Midday and PM time periods for more than half of OD pairs with distance less than 3 km, BSS is either faster or competitive with taxi mode. To further shed light on the travel time comparison, we develop a multivariate analysis using a random utility framework in the form of a panel mixed multinomial logit model. Identifying and understanding the factors that influence the travel time differences can help planners to enhance the BSS service offerings. The provision of information to bicycling-inclined individuals on the “faster” alternative could be used as a marketing tool to attract higher usage for BSS within dense urban cores. The comparison of BSS and taxi can also shed light on the competition between bicycle and car modes in general in dense urban areas.

**Subject Areas:** Bicycle sharing systems; CitiBike New York; Taxi; Travel time; Panel mixed multinomial logit model

**Availability:** Faghih-Imani, A., Anowar, S., Miller, E.J. and Eluru, N., 2017. *Hail a Cab or Ride a Bike? A Travel Time Comparison of Taxi and Bicycle-sharing systems in New York City*. *Transportation Research Part A: Policy and Practice*, 101, pp.11-21.

<http://www.sciencedirect.com/science/article/pii/S0965856416306978>

### **1.10. Title: Making Every Mode Count in Washington State**

**Author:** Nordback, K.

**Abstract:** A NITC report by Krista Nordback of Portland State University offers a step toward establishing a performance metric by which statewide progress with respect to bicycling and walking can be evaluated. The Washington State Pedestrian and Bicycle Miles Traveled Project discusses the relative merits of three different methods which can be used to compute bicycle miles traveled (BMT) and pedestrian miles traveled (PMT).

**Subject Areas:** Commuting; Cycling; Pedestrians; Automatic data collection systems; Transportation

**Availability:** Nordback, K., 2017. *Making Every Mode Count in Washington State*. NITC Project Brief. Project Number 2015-708. Portland, OR: Transportation Research and Education Center (TREC)

[http://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1040&context=trec\\_briefs](http://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1040&context=trec_briefs)

**1.11. Title: Exploring the Impact of Walk-bike Infrastructure, Safety Perception, and Built-Environment on Active Transportation Mode Choice: A Random Parameter Model using New York City Commuter Data**

**Authors:** Aziz, H.A., Nagle, N.N., Morton, A.M., Hilliard, M.R., White, D.A. and Stewart, R.N.

**Abstract:** This study estimates a random parameter (mixed) logit model for active transportation (walk and bicycle) choices for work trips in the New York City (using 2010-2011 Regional Household Travel Survey Data). We explored the effects of traffic safety, walk-bike network facilities, and land use attributes on walk and bicycle mode choice decision in the New York City for home-to-work commute. Applying the flexible econometric structure of random parameter models, we capture the heterogeneity in the decision making process and simulate scenarios considering improvement in walk-bike infrastructure such as sidewalk width and length of bike lane. Our results indicate that increasing sidewalk width, total length of bike lane, and proportion of protected bike lane will increase the likelihood of more people taking active transportation mode. This suggests that the local authorities and planning agencies to invest more on building and maintaining the infrastructure for pedestrians. Further, improvement in traffic safety by reducing traffic crashes involving pedestrians and bicyclists, will increase the likelihood of taking active transportation modes. Our results also show positive correlation between number of non-motorized trips by the other family members and the likelihood to choose active transportation mode. The model would be an essential tool to estimate the impact of improving traffic safety and walk-bike infrastructure which will assist in investment decision making.

**Subject Areas:** Active transportation; Travel behavior; Random parameter model; Walking; Bicycling

**Availability:** Aziz, H.A., Nagle, N.N., Morton, A.M., Hilliard, M.R., White, D.A. and Stewart, R.N., 2017. *Exploring the Impact of Walk-bike Infrastructure, Safety Perception, and Built-Environment on Active Transportation Mode Choice: A Random Parameter Model using New York City Commuter Data*. Transportation, pp.1-23.

<https://link.springer.com/article/10.1007/s11116-017-9760-8>

**1.12. Title: How Bicycling Sharing System usage is affected by Land Use and Urban Form: Analysis from System and User Perspectives**

**Authors:** Faghih-Imani, A., Eluru, N. and Paleti, R.

**Abstract:** There is a rapid growth of bicycle-sharing systems (BSS) around the world. Cities are supporting these systems as a more sustainable transport mode for short trips. Given the relatively recent adoption of BSS, there is substantial interest in understanding how these systems impact urban transportation. In this paper, we examine the functioning of the hugely successful New York City CitiBike system. We focus on the interaction of BSS with land-use and built environment attributes and the influence of weather condition and temporal characteristics on BSS usage. Towards this end, CitiBike system is analyzed along two dimensions: (1) at the system level, we examine the hourly station level arrival and departure rates using a linear mixed model and (2) at the trip level, we investigate users' destination station choice preferences after they pick up a bicycle from a station employing a random utility maximization approach. The results highlight clear spatial and temporal differences in the usage of CitiBike by users with annual membership and users with temporary passes. Overall, our analysis provides a framework and useful insights for cities that are planning to install a new bicycle sharing system or to expand an existing system.

**Subject Areas:** Bicycle-sharing; CitiBike; Destination Choice; Built environment

**Availability:** Faghih-Imani, A., Eluru, N. and Paleti, R., 2017. *How Bicycling Sharing System usage is affected by Land Use and Urban Form: Analysis from System and User Perspectives*. EJTIR, 17(3), pp.425-441.

[http://www.tbm.tudelft.nl/fileadmin/Faculteit/TBM/Onderzoek/EJTIR/Back\\_issues/17.3/2017\\_03\\_07.pdf](http://www.tbm.tudelft.nl/fileadmin/Faculteit/TBM/Onderzoek/EJTIR/Back_issues/17.3/2017_03_07.pdf)

### 1.13. Title: Estimating Walking and Bicycling at the State Level

**Authors:** Nordback, K., Sellinger, M. and Phillips, T.

**Abstract:** Estimates of vehicle miles traveled (VMT) drive policy and planning decisions for surface transportation. No similar metric is computed for cycling and walking. What approaches could be used to compute such a metric on the state level? This report discusses three such approaches, identifies the advantages and disadvantages of each, and applies them to Washington State. The first approach employs travel survey data. The second approach is sample-based using pedestrian and bicycle count data. The third approach is an aggregate demand model approach using demographic data combined with count data. Due to data limitations, none of these methods could be properly implemented on the statewide level. Despite the data limits, the methods were implemented for one county (King County) in order to compare findings. The travel survey method estimated the lowest bicycle and pedestrian miles traveled (BMT and PMT), and the sample-based method estimated the highest. The travel survey method is useful for a statewide measure, but it does not provide the detail needed for facility-level estimates. For bicyclists, the sample-based method is appropriate if volumes are desired at the facility level. For pedestrians, the aggregate model might be more appropriate, because of the more dispersed nature of pedestrian travel. Each method has strengths and weaknesses, and each helps us understand bicycle and pedestrian travel in different ways.

For this reason, the project team recommends improving both statewide travel survey data and pedestrian and cyclist traffic count data which feed these methods. Travel survey data should be collected statewide with oversampling for non-motorized travelers. Pedestrian and cyclist traffic counts should be expanded to include a continuous counting program in addition to the short-duration count program. After the continuous count program is in place, short-duration counts should be chosen using a stratified random sampling approach. For example, the sampling frame could consist of all road and path segments in the state divided by region (Coast Range, Puget Lowland, Cascades, Eastern Washington), by urbanity (rural, urban), by facility type (highways/arterials, local/collector roads, paths), and by whether the location is on a bridge or not. To increase sites sampled, the short-duration count program could also be rotated, with each location being counted every three years instead of every year. Better data will allow the state to quantify bicycling and walking at both the state level and facility level to inform decision-making, facility design and planning, and safety analysis.

**Subject Areas:** Commuting; Pedestrians; Cycling; Automatic data collection systems; Oregon; Transportation Planning

**Availability:** Nordback, K., Sellinger, M. and Phillips, T., 2017. *Estimating Walking and Bicycling at the State Level*. NITC-RR-708. Portland, OR: Transportation Research and Education Center (TREC).

<http://dx.doi.org/10.15760/trec.163>



**1.14. Title: No Need for Training Wheels: Ideas for Including Balance Bikes in Elementary Physical Education**

**Authors:** Becker, A. and Jenny, S.E.

**Abstract:** Although it was invented nearly two centuries ago in Germany, the balance bike is only now beginning to make its presence known in the United States. A balance bike is a bicycle with no pedals - propelled by running or walking - and is designed to teach young children how to ride a bike in less time by allowing them to practice balance and steering with minimal risk of falling. The use of balance bikes is gaining traction as the “new” way to transition children to riding a bicycle without the need to use training wheels. However, the implementation of a balance bike unit is surprisingly lacking in the vast majority of elementary physical education programs. The purpose of this article is to provide an introduction to the balance bike, highlight the benefits of implementing it in the elementary physical education curriculum, and offer a four-lesson, ready-to-use balance-bike unit plan.

**Subject Areas:** Balance-bikes; Training wheels; Children

**Availability:** Becker, A. and Jenny, S.E., 2017. *No Need for Training Wheels: Ideas for Including Balance Bikes in Elementary Physical Education*. *Journal of Physical Education, Recreation & Dance*, 88(4), pp.14-21.

<http://www.tandfonline.com/doi/abs/10.1080/07303084.2016.1270789>

### **1.15. Title: Improving Walkability Through Control Strategies at Signalized Intersections**

**Authors:** Kothuri, S.M., Kading, A., Smaglik, E.J. and Sobie, C.

**Abstract:** As cities and communities nationwide seek to develop Complete Streets that foster livability and accommodate all modes, signal timing control strategies that include pedestrians in the operational decision process are gaining importance. This research tested several efficiency-focused pedestrian treatments - coordination, actuated-coordination, free operation, short cycle lengths - and safety-focused treatment including leading pedestrian intervals and Barnes Dance. Using a software-in-the-loop simulation, the operational impacts of these treatments on all users (vehicles, heavy vehicles, bicyclists and pedestrians) at an intersection were evaluated. Results showed that among the efficiency-based treatments, free operation was most beneficial for reducing minor-street pedestrian delays. Both safety treatments increased major-street vehicle delays. A new pedestrian priority algorithm is proposed and developed, which is designed to prioritize pedestrian service under certain traffic conditions. The algorithm is designed to analyze field data and change the user-defined operational strategy to match the conditions in the field. The developed algorithm was deployed at three separate locations, two of which used a Raspberry Pi device and one used the onboard logic processor of the ASC/3 controller. Before-and-after data analysis showed that the algorithm was successful in reducing pedestrian delay. While this research provides field-implementable solutions for reducing pedestrian delays, there is no one “right solution”. Ultimately, choice of a control strategy may rest on operational objectives and geometric characteristics of an intersection. The findings from this research may benefit cities that are looking to create safe, sustainable streets capable of accommodating multiple modes.

**Subject Areas:** Traffic signs and signals; Pedestrians; Safety measures

**Availability:** Kothuri, S.M., Kading, A., Smaglik, E.J. and Sobie, C., 2017. *Improving Walkability Through Control Strategies at Signalized Intersections*. NITC-RR-782. Portland, OR: Transportation Research and Education Center (TREC).

<http://www.tandfonline.com/doi/abs/10.1080/07303084.2016.1270789>

### **1.16. Title: Cycling in Toronto: Route Choice Behavior and Implications to Infrastructure Planning**

**Author:** Li, S.

**Abstract:** This research investigates the route choice behavior of cyclists in the City of Toronto using data collected from a smartphone application deployed to a large number of cyclists in the City. A total 4,556 cyclists registered for this study and logged over 30,000 commuting trips and 9,600 recreational trips over a study period of 9 months. The routes of individual cycling trips were estimated by a map-matching algorithm using second-by-second GPS readings of each trip and Toronto's cycling road network. Personal information such as age, gender and residence, work or school place was collected from the participants on a voluntary basis. The collected cycling trip data were used to estimate path-size logit route choice models - variant of multinomial logit model for both commuting and recreational trips with various modeling options and combinations of candidate factors. The estimations of the models were evaluated using various performance measures and statistical tests, resulting in findings and conclusions on the optimal modeling structure, the factors that had statistical significant effects on cyclists' routing decisions and the magnitude of these effects.

The modeling results revealed the critical importance of cycling facilities such as bicycle lanes, multiuse pathways and trails on cyclists' route choice decisions. It was shown that directness as measured by travel distance is the most important factor considered by commuting cyclists in making their route choices. It was also found that cyclists prefer cycling along major streets than local streets and do not mind traveling along transit routes. Furthermore, they tend to choose routes with more bicycle facilities especially dedicated off-street facilities. Comparing to recreational trips, the routes chosen for commuting were in general closer to the routes of minimum distance and energy consumption. In contrast, for recreational trips, cyclists were less concerned about the directness or the degree of challenges of the routes. For these trips, cyclists appeared to place safety at a higher priority instead of time as they showed a higher preference to dedicated bike facilities such as bike lanes and off-street bike paths than on-street mixed facility. Weather and personal attributes were not found to be statistical significant in affecting cyclists' route choices. These along with other findings from this thesis research have provided valuable information for Toronto's ongoing effort on bicycle network planning. The results could also be used to enhance route-finding tools available to cyclists for improved cycling experience.

**Subject Areas:** Cycling; Routechoice decisions; Bicycle facilities

**Availability:** Li, S., 2017. *Cycling in Toronto: Route Choice Behavior and Implications to Infrastructure Planning*. M.S. Thesis, University of Waterloo

[https://uwspace.uwaterloo.ca/bitstream/handle/10012/11250/Li\\_Siyuan.pdf?sequence=1](https://uwspace.uwaterloo.ca/bitstream/handle/10012/11250/Li_Siyuan.pdf?sequence=1)

**1.17. Title: Spring Weather Brings Bicyclists out for the Season**

**Author:** Lavender, D.

**Abstract:** Blog

**Subject Areas:** Bicycle; Pedestrian; Commuting Modes

**Availability:** Lavender, D., 2017. *Spring Weather Brings Bicyclists out for the Season*. The Herald-Dispatch.

[http://www.herald-dispatch.com/features\\_entertainment/spring-weather-brings-bicyclists-out-for-the-season/article\\_7ab1ab53-c841-5a0b-b8e9-273b6d7764f0.html](http://www.herald-dispatch.com/features_entertainment/spring-weather-brings-bicyclists-out-for-the-season/article_7ab1ab53-c841-5a0b-b8e9-273b6d7764f0.html)

**1.18. Title: Savannah celebrates National Bike to Work Day**

**Author:** Ray, B.

**Abstract:** Newspaper Article

**Subject Areas:** Bike-friendly; National Bike to Work Day

**Availability:** Ray, B., 2017. *Savannah celebrates National Bike to Work Day*. SavannahNow, Savannah Morning News.

<http://savannahnow.com/news/2017-05-18/savannah-celebrates-national-bike-work-day>

**1.19. Title: Examining the Impact of Sample Size in the Analysis of Bicycle-Sharing Systems**

**Authors:** Faghieh-Imani, A. and Eluru, N.

**Abstract:** Research efforts examining bicycle-sharing systems (BSS) employed a wide range of sample size depending on the temporal or spatial aggregation. This paper proposes a systematic evaluation of the impact of sample size on model estimates, inference measures and predictive performance using data from New York City's CitiBike. We evaluate two major dimensions of BSS data: (1) system usage - impact of contributing factors on hourly arrival and departure rates at station level, (2) user destination choice - impact of factors on users' preference of destination station choice. The model estimation exercises for system demand and destination choice are conducted on several samples of data. The performance of these sample models in terms of parameters, inference statistics and predictions relative to a base sample data is observed. The results would help the analysts to make decisions on sample size for accurately examining BSS usage.

**Subject Areas:** Sample size; Bicycle-sharing systems; CitiBike New York; Linear mixed model; Multinomial logit model; Arrival and departure rates; Destination choice; Bicycle infrastructure; Land use and built environment

**Availability:** Faghieh-Imani, A. and Eluru, N., 2017. *Examining the Impact of Sample Size in the Analysis of Bicycle-Sharing Systems*. *Transportmetrica A: transport science*, 13(2), pp.139-161. <http://www.tandfonline.com/doi/abs/10.1080/23249935.2016.1223205>

## **1.20. Title: Evaluation of an Electric Bike Pilot Project at Three Employment Campuses in Portland, Oregon**

**Authors:** MacArthur, J., Kobel, N., Dill, J. and Mumuni, Z.

**Abstract:** Oregon, and Portland in particular, is internationally known for its love for bikes. Not only does the region have some of the highest bike ridership but the Oregon bike manufacturing industry is quickly growing. Oregon's electric bike (e-bike) market is also growing but little data are available on the potential market and e-bike user behavior and interest. Only a limited amount of research has explored the potential new market segments for e-bikes and the economic, operational, safety, and transportation issues surrounding e-bikes in the United States. This report examines the results of an electric bike (e-bike) pilot project, which took place April 2014-September 2015 in the Portland region. Participants from three Kaiser Permanente Northwest campuses (1 urban and 2 suburban) were issued an e-bike for 10 weeks to use for various trip purposes, focusing on first/last-mile commuting. Participants were asked to complete three surveys - before, during and after using the e-bike - to evaluate how their perceptions and levels of cycling may have changed. Responses were analyzed using statistical software and a GIS. Results show that participants biked more often and to a wider variety of places than before the study; they become more confident cyclists after the study; and they cited fewer barriers to cycling when given the opportunity to use an e-bike, particularly for overcoming hills and reducing sweat. This study's findings support the general hypothesis that e-bikes enable users to bike to more distant locations, bike more frequently and allow a broader participation in cycling for certain segments of the population by reducing barriers to cycling. Further research is needed to understand how e-bikes might replace other modes of transportation, including standard bicycles, vehicles and public transit.

**Subject Areas:** Electric bicycles; Cyclists; Electric bicycles; Effect on reducing barriers to cycling

**Availability:** MacArthur, J., Kobel, N., Dill, J. and Mumuni, Z., 2017. *Evaluation of an Electric Bike Pilot Project at Three Employment Campuses in Portland, Oregon*. NITC-RR-564B. Portland, OR: Transportation Research and Education Center (TREC).  
[http://pdxscholar.library.pdx.edu/trec\\_reports/125/](http://pdxscholar.library.pdx.edu/trec_reports/125/)

### **1.21. Title: The Built Environment and Walking**

**Authors:** Riggs, W. and Steiner, R.L.

**Abstract:** This chapter introduces how the built environment and walking are connected. It looks at the interrelationships within the built environment, and how those are changing given planning and policy efforts to facilitate increased walking for both leisure activity and commuting. Using a broad review and case-based approach, the chapter examines this epistemological development of walking and the built environment over time, reviews the connections, policies and design strategies and emerging issues. The chapter shows many cases of cities which are creating a more walkable environment. It also reveals that emerging issues related to technology and autonomous vehicles, vision zero and car-free cities, and increased regional policy may play a continued role in shaping the built environment for walking. This dialogue provides both a core underpinning and a future vision for how the built environment can continue to influence and respond to pedestrians in shaping a more walkable world.

**Subject Areas:** Pedestrians; Built Environment; Walkability; Public Health; Street Design; Complete Streets

**Availability:** Riggs, W. and Steiner, R.L., 2017. *The Built Environment and Walking*. Connecting Sustainable Transport with Health (pp. 139-165). Emerald Publishing Limited.  
<http://www.emeraldinsight.com/doi/abs/10.1108/S2044-99412017000009010>



**1.22. Title: Utah cyclists share why they ride in 200th Anniversary Year of the Bicycle's Invention**

**Author:** Adams, K.S.

**Abstract:** Newspaper Article

**Subject Areas:** Cycling; Public Transportation; Biking trails

**Availability:** Adams, K.S., 2017. *Utah cyclists share why they ride in 200th Anniversary Year of the Bicycle's Invention*. Desert News Entertainment.

<http://www.deseretnews.com/article/865684237/Utah-cyclists-share-why-they-ride-in-200th-anniversary-year-of-the-bicycles-invention.html>

**1.23. Title: Bicycle Rodeo in Poughkeepsie Focuses on Skills, Safety and Comfort**

**Author:** Barry, J.W.

**Abstract:** Blog

**Subject Areas:** Cycling; Safety

**Availability:** Barry, J.W., 2017. *Bicycle Rodeo in Poughkeepsie Focuses on Skills, Safety and Comfort*. Poughkeepsie Journal.

<http://www.poughkeepsiejournal.com/story/news/local/2017/07/08/bicycle-rodeo-poughkeepsie-focuses-skills-safety-and-comfort/462131001/>

**1.24. Title: On a Roll: Cycling is the Go-to Sport for Enjoying the Outdoors**

**Author:** Walsh, Lawrence.

**Abstract:** Newspaper Article

**Subject Areas:** Cycling; Bike trails, recreational activity.

**Availability:** Walsh, Lawrence., 2017. *On a Roll: Cycling is the Go-to Sport for Enjoying the Outdoors*. Pittsburgh Post-Gazette.

<http://www.post-gazette.com/aging-edge/aging-edge-reports/2017/10/22/seniors-cycling-Pittsburgh-bike-trails-bicycles-aging/stories/201710220013>

### **1.25. Title: Accessibility Evaluations for Nighttime Walking and Bicycling for Low-income Shift Workers**

**Authors:** Chandra, S., Jimenez, J. and Radhakrishnan, R.

**Abstract:** This paper addresses an important issue related to nighttime commuting of low-income shift workers who walk and/or bike to their workplace using public transit. A shift worker is anyone who follows a work schedule that is outside of the typical daytime working hours of a business day and commute after dark - by walking or bicycling to a transit stop. However, poor visibility conditions on sidewalks and bicycle lanes often thwart safety of their walking and bicycling activities. Therefore, this paper develops two simple scores - nighttime accessibility score for walking (NASW) and nighttime accessibility for bicycling (NASB) - for evaluating nighttime infrastructure for pedestrians and bicyclist. The scores consider the employment data, travel time and the physical distribution of streetlight poles along the sidewalks and bicycle lanes. Data from the city of El Paso in Texas is used to demonstrate the applicability of the two scores. Employment data from three prominent service industry sectors known to employ low-income shift workers - i) Retail Trade, ii) Accommodation and Food Services, and iii) Health Care and Social Assistance - are used for demonstration purposes. It is observed that amongst the three sectors analyzed, both NASW and NASB values are higher for regions in El Paso with low-income employment concentrations from the Health Care and Social Assistance sector. It is also observed that some prominent regions in north-east, south-east and west of El Paso need improvements in streetlight systems, sidewalks and bicycle network to facilitate walking and bicycling amongst low-income shift workers employed in Retail Trade, and Accommodation and Food Services industry sectors to access transit stops at night.

**Subject Areas:** Nighttime commuting; Walking; Bicycling, Low-income; Shift workers

**Availability:** Chandra, S., Jimenez, J. and Radhakrishnan, R., 2017. *Accessibility Evaluations for Nighttime Walking and Bicycling for Low-income Shift Workers*. Journal of Transport Geography, 64, pp.97-108.

<https://www.sciencedirect.com/science/article/pii/S0966692316307372>

**1.26. Title: Grounding Urban Walking and Cycling Research in a Political Economy Framework**

**Authors:** Khayesi, M., Litman, T., Vasconcellos, E. and Mitullah, W.V.

**Abstract:** Book Chapter

**Subject Areas:** Not Available

**Availability:** Khayesi, M., Litman, T., Vasconcellos, E. and Mitullah, W.V., 2017. *Grounding Urban Walking and Cycling Research in a Political Economy Framework*. Non-Motorized Transport Integration Into Urban Transport Planning in Africa, p.224.

<https://books.google.com/books?hl=en&lr=&id=JgcqDwAAQBAJ&oi=fnd&pg=PA224&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=7VYMzcSfDW&sig=Av-fMM5MWJNEcPHR0reINptauUQ#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%20NHTS&f=false>

### **1.27. Title: Bike-Sharing Systems and Congestion: Evidence from US Cities**

**Authors:** Wang, M. and Zhou, X.

**Abstract:** In the past decades, there has been a resurgence of public bike-sharing systems (BSSs). While it is claimed that social and environmental benefits are associated with the implementation of BSSs, few empirical studies have investigated the actual congestion reduction effect of BSSs on cities. To fill such gap, this paper aims to examine whether the launch of BSSs can reduce citywide congestion. With a panel dataset of 96 urban areas in the US from 2005 to 2014, we employed a difference-in-differences model with two-way fixed-effects panel regression. The results suggested that the introduction of BSSs shows a significant mixed impact on congestion in general: Larger cities get better off but richer cities get worse off. Such results are consistent with both subsample regression with propensity score matching and different congestion measures. Post-hoc analysis reveals that BSSs have a significant positive effect on reducing rush-hour congestion. Finally, implications, limitations, and future work directions are offered.

**Subject Areas:** Bike-sharing systems; Congestion; Difference-in-differences; Fixed effects model

**Availability:** Wang, M. and Zhou, X., 2017. *Bike-Sharing Systems and Congestion: Evidence from US Cities*. *Journal of Transport Geography*, 65, pp.147-154.

<https://www.sciencedirect.com/science/article/pii/S0966692317302715>

## 1.28. Title: The Routledge International Handbook of Walking

**Authors:** Hall, C.M., Ram, Y. and Shoval, N.

**Abstract:** Walking is an essentially human activity. From a basic means of transport and opportunity for leisure through to being a religious act, walking has served as a significant philosophical, literary and historical subject. Thoreau's 1851 lecture on Walking or the Romantic walks of the Wordsworths at Grasmere in the early 19th Century, for example, helped create a philosophical foundation for the importance of the act of walking as an act of engagement with nature. Similarly, and sometimes inseparable from secular appreciation, pilgrimage trails provide opportunities for finding self and others in the travails of the walk. More recently, walking has been embraced as a means of encouraging greater health and well-being, community improvement and more sustainable means of travel. Yet despite the significance of the subject of walking there is as yet no integrated treatment of the subject in the social science literature. This handbook therefore brings together a number of the main themes on the study of walking from different disciplines and literatures into a single volume that can be accessed from across the social sciences. It is divided into five main sections: culture, society and historical context; social practices, perceptions and behaviours; hiking trails and pilgrimage routes; health, well-being and psychology; and method, planning and design. Each of these highlights current approaches and major themes in research on walking in a range of different environments. This handbook carves out a unique niche in the study of walking. The international and cross-disciplinary nature of the contributions of the book are expected to be of interest to numerous academic fields in the social and health sciences, as well as to urban and regional planners and those in charge of the management of outdoor recreation and tourism globally.

**Subject Areas:** Walking; Social science literature; Different environments

**Availability:** Hall, C.M., Ram, Y. and Shoval, N. eds., 2017. *The Routledge International Handbook of Walking*. Routledge.

[https://books.google.com/books?hl=en&lr=&id=5JouDwAAQBAJ&oi=fnd&pg=PT23&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=YCU1N5Gy5A&sig=HY7aIoOIn3d\\_spt82XcQOYtm2wY#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%2C%20NHTS&f=false](https://books.google.com/books?hl=en&lr=&id=5JouDwAAQBAJ&oi=fnd&pg=PT23&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=YCU1N5Gy5A&sig=HY7aIoOIn3d_spt82XcQOYtm2wY#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%2C%20NHTS&f=false)

**1.29. Title: Bike Infrastructure for Multifamily Communities**

**Author:** Bulman, M.

**Abstract:** Newspaper Article

**Subject Areas:** Bicycle storage and protection; Urban commuters; Sustainability

**Availability:** Bulman, M., 2017. *Bike Infrastructure for Multifamily Communities*. Multi-housing News.

<https://www.multihousingnews.com/post/bike-infrastructure-for-multifamily-communities/>



### **1.30. Title: Use of Technology to Improve Bicycle Mobility in Smart Cities**

**Authors:** Stamatiadis, N., Pappalardo, G. and Cafiso, S.

**Abstract:** In the past few decades there has been a significant growth in cycling and the use of bicycles as a transportation mode and beyond recreational use. Technological advancements along with mobile phones and web platforms can aid bicyclists while considering and planning their routes. Moreover, the vast data that can be generated, and thus collected, from smartphones can provide a database that can be used to develop a systematic evaluation of potential routes and provide meaningful information to the bicyclists. Several of these technologies are based on self-monitoring efforts and sharing experiences among bicyclists but they do not provide a systematic and objective evaluation of the infrastructure. Throughout the world, transportation agencies are promoting bicycling as a serious alternative transportation option, since it provides health benefits and reduces carbon emissions and congestion. It is imperative then that transportation agencies can provide an appropriate infrastructure in order to encourage the continued growth of bicycling. The current technological tools can aid in data collection but what is currently lacking is a systematic, objective review of such information that a transportation agency can use aiming to assess existing infrastructure and develop an action plan to complete and improve it. Transportation agencies require information about their facilities and the use of technology can provide such data in order to better estimate needs and develop an action plan. This paper reviews existing such platforms and applications under the premise of developing a systematic review and an objective performance index for bicycling infrastructure.

**Subject Areas:** Bicycling; Smartphones; Apps; Infrastructure

**Availability:** Stamatiadis, N., Pappalardo, G. and Cafiso, S., 2017. *Use of Technology to Improve Bicycle Mobility in Smart Cities*. Models and Technologies for Intelligent Transportation Systems (MT-ITS), 2017 5th IEEE International Conference on(pp. 86-91). IEEE.

<http://ieeexplore.ieee.org/abstract/document/8005636/>

### **1.31. Title: Travel and Built Environment: Evidence from 23 Diverse Regions of the United States**

**Author:** Tian, G.

**Abstract:** I have opted for a three-paper dissertation, studying the relationship between travel and the built environment for three types of trips: walk and bike trips by the entire population, trips from home to school and back for students, and trips of all types by the elderly. As part of my dissertation, I have gathered the most extensive set of regional travel surveys that anyone has ever collected, specifically including 815,160 trips by 81,056 households in 23 regions. I have also linked travel records to so-called D variables for buffers of different widths around households and routes from home to school. The five D variables, widely used in travel research, are development density, land use diversity, street network design or connectivity, destination accessibility, and distance to transit. The main goal of this dissertation is to determine how we can promote walking and biking, especially for students and seniors.

From the first paper, walk mode choice in the 23 regions depends primarily on land use diversity, street connectivity, and transit accessibility, while bike mode choice depends primarily on street connectivity and transit accessibility. The resulting trip chain shows that accessibility of destinations to one another may be almost as important as accessibility of residences to destinations. The second paper analyzes student travel to school in the 14 regions. I find that the most important D variables in the decision to walk or bike to school is development density and street network design or connectivity, and the least important is land use diversity. While not a D variable exactly, the need to cross major roads or commercial developments has strong negative impacts on active travel to school. In the third paper, the analysis of variance (ANOVA) tests show that seniors living in compact neighborhoods are more active than those living in sprawl neighborhoods. They generally travel more and travel more by walking and public transportation, yet travel less by automobile.

The resulting models and findings in this dissertation are appropriate for postprocessing outputs of conventional travel demand models, and for sketch planning applications in traffic impact analysis, climate action planning, and health policy implementations.

**Subject Areas:** Bike trips; Walk trips; Built environment; D variables

**Availability:** Tian, G., 2017. *Travel and Built Environment: Evidence from 23 Diverse Regions of the United States*. (Doctoral dissertation, The University of Utah).

<https://search.proquest.com/openview/2c350176c2e6446ffc7fb327066aebc8/1?pq-origsite=gscholar&cbl=18750&diss=y>

### **1.32. Title: Planning for Cycling in Peterborough**

**Author:** Post, E.A.

**Abstract:** With a changing climate driven by an unsustainable lifestyle, cycling is becoming increasingly popular due to its environmental benefits as well as its physical and mental health benefits. Cycling emits virtually no greenhouse gases and is a quick and easy way for anyone to travel. Recent trends in urban planning have placed greater emphasis on denser cities and alternative modes of transportation including public transit, walking, and cycling. In North America, these trends have been slow to catch on aside from a few communities that are starting to make waves. This paper examines the current state of cycling infrastructure and policy in Peterborough, Ontario and assesses the future plans for the city. Innovative ideas from some of the world's top cycling countries, the Netherlands, Denmark, and Germany, are discussed and situated in the local context. Suggestions are made as potential options for Peterborough and other North American communities to improve cycling rates and make our cities healthier and happier.

**Subject Areas:** Cycling; Urban planning; Public transit

**Availability:** Post, E.A., 2017. *Planning for Cycling in Peterborough*. Journal of Undergraduate Studies at Trent (JUST), 5(1), pp.68-72.

<http://ojs.trentu.ca/ojs/index.php/just/article/view/83>

### **1.33. Title: Contextualizing Walkability: Do Relationships Between Built Environments and Walking Vary by Socioeconomic Context?**

**Authors:** Adkins, A., Makarewicz, C., Scanze, M., Ingram, M. and Luhr, G.

**Abstract:** Problem, Research Strategy, and Findings: Supportive built environments for walking are linked to higher rates of walking and physical activity, but little is known about this relationship for socioeconomically disadvantaged (e.g., low-income and racial/ethnic minority) populations. We review 17 articles and find that most show that the built environment has weaker effects on walking and physical activity for disadvantaged than advantaged groups. Those who lived in supportive built environments walked more and were more physically active than those who did not, but the effect was about twice as large for advantaged groups. We see this difference because disadvantaged groups walked more in unsupportive built environments and less in supportive built environments, though the latter appears more influential.

Takeaway for Practice: Defining walkability entirely in built environment terms may fail to account for important social and individual/household characteristics and other non-built environment factors that challenge disadvantaged groups, including fear of crime and lack of social support. Planners must be sensitive to these findings and to community concerns about gentrification and displacement in the face of planned built environment improvements that may benefit more advantaged populations. We recommend five planning responses: Recognize that the effects of the built environment may vary by socioeconomics; use holistic approaches to improve walkability; expand walkability definitions to address a range of social and physical barriers; partner across agencies, disciplines, and professions; and evaluate interventions in different socioeconomic environments.

**Subject Areas:** Walking; Transportation equity; Walkability; Socioeconomic context

**Availability:** Adkins, A., Makarewicz, C., Scanze, M., Ingram, M. and Luhr, G., 2017. *Contextualizing Walkability: Do Relationships Between Built Environments and Walking Vary by Socioeconomic Context?* Journal of the American Planning Association, 83(3), pp.296-314.

<http://www.tandfonline.com/doi/abs/10.1080/01944363.2017.1322527>

### **1.34. Title: Are They Telling The Truth? Revealing Hidden Traits of Satisfaction with a Public Bike-sharing Service**

**Authors:** Manzi, G. and Saibene, G.

**Abstract:** Public bike-sharing systems (BSSs) are an emerging mode of transportation introduced by municipalities to solve congestion problems in metropolitan areas, especially when integrated with other types of transportation. In the last years, the number of public bike-sharing services has been constantly on the rise all over the world, and generally the overall satisfaction with them is high. However, satisfaction with public services is driven by mechanisms that can differ from those in the private sector. It is important to establish to what extent a high satisfaction is genuine or simply ephemeral. Even “old” public services (like public transportation) become “gold” when accompanied by the introduction of new technologies. In this paper we analyze this phenomenon using data from a satisfaction web-survey conducted among customers of the public BSS “BikeMi” in Milan, Italy, in a period when mobile technologies have been introduced to speed up the service. On analyzing the responses to satisfaction questions using simple summary statistics, the level of satisfaction resulted very high. However, our aim was to look for potential “darker” sides of the service by detecting possible hidden satisfaction components. For this purpose, we used the Nonlinear Principal Components Analysis, which is particularly powerful in this context. A simple textual analysis was also performed as a validating test. Results from our analysis indicated that satisfaction is flawed by a set of factors like the mechanics of the bikes, the picking and dropping system, and the apps used to organize the service. Less concern was detected for more general aspects of the service.

**Subject Areas:** Bike Sharing; Nonlinear Principal Component Analysis; Public Transport; Quality Perception; Satisfaction Indicators

**Availability:** Manzi, G. and Saibene, G., 2017. *Are They Telling The Truth? Revealing Hidden Traits of Satisfaction with a Public Bike-sharing Service*. International Journal of Sustainable Transportation, pp.1-18.

<http://www.tandfonline.com/doi/abs/10.1080/15568318.2017.1353186>

**1.35. Title: Pedaling Disaster: Citizen Bicyclists in Disaster Response - Innovative Solution or Unnecessary Effort?**

**Author:** Kirkpatrick, S.J.B.

**Abstract:** Citizens have historically become involved in response to disasters by helping both themselves and others. Recently, the idea has emerged of individuals providing this assistance in the response period using bicycles. Community events have been organized by bicycling enthusiasts in US cities to demonstrate how bicycles could potentially be of use in disaster situations. Yet, there has been no empirical research around the idea of citizen bicyclists in disaster response. This study explored the potential use of bicycles and their citizen riders in disaster events in the USA - specifically considering what role, if any, citizen bicyclists could play in such scenarios. Data were initially collected through 21 in-depth, telephone interviews with emergency management officials and bicycling advocates from bicycle-friendly cities in ten different states. Grounded theory was used to conceptualize the overall research design and analyze the data. Based on theoretical and snowball sampling, an additional six interviews were completed with individuals who had requisite knowledge and experiences applicable to the research question. Participants indicated that there are a variety of tasks and activities citizen bicyclists could undertake in disaster response; however, it would have to be an event of significant scope and magnitude for bicycle usage to be widespread - an unlikely occurrence for many jurisdictions. Concerns about training and integration with the formal emergency management structure were also identified. Implications for potential citizen bicyclists - and citizen responders more broadly - are discussed.

**Subject Areas:** Disaster; Response; Bicyclists; Emergency management; Citizen responders

**Availability:** Kirkpatrick, S.J.B., 2018. *Pedaling Disaster: Citizen Bicyclists in Disaster Response - Innovative Solution or Unnecessary Effort?* *Natural Hazards*, 90(1), pp.365-389.  
<https://link.springer.com/article/10.1007/s11069-017-3048-3>

**1.36. Title: Correlates of Bicycling for Recreation and Transportation: Ecological Approach**

**Author:** Porter, A.K.

**Abstract:** Bicycling is known to be associated with significant health benefit. Few studies have examined potential correlates of domain specific bicycling, recreation and transportation, in the context of the United States. This dissertation aimed to assess the association between (1) intrapersonal and environmental variables and bicycling for recreation and transportation, (2) perceived social and built environment factors and bicycling for recreation and transportation, and (3) objectively measured built environment variables and bicycling for recreation and transportation.

**Subject Areas:** Bicycling; Health benefit; Environment; Recreation; Transportation sector

**Availability:** Porter, A.K., 2017. *Correlates of Bicycling for Recreation and Transportation: Ecological Approach*. (Doctoral dissertation, The University of Texas School of Public Health). <https://link.springer.com/article/10.1007/s11069-017-3048-3>

### **1.37. Title: Pedestrian Crossing Behavior in College Students: Exploration Using the Theory of Planned Behavior**

**Author:** Piazza, A.J.

**Abstract:** Background: In the United States, pedestrian fatalities make up a substantial proportion of total traffic fatalities. High use of mobile data and exposure to high-traffic environments place college students at increased risk. The present study aimed to utilize the theory of planned behavior (TPB) to examine college students' behavioral intention to cross the street on campus while using a mobile device. A secondary aim was to estimate the incidence of distracted mobile device use among street-crossing pedestrians at a large public southeastern university.

Methods: Questionnaire data were collected from undergraduate college students attending a Southeastern university. Questionnaire development involved a literature review, face and content validity by expert panel, readability and comprehensibility by pilot test, stability reliability by test-retest, and internal consistency using Cronbach's alpha. Construct validity of the TPB for predicting behavioral intention to cross the street on campus while using a mobile device was assessed using linear regression analyses. The second aim involved performing observations to estimate the incidence of distracted mobile device use among street-crossing pedestrians.

Results: The TPB constructs of attitude toward the behavior ( $B=.395, p < .001$ ), subjective norm ( $B=.328, p < .001$ ), and perceived behavioral control ( $B=.158, p < .001$ ) were significant predictors of behavioral intention and explained 48.4% of the variance. Observations yielded 4,878 crossing instances (33.9% male and 66.1% female). Overall, 1,201 (24.6%) cases involved device use with 16.8% of male crossings and 28.6% of female crossings involving distraction. A significant difference in device use while crossing was found between some observation locations,  $\chi^2(3)=8.866, p=.031$ .

**Subject Areas:** Pedestrian fatalities; Distracted mobile device use; Linear regression analyses

**Availability:** Piazza, A.J., 2017. *Pedestrian Crossing Behavior in College Students: Exploration Using the Theory of Planned Behavior*. (Doctoral dissertation, The University of Alabama).

<https://search.proquest.com/openview/d43b27b6fc4745545ba67d72df13ffa8/1?pq-origsite=gscholar&cbl=18750&diss=y>



**1.38. Title: Increasing Winter Bikeability in Toronto Through Improved Bicycle Network Design**

**Author:** Bullock, E.

**Abstract:** Cycling, a sustainable mode of transportation, is often discredited as a four-season option as it is perceived as being dependent on weather conditions. This research presents the concept of cycling and its impact on, and how it is impacted by, bicycle network design. Winter bikeability criteria were synthesized from the literature and applied to four case study cities known for their bikeability and year-round maintenance of cycling infrastructure, including Montréal (Canada), Minneapolis (USA), Copenhagen (Denmark), and Oulu (Finland). Through analysis of the applied criteria, a set of best practices from each city was created based on safety, ease of use, and improved bikeability. The best practices were supported by current literature and active transportation guidelines. The best practices were then applied to Toronto (Canada) as design recommendations to improve the City's bicycle network design. The results provide direction for planning of bicycle networks in cities with winter climates.

**Subject Areas:** Winter Cycling; Bicycle network design;

**Availability:** Bullock, E., 2017. *Increasing Winter Bikeability in Toronto Through Improved Bicycle Network Design*. (Doctoral dissertation, School of Environmental Design and Rural Development).

<http://atrium.lib.uoguelph.ca/xmlui/handle/10214/10349>

**1.39. Title: Talking the Walk: An Autoethnography of Pedestrianism in Chicagoland**

**Author:** Kuka, A.

**Abstract:** For over one million years walking was the primary way that people got around on an everyday basis. But, over the past one hundred years our long history with walking has been erased from both our collective memory and the physical landscape itself. Currently, automobility stands as the primary form of transportation in the United States and many other countries around the world. In many places in the U.S. it is difficult if not impossible to access food, work, or essential services without the use of a car. This begs the question: When we lose the ability to walk places, what else do we lose? In other words, what sensory, social, and emotional experiences are associated with pedestrianism, and what have become of these experiences today? This autoethnographic account of pedestrianism in Chicagoland aims to remind us of what sensory, social, and emotional experiences walking can provide us, as well as what kind of experiences walking tends to provide us within a built environment centered around the automobile.

**Subject Areas:** Pedestrian; Built environment; Automobile; Primary form of Transportation

**Availability:** Kuka, A., 2017. *Talking the Walk: An Autoethnography of Pedestrianism in Chicagoland*. Stevenson Center for Community and Economic Development. 24.  
<https://ir.library.illinoisstate.edu/cgi/viewcontent.cgi?article=1024&context=scced>

## 2. Energy

### 2.1. Title: Quantifying the Impacts of Electric Vehicle Travel Patterns on Battery Life Span

**Authors:** Agrawal, S., Liu, X., Jin, X., Vora, A., Shaver, G., Peeta, S., Dietz, J. and Pekny, J.

**Abstract:** Electric vehicles (EVs) are a promising alternative to conventional vehicles. Several commercial EVs have already been in the market for a few years. However, greater adoption of EVs still faces several challenges. The concern about lifespan of EV batteries due to degradation is one of them. Lifespan information of populations of EV batteries is still scarce. Understanding the lifespan characteristics of EV batteries is significant for EV adoption, vehicle and/or battery resale market, and battery warranty strategy design. This study quantifies the impacts of EV travel patterns on the battery lifespan. Real-world household vehicle travel information extracted from the National Household Travel Survey (NHTS) of 2009 data. A microscopic traffic simulation model is built for the Indianapolis road network to generate speed profiles. Then, household vehicle travel patterns are obtained by matching the NHTS travel information (such as departure time, distance, travel time, purpose, etc.) with the simulated speed profiles. A semi-empirical battery degradation model is used to predict battery lifespan for a simulated population of vehicle travel patterns based upon the NHTS data. The results indicate that vehicle travel patterns, driving behavior (that is, average speed, speed deviation, etc.), and temperature have significant impacts on EV battery lifespan. The impact of vehicle travel patterns and driving behavior increases with decrease in temperature. For Indianapolis, 10% of batteries have lifespan less than 5.15 years, 50% have less than 7.57 years, and 90% have less than 9.65 years.

**Subject Areas:** Energy; Highways; Vehicles and Equipment

**Availability** Agrawal, S., Liu, X., Jin, X., Vora, A., Shaver, G., Peeta, S., Dietz, J. and Pekny, J., 2017. *Quantifying the Impacts of Electric Vehicle Travel Patterns on Battery Life Span*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-00601).  
<https://trid.trb.org/view.aspx?id=1437290>

## **2.2. Title: Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts**

**Authors:** Wood, E., Raghavan, S., Rames, C., Eichman, J. and Melaina, M.

**Abstract:** This analysis of regional plug-in electric vehicle (PEV) infrastructure was conducted to provide guidance on charging infrastructure for PEVs to regional stakeholders through the U.S. Department of Energy's (DOE's) Vehicle Technologies Office. Given the complex issues associated with PEV charging and options in deploying charging infrastructure, there is interest in exploring scenarios of future charging infrastructure deployment to provide insight and guidance to national and regional stakeholders. The complexity and cost of PEV charging infrastructure pose challenges to decision makers, including individuals, communities, and companies considering infrastructure installations. The value of PEVs to consumers and fleet operators can be increased with well-planned and cost effective deployment of charging infrastructure. This will increase the number of miles driven electrically and accelerate PEV market penetration, increasing the shared value of charging networks to an expanding consumer base. Given these complexities and challenges, the objective of the present study is to provide additional insight into the role of charging infrastructure in accelerating PEV market growth. To that end, existing studies on PEV infrastructure are summarized in a literature review. Next an analysis of current markets is conducted with a focus on correlations between PEV adoption and public charging availability. A forward looking case study is then conducted focused on supporting 300,000 PEVs by 2025 in Massachusetts. The report concludes with a discussion of potential methodology for estimating economic impacts of PEV infrastructure growth.

**Subject Areas:** Energy; Plug-in electric vehicle (PEV); Infrastructure growth

**Availability:** Wood, E., Raghavan, S., Rames, C., Eichman, J. and Melaina, M., 2017. *Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts*. (No. NREL/TP-5400-67436). National Renewable Energy Lab.(NREL), Golden, CO (United States). <http://www.nrel.gov/docs/fy17osti/67436.pdf>

### **2.3. Title: Estimating Household Travel Energy Consumption in Conjunction with a Travel Demand Forecasting Model**

**Authors:** Garikapati, V.M., You, D., Zhang, W., Pendyala, R.M., Guhathakurta, S., Brown, M.A. and Dilkina, B.

**Abstract:** This paper presents a methodology for the calculation of household travel energy consumption at the level of the traffic analysis zone (TAZ) in conjunction with information that is readily available from a standard four-step travel demand model system. The methodology presented in this paper embeds two algorithms. The first algorithm provides a means of allocating non-home-based trips to residential zones that are the source of such trips, while the second algorithm provides a mechanism for incorporating the effects of household vehicle fleet composition on fuel consumption. The methodology is applied to the Greater Atlanta metropolitan region in the United States. The methodology is found to offer a robust mechanism for calculating household travel energy footprint at the level of the individual TAZ, which makes it possible to study variations in energy footprint across space. It is found that the travel energy footprint is strongly correlated to density of the built environment, although it is likely that socio-economic differences across TAZs also contribute to differences in travel energy footprints. The TAZ-level household travel energy footprint calculator can be used to analyze alternative futures and relate differences in the energy footprint to differences in a number of contributing factors, thus enabling the design of urban form, formulation of policy interventions, and implementation of awareness campaigns that may bring about more sustainable energy consumption patterns.

**Subject Areas:** Integrated Modeling of Travel Demand and Travel Energy Consumption; Travel Energy Consumption Estimation; Household Travel Energy Demand; Built Environment and Transport Energy Demand

**Availability:** Garikapati, V.M., You, D., Zhang, W., Pendyala, R.M., Guhathakurta, S., Brown, M.A. and Dilkina, B., 2017. *Estimating Household Travel Energy Consumption in Conjunction with a Travel Demand Forecasting Model*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-04855).

<http://www.prism.gatech.edu/wzhang300/wenwen/papers/17-TRB-TRAVEL-ENERGY.pdf>

#### **2.4. Title: Modelling Electric Vehicles Use: A Survey on the Methods**

**Authors:** Daina, N., Sivakumar, A. and Polak, J.W.

**Abstract:** In the literature electric vehicle use is modelled using of a variety of approaches in power systems, energy and environmental analyses as well as in travel demand analysis. This paper provides a systematic review of these diverse approaches using a two-fold classification of electric vehicle use representation, based on the time scale and on substantive differences in the modelling techniques. For time of day analysis of demand we identify activity-based modelling (ABM) as the most attractive because it provides a framework amenable for integrated cross-sector analyses, required for the emerging integration of the transport and electricity network. However, we find that the current examples of implementation of AMB simulation tools for EV-grid interaction analyses have substantial limitations. Amongst the most critical there is the lack of realism how charging behaviour is represented.

**Subject Areas:** Electric vehicles use; Activity based models; Charging behavior

**Availability:** Daina, N., Sivakumar, A. and Polak, J.W., 2017. *Modelling Electric Vehicles Use: A Survey on the Methods*. *Renewable and Sustainable Energy Reviews*, 68, pp.447-460.

: <http://www.sciencedirect.com/science/article/pii/S1364032116306566>

**2.5. Title: On the Impact of Single-Phase Plug-in Electric Vehicles Charging and Rooftop Solar Photovoltaic on Distribution Transformer Aging**

**Authors:** Gray, M.K. and Morsi, W.G.

**Abstract:** This study investigates the impact of single-phase plug-in electric vehicles charging on increasing the rate at which center-tapped distribution transformers experience aging. Distribution transformer aging is investigated considering varying rooftop solar photovoltaic generation penetration rates. Monte Carlo methods are used to probabilistically estimate the transformer's loss of life considering the effect of time-of-use (TOU) pricing. The results of applying the proposed method have revealed that plug-in battery electric vehicle charging impact on both transformer aging and neutral current is largest in the case that vehicles charge based on time-of-use pricing methods. Further application has shown that while rooftop solar photovoltaic generation reduces transformer aging, no significant reduction in neutral current is observed.

**Subject Areas:** Monte Carlo methods; Plug-in electric vehicles; Power quality; Rooftop solar photovoltaics; Transformer aging

**Availability:** Gray, M.K. and Morsi, W.G., 2017. *On the Impact of Single-Phase Plug-in Electric Vehicles Charging and Rooftop Solar Photovoltaic on Distribution Transformer Aging*. Electric Power Systems Research, 148, pp.202-209.

<http://www.sciencedirect.com/science/article/pii/S0378779617301220>

## **2.6. Title: Socially Optimal Replacement of Conventional with Electric Vehicles for the U.S. Household Fleet**

**Authors:** Kontou, E., Yin, Y., Lin, Z. and He, F.

**Abstract:** In this study a framework is proposed for minimizing the societal cost of replacing gas-powered household passenger cars with battery electric ones (BEVs). The societal cost consists of operational costs of heterogeneous driving patterns' cars, the government investments for charging deployment, and monetized environmental externalities. The optimization framework determines the timeframe needed for conventional vehicles to be replaced with BEVs. It also determines the BEVs driving range during the planning timeframe, as well as the density of public chargers deployed on a linear transportation network over time. We leverage datasets that represent U.S. household driving patterns, as well as the automobile and the energy markets, to apply the model. Results indicate that it takes 8 years for 80% of our conventional vehicle sample to be replaced with electric vehicles, under the base case scenario. The socially optimal all-electric driving range is 204 miles, with chargers placed every 172 miles on a linear corridor. All of the public chargers should be deployed at the beginning of the planning horizon to achieve greater savings over the years. Sensitivity analysis reveals that the timeframe for the socially optimal conversion of 80% of the sample varies from 6 to 12 years. The optimal decision variables are sensitive to battery pack and vehicle body cost, gasoline cost, the discount rate, and conventional vehicles' fuel economy. Faster conventional vehicle replacement is achieved when the gasoline cost increases, electricity cost decreases, and battery packs become cheaper over the years.

**Subject Areas:** Vehicle Replacement; Battery Electric Vehicles (Bevs); Internal Combustion Engine Vehicles (Icevs); Charging Density; All-Electric Driving Range

**Availability:** Kontou, E., Yin, Y., Lin, Z. and He, F., 2017. *Socially Optimal Replacement of Conventional with Electric Vehicles for the U.S. Household Fleet*. International Journal of Sustainable Transportation, (just-accepted).

<http://www.tandfonline.com/doi/abs/10.1080/15568318.2017.1313341>



**2.7. Title: Are Consumers Poorly-Informed about Fuel Economy? Evidence from Two Experiments**

**Authors:** Allcott, H. and Knittel, C.

**Abstract:** It has long been argued that people are poorly-informed about and inattentive to fuel economy when buying cars, and that this causes us to buy low-fuel economy vehicles despite our own best interest. We test this assertion by running two experiments providing fuel economy information to people shopping for new vehicles. We find zero statistical or economic effect of information on average fuel economy of vehicles purchased. In the context of a simple optimal policy model, the estimates suggest that imperfect information and inattention are not valid as significant justifications for fuel economy standards at current or planned levels.

**Subject Areas:** Fuel Economy; New Vehicles.

**Availability:** Allcott, H. and Knittel, C., 2017. *Are Consumers Poorly-Informed about Fuel Economy? Evidence from Two Experiments*. National Bureau of Economic Research,(No. w23076). <http://www.nber.org/papers/w23076>

## **2.8. Title: Reliability Assessment of Power Grid Supporting Sustainable Transportation**

**Authors:** Wang, X. and Karki, R.

**Abstract:** This chapter titled “Reliability Assessment of Power Grid Supporting Sustainable Transportation” presents analytical models to evaluate the reliability of a power system with PHEV penetration considering the important PHEV characteristics and charging scenarios. The parameters of the PHEV-30 and the transportation data from NHTS 2009 were used to create the relevant models to obtain the load model of a PHEV. A MCS method was applied to combine individual PHEV models and build the overall model of PHEV fleet. The impact of PHEV penetration in a power system was assessed using the IEEE-RTS as a test system. Different PHEV penetrations and charging scenarios were examined to analyze the results. The results show that the system reliability degrades with the increase in PHEV penetration, and the negative impact is increased with fast charging which requires a higher power demand for a shorter duration. The negative reliability impacts can however be mitigated by shifting and controlling the charging time, which is area of ongoing research.

**Subject Areas:** Power System; Transportation; PHEV

**Availability:** Wang, X. and Karki, R., 2017. *Reliability Assessment of Power Grid Supporting Sustainable Transportation*. In *Sustainable Power Systems* (pp. 1-21). Springer Singapore.  
[https://link.springer.com/chapter/10.1007/978-981-10-2230-2\\_1](https://link.springer.com/chapter/10.1007/978-981-10-2230-2_1)

## **2.9. Title: On the Effects of a Routing and Reservation System on the Electric Vehicle Public Charging Network**

**Author:** Conway, T.

**Abstract:** One solution to the limited range of battery electric vehicles is the provision of a public charging infrastructure to enable longer journeys. This paper describes a simulation model of a routing and charge point reservation system based on the charging infrastructure deployed in Ireland during early 2016. Extensive Monte Carlo simulations are run using the Irish population density and an estimated trip length distribution. The results show quantitatively the advantages of a routing and charge point reservation systems on a country wide scale in terms of the number of electric vehicles that can be supported. The effect of charge point fault rates is also quantitatively assessed and shown to be a critical factor in public charging infrastructure deployment.

**Subject Areas:** Routing; Electric vehicles; Resource management

**Availability:** Conway, T., 2017. *On the Effects of a Routing and Reservation System on the Electric Vehicle Public Charging Network*. IEEE Transactions on Intelligent Transportation Systems, Volume: PP, Issue: 99.

<http://ieeexplore.ieee.org/abstract/document/7811294/?reload=true>

## **2.10. Title: Intelligent Charge Rate Optimization of PHEVs Incorporating Driver Satisfaction and Grid Constraints**

**Authors:** Darabi, Z., Fajri, P. and Ferdowsi, M.

**Abstract:** In this paper, an optimization model is developed to find a plug-in hybrid electric vehicle (PHEV) optimum charging rate profile that dynamically varies throughout the day. From the grid point of view, the model takes into account the constraints of maximum demand and charging facilities, while from the driver's point of view, waiting and charging time restrictions are considered. The novelty of this paper lies in maximizing the energy delivered to PHEVs in a region equipped with smart grid technology by intelligently alternating charging rates during the day while incorporating both driver satisfaction constraints as well as grid limitations. Using the proposed optimization model, two cases with optimized charging rates are studied and compared with constant charging levels. Furthermore, quantitative results from the perspective of both power grid contribution and driver satisfaction are presented and discussed in detail for each case.

**Subject Areas:** Optimization; Smart grids; Batteries; Plug-in hybrid electric vehicles; Customer satisfaction

**Availability:** : Darabi, Z., Fajri, P. and Ferdowsi, M., 2017. *Intelligent Charge Rate Optimization of PHEVs Incorporating Driver Satisfaction and Grid Constraints*. IEEE Transactions on Intelligent Transportation Systems, 18(5), pp.1325-1332.  
<http://ieeexplore.ieee.org/abstract/document/7744591/>

## **2.11. Title: Energy Demand Model for Residential Sector: A First Principles Approach**

**Authors:** Subbiah, R., Pal, A., Nordberg, E.K., Marathe, A. and Marathe, M.V.

**Abstract:** According to the U.S. Energy Information Administration (EIA), the residential sector accounts for one-third of the country's energy consumption. This number is steadily increasing, posing a challenge to energy regulators as well as suppliers. To manage the growing demand for energy, there is a need for energy system optimization, especially on the demand side. This paper uses a first principles approach to build a high-resolution energy demand model, which can be used as a test bed by academicians as well as policy makers for performing such optimizations. This framework generates activity-based, building-level, time-dependent demand profiles. The model associates appliance usage with each household activity and calculates energy consumption based on the appliance energy rating, the duration of the energy consuming activity, and the type of activity performed by each household member. It also accounts for shared activities among household members to avoid double counting. Additionally, passive energy consumptions such as space heating/cooling, lighting, etc. are measured. Finally, validation of the results obtained by this model against real-world data for Virginia is carried out. The results indicate that the modeling framework is robust and can be extended to other parts of the U.S. and beyond.

**Subject Areas:** Activity-based, Appliance Usage; Energy demand; Residential

**Availability:** Subbiah, R., Pal, A., Nordberg, E.K., Marathe, A. and Marathe, M.V., 2017. *Energy Demand Model for Residential Sector: A First Principles Approach*. IEEE Transactions on Sustainable Energy, PP (99).

<http://ieeexplore.ieee.org/abstract/document/7744591/>

**2.12. Title: The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the U.S.: A Retrospective and Prospective Analysis**

**Authors:** Greene, D.L. and Welch, J.G.

**Abstract:** Lower income households tend to spend more on motor fuel than on vehicles while households in the highest income quintile tend to spend more on vehicles (NRC, 2015; CFA, 2012). This observation suggests that the regulatory standards that require increased fuel economy but at the cost of higher vehicle prices might affect the distribution of disposable income in the United States. This study analyzes the effects of historical increases in fuel economy on households' expenditures on fuel and vehicles over the past four decades and quantifies the impacts by income quintile. Distributional impacts are also estimated for future fuel economy improvements which are expected to increase through 2025 given fuel economy standards currently in place. We do not estimate the effects of fuel economy improvements on producer and consumer surplus. Rather we estimate the impacts of fuel economy improvements on disposable income: the difference between decreased expenditures on fuel and increased expenditures on motor vehicles.

**Subject Areas:** Fuel Economy; Expenditure per Vehicle

**Availability:** Greene, D.L. and Welch, J.G., 2017. *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the U.S.: A Retrospective and Prospective Analysis*. The Howard H. Baker Jr. Center for Public Policy.

<http://bakercenter.utk.edu/wp-content/uploads/2017/03/WhitePaper2-2017.pdf>

### **2.13. Title: Experiences and Applications of Electric and Plug-in Hybrid Vehicles in Power System Networks**

**Authors:** Ozansoy, C., Ustun, T.S. and Zayegh, A.

**Abstract:** Transportation electrification is inevitable driven by rising energy costs, climate and emission control requirements, and availability of petroleum supplies. Even a realistic 10% electrification of transportation is expected to impact the electricity generation, transmission, and distribution capacities, and hence the world economy. In this chapter, the authors seek to enlighten the reader on electric vehicle usage around the world by discussing their applications, electric vehicle trials, and key learnings from these trials across three continents: America, Europe, and Australia. Special emphasis has been given to discussing the commuting trends across the three continents and how that effects the transition into the electrification of transportation. The chapter continues with an impact analysis of electric vehicles on car users, the power quality of grids, and finally carbon emissions. Finally, examples of charging infrastructure and worldwide vehicle-to-grid applications are reviewed. The chapter concludes with a discussion on the need for interoperable communication standards, as an enabling technology for the management of the transactions between the grid and electric vehicles.

**Subject Areas:** Electric vehicles; Grids; Impacts; Trials; Usage

**Availability:** Ozansoy, C., Ustun, T.S. and Zayegh, A., 2017. *Experiences and Applications of Electric and Plug-in Hybrid Vehicles in Power System Networks*. Technologies and Applications for Smart Charging of Electric and Plug-in Hybrid Vehicles (pp. 243-280). Springer International Publishing.

[https://link.springer.com/chapter/10.1007/978-3-319-43651-7\\_7](https://link.springer.com/chapter/10.1007/978-3-319-43651-7_7)

#### **2.14. Title: A Review of Literature on Espousal of Electric and Hybrid Vehicle**

**Authors:** Sharma, N.K. and Sinha, D.B.

**Abstract:** According to National Electric Mobility Mission Plan (NEMMP) 2020 launched on 9th Jan 2013, under National Electric Vehicle Policy, the principal end objectives of the National Mission for Electric Mobility (NMEM) are national energy security, mitigation of the adverse impact of vehicles on the environment and growth of domestic manufacturing capabilities. NMEM that was approved by the National Council for Electric Mobility (NCEM), as per the projections, 6-7 million units of new vehicle sales of the full range of electric vehicles, along with resultant liquid fuel savings of 2.2-2.5 million tones can be achieved in 2020. This will also result in substantial lowering of vehicular emissions and decrease in carbon di-oxide emissions by 1.3% to 1.5% in 2020 as compared to a status quo scenario. An extensive review of published evidence for the last 20 years across the world carried out in order to capture current knowledge in the area of adoption and absorption of electric and hybrid vehicles (EHVs).

**Subject Areas:** Electric and Hybrid Vehicles; Attitude; Behavior

**Availability:** Sharma, N.K. and Sinha, D.B., 2017. *A Review of Literature on Espousal of Electric and Hybrid Vehicle*. International Journal of Business Management and Scientific Research, (27). <http://eminencejournal.com/images/pdf/MC6.pdf>



## **2.15. Title: San Francisco's 2030 District: Performance and Implications for Urban Energy Efficiency**

**Authors:** Johnstone, E.

**Abstract:** Buildings are responsible for 40% of the United States' total energy consumption and a proportionate amount of greenhouse gas emissions. Transportation activities are responsible for another 30%, of which a significant amount is linked to workers' daily commutes by car. Individual investments in home energy retrofits are helpful in the fight against climate change, but the greatest opportunities in the built environment lie with commercial properties in urban cores. As one of 15 cities subscribed to the 2030 Challenge, San Francisco has organized 40+ downtown properties to reduce their aggregate energy consumption and commuter-based emissions by 50-100% by 2030. This master's project analyzes energy consumption by District properties against a city-established baseline and reduction target. It also calculates a commuter emissions baseline for the San Francisco 2030 District (SF2030D), and compares it to the District's current performance as measured by a custom survey. The results show that SF2030D has outperformed its peers and reached its 2030 energy target within its first reportable year (2016). These findings have significant implications for the 2030 Challenge's design, and may position SF2030D as a leader in the pursuit of energy efficiency innovations at the district scale. (EHVs).

**Subject Areas:** Energy consumption; Greenhouse gas emission; Transportation activities

**Availability:** Johnstone, E., 2017. *San Francisco's 2030 District: Performance and Implications for Urban Energy Efficiency*. M.S. Thesis, Nicholas School of the Environment of Duke University.

[https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/14122/Johnstone\\_E\\_MP\\_2017.pdf?sequence=1](https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/14122/Johnstone_E_MP_2017.pdf?sequence=1)

## 2.16. Title: A Dynamic Stochastic Optimization for Recharging Plug-in Electric Vehicles

**Author:** Liu, S. and Etemadi, A.H.

**Abstract:** Abstract: This paper presents a recharging scheme for plugin (hybrid) electric vehicles. Despite their many advantages such as reducing carbon footprint, lower fuel costs, and high performance, uncoordinated recharging of electric vehicles in a high-penetration system can increase system peak load and create new peaks in the demand profile, hence reducing system reliability and operational integrity. To optimize electric vehicle recharging costs and prevent such reliability problems, a dynamic stochastic optimization method is proposed that formulates a stochastic linear programming approach taking into account load, electricity pricing, and renewable energy generation uncertainties, and solves the day-ahead problem in an offline fashion. A second online stage is also proposed that uses offline solutions, collects real-time system data, and adjusts recharging schedules to obtain a better recharging scheme once system uncertainties are revealed. The proposed method is robust to variations in different stochastic parameters, has a low communication requirement, and benefits both users and the power utility. Recharging system structure, data models, and mathematical formulation of the proposed method are presented. Results demonstrate that unlike other recharging schemes, the proposed method does not increase system peak, does not create new peaks, and fills the valleys of demand profile to optimize power system operations.

**Subject Areas:** Stochastic linear programming; Electric vehicle, Recharging Schemes

**Availability:** Liu, S. and Etemadi, A.H., 2017. *A Dynamic Stochastic Optimization for Recharging Plug-in Electric Vehicles*. IEEE Transactions on Smart Grid, PP(99).

<http://ieeexplore.ieee.org/abstract/document/7815433/>

**2.17. Title: A Data-Driven Optimization-Based Approach for Siting and Sizing of Electric Taxi Charging Stations**

**Author:** Yang, J., Dong, J. and Hu, L.

**Abstract:** This paper presents a data-driven optimization-based approach to allocate chargers for battery electric vehicle (BEV) taxis throughout a city with the objective of minimizing the infrastructure investment. To account for charging congestion, an M/M/x/s queueing model is adopted to estimate the probability of BEV taxis being charged at their dwell places. By means of regression and logarithmic transformation, the charger allocation problem is formulated as an integer linear program (ILP), which can be solved efficiently using Gurobi solver. The proposed method is applied using large-scale GPS trajectory data collected from the taxi fleet of Changsha, China. The key findings from the results include the following: (1) the dwell pattern of the taxi fleet determines the siting of charging stations; (2) by providing waiting spots, in addition to charging spots, the utilization of chargers increases and the number of required chargers at each site decreases; and (3) the tradeoff between installing more chargers versus providing more waiting spaces can be quantified by the cost ratio of chargers and parking spots.

**Subject Areas:** Electric taxis; Charging infrastructure planning; GPS trajectory data; Integer programming; Queueing model

**Availability:** Yang, J., Dong, J. and Hu, L., 2017. *A Data-Driven Optimization-Based Approach for Siting and Sizing of Electric Taxi Charging Stations*. *Transportation Research Part C: Emerging Technologies*, 77, pp.462-477.

<http://www.sciencedirect.com/science/article/pii/S0968090X17300542>

## 2.18. Title: Model-Based Analysis of V2G Impact on Battery Degradation

**Authors:** Wang, L. and Chen, B.

**Abstract:** Vehicle-to-Grid (V2G) service has a potential to improve the reliability and stability of the electrical grid due to the ability of providing bi-directional power flow from/to the grid. However, frequent charging/discharging may impact the battery lifetime. This paper presents the analysis of battery degradation in three scenarios. In the first scenario, different battery capacities are considered. In the second scenario, the battery degradation with various depth of discharge (DOD) are studied. In the third scenario, the capacity loss due to different charging regime are compared. The charging/discharging of plug-in electric vehicles (PEVs) are simulated in a single-phase microgrid system integrated with a photovoltaics (PV) farm, an energy storage system (ESS), and ten electric vehicle service equipment (EVSE). The battery degradation model is an energy throughput model, which is developed based on the Arrhenius equation and a power law relationship between time and capacity fading. The simulation results show that V2G service potentially increases the PEV battery degradation. With the same DOD, higher battery capacity can increase the degradation degree. For a specific PEV battery, the higher DOD, higher temperature, and more frequent discharging accelerate the battery degradation to some extent.

**Subject Areas:** Electric vehicles; Batteries; Energy storage systems; Vehicle to grid (V2G)

**Availability:** Wang, L. and Chen, B., 2017. *Model-Based Analysis of V2G Impact on Battery Degradation*. . SAE Technical Paper, (2017-01-1699).  
<http://papers.sae.org/2017-01-1699/>

## **2.19. Title: Environmentally-friendly Demand Response for Residential Plug-in Electric Vehicles**

**Authors:** Rassaei, F., Soh, W.S., Chua, K.C. and Modarresi, M.S.

**Abstract:** In December 2015, the world has reached an agreement in Paris by which many countries commit to bolster their efforts about reducing adverse climate changes. Hence, we can expect that decarbonization will even attract more attention in different energy sectors in near future. In particular, both generation side and consumption side are required to be run more congruently and environmentally friendly. Thus, employing the renewables at the generation side along with our proposed decarbonized demand response (DDR) at the consumption side could significantly reduce deleterious impacts on the climate. In this paper, we present such matching demand response (DR) algorithm for residential users owning vehicle-to-grid (V2G) enabled plug-in electric vehicles (PEVs) who obtain electricity from a common retailer. The retailer itself is connected to the wholesale electricity market to purchase and sell electricity. Our simulation results illustrate that substantial cost savings can be achieved along with pollution reduction by our proposed technique.

**Subject Areas:** Vehicle to grid (V2G); Climate change; Plug-in electric vehicles (PEVs); Power demand elasticity; Residential load, Smart grids

**Availability:** Rassaei, F., Soh, W.S., Chua, K.C. and Modarresi, M.S., 2017. *Environmentally-friendly Demand Response for Residential Plug-in Electric Vehicles*. In Power and Energy Conference (TPEC), IEEE Texas (pp. 1-6). IEEE.

<http://ieeexplore.ieee.org/abstract/document/7868269/>

## **2.20. Title: Distribution System Planning to Accommodate Distributed Energy Resources and PEVs**

**Authors:** Humayd, A.S.B. and Bhattacharya, K.

**Abstract:** With deregulation of the power industry, environmental policy changes, advancements in technology, and the transformation to smart grid, the distribution planning paradigm has gone through significant changes in recent years. Concurrently, with increase in gas prices, driven by a foreseeable fossil fuel depletion in the future, developments in the automotive sector, and environmental concerns, penetration of plug-in electric vehicles (PEVs) has been increasing. These changes will continue to drive the distribution planning problem to evolve in the coming years. This paper presents a comprehensive long-term distribution planning framework from the perspective of local distribution companies (LDCs) considering distributed generation (DG), substations, capacitors, and feeders. Apart from considering the usual demand profile, the proposed framework considers uncontrolled and controlled (smart) PEV charging demand, as well as demand response (DR) options. Based on a back-propagation algorithm combined with cost-benefit analysis, a novel approach is proposed to determine the optimal upgrade plan, allocation, and sizing of the selected components in distribution systems, to minimize the total capital and operating cost. A new iterative method is proposed which involves post-processing the plan decisions to guarantee acceptable adequacy levels for each year of the planning horizon. The performance of the proposed framework is examined considering several case studies on the 33-bus and 69-bus test systems. It is noted from the studies that the presence of uncontrolled PEV charging loads results in much higher plan costs as compared to the case without PEVs, impacts the distribution plan significantly, and hence these loads indeed need be considered in the planning process. On the other hand, smart charging of PEVs have a much reduced impact on the plan cost, and helps alleviate some investments which were needed with uncontrolled charging PEVs. Therefore, the LDCs and policy makers need to encourage customers to adapt these options in the long-run.

**Subject Areas:** Distributed generation; Distribution planning; Local distribution company; Plug-in electric vehicles; Demand response

**Availability:** Humayd, A.S.B. and Bhattacharya, K., 2017. *Distribution System Planning to Accommodate Distributed Energy Resources and PEVs*. Electric Power Systems Research, 145, pp.1-11.

<http://www.sciencedirect.com/science/article/pii/S0378779616305296>

**2.21. Title: Optimal Design of Electric Vehicle Charging Stations Considering Various Energy Resources**

**Authors:** Hafez, O. and Bhattacharya, K.

**Abstract:** In this paper the optimal design of an Electric Vehicle Charging Station (EVCS) with the goal of minimizing the lifecycle cost, while taking into account environmental emissions, is presented. Different energy sources such as renewable energy technology based and diesel generation are considered, with realistic inputs on their physical, operating and economic characteristics. In order to address the "range anxiety", concern of EV owners regarding the distance the vehicle can travel, the design of an EVCS along highways, as an isolated microgrid, is studied. In another study, the EVCS is assumed to be connected to the grid as a smart energy hub. The charging demand of the EVCS is estimated considering real drive data. Analysis is also carried out to compare the economics of a grid-connected EVCS with an isolated EVCS and the optimal break-even distance for the grid connected EVCS to be a viable option, is determined.

**Subject Areas:** Electric vehicle charging station; Renewable energy; Plug-in electric vehicle; Microgrid; Environmental emissions

**Availability:** Hafez, O. and Bhattacharya, K., 2017. *Optimal Design of Electric Vehicle Charging Stations Considering Various Energy Resources*. Renewable Energy, 107, pp.576-589.

[https://www.researchgate.net/publication/313685398\\_Optimal\\_design\\_of\\_electric\\_vehicle\\_charging\\_stations\\_considering\\_various\\_energy\\_resources](https://www.researchgate.net/publication/313685398_Optimal_design_of_electric_vehicle_charging_stations_considering_various_energy_resources)

## **2.22. Title: Reliability Studies of Modern Distribution Systems Integrated with Renewable Generation and Parking Lots**

**Authors:** Farzin, H., Fotuhi-Firuzabad, M. and Moeini-Aghaie, M.

**Abstract:** This paper investigates the role of parking lots in improving the reliability of renewable-based distribution systems, through provision of vehicle-to-grid (V2G) programs during outage events. In this regard, municipal parking decks are viewed as distributed energy storage systems and the amount of available energy from these units in random contingency events is probabilistically modeled for reliability studies. Appropriate stochastic models are also introduced to capture the volatility and intermittency of renewable sources. Moreover, it is discussed that how the adopted outage management scheme (OMS) in contingency events can affect the reliability level of customers. In response, several OMSs on the basis of bankruptcy problem are proposed to fairly distribute the available resources among different microgrids/sections, once a failure occurs in the system. Subsequently, a general framework based on the non-sequential Monte Carlo simulation method is developed to evaluate different customers and system reliability indices in presence of emergency V2G programs. The effectiveness of the proposed framework is validated through implementation on a test system and several case studies are presented. The results suggest that realization of V2G programs offered by EV parking lots, accompanied by an appropriate OMS, can significantly enhance the reliability of supply in modern distribution networks.

**Subject Areas:** Reliability; Renewable energy sources (RESs); Parking deck; Batteries

**Availability:** Farzin, H., Fotuhi-Firuzabad, M. and Moeini-Aghaie, M., 2017. *Reliability Studies of Modern Distribution Systems Integrated with Renewable Generation and Parking Lots*. IEEE Transactions on Sustainable Energy, 8(1), pp.431-440.

<http://www.mdpi.com/2071-1050/9/2/323/htm>



### **2.23. Title: A MPC-Based PEV Charging Scheduling**

**Authors:** Tang, W. and Zhang, Y.J.A.

**Abstract:** Recall that in Chap. 2, the controller of PEV charging station relies on no assumptions nor predictions of the future information. Whereas in this chapter, we study another practical scenario, where the non-causal information about future PEV arrivals is not known in advance, but its statistical information can be estimated. In fact, the statistical information of the future charging demands can often be acquired through historic data, which benefits the control of the PEV charging scheduling in practical scenarios.

**Subject Areas:** Plug-in Electric Vehicle (PEV); Energy

**Availability:** Tang, W. and Zhang, Y.J.A., 2017. *A MPC-Based PEV Charging Scheduling*. In *Optimal Charging Control of Electric Vehicles in Smart Grids* (pp. 47-76). Springer International Publishing.

[https://link.springer.com/chapter/10.1007/978-3-319-45862-5\\_3](https://link.springer.com/chapter/10.1007/978-3-319-45862-5_3)

## **2.24. Title: Decentralized Electric Vehicle Charging Strategies for Reduced Load Variation and Guaranteed Charge Completion in Regional Distribution Grids**

**Authors:** Zhang, W., Zhang, D., Mu, B., Wang, L.Y., Bao, Y., Jiang, J. and Morais, H.

**Abstract:** A novel, fully decentralized strategy to coordinate charge operation of electric vehicles is proposed in this paper. Based on stochastic switching control of on-board chargers, this strategy ensures high-efficiency charging, reduces load variations to the grid during charging periods, achieves charge completion with high probability, and accomplishes approximate “valley-filling”. Further improvements on the core strategy, including individualized power management, adaptive strategies, and battery support systems, are introduced to further reduce power fluctuation variances and to guarantee charge completion. Stochastic analysis is performed to establish the main properties of the strategies and to quantitatively show the performance improvements. Compared with the existing decentralized charging strategies, the strategies proposed in this paper can be implemented without any information exchange between grid operators and electric vehicles (EVs), resulting in a communications cost reduction. Additionally, it is shown that by using stochastic charging rules, a grid-supporting battery system with a very small energy capacity can achieve substantial reduction of EV load fluctuations with high confidence. An extensive set of simulations and case studies with real-world data are used to demonstrate the benefits of the proposed strategies.

**Subject Areas:** Battery storage system; decentralized charging strategy; Distribution grid; Electric vehicle; Load variation

**Availability:** Zhang, W., Zhang, D., Mu, B., Wang, L.Y., Bao, Y., Jiang, J. and Morais, H., 2017. *Decentralized Electric Vehicle Charging Strategies for Reduced Load Variation and Guaranteed Charge Completion in Regional Distribution Grids*. *Energies*, 10(2), p.147.

<http://www.mdpi.com/1996-1073/10/2/147/htm>

## 2.25. Title: Development of a Control System for a Series-Parallel Plug-In Hybrid Electric Vehicle

**Author:** Lebel, A.

**Abstract:** This thesis outlines the development of a control system for a series-parallel plugin hybrid electric vehicle. The vehicle, developed at McMaster University for the EcoCAR 3 Advanced Vehicle Technology Competition, was produced in an effort to provide a Chevrolet Camaro with a high-performance, fuel efficient, hybrid powertrain.

A rational design methodology was adopted and guided the development of the control system and the implementation of its respective algorithms. A simulation tool was created using MATLAB and Simulink which, in turn, allowed for the effectiveness of the supervisory control logic to be evaluated by approximating the vehicle's energy consumption, fuel consumption, and emissions. The impact of hybridizing the vehicle's powertrain was similarly assessed by comparing it against its un-electrified counterpart, the 2016 Chevrolet Camaro LT. A solution to the vehicle's energy management problem was proposed in the form of an Adaptive Equivalent Consumption Minimization Strategy (A-ECMS) which was then evaluated against more common heuristic approaches as well as non-adaptive instantaneous minimization methods. An artificial neural network was selected as the strategy's adaptation mechanism and it was used to identify specific vehicular driving patterns in real-time. The neural network addresses many issues that arise due to the sensitivity of algorithms that attempt to solve the energy management problem without prior knowledge of the driving cycle.

The methods used during the process of the control system's verification and calibration are also discussed in this thesis and, in addition, encompass the use of software representations of the vehicle's Electronic Control Units (ECUs), the development of test cases, and the supervisory control software's evaluation in the Model-in-the-Loop (MIL), Software-in-the-Loop (SIL), and Hardware-in-the-Loop (HIL) environments.

**Subject Areas:** Plugin hybrid electric vehicle; Energy consumption

**Availability:** Lebel, A., 2017. *Development of a Control System for a Series-Parallel Plug-In Hybrid Electric Vehicle*. M.S. Thesis, McMaster University.

[file:///Users/Apara/Downloads/Lebel\\_Alexander\\_M\\_March2017\\_MASc.pdf](file:///Users/Apara/Downloads/Lebel_Alexander_M_March2017_MASc.pdf)

## 2.26. Title: Opportunistic Energy Sharing Between Power Grid and Electric Vehicles: A Game Theory-Based

**Authors:** Sarker, A., Li, Z., Kolodzey, W. and Shen, H.

**Abstract:** Electric vehicles (EVs) have great potential to reduce dependency on fossil fuels. The recent surge in the development of online EV (OLEV) will help to address the drawbacks associated with current generation EVs, such as the heavy and expensive batteries. OLEVs are integrated with the smart grid of power infrastructure through a wireless power transfer system (WPT) to increase the driving range of the OLEV. However, the integration of OLEVs with the grid creates a tremendous load for the smart grid. The demand of a power grid changes over time and the price of power is not fixed throughout the day. There should be some congestion avoidance and load balancing policy implications to ensure quality of services for OLEVs. In this paper, first, we conduct an analysis to show the existence of unpredictable power load and congestion because of OLEVs. We use the Simulation for Urban Mobility tool and hourly traffic counts of a road section of the New York City to analyze the amount of energy OLEVs can receive at different times of the day. Then, we present a game theory based on a distributed power schedule framework to find the optimal schedule between OLEVs and smart grid. In the proposed framework, OLEVs receive the amount of power charging from the smart grid based on a power payment function which is updated using best response strategy. We prove that the updated power requests converge to the optimal power schedule. In this way, the smart grid maximizes the social welfare of OLEVs, which is defined as mixed consideration of total satisfaction and its power charging cost. Finally, we verify the performance of our proposed pricing policy under different scenarios in a simulation study.

**Subject Areas:** Electric vehicles; Online electric vehicles; Wirelesspower transfer; Smart grid

**Availability:** Sarker, A., Li, Z., Kolodzey, W. and Shen, H., 2017. *Opportunistic Energy Sharing Between Power Grid and Electric Vehicles: A Game Theory-Based*. University of Virginia <http://www.cs.virginia.edu/z15uq/paper/conference/Opportunistic-ICDCS2017.pdf>

**2.27. Title: Energy Efficiency Mandates Are Worse for Poor Americans Than Energy Taxes**

**Author:** Bailey, R.

**Abstract:** Blog

**Subject Areas:** Energy efficiency standard; Energy taxes

**Availability:** Bailey, R., 2017. *Energy Efficiency Mandates Are Worse for Poor Americans Than Energy Taxes*. Reason.com Blog.

<http://reason.com/archives/2017/01/27/energy-efficiency-standards-are-worse-fo>

## 2.28. Title: Smart Operation of Four-Quadrant Electric Vehicle Chargers in Distribution Grids

**Author:** Restrepo, M.

**Abstract:** Many policies and programs adopted in the context of climate change mitigation and substitution of fossil fuels are contributing to the continuous development and growth of Electric Vehicles (EVs) in urban mobility systems, reaching 1.26 million units on the roads through the end of 2015. Even though the increasing number of EVs will create problems in distribution systems, which can be mitigated using smart charging strategies, there will also be economic opportunities for EV owners to provide services to the grid while their vehicle are parked and plugged in, a concept known as Vehicle-to-Grid (V2G). Most of the studies on V2G have concentrated on the provision of services such as frequency regulation or spinning reserves, which may reduce the battery life because of the required extra charging/discharging cycles, and little attention has been paid to the possibility of providing reactive power control services to the grid by using the ac/dc converter and the dc link capacitor available in most advanced chargers, a practice that does not compromise the vehicle battery life. These kinds of chargers, which are known as four-quadrant EV chargers due to the capability of being operated in all quadrants of the P-Q plane, can be used in distribution networks to improve the power factor and help regulate voltage, thus facilitating larger EV penetrations, as discussed in this thesis.

In the first part of this thesis, a new average model of a single-phase, four-quadrant EV charger is developed. The steady-state and step responses of the proposed model for different P-Q requests, corresponding to the operation in the four quadrants of the P-Q plane, are used to validate its performance against a four-quadrant EV charger prototype. The model is shown to be useful for efficient time-domain simulations and studies that include a number of EV chargers, such as EV integration studies in Low-Voltage (LV) distribution networks. A practical case study is presented to demonstrate and test the performances of the four-quadrant charger and its model, investigating the voltage interactions of several chargers in an LV residential network during the provision of three vehicle-to-grid (V2G) strategies for active and reactive power.

In the second part, a novel three-stage algorithm to coordinate the operation of four-quadrant EV chargers with other volt/var control devices in Medium-Voltage (MV) and LV distribution feeders is proposed. The first stage of the algorithm is operated on a day-ahead basis and defines the Load Tap Changer (LTC) and capacitor schedules while minimizing the peak load associated with EVs in the distribution system. The second and third stages update their operation every five minutes, to fairly allocate the aggregated and individual EV loads in the MV and LV feeders, respectively, while minimizing active power losses and voltage deviations. The proposed technique is applied to CIGRE's North-American MV and LV benchmark systems to demonstrate its ability to properly allocate EV loads, and improve distribution system performance in terms of losses and voltage profiles.

**Subject Areas:** Electric Vehicle; Vehicle-to-Grid (V2G)

**Availability:** Restrepo, M., 2017. *Smart Operation of Four-Quadrant Electric Vehicle Chargers in Distribution Grids* Doctoral Thesis, University of Waterloo, Ontario, Canada.

[https://uwspace.uwaterloo.ca/bitstream/handle/10012/11870/RestrepoRestrepo\\_Mauricio.pdf?sequence=3&isAllowed=y](https://uwspace.uwaterloo.ca/bitstream/handle/10012/11870/RestrepoRestrepo_Mauricio.pdf?sequence=3&isAllowed=y)

**2.29. Title: A Second Order Cone Programming Model for Planning PEV Fast-Charging Stations**

**Author:** Zhang, H., Moura, S., Hu, Z., Qi, W. and Song, Y.

**Abstract:** This paper studies siting and sizing of plug-in electric vehicle (PEV) fast-charging stations on coupled transportation and power networks. We develop a closed-form service rate model of PEV fast-charging stations' service abilities, which considers heterogeneous PEV driving ranges and charging demands. We utilize a modified capacitated flow refueling location model based on sub-paths (CFRLM SP) to explicitly capture time varying PEV charging demands on the transportation network under driving range constraints. We explore extra constraints of the CFRLM SP to enhance model accuracy and computational efficiency. We then propose a stochastic mixed-integer second order cone programming (SOCP) model for PEV fast-charging station planning. The model considers the transportation network constraints of CFRLM SP and the power network constraints with AC power flow. Numerical experiments are conducted to illustrate the effectiveness of the proposed method.

**Subject Areas:** Plug-in electric vehicle; Charging station; Heterogeneous driving ranges; Transportation; Power system; Second order cone programming.

**Availability:** Zhang, H., Moura, S., Hu, Z., Qi, W. and Song, Y., 2017. *A Second Order Cone Programming Model for Planning PEV Fast-Charging Stations*. IEEE, arXiv preprint.

<https://arxiv.org/pdf/1702.01897.pdf>

### **2.30. Title: Robust Frequency Regulation Capacity Scheduling Algorithm for Electric Vehicles**

**Author:** Yao, E., Wong, V.W. and Schober, R.

**Abstract:** Electric vehicles (EVs) have the potential to provide frequency regulation service to an independent system operator (ISO) by changing their real-time charging or discharging power according to an automatic generation control (AGC) signal. Recently, the Federal Energy Regulatory Commission has issued Order 755 to ISOs to introduce a performance-based compensation scheme in the frequency regulation market. The goal is to provide economic incentives for fast ramping resources such as EVs to participate in the market. In this paper, we model the EV frequency regulation service under the performance-based compensation scheme. Thereby, a robust optimization framework is adopted for the formulation of a frequency regulation capacity scheduling problem. Our problem formulation takes into account the performance-based compensation scheme, the random AGC signal, and the dynamic arrival and departure times of the EVs. We propose an efficient algorithm to solve the formulated problem. Simulation results show that the proposed algorithm improves the revenue under the performance-based compensation scheme compared with a benchmark algorithm.

**Subject Areas:** Electric vehicles; Frequency regulation; Robust optimization; Scheduling algorithm

**Availability:** Yao, E., Wong, V.W. and Schober, R., 2017. *Robust Frequency Regulation Capacity Scheduling Algorithm for Electric Vehicles*. IEEE Transactions on Smart Grid, 8(2), pp.984-997. [https://scholar.google.com/scholar?start=220&q=NHTS+%22National+Household+Travel+Survey%22&hl=en&as\\_sdt=0,21&as\\_ylo=2017&as\\_yhi=2017](https://scholar.google.com/scholar?start=220&q=NHTS+%22National+Household+Travel+Survey%22&hl=en&as_sdt=0,21&as_ylo=2017&as_yhi=2017)



### **2.31. Title: Mitigation of the Impact of High Plug-in Electric Vehicle Penetration on Residential Distribution Grid Using Smart Charging Strategies**

**Authors:** Cao, C., Wang, L. and Chen, B.

**Abstract:** Vehicle electrification presents a great opportunity to reduce transportation greenhouse gas emissions. The greater use of plug-in electric vehicles (PEVs), however, puts stress on local distribution networks. This paper presents an optimal PEV charging control method integrated with utility demand response (DR) signals to mitigate the impact of PEV charging to several aspects of a grid, including load surge, distribution accumulative voltage deviation, and transformer aging. To build a realistic PEV charging load model, the results of National Household Travel Survey (NHTS) have been analyzed and a stochastic PEV charging model has been defined based on survey results. The residential distribution grid contains 120 houses and is modeled in GridLAB-D. Co-simulation is performed using Matlab and GridLAB-D to enable the optimal control algorithm in Matlab to control PEV charging loads in the residential grid modeled in GridLAB-D. Simulation results demonstrate the effectiveness of the proposed optimal charging control method in mitigating the negative impacts of PEV charging on the residential grid.

**Subject Areas:** Demand Response (DR); Gridlab-D; Plug-in Electric Vehicle (PEV) Charging; Power Distribution System

**Availability:** Cao, C., Wang, L. and Chen, B., 2016. *Mitigation of the Impact of High Plug-in Electric Vehicle Penetration on Residential Distribution Grid Using Smart Charging Strategies*. *Energies*, 9(12), p.1024.

<http://www.mdpi.com/1996-1073/9/12/1024/html>

### **2.32. Title: Modeling of Plug-in Electric Vehicle Travel Patterns and Charging Load Based on Trip Chain Generation**

**Authors:** Wang, D., Gao, J., Li, P., Wang, B., Zhang, C. and Saxena, S.

**Abstract:** Modeling PEV travel and charging behavior is the key to estimate the charging demand and further explore the potential of providing grid services. This paper presents a stochastic simulation methodology to generate itineraries and charging load profiles for a population of PEVs based on real-world vehicle driving data. In order to describe the sequence of daily travel activities, we use the trip chain model which contains the detailed information of each trip, namely start time, end time, trip distance, start location and end location. A trip chain generation method is developed based on the Naive Bayes model to generate a large number of trips which are temporally and spatially coupled. We apply the proposed methodology to investigate the multi-location charging loads in three different scenarios. Simulation results show that home charging can meet the energy demand of the majority of PEVs in an average condition. In addition, we calculate the lower bound of charging load peak on the premise of lowest charging cost. The results are instructive for the design and construction of charging facilities to avoid excessive infrastructure.

**Subject Areas:** Multi-location charging; Electric power systems; Plug-in electric vehicle; Trip chain; Naive Bayes model

**Availability:** Wang, D., Gao, J., Li, P., Wang, B., Zhang, C. and Saxena, S., 2017. *Modeling of Plug-in Electric Vehicle Travel Patterns and Charging Load Based on Trip Chain Generation*. Journal of Power Sources, 359, pp.468-479.

<http://www.sciencedirect.com/science/article/pii/S0378775317306687>

### **2.33. Title: Optimal allocation for electric vehicle charging stations using Trip Success Ratio**

**Authors:** Alhazmi, Y.A., Mostafa, H.A. and Salama, M.M.

**Abstract:** This paper proposes a new model for optimally allocating Plug-in Electric Vehicle (PEV) Charging Stations (CSs) in the network. The model considers Trip Success Ratio (TSR) in order to enhance CS accessibility for PEV drivers. Diversity of usage and different driving habits are considered in the presented model, as well as different trip types (In-city, Highway). The allocation model has two stages: modeling TSR to estimate Charging Station Service Range (CSSR), and the CS allocation stage. In the first stage, the service range of charging stations has been estimated using TSR with consideration of the uncertainty of trip distances (In-city, Highway) and the uncertainty in the Remaining Electric Range (RER) of PEVs. The estimated CSSR is utilized in the CS allocation stage in order to optimize the CS location set that covers the network with a certain guaranteed TSR level. The allocation problem has been formulated as the Maximum Covering Location Problem (MCLP) in order to make the optimal decision for allocating CSs in the network.

**Subject Areas:** Plug-in electric vehicles; Service range; Siting charging stations; Trip Success Ratio

**Availability:** Alhazmi, Y.A., Mostafa, H.A. and Salama, M.M., 2017. *Optimal allocation for electric vehicle charging stations using Trip Success Ratio*. . International Journal of Electrical Power & Energy Systems, 91, pp.101-116.

<http://www.sciencedirect.com/science/article/pii/S0142061516314260>

### **2.34. Title: Estimating the Benefits of Fuel Economy Information: An Analysis, Update and Recommendations for Enhancing ORNL's Methodology**

**Authors:** Greene, D.L. and Welch, J.G.

**Abstract:** Since the mid-1970s, the federal government has produced and published information on the fuel economy of new passenger cars and light trucks as required by statute (EPA, 2017a). Beginning in 1999, the Department of Energy (DOE) and Oak Ridge National Laboratory (ORNL) established a website to more efficiently provide fuel economy information to the public. This report reviews the methods and data used by DOE/ORNL to estimate the dollar and petroleum savings due to their fuel economy information efforts. We find that the methods used to estimate savings are reasonable and appropriately transparent, given the existing state of knowledge and available data. Where possible, we updated time-sensitive data. However, empirical data are lacking for many of the key steps in the estimation process which forced DOE/ ORNL to make plausible assumptions about important parameters. In general, conservative assumptions have been used, reflecting a preference for under-estimating the program's benefits. In a few cases we recommend even more conservative estimates. We carried out an analysis of the sensitivity of estimated benefits to uncertain parameters. Parameters were grouped into three classes and assigned approximate uncertainty ranges: 1) well supported by empirical data (+/- 10%), 2) supported by incomplete or indirect empirical evidence (+/-20%) or 3) plausible conjectures (+/-50%). Ten thousand Monte Carlo simulations each were run using first uniform and then triangular probability distributions. Estimated dollar savings in 2016 due to the program's activities in that year alone ranged from a minimum of \$40 million to a maximum of \$220 million. Estimated savings in all future years due to the program's 2016 activities ranged from \$230 million to \$1.7 billion. Petroleum savings and estimated greenhouse gas (GHG) reductions were of similar magnitude. We consider the finding that the impacts of the program are orders of magnitude larger than the program's cost to be reasonably robust. Sensitivity analysis indicated that assumptions about the fraction of new car buyers visiting the website ([www.fueleconomy.gov](http://www.fueleconomy.gov)) who changed their new car choices as a result of their visit had the greatest impact on estimated benefits. Next in importance was the increase in fuel economy resulting from information obtained from the website. We make specific recommendations concerning periodic updating of data and the use of online surveys of website customers to develop empirical support of key parameters.

**Subject Areas:** Fuel economy; New car choices; Monte Carlo simulations; Sensitivity analysis

**Availability:** Greene, D.L. and Welch, J.G., 2017. *Estimating the Benefits of Fuel Economy Information: An Analysis, Update and Recommendations for Enhancing ORNL's Methodology*. Oak Ridge National Laboratory and Howard H. Baker Jr. Center for Public Policy. <http://bakercenter.utk.edu/wp-content/uploads/2017/03/WhitePaper1-2017.pdf>

**2.35. Title: A Cost Efficiency Analysis for Private Vehicles: Determinants for Households' Choices of Vehicles Using a Household-Level Commute Data Approach**

**Author:** Vu, T.

**Abstract:** In attempts to evaluate the different levels of fuel efficiencies across different types of vehicles, this paper uses a household-level commute dataset to look at the different determinants for a household owning an efficient vehicle. Employing both an OLS and a Probit model, the empirical results illustrate that the current number of vehicles and the vehicle's purchasing price are the attributes that most significantly affect the household's probability to own an efficient vehicle. A similar analysis is adopted for the case of electric vehicles as well. A further analysis includes calculations for different total costs of owning vehicles with different fuel economies. The results of these calculations suggest that while the more efficient vehicle is more expensive to own at first, its benefits will outweigh its costs as the vehicle is utilized more.

**Subject Areas:** fuel efficiency; Household vehicle choice; OLS; Probit model

**Availability:** Vu, T., 2017. *A Cost Efficiency Analysis for Private Vehicles: Determinants for Households' Choices of Vehicles Using a Household-Level Commute Data Approach*. Economics Student Theses and Capstone Projects. 37, Skidmore College.

[http://creativematter.skidmore.edu/econ\\_studt\\_schol/37/?utm\\_source=creativematter.skidmore.edu%2Fecon\\_studt\\_schol%2F37&utm\\_medium=PDF&utm\\_campaign=PDFCoverPages](http://creativematter.skidmore.edu/econ_studt_schol/37/?utm_source=creativematter.skidmore.edu%2Fecon_studt_schol%2F37&utm_medium=PDF&utm_campaign=PDFCoverPages)

**2.36. Title: A New Model of Charging Demand Related to Plug-in Hybrid Electric Vehicles Aggregation**

**Authors:** Pouladi, J., Bannae Sharifian, M.B. and Soleymani, S.

**Abstract:** This paper offers a comprehensive and exact model for Plug-in Hybrid Electric Vehicle (PHEV) aggregation based on the real statistics. For this purpose, available transportation and technical reports are analyzed to extract Cumulative Distribution Functions and accurate modeling of PHEVs charging load profile. We can study PHEVs effects on the distribution system by analyzing available registered data; however, the main problem is that such data, due to the low penetration of PHEVs, are not accessible, and expensive monitoring equipment such as Global Positioning Systems are needed to collect such data. Therefore, due to the lack of access to such data, researchers have offered different estimations for the charging load profile of PHEVs using statistical methods. In this study, a new model for the initial state of charge (SOC) is introduced that it is a function of fuel consumption of the vehicles. The driving behaviors such as speed and road slope have been considered in the proposed model. Simulation results show the impressiveness effectiveness and accuracy of the proposed methodology.

**Subject Areas:** Plug-In Hybrid Electric Vehicles (PHEVs); Load Profile, Aggregated Model; Charging Curve; Distribution System; Monte Carlo Simulation; State of Charge (SOC); All Electric Range (AER); Charge Level; Power Unbalance

**Availability:** Pouladi, J., Bannae Sharifian, M.B. and Soleymani, S., 2017. *A New Model of Charging Demand Related to Plug-in Hybrid Electric Vehicles Aggregation*. Electric Power Components and Systems, pp.1-16.

<http://www.tandfonline.com/doi/full/10.1080/15325008.2017.1312719?scroll=top&needAccess=true>

**2.37. Title: Optimal Scheduling of the Plug-in Electric Vehicles Aggregator Energy and Regulation Services Based on Grid to Vehicle**

**Authors:** Hou, M., Zhao, Y. and Ge, X.

**Abstract:** The advantage of grid-to-vehicle power over vehicle to grid is that the existing power grid infrastructure and technology are able to support its operation. In this paper, a regulation operation framework for grid-to-vehicle-based plug-in electric vehicle (PEV) aggregator is proposed. Based on that, PEVs can provide regulation services during charging. The objective function consider the influence of regulation services on the energy of battery charging for PEVs and the constraint of systems for battery charging power of PEVs, achieving the maximum aggregator earnings. A regulation algorithm is proposed for the aggregator to schedule PEVs. The algorithm considers the constraint of PEVs battery capacity and reduces the communication traffic between the aggregator and the PEVs. Simulation results indicate that the optimal scheduling can not only increase the earnings of the aggregator but also reduce the charging cost of PEV owners on the basis of meeting the charging requirements of PEVs.

**Subject Areas:** Plug-in electric vehicle (PEV); Grid to Vehicle

**Availability:** Hou, M., Zhao, Y. and Ge, X., 2017. *Optimal Scheduling of the Plug-in Electric Vehicles Aggregator Energy and Regulation Services Based on Grid to Vehicle*. International Transactions on Electrical Energy Systems, 27(6).

<http://onlinelibrary.wiley.com/doi/10.1002/etep.2364/full>

**2.38. Title: Performance Evaluation of Distribution Network in Presence of Plug-in Electric Vehicles through a New Index**

**Authors:** Pouladi, J. and Abedinzadeh, T.

**Abstract:** In recent decades, the presence of Plug-in Electric Vehicles (PEVs) has increased in the distribution networks. PEVs are probabilistic loads that can have negative effects on the performance of the distribution networks. These effects include overloads, losses, voltage drops, and unbalances that may take place in the distribution networks by PEV charging. Hence, the use of important and practical indices to assess a distribution network can be useful. It should be noted that it is very difficult to compare between the effects of different indices for the penetration level of the specified PEVs using the available indices. In order to compare the effects of different indices, the available ones are modified and then a new index is proposed based on the modified indices. The IEEE-37 node test feeder is used to assess the performance of the modified and proposed indices. Simulation results show the flexibility and precision of the proposed approach.

**Subject Areas:** Plug-in Electric Vehicles (PEVs); Demand Curve; Performance Index; Distribution Network

**Availability:** Pouladi, J. and Abedinzadeh, T., 2017. *Performance Evaluation of Distribution Network in Presence of Plug-in Electric Vehicles through a New Index*. In Smart Grid and Cities Congress and Fair (ICSG), 2017 5th International Istanbul (pp. 157-160). IEEE.

<http://ieeexplore.ieee.org/abstract/document/7947624/>



### **2.39. Title: Modelling Probabilistic Transmission Expansion Planning in the Presence of Plug-in Electric Vehicles Uncertainty by Multi-State Markov Model**

**Authors:** Jahromi, S.N., Askarzadeh, A. and Abdollahi, A.

**Abstract:** Increasing penetration of plug-in electric vehicles (PEVs) in the power system makes a need to consider the impact of PEVs on the transmission expansion planning (TEP) studies especially for large-scale PEV parking lots. Modelling of PEVs (as vehicle to grid (V2G)) is highly dependent on the owner's behaviour. In this study, a systematic method based on multi-state Markov model is utilised to represent the uncertainty of V2G's presence. To investigate the impact of PEVs, a probabilistic TEP in the presence of V2Gs (P\_TEP<sup>V2G</sup>) is proposed. In the proposed TEP model, the objective function consists of the total line and risk costs (RCs). Moreover, the optimal place and capacity of PEV parking lots are considered as the decision variables. It is assumed that there is an electric vehicle fleet operator for the management of electric vehicles. Because P\_TEP<sup>V2G</sup> is a complex and non-linear optimisation problem, an improved cuckoo search algorithm (ICS) is utilised to effectively solve the problem. On the IEEE 24-bus system, simulation results show that the availability of the PEVs at the proper bus leads to decreasing RC and deferring construction of new transmission lines.

**Subject Areas:** Plug-in Electric Vehicles (PEVs); Markov processes; Transportation; Distributed power generation

**Availability:** Jahromi, S.N., Askarzadeh, A. and Abdollahi, A., 2017. *Modelling Probabilistic Transmission Expansion Planning in the Presence of Plug-in Electric Vehicles Uncertainty by Multi-State Markov Model*. IET Generation, Transmission & Distribution, 11(7), pp. 1716-1725. <http://digital-library.theiet.org/content/journals/10.1049/iet-gtd.2016.1330>

## 2.40. Title: Battery Aging Studies Based on Real-World Driving

**Author:** Liu, Z.

**Abstract:** While being a competitive candidate for energy storage systems in automotive applications, lithium-ion battery still needs to overcome fundamental compromises regarding energy density, power density, lifetime, costs and safety concerns. A significant breakthrough can be expected by understanding the real-world customer usage patterns and leveraging this knowledge to develop an optimized battery design and control. However, the challenges of filtering through massive real-world driving data and identifying the features relevant to the real-world battery operations still remain. This dissertation aims to bridge this gap by linking vehicle drive cycles to battery cell duty cycles, which enables quantifying the impacts of real-world variability on battery performance. In addition to performance and efficiency considerations, the methodology enables battery aging analysis in the context of optimal design and control of hybrid electric vehicles. This will facilitate design decisions that ensure adequate performance over the life span of the vehicle with considerations of the battery health objective. The novelty of this work lies in a more accurate method of synthesizing representative real-world drive cycles with a new algorithm to classify road and an innovative quantitative metric of driver style. A modified 48V mild hybrid vehicle model was built to relate the real-world drive cycles all the way to the battery cell duty cycles and to validate the impacts from driver aggressiveness on both the fuel efficiency and the battery loads. The cell duty cycles were further analyzed in frequency domain to synthesize characteristic cell test profiles representative of driver styles and road conditions. A battery cell cycle aging experiment was carried out using the synthesized test profiles. Results validate the positive correlation between driver aggressiveness and cell degradation, and further allow parameter identification of cell electro-chemical model. Modeling effort was extended to generate insights regarding the aging mechanisms, and calibrate a semi-empirical aging model. These tools will enable the inclusion of road conditions and driver styles into the development of battery pack design and propulsion system control hence improving the design assumption fidelity and real-world representativeness of the modeling approach.

**Subject Areas:** Vehicle drive cycles; Battery cell duty cycles; Hybrid vehicle model

**Availability:** Liu, Z., 2017. *Battery Aging Studies Based on Real-World Driving*. All Dissertations. 1921.

[http://tigerprints.clemson.edu/all\\_dissertations/1921/?utm\\_source=tigerprints.clemson.edu%2Fall\\_dissertations%2F1921&utm\\_medium=PDF&utm\\_campaign=PDFCoverPages](http://tigerprints.clemson.edu/all_dissertations/1921/?utm_source=tigerprints.clemson.edu%2Fall_dissertations%2F1921&utm_medium=PDF&utm_campaign=PDFCoverPages)

#### **2.41. Title: Distributed Control of PEV Charging Based on Energy Demand Forecast**

**Authors:** Kisacikoglu, M., Erden, F. and Erdogan, N.

**Abstract:** This paper presents a new distributed smart charging strategy for grid integration of plug-in electric vehicles (PEVs). The main goal is to smooth the daily grid load profile while ensuring that each PEV has a desired state of charge (SOC) level at the time of departure. Communication and computational overhead, and PEV user privacy are also considered during the development of the proposed strategy. It consists of two stages: (i) an offline process to estimate a reference operating power level based on the forecasted mobility energy demand and base loading profile, and (ii) a real-time process to determine the charging power for each PEV so that the aggregated load tracks the reference loading level. Tests are carried out both on primary and secondary distribution networks for different heuristic charging scenarios and PEV penetration levels. Results are compared to that of the optimal solution and other state-of-the-art techniques in terms of variance and peak values, and shown to be competitive. Finally, a real vehicle test implementation is done using a commercial-of-the-shelf charging station and an electric vehicle.

**Subject Areas:** Distributed Control; Grid Integratio; Peak Shaving; Plug-In Electric Vehicle; Smart Charging

**Availability:** Kisacikoglu, M., Erden, F. and Erdogan, N., 2017. *Distributed Control of PEV Charging Based on Energy Demand Forecast*. IEEE Transactions on Industrial Informatics, PP(99).

<http://ieeexplore.ieee.org/abstract/document/7930409/>

## 2.42. Title: Balanced Charging Strategies for Electric Vehicles on Power Systems

**Authors:** Moon, S.K. and Kim, J.O.

**Abstract:** This paper presents an electric vehicle charging demand management method by modeling the demand dispatch calculation. Despite the demand shift owing to the price signal, the signal is occasionally inaccurate because of the load variability. The electricity rate has features that can shift the electric vehicle charging priorities; the application of the load fluctuation criterion is sufficient for the management plan. We expect that there is a point, wherein, both the electric vehicle users (saving costs) and the system operators (relieving loads) are satisfied with the mutually beneficial arrangements. Our method determines the balanced state in which the loads and costs are considered simultaneously with the proposing criteria. The method allows the discordance between the electrical prices and the system load fluctuations to be managed, while the time-of-use pricing and load deviation indices are accounted for. We focus on the gap corresponding to the load variation and the charging price in a daily scheme. In contrast to the typical valley filling strategies, the aim of this study is to determine and solve the mismatches in the different goals of the costs and loads, if the state is not mutually beneficial. Therefore, to ensure a system operator perspective selectively, we introduce the load weight and ranking method concepts for dispersing the charging loads, lowering the system marginal prices, and investment avoidance because electricity rates cannot describe the load curves accurately. The charging demand calculation is investigated based on the determination of the charging patterns and daily demands using the priority comparison method. The balancing strategy first fills the mutual benefit points with respect to the changing priorities and then, competes to find the balanced points. The significance of the method is that it is based on the unique relationship between two comprehensive competitive strategies. Thus, we determine that valley filling, flat load management, and regulated deviation are insufficient to describe the user and operator behaviors simultaneously.

**Subject Areas:** Electric vehicles; Load management; Load leveling; Time-of-use pricing; Demand scheduling

**Availability:** Moon, S.K. and Kim, J.O., 2017. *Balanced Charging Strategies for Electric Vehicles on Power Systems*. Applied Energy, 189, pp.44-54.

<http://www.sciencedirect.com/science/article/pii/S0306261916317895>

### 2.43. Title: Robust Online Algorithms for Peak-Minimizing EV Charging under Multi-Stage Uncertainty

**Authors:** Zhao, S., Lin, X. and Chen, M.

**Abstract:** This paper presents an electric vehicle charging demand management method by modeling the demand dispatch calculation. Despite the demand shift owing to the price signal, the signal is occasionally inaccurate because of the load variability. The electricity rate has features that can shift the electric vehicle charging priorities; the application of the load fluctuation criterion is sufficient for the management plan. We expect that there is a point, wherein, both the electric vehicle users (saving costs) and the system operators (relieving loads) are satisfied with the mutually beneficial arrangements. Our method determines the balanced state in which the loads and costs are considered simultaneously with the proposing criteria. The method allows the discordance between the electrical prices and the system load fluctuations to be managed, while the time-of-use pricing and load deviation indices are accounted for. We focus on the gap corresponding to the load variation and the charging price in a daily scheme. In contrast to the typical valley filling strategies, the aim of this study is to determine and solve the mismatches in the different goals of the costs and loads, if the state is not mutually beneficial. Therefore, to ensure a system operator perspective selectively, we introduce the load weight and ranking method concepts for dispersing the charging loads, lowering the system marginal prices, and investment avoidance because electricity rates cannot describe the load curves accurately. The charging demand calculation is investigated based on the determination of the charging patterns and daily demands using the priority comparison method. The balancing strategy first fills the mutual benefit points with respect to the changing priorities and then, competes to find the balanced points. The significance of the method is that it is based on the unique relationship between two comprehensive competitive strategies. Thus, we determine that valley filling, flat load management, and regulated deviation are insufficient to describe the user and operator behaviors simultaneously.

**Subject Areas:** Prediction algorithms; Algorithm design and analysis; Robustness; Renewable energy sources; Predictive models; Computational modeling

**Availability:** Zhao, S., Lin, X. and Chen, M., 2017. *Robust Online Algorithms for Peak-Minimizing EV Charging under Multi-Stage Uncertainty*. IEEE Transactions on Automatic Control. <http://ieeexplore.ieee.org/abstract/document/7914741/>

**2.44. Title: Analysis on the Operation of a Charging Station with Battery Energy Storage System**

**Authors:** Zhu, L. and Pu, Y.

**Abstract:** Fossil oil, as the main energy of transportation, is destined to be exhausted. The electrification of transportation is a sustainable solution to the energy crisis, since electric power could be acquired from the inexhaustible sun, wind and water. Among all the problems that hinder the development of Electric Vehicle (EV) industry, charging issue might be the most prominent one. In this paper, the service process of a charging station with Battery Energy Storage System (BESS) is analyzed by means of Cramer - Lundberg model which has been intensively utilized in ruin theory. The service quality is proposed in two dimensions: the service efficiency and the service reliability. The arrival rate and State of Charge (SOC) upon arrival are derived from 2009 National Household Travel Survey (NHTS). The simulations are performed to show how the service quality is determined by the system parameters such as the number of servers, the service rate, the initial capacity, the charge rate and the maximum waiting time. At last, the economic analysis of the system is conducted and the best combination of the system parameters are given.

**Subject Areas:** Battery Energy Storage System; Charging Station; Electric vehicle; Queueing Theory

**Availability:** Zhu, L. and Pu, Y., 2017. *Analysis on the Operation of a Charging Station with Battery Energy Storage System*. Journal of Electrical Engineering & Technology, 12(5), pp.1916-1924.

<http://www.dbpia.co.kr/Journal/ArticleDetail/NODE07229247>

**2.45. Title: Analyzing The Impacts of Plug-in EVs on the California Power Grid using Quadratic Programming and Fixed-Point Iteration**

**Authors:** Guo, Y. and Bashash, S.

**Abstract:** This paper investigates the impacts of a large fleet of Plug-in Electric Vehicles (PEVs) charging/discharging behaviors on the electricity price dynamics of California power grid. Assuming that PEV owners charge/discharge their vehicles in a way which minimizes the total electricity cost, a quadratic programming framework is applied to optimize the PEVs' charging patterns. The charge requirement of all PEVs is estimated based on the projected PEV population in 2025 and estimated seasonal variations. Due to increase in the demand and electricity price because of the added PEV load, a fixed point iteration method is applied to find new equilibrium load and price trajectories. By comparing the real electricity price and that resulted from the fixed point iteration, we can observe the impact of the PEVs on the power grid. In order to establish a realistic estimation pertaining to the PEV energy consumption and charging requirements, we use data from the National Household Travel Survey (NHTS) to generate a set of driving profiles. Moreover, we use the California ISO's historical electricity price and load data to develop a simplified electricity price model, as well as the California historical VMT data to calculate seasonality factors. Simulation results indicate that the PEVs in large numbers can help shave the demand peak and fill the demand valley, thereby flattening the grid demand profile. Moreover, we observe that California power grid is capable of accommodating a large PEV fleet without requiring a major upgrade to the existing electricity infrastructure, provided that optimal charge scheduling and bidirectional V2G interaction are enabled for the PEVs.

**Subject Areas:** Batteries; Optimization; Trajectory; State of charge; Mathematical model

**Availability:** Guo, Y. and Bashash, S., 2017. *Analyzing The Impacts of Plug-in EVs on the California Power Grid using Quadratic Programming and Fixed-Point Iteration*. In American Control Conference (ACC), 2017 (pp. 2060-2065). IEEE.  
<http://ieeexplore.ieee.org/abstract/document/7963256/?reload=true>

#### **2.46. Title: Plug-in Hybrid Electric Vehicle Load Profile Estimation with Opportunity Charging**

**Author:** Kazem Sharif Sharifi, R.

**Abstract:** This thesis focuses on the load profile analysis of the plug-in hybrid electric vehicles (PHEV), examining two different scenarios. In the first scenario, the battery of a PHEV is charged at the final arrival time, and the arrival time analysis has a minute accuracy. In the second scenario, opportunity charging, which refers to the stop-time between two trips, is used for charging the battery of the vehicle. However, if the stop-time between two trips is less than 30 minutes, the duration is not counted as an opportunity charging and it is filtered. The results of the two scenarios are compared, and through this comparison, it is revealed that the opportunity charging scenario has a more flat profile. The improvement not only shows the positive features of the opportunity charging in terms of using more electrical power instead of traditional petroleum-based fuel, but also creates more opportunity for the power grid to use renewable energy resources instead of traditional fossil fuels. These two significant features, present opportunity charging as a strong solution for the negative environmental effects of petroleum vehicles in urban areas, and even in a world-scale view. The data pool is collected from the national household travel survey (NHTS) database, which is a major reference for transportation studies. The analyses are done for the years 2001 and 2009, and the resulting data file includes the data of about 43000 different vehicles.

**Subject Areas:** Electric Vehicle; Load Profile; NHTS; Opportunity Charging; Plug-in Hybrid; Vehicle-to-grid

**Availability:** Kazem Sharif Sharifi, R., 2017. *Plug-in Hybrid Electric Vehicle Load Profile Estimation with Opportunity Charging*. M.S. Thesis, Missouri University of Science and Technology. [http://scholarsmine.mst.edu/masters\\_theses/7650/](http://scholarsmine.mst.edu/masters_theses/7650/)



**2.47. Title: Trip Energy: Estimating Personal Vehicle Energy Consumption Given Limited Travel Survey Data**

**Authors:** McNerney, J., Needell, Z.A., Chang, M.T., Miotti, M. and Trancik, J.E.

**Abstract:** Estimating personal vehicle energy consumption is important for nationwide climate policy, local and statewide environmental policy, and technology planning. Transportation energy use is complex, depending on vehicle performance and the driving behavior of individuals, as well as on travel patterns of cities and regions. Previous studies combine large samples of travel behavior with fixed estimates of per mile fuel economy or use detailed models of vehicles with limited samples of travel behavior. This paper presents a model for estimating privately operated vehicle energy consumption- TripEnergy- that accurately reconstructs detailed driving behavior across the United States and simulates vehicle performance for different driving conditions. The accuracy of this reconstruction was tested by using out-of-sample predictions, and the vehicle model was tested against microsimulation. TripEnergy consists of a demand model, linking GPS drive cycles to travel survey trips, and a vehicle model, efficiently simulating energy consumption across different types of driving. Because of its ability to link small-scale variation in vehicle technology and driver behavior with large-scale variation in travel patterns, it is expected to be useful for a variety of applications, including technology assessment, cost and energy savings from ecodriving, and the integration of electric vehicle technologies into the grid.

**Subject Areas:** Energy consumption; Travel Patterns; TripEnergy

**Availability:** McNerney, J., Needell, Z.A., Chang, M.T., Miotti, M. and Trancik, J.E., 2017. *Trip Energy: Estimating Personal Vehicle Energy Consumption Given Limited Travel Survey Data*. Transportation Research Record: Journal of the Transportation Research Board, (2628), pp.58-66.

<http://trjournalonline.trb.org/doi/pdf/10.3141/2628-07>

**2.48. Title: Modeling Framework and Results to Inform Charging Infrastructure Investments**

**Authors:** Melaina, M.W. and Wood, E.W.

**Abstract:** The plug-in electric vehicle (PEV) market is experiencing rapid growth with dozens of battery electric (BEV) and plug-in hybrid electric (PHEV) models already available and billions of dollars being invested by automotive manufacturers in the PEV space. Electric range is increasing thanks to larger and more advanced batteries and significant infrastructure investments are being made to enable higher power fast charging. Costs are falling and PEVs are becoming more competitive with conventional vehicles. Moreover, new technologies such as connectivity and automation hold the promise of enhancing the value proposition of PEVs. This presentation outlines a suite of projects funded by the U.S. Department of Energy's Vehicle Technology Office to conduct assessments of the economic value and charging infrastructure requirements of the evolving PEV market. Individual assessments include national evaluations of PEV economic value (assuming 73M PEVs on the road in 2035), national analysis of charging infrastructure requirements (with community and corridor level resolution), and case studies of PEV ownership in Columbus, OH and Massachusetts.

**Subject Areas:** Energy; PEV; Renewable energy

**Availability:** Melaina, M.W. and Wood, E.W., 2017. *Modeling Framework and Results to Inform Charging Infrastructure Investments*. National Renewable Energy Laboratory (NREL), Golden, CO (United States), (No. NREL/PR-5400-68370).

<https://www.osti.gov/scitech/biblio/1379471>

## **2.49. Title: Plug-in Fuel Cell Electric Vehicles: A California Case Study**

**Authors:** Lane, B., Shaffer, B. and Samuelson, G.S.

**Abstract:** Plug-in fuel cell electric vehicles (PFCEVs) combine features of battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). With a 40-mile battery electric range (BER), the PFCEV provides unusually efficient driving. The BER also affords convenient recharging. The fuel cell and hydrogen fuel facilitate long range and quick refueling, removing range anxiety. With a small battery and fuel cell, the PFCEV maintains weight low and efficiency high. Thereby, PFCEVs are economically competitive with other vehicles and unusually efficient. This paper uses California as a case study of PFCEV deployment due to regulations that make it the first deployment area of alternative vehicle technology. If all vehicles in California today were PFCEVs, the hydrogen required would be significantly less than current hydrogen production for petroleum refining in California, and the electricity used would be 19% of California's current total demand. The BER capability suggests fewer hydrogen fueling stations needed to fuel PFCEVs compared to non-plug-in FCEVs. These results suggest that PFCEVs are an attractive candidate as the principal vehicle owned by the majority of the motoring public in the electric vehicle era.

**Subject Areas:** Plug-in fuel cell electric vehicle; Fuel cell electric vehicle; Battery electric vehicle; Electricity; Hydrogen; Future transportation sector

**Availability:** Lane, B., Shaffer, B. and Samuelson, G.S., 2017. *Plug-in Fuel Cell Electric Vehicles: A California Case Study*. International Journal of Hydrogen Energy, 42(20), pp.14294-14300.

<http://www.sciencedirect.com/science/article/pii/S0360319917309138>

## **2.50. Title: Exploiting PHEV to Augment Power System Reliability**

**Authors:** Wang, X. and Karki, R.

**Abstract:** Environmental concerns with gasoline vehicles have led to increased attention to electric vehicles in recent years. Plug-in hybrid electric vehicles (PHEV) use both electricity and gasoline to propel the vehicle, and is being recognized as a potential alternative to conventional vehicles. PHEVs offer opportunity to use electric energy generated by renewable resources and significantly reduce greenhouse gas emissions. The electric energy requirement of PHEV can, however, cause negative impacts on the power system reliability, especially when the size of a PHEV fleet is relatively large. This paper presents the development of a probabilistic model considering the driving distance, charging times, charging locations, battery state of charge, and charging requirements of a PHEV. A methodology using hybrid analytical and Monte Carlo simulation approach is presented to evaluate the reliability of a power system integrated with PHEVs, considering the important PHEV characteristics, charging scenarios, and power system parameters. Studies are presented on the IEEE-reliability test system to illustrate the impact of PHEV penetration in a power system. Based on the study results, the methods of augmenting system reliability through controlled PHEV charging are presented in this paper.

**Subject Areas:** Batteries; Vehicles; Reliability; Power system reliability; Petroleum; Load modeling; Plug-in hybrid electric vehicle (PHEV)

**Availability:** Wang, X. and Karki, R., 2017. *Exploiting PHEV to Augment Power System Reliability*. IEEE Transactions on Smart Grid, 8(5), pp.2100-2108.  
<http://ieeexplore.ieee.org/abstract/document/7386695/>

## **2.51. Title: U.S. Light-duty Vehicle Air Conditioning Fuel Use and the Impact of Four Solar/Thermal Control Technologies**

**Authors:** Rugh, J.P., Kekelia, B., Kreutzer, C.J. and Titov, E.V.

**Abstract:** The U.S. uses 7.6 billion gallons of fuel per year for vehicle air conditioning (A/C), equivalent to 5.7 percent of the total national light-duty vehicle (LDV) fuel use. This equates to 30 gallons/year per vehicle, or 23.5 grams (g) of carbon dioxide (CO<sub>2</sub>) per mile, for an average U.S. vehicle. A/C is a significant contribution to national fuel use; therefore, technologies that reduce A/C loads may reduce operational costs, A/C fuel use, and CO<sub>2</sub> emissions. Since A/C is not operated during standard EPA fuel economy testing protocols, EPA provides off-cycle credits to encourage OEMs to implement advanced A/C technologies that reduce fuel use in the real world. NREL researchers assessed thermal/solar off-cycle credits available in the U.S. Environmental Protection Agency's (EPA's) Final Rule for Model Year 2017 and Later Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy. Credits include glazings, solar reflective paint, and passive and active cabin ventilation. Implementing solar control glass reduced CO<sub>2</sub> emissions by 2.0 g/mi, and solar reflective paint resulted in a reduction of 0.8 g/mi. Active and passive ventilation strategies only reduced emissions by 0.1 and 0.2 g/mi, respectively. The national-level analysis process is powerful and general; it can be used to determine the impact of a wide range of new vehicle thermal technologies on fuel use, EV range, and CO<sub>2</sub> emissions.

**Subject Areas:** Light-Duty Vehicle Greenhouse Gas Emissions; Corporate Average Fuel Economy

**Availability:** Rugh, J.P., Kekelia, B., Kreutzer, C.J. and Titov, E.V., 2017. *U.S. Light-duty Vehicle Air Conditioning Fuel Use and the Impact of Four Solar/Thermal Control Technologies*. No. NREL/PR-5400-69047). National Renewable Energy Lab.(NREL), Golden, CO (United States). <https://www.osti.gov/scitech/biblio/1411130>

## **2.52. Title: A Stochastic Game Approach for PEV Charging Station Operation in Smart Grid**

**Authors:** Liu, Y., Deng, R. and Liang, H.

**Abstract:** In the future smart grid, charging stations are critical infrastructures for plug-in electric vehicle (PEV) to replenish their batteries in a convenient way. Due to the everincreasing penetration rate of PEVs, how to efficiently manage the loads of PEV charging stations to ensure system efficiency and reliability is a major challenge faced by the distribution service providers (DSPs) in the smart grid. This challenge is further complicated by the highly dynamic PEV mobility, which results in random PEV arrivals, departures and charging demands. In order to address this challenge, a stochastic game approach is proposed in this paper to characterize the interactions among DSP, charging stations and PEV owners, where the randomness in charging decision making processes of PEV owners is modelled by a Markov decision process. Based on the Nash equilibrium solution of the stochastic game, a real time pricing (RTP) scheme is proposed for the DSP to minimize power distribution losses while ensuring system reliability. The performance of the proposed approach is evaluated via extensive simulations based on the IEEE 123 bus test feeder with real vehicle mobility data from 2009 National Household Travel Survey (NHTS) and 2010 National Travel Survey (NTS).

**Subject Areas:** Charging stations; Games; Stochastic processes, Real-time systems; Smart grids; Reliability; Optimization

**Availability:** Liu, Y., Deng, R. and Liang, H., 2017. *A Stochastic Game Approach for PEV Charging Station Operation in Smart Grid*. IEEE Transactions on Industrial Informatics,(PP)99. <http://ieeexplore.ieee.org/abstract/document/8170319/>

**2.53. Title: Comparison of EV Smart Charging Strategies from Multiple Stakeholders' Perception**

**Author:** Niazi, K.

**Abstract:** Electric vehicles (EVs) will become an integral part of the future smart grid. Random charging of EVs may give birth to many issues such as increasing losses, voltage deviation, and increase in peak. The threats imposed by random charging can be conquered by smart or coordinated charging strategies. The liberalisation of energy sector creates an opportunity for different market actors to use flexible EV demand for their own benefits. Thus, the objectives for smart EV charging can be formulated to meet the interest of a single stakeholder or multiple stakeholders. In this study, a comparative analysis of three smart charging strategies from different stakeholders' perception/interests - (i) aggregator (also representing customers), (ii) Network operator, and (iii) both aggregator and network operator simultaneously - while considering different EV penetration is presented in terms of increase in peak load, peak-valley difference, load factor, and total charging cost. The influence of fast charging and battery charging efficiency on these results is also discussed.

**Subject Areas:** Power systems; Automobile electronics

**Availability:** Niazi, K., 2017. *Comparison of EV Smart Charging Strategies from Multiple Stakeholders' Perception*. The Journal of Engineering, 1(1).

<http://digital-library.theiet.org/content/journals/10.1049/joe.2017.0553>

**2.54. Title: Optimal Energy Management Scheme for Electric Vehicle Integration in Microgrid**

**Authors:** Lakshminarayanan, V., Pramanick, S., Rajashekara, K., Ben-Brahim, L. and Gastli, A.

**Abstract:** Electric vehicles (EV) connected to a charging station in a microgrid system is a potential power source for participation in energy management (EM). However, an autonomous controller scheme is required to schedule the charging and discharging of the EV battery for optimal EM. This paper proposes an intelligent EM controller for a workplace with EV integration. A Multi-Agent System (MAS) based coordinated optimization scheme is developed for EM. The optimal charging and discharging schedule is obtained by forecasting the trip pattern of EV based on regression by discretization methodology. Furthermore, the optimization scheme is designed considering monetary benefits to the workplace and the EV owner. The controller scheme is developed using Java Agent Development framework (JADE). The proposed EM scheme is tested with real-world data and the results are verified.

**Subject Areas:** Forecasting; Energy management; Employment; Schedules; Optimal scheduling; Pricing; Electric vehicles

**Availability:** Lakshminarayanan, V., Pramanick, S., Rajashekara, K., Ben-Brahim, L. and Gastli, A., 2017. *Optimal Energy Management Scheme for Electric Vehicle Integration in Microgrid*. In Power Symposium (NAPS), 2017 North American (pp. 1-6). IEEE.

<http://ieeexplore.ieee.org/abstract/document/8107184/>



## 2.55. Title: National Plug-In Electric Vehicle Infrastructure Analysis

**Authors:** Lakshminarayanan, V., Pramanick, S., Rajashekara, K., Ben-Brahim, L. and Gastli, A.

**Abstract:** This document describes a study conducted by the National Renewable Energy Laboratory quantifying the charging station infrastructure required to serve the growing U.S. fleet of plug-in electric vehicles (PEVs). PEV sales, which include plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), have surged recently. Most PEV charging occurs at home, but widespread PEV adoption will require the development of a national network of non-residential charging stations. Installation of these stations strategically would maximize the economic viability of early stations while enabling efficient network growth as the PEV market matures. This document describes what effective co-evolution of the PEV fleet and charging infrastructure might look like under a range of scenarios. To develop the roadmap, NREL analyzed PEV charging requirements along interstate corridors and within urban and rural communities. The results suggest that a few hundred corridor fast-charging stations could enable long-distance BEV travel between U.S. cities. Compared to interstate corridors, urban and rural communities are expected to have significantly larger charging infrastructure requirements. About 8,000 fast-charging stations would be required to provide a minimum level of coverage nationwide. In an expanding PEV market, the total number of non-residential charging outlets or 'plugs' required to meet demand ranges from around 100,000 to more than 1.2 million. Understanding what drives this large range in capacity requirements is critical. For example, whether consumers prefer long-range or short-range PEVs has a larger effect on plug requirements than does the total number of PEVs on the road. The relative success of PHEVs versus BEVs also has a major impact, as does the number of PHEVs that charge away from home. This study shows how important it is to understand consumer preferences and driving behaviors when planning charging networks.

**Subject Areas:** PEV fleet ; Charging infrastructure; Consumer preferences; Charging networks

**Availability:** Wood, E.W., Rames, C.L., Muratori, M., Srinivasa Raghavan, S. and Melaina, M.W., 2017. *National Plug-In Electric Vehicle Infrastructure Analysis*. No. NREL/TP-5400-69031; DOE/GO-102017-5040). National Renewable Energy Laboratory (NREL), Golden, CO (United States).

<https://www.osti.gov/scitech/biblio/1393792>

## **2.56. Title: Analysis of Electric Vehicle Charging Impact on Grid Voltage Regulation**

**Authors:** Ihekwaba, A. and Kim, C.

**Abstract:** As adoption of electric vehicles increases exponentially globally, there is a need for continuous relevant research in the area of the impacts of charging infrastructure integration on the grid. One of such impacts is voltage regulation. This paper develops a practical time-varying electric vehicle load model as opposed to the state-of-the-art static constant load model and simulates the impact of electric vehicles on the grid hourly, rather than daily, placed at selected nodes in the system. It is observed that as electrical distance of a charging node to the feeder increases, the occurrence of prolonged voltage drop increases. This is relevant for utility planners and industry to ascertain the hourly number of electric vehicles that can be charged in a cluster without violating the statutory voltage regulation requirement.

**Subject Areas:** Voltage regulation; Electric vehicle impacts; Time-varying loads

**Availability:** Ihekwaba, A. and Kim, C., 2017. *Analysis of Electric Vehicle Charging Impact on Grid Voltage Regulation*. Power Symposium (NAPS), 2017 North American (pp. 1-6). IEEE. <http://ieeexplore.ieee.org/abstract/document/8107177/>

**2.57. Title: Statistical Analysis And Modeling of Plug-In Electric Vehicle Charging Demand in Distribution Systems**

**Authors:** Yan, Q., Qian, C., Zhang, B. and Kezunovic, M.

**Abstract:** This paper establishes stochastic model of plug-in electric vehicle (PEV) charging and derives the probabilistic description of the electricity needs from EV charging for one charging station at any hour of a day. Three key variables are used to characterize the stochastic behavior of EV charging: starting time of charging, state of charge (SOC), and total number of charging EVs. The electricity needs of an EV charging station is a function of time, which can be depicted by the expectation of charging needs at a certain time of day. Numerical simulations are implemented to validate the proposed analysis approach and illustrate the impact of EVs' charging demand on the distribution systems.

**Subject Areas:** Charging stations; Plug-in electric vehicles; Statistical analysis

**Availability:** Yan, Q., Qian, C., Zhang, B. and Kezunovic, M., 2017. *Statistical Analysis And Modeling of Plug-In Electric Vehicle Charging Demand in Distribution Systems*. Intelligent System Application to Power Systems (ISAP), 2017 19th International Conference on (pp. 1-6). IEEE.

<http://ieeexplore.ieee.org/abstract/document/8071365/>

**2.58. Title: A Novel Markov-based temporal- SoC Analysis for Characterizing PEV Charging Demand**

**Authors:** Sun, S., Yang, Q. and Yan, W.

**Abstract:** The integration of a massive number of plug-in electric vehicles (PEVs) into current power distribution networks brings direct challenges to network planning, control and operation. To increase the PEV penetration level with minimal negative impact, the dynamical PEV travel behaviors and charging demand need to be better understood. This paper presents a Markov-based analytical approach for modeling PEV travel behaviors and charging demand. The travel behaviors of individual PEVs are expressed mathematically through Monte Carlo simulation considering two essential factors: temporal travel purposes and state of charge (*SoC*). Markov model and hidden Markov model (HMM) are adopted to explicitly formulate the probabilistic correlation between multiple PEV states and (*SoC*) ranges. This modeling approach provides an efficient and generic tool for analyzing PEV travel behaviors and charging demand based on available PEV statistics. The analytical model is further adopted in the impact assessment of two PEV normal charging scheduling strategies for a range of PEV penetration levels in an IEEE 53-bus test network with field data (network parameters and realistic PEV statistics). The results demonstrate the benefit of the proposed modeling approach in network analysis considering PEV integration.

**Subject Areas:** Charging demand; Distribution networks; Hidden Markov model (HMM); Markov model; Monte Carlo simulation; Plug-in electric vehicle (PEV); State of Charge (*SoC*)

**Availability:** Sun, S., Yang, Q. and Yan, W., 2017. *A Novel Markov-based temporal-SoC Analysis for Characterizing PEV Charging Demand*. IEEE Transactions on Industrial Informatics,(PP)99. <http://ieeexplore.ieee.org/abstract/document/7961249/>

**2.59. Title: Understanding the Heterogeneous Effects of Gasoline Taxes Across Income and Location**

**Authors:** Spiller, E., Stephens, H.M. and Chen, Y.

**Abstract:** Using confidential household-level data, we estimate spatial and demographic heterogeneity in household-level gasoline price elasticities and gasoline tax burdens from a 60-cent federal gasoline tax increase. In order to address unobserved consumer heterogeneity, we employ a parametric adaptation of the maximum score methodology to model the household's choice of vehicles and driving decisions, allowing for disaggregated vehicle choices, vehicle-specific fixed effects, and interactions among the multiple vehicles in each household. We estimate average price elasticities of demand for gasoline at -0.74, with significant heterogeneity across space and demographics. We also find that rural and poor households bear the greater share of the burden from increasing taxes. Finally, we suggest a revenue recycling policy that helps mitigate the gasoline tax's resulting economic inequalities across household location and income. In addition, though a gasoline tax is an effective policy for reducing the externalities associated with driving, our policy also allows the government to retain some revenue from the tax even after the revenue recycling.

**Subject Areas:** Gasoline taxes; Vehicle choice; Driving decisions; Household location

**Availability:** Spiller, E., Stephens, H.M. and Chen, Y., 2017. *Understanding the Heterogeneous Effects of Gasoline Taxes Across Income and Location*. *Resource and Energy Economics*, 50, pp.74-90.

<https://www.sciencedirect.com/science/article/pii/S0928765516302688>

## **2.60. Title: Cost-Effective and Ecofriendly Plug-In Hybrid Electric Vehicle Charging Management**

**Authors:** Kontou, E., Yin, Y. and Ge, Y.E.

**Abstract:** This study explored two charging management schemes for plug-in hybrid electric vehicles (PHEVs). The PHEV drivers and the government were stakeholders who might have preferred different charging control strategies. For the former, a proposed controlled charging scheme minimized the operational cost during PHEV charge-depleting and sustaining modes. For the latter, the research minimized monetized carbon dioxide emissions from electricity generation for the PHEVs charging, as well as tailpipe emissions for the portion of PHEV trips fueled by gasoline. Hourly driving patterns and electricity data were leveraged. Both were representative of each of the eight North American Electric Reliability Corporation regions to examine the results of the proposed schemes. The model accounted for drivers' activity patterns and charging availability spatial and temporal heterogeneity. The optimal charging profiles confirmed the differing nature of the objectives of PHEV drivers and the government; cost-effective charge should occur early in the morning, while ecofriendly charge should be late in the afternoon. Each control's trade-offs between operation cost and emission savings are discussed for each North American Electric Reliability Corporation region. The availability of workplace and public charging was found to affect the optimal charging profiles greatly. Charging control is more efficient for drivers and government when PHEVs have greater electric range.

**Subject Areas:** Plug-in hybrid electric vehicles (PHEVs); Operational cost; Carbon dioxide emissions; Drivers' activity patterns

**Availability:** Kontou, E., Yin, Y. and Ge, Y.E., 2017. *Cost-Effective and Ecofriendly Plug-In Hybrid Electric Vehicle Charging Management*. Journal of the Transportation Research Board, (2628), pp.87-98.

<http://trjournalonline.trb.org/doi/abs/10.3141/2628-10>

## 2.61. Title: Vehicle Activity Patterns and Electrification Potential

**Author:** Wei, W.

**Abstract:** Battery electric vehicles (BEVs) are among the most promising solutions to transportation decarbonization, yet some vehicle-days' energy requirements cannot be satisfied by an existing, affordable BEV. These days account for a significant percentage of total personal vehicle energy consumption in the United States (US). Identifying activity patterns on these high-energy days is important for estimating the potential for mass adoption of BEVs. However, the current literature has yet to understand the characteristics of such days at the national level, and the implications for the electrification potential of personal vehicles. This thesis aims to understand what kinds of vehicle activity patterns constitute high energy vehicle-days and to evaluate potential solutions for vehicle electrification, namely improving BEV charging infrastructure and car-sharing. We have developed a set of methods to extract representative high-energy vehicle-day activity profiles. Targeting such days, the thesis evaluates the increase in BEV adoption potential through expanded charging infrastructure, providing commercial car-sharing, and allowing intrahousehold vehicle-sharing. This research finds that high-energy days across the US have relatively regular vehicle day activity patterns. Car-sharing and expanded charging infrastructure can help enable BEV adoption potential. On a typical day, providing commercial car-sharing services for the longest home-based tour to 9% of vehicle-days is equivalent to increasing everyone's battery capacity level by 17%, in terms of BEV adoption potential. Furthermore, intrahousehold vehicle-sharing shows promise for increasing BEV adoption potential. Methods and insights from this research can help decision-makers identify efficient policy options for accelerating BEV adoption.

**Subject Areas:** Battery electric vehicles (BEVs); Car-sharing; Charging infrastructure

**Availability:** Wei, W., 2017. *Vehicle Activity Patterns and Electrification Potential*. (Doctoral dissertation, Massachusetts Institute of Technology).  
<https://dspace.mit.edu/handle/1721.1/111418>

**2.62. Title: With and Without the Tracks: How Railroad Access Impacts Gas Price Elasticity**

**Authors:** Kaechele, A. and Slusky, D.J.

**Abstract:** Since 2011, gas prices have fallen 43%, raising the question of how different communities adjust their vehicle miles travelled. Data from the National Household Travel Survey's EPA fuel economy database and the Energy Information Administration database are used to measure consumers' elasticity to changes in gas prices. We find no significant difference between the price elasticity of individuals in cities with rail access and those without. Furthermore, we are able to rule out an elasticity in those with rail that is greater than 0.61, suggesting that rail access does not make consumer demand elastic.

**Subject Areas:** Gas prices; Vehicle miles; Rail

**Availability:** Kaechele, A. and Slusky, D.J., 2017. *With and Without the Tracks: How Railroad Access Impacts Gas Price Elasticity*. Applied Economics Letters, pp.1-4.  
<http://www.tandfonline.com/doi/abs/10.1080/13504851.2017.1397849>



### **2.63. Title: Modeling Electric Taxis' Charging Behavior Using Real-World Data**

**Authors:** Rao, R., Cai, H. and Xu, M.

**Abstract:** Charging behavior is critical to the development and deployment of electric vehicle (EV) systems, given its impacts in EV adoption, the energy and environmental performance of EVs, potential load change to the electric grid, etc. However, the general characteristics of practical charging behavior have not been well studied. Existing studies are mostly based on travel data from conventional internal combustion engine vehicles, modeled with assumed and simplified charging scenarios. The use of public charging infrastructure is often neglected. Few studies evaluate real-world charging behaviors of EVs currently in operation using public charging stations. To address this gap, this study analyzes the data of 39,372 charging events from 129 unique electric taxis in Shenzhen, China to study the distributions of daily charging frequency, charging start time, and charging duration. The insights we learned from this study are: 1) the daily frequency for a vehicle to visit charging stations is unlikely to exceed five times; 2) the distribution of charging start time have multiple peaks and can be fitted with Gaussian Mixture Models; 3) charging duration is influenced by charging start time; and 4) charging dynamics can be modeled using the distributions of daily charging frequency, charging start time, and charging duration. Results from this study can inform charging behavior modeling for EVs and charging infrastructure development.

**Subject Areas:** Electric Vehicle; Charging Behavior; Gaussian Mixture Model; Shenzhen; Electric Taxi

**Availability:** Rao, R., Cai, H. and Xu, M., 2017. *Modeling Electric Taxis' Charging Behavior Using Real-World Data*. International Journal of Sustainable Transportation, (just-accepted). <http://www.tandfonline.com/doi/abs/10.1080/15568318.2017.1388887>

## **2.64. Title: Refueling and Infrastructure Costs of Expanding Access to E85 in Pennsylvania**

**Authors:** Seki, S.M., Griffin, W.M., Hendrickson, C. and Matthews, H.S.

**Abstract:** United States federal regulations require increasing renewable fuel blending in the transportation sector, a majority of which is corn ethanol. Nationally, ethanol is blended with gasoline up to 10% (E10) for use in conventional vehicles, and up to 85% (E85) for use in flexible fuel vehicles (FFVs). Meeting the blending requirements could mean increasing the ethanol blended with gasoline or E85 use in FFVs. The authors estimate costs typically not quantified for FFV drivers refueling with E85, which are a small component of total costs, and consider the infrastructure costs to expand E85 access in Pennsylvania. Even with a retailer incentive of \$0.01 to \$0.39/gasoline liter equivalent (gle) to encourage ethanol infrastructure installation, an E85 consumer would still also experience higher refueling costs. A E85 consumer refueling and convenience cost of \$0.95/gle is higher than historical ethanol subsidies. Additionally, although switching from E10 to E85 could reduce emissions, a refueling incentive of \$1,320/metric ton CO<sub>2</sub> is 36 times larger than the average U.S. social cost of carbon CO<sub>2</sub> for 2015.

**Subject Areas:** Renewable fuel; Gasoline; E85 consumer

**Availability:** Seki, S.M., Griffin, W.M., Hendrickson, C. and Matthews, H.S., 2017. *Refueling and Infrastructure Costs of Expanding Access to E85 in Pennsylvania*. Journal of Infrastructure Systems, 24(1), p.04017045.

[https://ascelibrary.org/doi/full/10.1061/\(ASCE\)IS.1943-555X.0000408](https://ascelibrary.org/doi/full/10.1061/(ASCE)IS.1943-555X.0000408)

## **2.65. Title: Optimal Planning of Charging for Plug-In Electric Vehicles Focusing on Users' Benefits**

**Authors:** Su, S., Li, H. and Gao, D.W.

**Abstract:** Many electric vehicles' (EVs) charging strategies were proposed to optimize the operations of the power grid, while few focus on users' benefits from the viewpoint of EV users. However, low participation is always a problem of those strategies since EV users also need a charging strategy to serve their needs and interests. This paper proposes a method focusing on EV users' benefits that reduce the cost of battery capacity degradation, electricity cost, and waiting time for different situations. A cost model of battery capacity degradation under different state of charge (SOC) ranges is developed based on experimental data to estimate the cost of battery degradation. The simulation results show that the appropriate planning of the (SOC) range reduces 80% of the cost of battery degradation, and the queuing theory also reduces over 60% of the waiting time in the busy situations. Those works can also become a premise of charging management to increase the participation. The proposed strategy focusing on EV users' benefits would not give negative impacts on the power grid, and the grid load is also optimized by an artificial fish swarm algorithm (AFSA) in the solution space of the charging time restricted by EV users' benefits.

**Subject Areas:** Electric vehicle; Cost model of battery degradation; Charging management; Optimal scheduling; Load control; Monte Carlo

**Availability:** Su, S., Li, H. and Gao, D.W., 2017. *Optimal Planning of Charging for Plug-In Electric Vehicles Focusing on Users' Benefits*. *Energies*, 10(7), p.952.  
[https://ascelibrary.org/doi/full/10.1061/\(ASCE\)IS.1943-555X.0000408](https://ascelibrary.org/doi/full/10.1061/(ASCE)IS.1943-555X.0000408)

**2.66. Title: Boosting the Adoption and the Reliability of Renewable Energy Sources: Mitigating the Large-Scale Wind Power Intermittency through Vehicle to Grid Technology**

**Authors:** Zhao, Y., Noori, M. and Tatari, O.

**Abstract:** The integration of wind energy in the electricity sector and the adoption of electric vehicles in the transportation sector both have the potential to significantly reduce greenhouse gas emissions individually as well as in tandem with Vehicle-to-Grid technology. This study aims to evaluate the greenhouse gas emission savings of mitigating intermittency resulting from the introduction of wind power through Vehicle-to-Grid technologies, as well as the extent to which the marginal electricity consumption from charging an electric vehicle fleet may weaken this overall environmental benefit. To this end, the comparisons are conducted in seven independent system operator regions. The results indicate that, in most cases, the emission savings of a combination of wind power and Vehicle-to-Grid technology outweighs the additional emissions from marginal electricity generation for electric vehicles. In addition, the fluctuations in newly-integrated wind power could be balanced in the future using EVs and V2G technology, provided that a moderate portion of EV owners is willing to provide V2G services. On the other hand, such a combination is not favorable if the Vehicle-to-Grid service participation rate is less than 5% of all electric vehicle owners within a particular region.

**Subject Areas:** Vehicle to grid; Wind power integration; Regulation requirements; Marginal electricity generation; GHG emissions

**Availability:** Zhao, Y., Noori, M. and Tatari, O., 2017. *Boosting the Adoption and the Reliability of Renewable Energy Sources: Mitigating the Large-Scale Wind Power Intermittency through Vehicle to Grid Technology*. Energy, 120, pp.608-618.

<http://www.sciencedirect.com/science/article/pii/S0360544216317674>

**2.67. Title: Toward a Sustainable Neighborhood: Examining the Impact of Mixed-use Development on Neighborhood Energy Consumption**

**Author:** Hashemi Toroghi, S.

**Abstract:** The population in urban area is expected to increase more than 12% during the next 30 years. The Transit Oriented Development (TOD) is a fast-growing trend in creating a sustainable community in urban areas. TOD goes beyond a dense development strategy to oppose the sprawl development, and suggests a compact development around transit system, with a pedestrian-friendly and mixed-used environment. TOD proves to bring many benefits to residents such as providing a low-stress atmosphere with much lower automobile dependency for the residents, reduction in carbon footprint, stimulation of the local economy, and higher accessibility. The impact of TOD on building stock and transportation can result in change in energy consumption per capita compared with a regular urban development strategy. In this study, I assess the impact of TOD on energy consumption in two main sectors: residential (buildings) and transportation in the city of Atlanta. The scope of study consists of three neighborhoods that are selected from three different socio-economic levels within the boundary of the Atlanta Metropolitan area. This study compares the energy consumption in both residential (building) and transportation sectors, before and after the TOD for each of the selected areas. The result of this study can help city planners, investors, and policy makers to develop a better strategy for a sustainable urban development via TOD, while aiming any specific neighborhood with strategies tailored to socio-economic characteristics of the target area.

**Subject Areas:** Transit Oriented Development (TOD); Energy consumption; Transportation sector; Sustainable community

**Availability:** Hashemi Toroghi, S., 2017. *Toward a Sustainable Neighborhood: Examining the Impact of Mixed-use Development on Neighborhood Energy Consumption*. School of City and Regional Planning Applied Research Papers, Georgia Tech.  
<https://smartech.gatech.edu/handle/1853/58544>

## **2.68. Title: Energy Scheduling of a Technical Virtual Power Plant in Presence of Electric Vehicles**

**Authors:** Pourghaderi, N., Fotuhi-Firuzabad, M., Kabirifar, M. and Moeini-Aghaie, M.

**Abstract:** In modern power systems, technical virtual power plants (TVPPs) play an important role enabling presence of distributed energy resources (DERs) in electricity markets. In this paper, strategy of using the available energy resources for a TVPP is put under investigation. A new optimization framework is presented for problem of TVPP energy scheduling by taking operational constraints of distribution network into account. In the proposed model, photovoltaic (PV) units and micro turbines along with the electric vehicles (EVs) are scheduled in such a way that the profit of TVPP owner would be maximized. The uncertainty in output generation of PV units is modeled by adopting fuzzy c-means (FCM) clustering algorithm. Also, the predicted amount of the load of TVPP is included in the scheduling problem using scenario-based approach. The model is mathematically formulated in the format of mixed integer linear programming which guarantees obtaining the global optimum solution. The capability of the model is examined through its implementation on the IEEE RBTS-Bus5 distribution test system. The obtained results demonstrate the applicability and effectiveness of the proposed model.

**Subject Areas:** Distributed Energy Resources (DERs); Electric Vehicles (EVs); Energy Scheduling; Technical Virtual Power Plant (TVPP); Uncertainty

**Availability:** Pourghaderi, N., Fotuhi-Firuzabad, M., Kabirifar, M. and Moeini-Aghaie, M., 2017. *Energy Scheduling of a Technical Virtual Power Plant in Presence of Electric Vehicles*. Electrical Engineering (ICEE), 2017 Iranian Conference on (pp. 1193-1198). IEEE.  
<http://ieeexplore.ieee.org/abstract/document/7985223/>

## **2.69. Title: Coordinated Charging Methods of Electric Vehicles**

**Author:** Hao, Y.

**Abstract:** With rapid growth of electrical vehicles accessed to grid, EVs charging is considered to be a crucial part of demand side flexibility in future smart grid. Uncoordinated charging of EVs in a high-penetration system can increase peak load and create new peaks in the total load (including EV load and original load) profile. Therefore, it is necessary to optimize the charging profile to avoid the harmful effects. Both of coordinated charging strategies proposed in this project can obviously decrease charging cost and reduce peak load of profile.

**Subject Areas:** Electric Vehicles (EVs); Smart grid;

**Availability:** Hao, Y., 2017. *Coordinated Charging Methods of Electric Vehicles*. Project (M.S., Electrical and Electronic Engineering), California State University, Sacramento.

<http://ieeexplore.ieee.org/abstract/document/7985223/>

## **2.70. Title: A Survey on PEV Charging Infrastructure: Impact Assessment and Planning**

**Authors:** Abdalrahman, A. and Zhuang, W.

**Abstract:** Plug-in electric vehicles (PEVs) represent a huge step forward in a green transportation system, contribute in reduction of greenhouse gas emission, and reduce the dependence on fossil fuel. Integration of PEVs into the electric power system will result in a considerable addition to electricity demand. Due to PEV mobility, this demand has a random distribution in space and time among distribution system nodes. Therefore, short term forecast of PEV charging demand is more challenging than that for conventional loads. Assessment of PEV impacts on the power system is essential to mitigate the impairments from PEV loads. Optimal planning of PEV charging infrastructure will promote the penetration rate of PEVs and minimize the negative impacts of PEVs on the electric power distribution system and transportation road network. Design of charging facilities with integrated distributed energy resources (DER) is considered a solution to alleviate strain on the grid, reduce the integration cost with the distribution network and the charging cost. In this paper, we present a comprehensive literature survey on modelling of PEV charging demand, impact assessment approaches and tools, and charging infrastructure planning. Moreover, an overview on charging facility design with integrated DER is given. Some future research directions are identified.

**Subject Areas:** Plug-in electric vehicles; Charging demand modeling; Impact assessment; Charging infrastructure planning

**Availability:** Abdalrahman, A. and Zhuang, W., 2017. *A Survey on PEV Charging Infrastructure: Impact Assessment and Planning*. *Energies*, 10(10), p.1650.  
<http://www.mdpi.com/1996-1073/10/10/1650/htm>



**2.71. Title: Study on the Impact of Electric Vehicle Charging Load on Nodal Voltage Deviation**

**Authors:** Ma, G., Jiang, L., Chen, Y., Dai, C. and Ju, R., 2017.

**Abstract:** The promotion and application of electric vehicles will contribute to the solution of several problems, such as energy shortage and environmental pollution, and the achievement of country economy and energy security. But a large-scale vehicle-to-grid system may cause adverse effects in the distribution network operation, the power network planning and such other parts. First, this paper collects the factors that influence the electric vehicle charging load and establishes the EV charging load model with a Monte-Carlo method. Then, we analyze the effect that the EV charging load made on the nodal voltage deviation under different permeability based on the IEEE30 node system. At last, this research gets the conclusion that the nodal voltage deviation is closely related to EV permeability, node type and node location. This research conclusion will provide practical guidance to the charging station planning.

**Subject Areas:** Distribution Network; Electric Vehicle Charging Load (EVCL); Stochastic Load; Voltage Deviation

**Availability:** Ma, G., Jiang, L., Chen, Y., Dai, C. and Ju, R., 2017. *Study on the Impact of Electric Vehicle Charging Load on Nodal Voltage Deviation*. Archives of Electrical Engineering, 66(3), pp.495-505.

<https://www.degruyter.com/view/j/aee.2017.66.issue-3/aee-2017-0037/aee-2017-0037.xml>

**2.72. Title: Multi-Party Energy Management for Networks of PV-Assisted Charging Stations: A Game Theoretical Approach**

**Authors:** Liu, N., Cheng, M. and Ma, L.

**Abstract:** Motivated by the development of electric vehicles (EVs), this paper addresses the energy management problem for the PV-assisted charging station (PVCS) network. An hour-ahead optimization model for the operation of PVCS is proposed, considering the profit of the PVCS, the local consumption of the photovoltaic (PV) energy and the impacts on the grid. Moreover, a two-level feasible charging region (FCR) model is built to guarantee the service quality for EVs and learning-based decision-making is designed to assist the optimization of the PVCS in various scenarios. The multi-party energy management problem, including several kinds of energy flows of the PVCS network, is formulated as a non-cooperative game. Then, the strategies of the PVCSs are modeled as the demand response (DR) activities to achieve their own optimization goals and a two-level distributed heuristic algorithm is introduced to solve the problem. The simulation results show that the economic profit of the network is increased by 6.34% compared with the common time of use (TOU) prices approach. Besides, the percentage of the PV energy in total charging load (PPTCL) and load rate are promoted by 28.93% and 0.3125, respectively, which demonstrates the validity and practicability of the proposed method.

**Subject Areas:** PV-assisted Charging Station (PVCS) Network; Energy Management; Game Theory; Energy Purchasing

**Availability:** Liu, N., Cheng, M. and Ma, L., 2017. *Multi-Party Energy Management for Networks of PV-Assisted Charging Stations: A Game Theoretical Approach*. *Energies*, 10(7), p.905. <http://www.mdpi.com/1996-1073/10/7/905/htm>

### 2.73. Title: Mileage Electrification Potential of Different Electric Vehicles in Germany

**Authors:** Plötz, P. and Funke, S.A.

**Abstract:** Electric vehicles (EV), both as battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) have noteworthy potential to reduce global and local CO<sub>2</sub> emissions. However, the fully exploitable potential depends on the actual vehicle kilometers travelled (VKT) that can be electrified. For BEV, the limited range excludes long-distance trips from electrification. For PHEV, long-distance trips are not excluded but the shorter electric driving range could reduce the miles electrified. The aim of the present paper is to compare the potential to electrify total VKT of BEV and PHEV. We use real-world driving data from several 780 German conventional passenger cars that are simulated as BEV and PHEV of different ranges. Furthermore, the CO<sub>2</sub> emission reduction potential of both technologies and the influence of battery sizes are analyzed, by combining electrified kilometers with CO<sub>2</sub> emission factors. We find PHEV to electrify more miles, both individual VKT as well as total VKT of the overall car fleet for given electric range. The difference in fleet electrification potential is maximal for about 30 km electric range. Compared to conventional vehicles both PHEV and BEV can significantly reduce well-to-wheel CO<sub>2</sub> emissions when using renewable energies for recharging. The maximal reduction potential per vehicle is larger for PHEV and achieved at smaller range than for BEV.

**Subject Areas:** Electric Vehicles, BEV, PHEV, GHG emissions, electrification potential

**Availability:** Plötz, P. and Funke, S.A., 2017. *Mileage Electrification Potential of Different Electric Vehicles in Germany*. *Energies*, 10(7), p.905.

[http://www.isi.fraunhofer.de/isi-wAssets/docs/e/de/publikationen/EEVC\\_17.Plötz\\_Funke\\_full-paper.pdf](http://www.isi.fraunhofer.de/isi-wAssets/docs/e/de/publikationen/EEVC_17.Plötz_Funke_full-paper.pdf)

## 2.74. Title: A Model of Charging Service Demand for the Czech Republic

**Author:** Pekárek, J.

**Abstract:** The paper introduces a standalone model of electric vehicle charging demand based on large-scale travel survey data of the Czech Republic. This demand model has been intended as a comprehensive input model for following charging infrastructure problem, where a spatial view of charging demand is usually needed. The model uses publicly available data, whose mutual incompatibility and information richness had to be overcome. The necessary data transformations are described and final data representation in the form of a mathematical graph allows the introduction of a point-defined (vertex-defined) charging demand model. Several drawbacks of the model are identified and their effect, as well as an application of whole model, is demonstrated on the large-scale numerical example. Sound demand model is a cornerstone for demand-related problems, such as general large-scale charging infrastructure problem, which is a common issue for countries that stand at the very beginning of the electric vehicle adoption process.

**Subject Areas:** Electric Vehicles; Charging service demand; Charging stations; Graph theory; Czech Republic road network; Charging infrastructure; Traffic survey; Traffic data.

**Availability:** Pekárek, J., 2017. *A Model of Charging Service Demand for the Czech Republic*. Acta Univ. Agric. Silvic. Mendelianae Brun, (65) 5, pp.1741-1750.  
<https://acta.mendelu.cz/65/5/1741/>

**2.75. Title: Simultaneous Inference of Partially Linear Error-in-Covariate Models: An Application to the U.S. Gasoline Demand**

**Authors:** Kim, K.H., Chao, S.K. and Härdle, W.K.

**Abstract:** In this paper, we conduct simultaneous inference of the non-parametric multivariate function of a partially linear model when the covariate terms in both parametric and non-parametric parts are subject to the Berkson measurement errors. Based on semiparametric estimates of the model, we construct a simultaneous confidence region of the multivariate function for simultaneous inference. The developed methodology is applied to perform inference for the U.S. gasoline demand where the income and price variables are measured with errors. The empirical results strongly suggest that the linearity of the U.S. gasoline demand is rejected.

**Subject Areas:** Simultaneous inference; Partially linear model; Multivariate function; Semiparametric regression; Simultaneous confidence region; Berkson measurement error; Regression calibration; U.S. Gasoline demand

**Availability:** Kim, K.H., Chao, S.K. and Härdle, W.K., 2017. *Simultaneous Inference of Partially Linear Error-in-Covariate Models: An Application to the U.S. Gasoline Demand*.

<https://pdfs.semanticscholar.org/d52f/947d3df64c7a3219d52dc081c64e1aef26a0.pdf/>

## **2.76. Title: Powering the Driverless Electric Car of the Future**

**Authors:** Webb, J. and Wilson, C.

**Abstract:** The automotive industry is entering an era of transformative change, a key element of which, is the increasingly rapid uptake of electric vehicles (EVs). The prospect of battery-powered electric vehicles (BEVs) becoming both a major power consumer and part of a new distributed supply source is, therefore, a critically important planning issue for power utilities. This chapter describes the likely ongoing exponential increase in EV adoption as a product of a coincidence of powerful technological, social, commercial, environmental, and governmental forces. Explored is the way in which EVs will interface with power grids and the likely effect on demand and supply.

**Subject Areas:** Autonomous vehicles; Electric vehicles; Distributed generation; Car sharing; Automotive batteries

**Availability:** Webb, J. and Wilson, C., 2017. *Powering the Driverless Electric Car of the Future*. Innovation and Disruption At the Grid's Edge (pp. 101-122).  
<https://www.sciencedirect.com/science/article/pii/B9780128117583000061>

**2.77. Title: Multi-Area Self-Adaptive Pricing Control in Smart City With EV User Participation**

**Authors:** Nie, Y., Wang, X. and Cheng, K.W.E.

**Abstract:** Promoting the market of electric vehicles (EV) can be one of the most effective ways to deal with the increasing severity of air pollution. However, the behavior of EV users can be rather stochastic and the aggregated charging power may add pressure to urban power grid during peak hours. In this paper, a novel smart city modeling with combined EV traveling and charging network is formulated. To alleviate the potential contingency brought by stochastic EV charging, mandatory control from grid operator and different kinds of electricity pricing schemes are introduced. Finally, the comparison between existing EV charging control schemes and multi-area self-adaptive (MASA) pricing control is performed to point out the limitation of passive control imposed on users as well as the flexibility of MASA pricing scheme. The results demonstrate that MASA pricing with active EV participation serves as an effective and economical solution to the future smart city under complex transportation network and massive EV integration.

**Subject Areas:** Electric vehicle; Smart city; MASA pricing; User behavior; Energy consumption.

**Availability:** Nie, Y., Wang, X. and Cheng, K.W.E., 2017. *Multi-Area Self-Adaptive Pricing Control in Smart City With EV User Participation*. IEEE Transactions on Intelligent Transportation Systems,(PP) 99.

<http://ieeexplore.ieee.org/abstract/document/8078239/>

## 2.78. Title: Grid Load Contributions Through Electric Vehicles and Their Uncertainties

**Authors:** Hanemann, P., Graupner, S., Grunert, P., Koepke, M. and Bruckner, T.

**Abstract:** With the numbers of electric vehicles on the increase, their additional electricity demand can no longer be neglected. From a power systems' perspective, it is the time dependent electricity consumption that matters. In particular, the peak demand is increased in the case of uncontrolled charging, imposing additional stress on the system. Unfortunately, since there is an absence of representative electric vehicle driving patterns, a quantification of such temporal charging requirements is challenging. To overcome this problem, we developed a detailed model, which maps combustion engine vehicles onto electric vehicle equivalents. The model's main strengths are the consideration of the diversity within the vehicle fleet as well as the differentiation into the boundary cases of pure battery electric vehicles and plug-in hybrid electric vehicles. Applied to a German traffic study, load curves for these two cases were generated. In addition, the existing uncertainty in between was quantified using Monte Carlo method. We show that the peak energy demand through electric vehicles is much greater on working days than on weekend days. Moreover, we find that the distinction between pure and plug-in-hybrid electric vehicles matters, at least for the time being. Apart from the numerical results, the model is well suited to generate input for more sophisticated investigations of charging strategies within energy system simulations.

**Subject Areas:** On-road fuel economy; Cumulative mileage; Vehicle usage; Multi-level modeling; My MPG

**Availability:** Hanemann, P., Graupner, S., Grunert, P., Koepke, M. and Bruckner, T., 2017. *Grid Load Contributions Through Electric Vehicles and Their Uncertainties*. *Zeitschrift für Energiewirtschaft*, 41(4), pp.269-281.

<https://link.springer.com/article/10.1007/s12398-017-0208-9>



**2.79. Title: Energy-saving Benefits from Plug-in Hybrid Electric Vehicles: Perspectives based on Real-World Measurements**

**Authors:** Zhou, B., Zhang, S., Wu, Y., Ke, W., He, X. and Hao, J.

**Abstract:** Promoting plug-in hybrid vehicles (PHEV) is one important option to mitigate greenhouse gas emissions and air pollutants for road transportation sector. In 2015, more than 220,000 new PHEVs were registered across the world, indicating a 25-fold growth during 2011-2015. However, more criticisms have been put forward against the current energy efficiency regulations for vehicles that are mostly depended on laboratory measurements. To better understand the real-world energy-saving and emission mitigation benefits from PHEVs, we conducted on-road testing experiments under various operating conditions for two in-use PHEVs in Beijing, China. Our results indicate that air condition usage, congested traffic conditions, and higher loading mass could significantly increase energy consumption and shorten actual all-electric distance for PHEVs. For example, the worst case (14.1 km) would occur under harshest usage conditions, which is lower by at least 35% than the claimed range over 20 km. In charge sustaining (CS) mode, real-world fuel consumption also presents a large range from 3.5 L/100 km to 6.3 L/100 km because of varying usage conditions. Furthermore, various vehicle users have significantly different travel profiles, which would lead to large heterogeneity of emission mitigation benefits among individual PHEV adopters. Therefore, this study suggests that the global policy makers should use real-world energy efficiency of emerging electrified powertrain techniques as criteria to formulate relevant regulations and supportive policies.

**Subject Areas:** Plug-in hybrid electric vehicle; On-road test; Energy consumption; Driving condition; Utility factor

**Availability:** Zhou, B., Zhang, S., Wu, Y., Ke, W., He, X. and Hao, J., 2017. *Energy-saving Benefits from Plug-in Hybrid Electric Vehicles: Perspectives based on Real-World Measurements*. Mitigation and Adaptation Strategies for Global Change, pp.1-22.  
<https://link.springer.com/article/10.1007/s11027-017-9757-9>

**2.80. Title: Impact of Electric Vehicles on the Expansion Planning of Distribution Systems considering Renewable Energy, Storage and Charging Stations**

**Authors:** de Quevedo, P.M., Muñoz-Delgado, G. and Contreras, J.

**Abstract:** Energy storage systems (ESS) have adopted a new role with the increasing penetration of electric vehicles (EVs) and renewable energy sources (RES). EVs introduce new charging demands that change the traditional demand profiles and RES are characterized by their high variability. This paper presents a new multistage distribution expansion planning model where investments in distribution network assets, RES, ESS and EV charging stations (EVCS) are jointly considered. The charging demand necessary for EVs transportation is performed using a vehicle model based on travel patterns. The variability associated with RES along with the demand requires the incorporation of uncertainty, which is characterized through a set of scenarios. These scenarios are generated by the k-means++ clustering technique that allows keeping the correlation in the information of the uncertainty sources. The resulting stochastic program is driven by the minimization of the present value of the total expected cost including investment, maintenance, production, losses and non-supplied energy. The associated scenario-based deterministic equivalent is formulated as a mixed-integer linear program, which can be solved by commercial software. Numerical results are presented for an illustrative 54-node test system.

**Subject Areas:** Clustering technique; Distribution system expansion planning (DSEP); ESS; EV charging demand; Renewable energy.

**Availability:** de Quevedo, P.M., Muñoz-Delgado, G. and Contreras, J., 2017. *Impact of Electric Vehicles on the Expansion Planning of Distribution Systems considering Renewable Energy, Storage and Charging Stations*. IEEE Transactions on Smart Grid, (PP) 99.  
<http://ieeexplore.ieee.org/abstract/document/8038012/>

**2.81. Title: Multi-Objective Scheduling of Microgrids to Harvest Higher Photovoltaic Energy**

**Authors:** Hamidi, A. and Golshannavaz, S.

**Abstract:** Photovoltaics (PVs) and plug-in electric vehicles (PEVs) could instigate voltage violation issues, if not controlled properly. Besides, these components highly contribute to economic efficiency of microgrids (MGs). Being motivated to enhance technical and economic issues, this study develops an energy management system (EMS) that is able to coordinate voltage control devices, say under load tap changers (ULTCs), PVs, PEV aggregators, and dispatchable distributed generations (DDGs). Active and reactive power provision of PEVs and DDGs along with voltage control of ULTC lessens the plausible violations. So, higher renewable energy is contributed by PVs and extra monetary saving is reflected. In this manner, augmented Epsilon-constraint method followed with fuzzy decision making is applied to operation cost and voltage deviation minimizations. The proposed approach is formulated as a mixed-integer non-linear multi-objective problem and tested on a modified IEEE 33-bus medium-voltage MG. Results are discussed in depth.

**Subject Areas:** Microgrid (MG); Energy management system (EMS); photovoltaics (PVs); Plug-in electric vehicles (PEVs); Multi-objective approach

**Availability:** Hamidi, A. and Golshannavaz, S., 2017. *Multi-Objective Scheduling of Microgrids to Harvest Higher Photovoltaic Energy*. IEEE Transactions on Industrial Informatics.

<http://ieeexplore.ieee.org/abstract/document/7954647/>

## **2.82. Title: Distributed Optimization Operation Strategy for Charging Stations Under Demand Response**

**Authors:** Qiu, D., Zhang, X. and Zhang, L.

**Abstract:** Time-of-use price will be an important demand side management method as a supplement of administrative strategy, which could encourage the electric vehicles to change the charging behaviors. In this paper, for parking garage charging stations with photovoltaic power generation, a pricing model is proposed to encourage different consumers to participate in demand response by providing them with a list of price plans. Firstly, we introduce the system structure of the photovoltaic-assisted charging station. Afterwards, the pricing and dispatch model for the charging station is proposed, aiming to achieve maximum profit. The formulated objective for this model is to maximize the profit of selling electricity to electric vehicles and back to the grid, feed-in-tariffs revenue and parking revenue or to minimize charging station's cost of purchasing electricity, while considering various electric vehicles demands. The decision variables for charging station include the time-of-use price, the rebate on parking fee and the charging/discharging power. To solve this model, the distributed alternating direction method of multipliers is adopted to determine the operational strategies of charging stations via local decision making and limited communication between adjacent charging stations. Finally, according to the simulation results, the optimal time-of-use pricing strategy for charging stations can play an important role in shaving the peak loads. Besides, the interconnected charging stations coordinated operation can enhance the overall system operational flexibility and reliability.

**Subject Areas:** Demand Response; Charging Station; Optimal Operation; Distributed Optimization

**Availability:** Qiu, D., Zhang, X. and Zhang, L., 2017. *Distributed Optimization Operation Strategy for Charging Stations Under Demand Response*. International Journal of Emerging Electric Power Systems, 18(4).

<https://www.degruyter.com/view/j/ijeeps.2017.18.issue-4/ijeeps-2016-0278/ijeeps-2016-0278.xml>

### **2.83. Title: Multi-level Charging Control Algorithm of Electric Vehicle in EVs-grid System**

**Authors:** Li, Y. and Han, P.

**Abstract:** In order to satisfy the needs of the clean energy usage and the rapid development of the smart micro grid and electric vehicle industry under the energy internet environment, an effective and highly applicable control algorithm which could ensure the safe and stable operation of smart micro grid with the large access of the electric vehicles is desperately needed. This paper firstly built the agent-based model of the electric vehicle by analyzing the autonomous operation of the electric vehicles, and then proposes a multilevel charging control algorithm oriented to the regional smart micro grid and the EVs' different kinds of power supplement, which includes the micro grid-level centralized control for the batteries' centralized charging and the user-level active control for the EVs' dispersed charging. The optimization goal is to minimize the fluctuation of the load in the regional smart micro grid under the premise that it does not affect the normal operation of electric vehicles. Finally, the corresponding case scene simulation is carried out in order to verify the effect of the proposed algorithm.

**Subject Areas:** EVs-Grid System; Electric Vehicle; Agent-Based Model; Multilevel Charging Control Algorithm

**Availability:** Li, Y. and Han, P., 2017. *Multi-level Charging Control Algorithm of Electric Vehicle in EVs-grid System*. Control And Decision Conference (CCDC), 2017 29th Chinese (pp. 6965-6970). IEEE.

<http://ieeexplore.ieee.org/abstract/document/7978437/>

## **2.84. Title: Strategic Scheduling of PEV Charging Load: A Non-cooperative Game Model**

**Authors:** Liu, H., Wang, Y., Wang, Y. and Li, Z.

**Abstract:** In this paper, we consider a scenario of future smart residential area in smart grid integrated with plug-in electric vehicles (PEV) where a smart meter is used to collect the load consumption caused by charging behavior, then the driving pattern of PEV owner is simulated by a probabilistic model. Then we perform a real-time load-based electricity price model in order to curb the charging impact during the time horizon of peak load, which turns this issue into a demand response problem. We assume that under the circumstances of unordered charging pattern, the inhabitants with PEVs prefer to start their charging process as soon as their arrival to house, meanwhile they wish to minimize their cost for charging personally according to the variation of charging price. Thus, we formulate this problem as a non-cooperative game framework to illustrate the competition of PEV owners and the Nash equilibrium is solved with an intelligent iterative algorithm. Simulation results show that the proposed framework could minimize the charging fee of PEV owners and achieve the purpose of peak load shaving.

**Subject Areas:** Plug-in electric vehicle; Smart grid; Demand response; Non-cooperative game; Peak load shaving

**Availability:** Liu, H., Wang, Y., Wang, Y. and Li, Z., 2017. *Strategic Scheduling of PEV Charging Load: A Non-cooperative Game Model*. Control Conference (CCC), 2017 36th Chinese (pp. 11284-11288). IEEE.

<http://ieeexplore.ieee.org/abstract/document/8029157/>

**2.85. Title: Innovative Appraisalment of Smart Grid Operation Considering Large-Scale Integration of Electric Vehicles Enabling V2G and G2V Systems**

**Authors:** Mozafar, M.R., Amini, M.H. and Moradi, M.H.

**Abstract:** Upgrading the internal combustion engine (ICE) driven cars to the electric vehicles (EVs) offers the opportunity to reduce the fossil fuel consumption, emission rates and total driving costs. However, the large scale utilization of the EVs introduces a stochastic load demand to the power grid. The effect of EVs charging demand on the distribution network operation should be investigated properly. This paper proposed a novel model to study the effects of power exchange between the grid and EVs on the power system demand profile, the operation stability index, and the reliability indices. To this end, the operation instability indices are introduced by the range and standard deviation of the load factor of the network components to evaluate the system stability. Further, the CAIFI,<sup>1</sup> SAIDI,<sup>2</sup> SAIFI,<sup>3</sup> and ASAI<sup>4</sup> reliability indices are calculated for various vehicle-to-grid (V2G) and grid-to-vehicle (G2V) power level to estimate the impact of different level of power exchange on system reliability. We introduced an EV charging scheduling approach which considers the specification of Li-Ion battery and the limitations for increasing battery life. The power exchange profile for V2G is also calculated using the constant power method to discharge the energy at different levels for times which cars are parked at the workplace. Due to the stochastic nature of EVs, the minimal path method is used to compute the stability and reliability parameters and the backward-forward algorithm is used to load flow analysis. The proposed model is evaluated via modified IEEE 33-bus test system.

**Subject Areas:** Electric vehicle; Electric range; Battery utilization; Stability; Reliability; Smart power distribution network; V2G; G2V

**Availability:** Mozafar, M.R., Amini, M.H. and Moradi, M.H., 2018. *Innovative Appraisalment of Smart Grid Operation Considering Large-Scale Integration of Electric Vehicles Enabling V2G and G2V Systems*. Electric Power Systems Research, 154, pp.245-256.  
<https://www.sciencedirect.com/science/article/pii/S0378779617303498>

**2.86. Title: Plug-in Electric Vehicle Batteries Degradation Modeling for Smart Grid Studies: Review, Assessment and Conceptual Framework**

**Authors:** Ahmadian, A., Sedghi, M., Elkamel, A., Fowler, M. and Golkar, M.A.

**Abstract:** The battery is a key component in Plug-in Electric Vehicles (PEVs) whose degradation should be considered in vehicle modeling and if the battery pack is to be used in a Vehicle to Grid (V2G) smart grid studies. Several researchers have proposed different methodologies for PEV batteries degradation modeling from various aspects. Most of the battery degradation literature consists of empirical-based studies with results extracted from experimental tests in laboratories. As such, the results have been presented in non-formulated forms and are of less effectiveness for smart grid researchers. Furthermore, the impact of battery degradation in V2G smart grid have not been examined in smart grid studies. This paper reviews and compares different battery technologies focusing on Lithium-ion batteries which dominant in today and future vehicle applications. After that the most prominent degradation models are assessed, the effects of degradation factors on battery performance are examined. The literature shows that the degradation causes can be categorized into two groups namely calendar ageing and cycling ageing. Generally, the calendar ageing is influenced by temperature, time, and state of charge, while the cycling ageing is influenced by cycle number, charge rate and depth of discharge. Finally, in this work a conceptual framework for battery degradation modeling is proposed that can be easily used in smart grid studies, without necessarily requiring a detailed understanding of fundamental electrochemical processes. The proposed framework considers not only the battery degradation modeling, but also that of other related components in a smart grid.

**Subject Areas:** Plug-in electric vehicles; Smart grid; Lithium-ion battery; V2G; G2V; Battery degradation modeling

**Availability:** Ahmadian, A., Sedghi, M., Elkamel, A., Fowler, M. and Golkar, M.A., 2017. *Plug-in Electric Vehicle Batteries Degradation Modeling for Smart Grid Studies: Review, Assessment and Conceptual Framework*. Renewable and Sustainable Energy Reviews. <https://www.sciencedirect.com/science/article/pii/S1364032117310067>



## 2.87. Title: Socio-economic Implications of Large-scale Electric Vehicle Systems

**Author:** Tatari, O.

**Abstract:** Transportation is a complex, technology-intensive socio-technical system, which needs to be tackled in an integrated manner. Also, transportation as a sector is a significant component of any national economy, and has far-reaching implications both with regard to socio-economic and environmental well-being of the society and within the context of sustainability science. For this reason, sustainable transportation is not only an important field of research within the academia but also an indispensable constituent of a sustainable economy. Therefore, investigating the path to sustainable transportation requires a holistic approach, encompassing the three dimensions of sustainability, i.e. environment, society, and economy. There are several proposals as to how to transition to a more sustainable transportation sector globally, and one of the most promising options is the electrification of vehicles. Hence, it is crucial to look at the electrification of transportation from different angles, and scrutinize different aspects to this matter.

This project developed several integrated sustainability assessment models that include the socio-economic as well as the environmental implications of an electrified transportation sector. These developed models covered a wide variety of means and aspects of an electrified transportation such as passenger vehicles, electric vehicle (EVs) market penetration, electric buses and long-haul trucks, vehicle to grid (V2G) technology that included delivery trucks, and the potential use of electric vehicles as a source of energy both for the grid and homes, i.e. vehicle to home technology (V2H). In the modeling, consideration was applied to stochastic costs, electricity mix sustainability, and life cycle impacts such as environmental, e.g. life cycle greenhouse gas emissions, social, e.g. life cycle health costs, and economic, e.g. life cycle costs. In depth comparison between electric vehicles and other alternative fuel vehicles (AFVs) (incl. hybrid-electric, plug-in hybrid-electric, liquefied-natural gas, compressed-natural gas, biodiesel-powered vehicles) was carried out to investigate the major advantages and/or disadvantages of electrifying different means and types of transportation, e.g. passenger vehicles, transit buses, and long-haul trucks.

**Subject Areas:** Sustainability assessment models; Socio-economic Implications; Environmental well-being; Electric vehicle (EVs)

**Availability:** Tatari, O., 2017. *Socio-economic Implications of Large-scale Electric Vehicle Systems*. (No. FSEC-CR-2073-17).

<https://ntl.bts.gov/lib/62000/62200/62236/FSEC-CR-2073-17.pdf>

**2.88. Title: Water-filling Algorithm Based Approach for Management of Responsive Residential Loads**

**Authors:** Z.M., Mehmood, K.K., Rafique, M.K., Khan, S.U., Soon-Jeong, L.E.E. and Chul-Hwan, K.I.M.

**Abstract:** Integration of large number of electric vehicles (EVs) with distribution networks is devastating for conventional power system devices such as transformers and power lines etc. This paper proposes a methodology for management of responsive household appliances management and EVs with water-filling algorithm. With the proposed scheme, the load profile of a transformer is retained below its rated capacity while minimally affecting the associated consumers. When the instantaneous demand at transformer increases beyond its capacity, the proposed methodology dynamically allocates demand curtailment limit (DCL) to each home served by transformer. The DCL allocation takes convenience factors, load profile and information of flexible appliances into account to assure the comfort of all the consumers. The proposed scheme is verified by modeling and simulating five houses and a distribution transformer. The smart appliances such as an HVAC, a water heater, a cloth dryer and an EV are also modeled for the study. Results show that the proposed scheme performs to reduce overloading effects of the transformer efficiently and assures comfort of the consumers at the same time.

**Subject Areas:** Water-filling (WF) algorithm; Responsive household appliances management (RHAM); Electric vehicle (EV); Demand curtailment limit (DCL); Convenience factor Load profile

**Availability:** Z.M., Mehmood, K.K., Rafique, M.K., Khan, S.U., Soon-Jeong, L.E.E. and Chul-Hwan, K.I.M., 2017. *Water-filling Algorithm Based Approach for Management of Responsive Residential Loads*. Journal of Modern Power Systems and Clean Energy, pp.1-14.

<https://link.springer.com/article/10.1007/s40565-017-0340-x>

**2.89. Title: A Novel Parallel-Series Hybrid Meta-Heuristic Method for Solving a Hybrid Unit Commitment Problem**

**Authors:** Yang, Z., Li, K., Niu, Q. and Xue, Y.

**Abstract:** Unit commitment is a traditional mixed-integer non-convex problem and remains a key optimisation task in power system scheduling. The high penetration of intermittent renewable generations such as wind and solar as well as mass roll-out of plug-in electric vehicles (PEVs) impose significant challenges to the traditional unit commitment problem, not only by significantly increasing the complexity of the problem in terms of the dimension and constraints, but also dramatically change the problem formulation. In this paper, a new hybrid unit commitment problem considering renewable generation scenarios and charging and discharging management of plug-in electric vehicles is first formulated. To effectively solve the problem, a novel parallel-series hybrid meta-heuristic optimisation method is then proposed, which combines a hybrid topology binary particle swarm optimisation, the self-adaptive differential evolution algorithm and a lambda iteration method, to simultaneously and intelligently determine the binary on/off status of each thermal unit, the generation power of online units, as well as the demand side management of plug-in electric vehicles. The proposed parallel-series hybrid method is first assessed on a 10-unit benchmark, and then on a case where renewable generation and smart PEV management are integrated. Numerical results confirm the superiority of the proposed new algorithm in comparison with some popular meta-heuristic approaches.

**Subject Areas:** Unit commitment; Hybrid meta-heuristic optimisation; Binary particle swarm optimisation; Differential evolution; Renewable generation; Plug-in electric vehicles

**Availability:** Yang, Z., Li, K., Niu, Q. and Xue, Y., 2017. *A Novel Parallel-Series Hybrid Meta-Heuristic Method for Solving a Hybrid Unit Commitment Problem*. Knowledge-Based Systems, 134, pp.13-30.

<https://www.sciencedirect.com/science/article/pii/S0950705117303283>

## **2.90. Title: Smart Grid adds to Renewable Resources Hosting Capacity: Collaboration of Plug-in Hybrid Electric Vehicles in Volt/VAr Control**

**Authors:** Hamidi, A., Nazarpour, D. and Golshannavaz, S.

**Abstract:** This paper develops an efficient energy management approach to increase the renewables share in energy provision of smart distribution grids (SDGs). Voltage violation ends in curtailment of renewables generations and, hence, decreases the economic success of distribution companies. To avert such deficits, this study fosters the collaboration of SDG components in an intelligent Volt/VAr control process. The investigated SDG is characterized with high penetration of photovoltaics (PVs), dispatchable distributed generations (DDGs), plug-in hybrid electric vehicles (PHEVs), and infield control devices say as under-load tap-changing transformers (ULTCs). In charge stations, PHEVs are coupled to the SDG through bidirectional inverters which are offering simultaneous exchanges of active and reactive powers. Thus, regarding the PHEV aggregators, optimal schedules of active power charge/discharge signals with their inductive/capacitive reactive power provisions are determined. This notion effectively increases PV power injections and, consequently, provides significant monetary savings. Besides, this mechanism reduces ULTC tap operations in Volt/VAr control process maintaining its nominal lifetime. The proposed approach is formulated as a mixed-integer non-linear programming (MINLP) and solved based on DICOPT solvers in general algebraic modeling system (GAMS). Effectiveness of the proposed approach is explored on a typical distribution test system. The obtained results show 8.94% increment in harvested PVs power and hence 5.24% reduction on daily operation cost of SDG.

**Subject Areas:** Plug-in hybrid electric vehicles (PHEVs); Smart distribution grids (SDGs); Voltage violation; Mixed-integer non-linear programming (MINLP)

**Availability:** Hamidi, A., Nazarpour, D. and Golshannavaz, S., 2017. *Smart Grid adds to Renewable Resources Hosting Capacity: Collaboration of Plug-in Hybrid Electric Vehicles in Volt/VAr Control*. International Journal of Energy Research. <http://onlinelibrary.wiley.com/doi/10.1002/er.3843/full>

**2.91. Title: Electric Vehicle Battery Cycle Aging Evaluation in Real-World Daily Driving and Vehicle-to-Grid Services**

**Authors:** Jafari, M., Gauchia, A., Zhao, S., Zhang, K. and Gauchia, L.

**Abstract:** In this paper, battery lifetime estimation of an electric vehicle (EV) using different driving styles on arterial roads integrating recharging scenarios in the neighborhood of the vehicle-to-grid (V2G) integration is studied. The real-world driving cycles from a fleet of connected vehicles are evaluated in an EV model with different charging options. Daily utility services are added to the simulations to explore the whole day performance of the battery and its daily degradation. Fifty driving cycles from different drivers on arterial roads are classified into aggressive, mild and gentle drivers based on their driving acceleration behavior. The standard level 1 and 2 chargers are considered for recharging and the frequency regulation, peak shaving and solar energy storage are assumed for the daily ancillary services. The results indicate that the aggressive driving and recharging behavior have significant effect on the battery life reduction. In addition, the daily utility services impose extra degradation of the battery. Also, the effect of temperature change on the battery degradation is explored. Simulation of active vs. passive thermal management systems in three different climates shows the significant impact of the battery temperature on its capacity fade.

**Subject Areas:** Batteries; Aging; Mathematical model; Vehicles; Data models

**Availability:** Jafari, M., Gauchia, A., Zhao, S., Zhang, K. and Gauchia, L., 2017. *Electric Vehicle Battery Cycle Aging Evaluation in Real-World Daily Driving and Vehicle-to-Grid Services*. IEEE Transactions on Transportation Electrification.

<http://ieeexplore.ieee.org/abstract/document/8070984/>

## **2.92. Title: Occupant-behavior Driven Appliance Scheduling for Residential Buildings**

**Authors:** Mirakhorli, A. and Dong, B.

**Abstract:** Building-to-grid integration is one important step in having a smart grid. This integration will support energy efficiency, load balancing, and the incorporation of renewables. This study introduces a residential building energy management solution to control connected devices based on economic signals from the grid and occupant behavior. An air-conditioning unit, a water heater, and an electric vehicle (EV) were modeled and controlled using a traditional on/off controller and model predictive controller (MPC). The MPC is designed to minimize the total building electricity costs while maintaining occupant comfort. The MPC utilizes the building thermal mass, the EV battery storage, and the water heater's hot water tank to shift electricity use to a period when the price is lower. This controller considers occupant behavior as a constraint in controlling these devices to maintain users' comfort. The simulation results show a 10% - 30% reduction in the electricity bill by applying the MPC in a dynamic electricity price scenario, as compared to the traditional methods of control. The proposed method of control makes buildings responsive to grid signals that provide the potential of peak shaving and ancillary services.

**Subject Areas:** Model predictive control (MPC); Smart home; Occupant behavior; Building-to-grid integration

**Availability:** Mirakhorli, A. and Dong, B., 2017. *Occupant-behavior Driven Appliance Scheduling for Residential Buildings*. Building Simulation (Vol. 10, No. 6, pp. 917-931). Tsinghua University Press.

<https://link.springer.com/article/10.1007/s12273-017-0402-z>

**2.93. Title: Rural Areas Will Be Late Adaptors to EV Surge, Study Says**

**Author:** Abbema, A. V.

**Abstract:** Newspaper Article

**Subject Areas:** Electric Vehicles (EVs); Rural Electric coops; CoBank; Batteries; Charging Stations

**Availability:** Abbema, A. V., 2017. *Rural Areas Will Be Late Adaptors to EV Surge, Study Says*. Ratchet+Wrench, December Issue.

<https://www.ratchetandwrench.com/articles/5588-rural-areas-will-be-late-adaptors-to-ev-surge-study-says>

**2.94. Title: Cost-Benefit Analysis of V2G Implementation in Distribution Networks Considering PEVs Battery Degradation**

**Authors:** Ahmadian, A., Sedghi, M., Mohammadi-ivatloo, B., Elkamel, A., Golkar, M.A. and Fowler, M.W.

**Abstract:** Charging of Plug-in Electric Vehicles (PEVs), especially as market penetration increases, is an important challenge for today's power systems. This paper presents a stochastic methodology for smart charging of PEVs. All of the associated uncertainties are taken into account in the proposed methodology. Moreover, a comprehensive model for impact of charging/discharging strategies on the battery pack degradation in the vehicle has been included. The proposed approach is applied to a typical distribution network that contains wind-based Distributed Generation (DG) units. A cost-benefit analysis is carried out to extract the benefits of Vehicle to Grid (V2G) implementation in distribution network. The simulation results show that the V2G implementation without considering battery degradation is economical. However, when considering a battery degradation cost, V2G implementation without wind generation is not beneficial, while it is economical when considering wind distributed generation. Moreover, the smart charging is economical in all conditions and also it reduces the battery degradation cost in comparison with uncoordinated charging.

**Subject Areas:** Vehicle to grid; Smart charging; Battery degradation; Distribution network; Uncertainty modeling

**Availability:** Ahmadian, A., Sedghi, M., Mohammadi-ivatloo, B., Elkamel, A., Golkar, M.A. and Fowler, M.W., 2017. *Cost-Benefit Analysis of V2G Implementation in Distribution Networks Considering PEVs Battery Degradation*. IEEE Transactions on Sustainable Energy. <http://ieeexplore.ieee.org/document/8093695/>



**2.95. Title: Vehicle Technologies and Fuel Cell Technologies Office Research and Development Programs: Prospective Benefits Assessment Report for Fiscal Year 2018**

**Authors:** Stephens, T.S., Birky, A. and Gohlke, D.

**Abstract:** Under the U.S. Department of Energy’s (DOE’s) Office of Energy Efficiency and Renewable Energy (EERE), the Vehicle Technologies Office (VTO) and Fuel Cell Technologies Office (FCTO) invest in research of technologies and innovations, including advanced batteries and electrification, engines and fuels, materials, and energy-efficient mobility systems; hydrogen production, delivery, and storage; and fuel cells. This report documents the estimated benefits of successfully developing and implementing these technologies (a “Program Success” case) relative to a base case (the “No Program” case). The Program Success case represents the future with successful implementation of VTO and FCTO technologies. The No Program case represents a future in which there is no contribution after Fiscal Year (FY) 2017 by VTO or FCTO to these technologies.

**Subject Areas:** Fuel consumption; Fiscal Year; Battery degradation; Light-duty vehicles Adoption

**Availability:** Stephens, T.S., Birky, A. and Gohlke, D., 2017. *Vehicle Technologies and Fuel Cell Technologies Office Research and Development Programs: Prospective Benefits Assessment Report for Fiscal Year 2018*. (No. ANL/ESD-17/22). Argonne National Lab.(ANL), Argonne, IL (United States).

<http://www.ipd.anl.gov/anlpubs/2017/11/140256.pdf>

**2.96. Title: Multi-objective Electric Vehicle Scheduling Considering Customer and System Objectives**

**Author:** Crow, M.L.

**Abstract:** Electric vehicle (EV) scheduling is a multi-objective optimization problem with conflicting system and customer interests. They bear the potential to support the grid while providing incentives to the customers through energy transactions, demand response and grid support. Vehicle-to-grid operations provide the customer with attractive avenues for earning revenues but degrade the battery life. Efficient and economical solutions require a balance between customer incurred costs, battery degradation costs and system health. In this paper, the relationships between these objectives have been explored using a multi-objective optimization technique called augmented epsilon-constraint method (AUGMECON). The Pareto optimal solutions will provide day-ahead strategies for coordinating electric vehicles which can then be used for selecting mutually beneficial outcomes.

**Subject Areas:** Battery Degradation; Electric Vehicles; Multi-objective Optimization; Vehicle-to-Grid

**Availability:** Crow, M.L., 2017. *Multi-objective Electric Vehicle Scheduling Considering Customer and System Objectives*. PowerTech, 2017 IEEE Manchester (pp. 1-6). IEEE.  
<http://ieeexplore.ieee.org/abstract/document/7981275/>

### 3. Environment

#### 3.1. Title: Greenhouse Gas and Air Quality Effects of Auto First-last Mile use with Transit

**Authors:** Hoehne, C.G. and Chester, M.V.

**Abstract:** With potential for automobiles to cause increased greenhouse gas emissions and air pollution relative to other modes, there is concern that using automobiles to access or egress public transportation may significantly increase the environmental impacts from door-to-door transit trips. Yet little rigorous work has been developed that quantitatively assesses the effects of transit access or egress by automobiles. This research evaluates the life-cycle impacts of first-and-last mile trips on multimodal transit. An environmental life-cycle assessment of transit and automobile travel in the greater Los Angeles region is developed to evaluate the impacts of multimodal transit trips by utilizing existing transportation life-cycle assessment methods. First-last mile automobile trips with transit may increase multimodal trip emissions significantly, mitigating potential impact reductions from transit usage. In some cases, multimodal transit trips with first-last mile automobile use may have higher emissions than competing automobile trips. In the near-term, first-last mile automobile trips in some Los Angeles transit services may account for up to 66% of multimodal greenhouse gas emissions, and as much as 75% of multimodal air quality impacts. Fossil fuel energy generation and combustion, low vehicle occupancies, and longer trip distances contribute most to increased multimodal impacts. Supply chain analysis indicates that life-cycle air quality impacts may occur largely locally (in Los Angeles) or largely remotely depending on the propulsion method and location of upstream life-cycle processes. Reducing 10% of transit system greenhouse emissions requires a shift of 23-50% of automobile first-last mile trips to a neutral emissions mode.

**Subject Areas:** First-last mile; Transit; Multimodal; Life-cycle assessment; Greenhouse gas; Air quality

**Availability:** Hoehne, C.G. and Chester, M.V., 2017. *Greenhouse Gas and Air Quality Effects of Auto First-last Mile use with Transit*. Transportation Research Part D: Transport and Environment, 53, pp.306-320.

<http://www.sciencedirect.com/science/article/pii/S1361920916306320>

### 3.2. Title: Regional Sky Transit III: The Primacy of Noise

**Author:** Seeley, B.A.

**Abstract:** The trend toward rapid urbanization into megacities and the enormous costs for transportation infrastructure that this entails are expected to continue for decades. The strong and consistent preference of individuals for distributed travel in private vehicles rather than for route-limited travel in crowded public transit also has shown no signs of diminishing. These trends have a significant adverse effect on climate change. Regional Sky Transit<sup>1,2</sup> (RST) has been proposed as a system that can drastically reduce infrastructure cost and CO<sub>2</sub> emissions while preserving people's preference for travel in personal vehicles by providing affordable, accessible, fast, and safe flights distributed across urban regions. RST could thus provide a substantial, new, efficient, value-added supply chain. As such, RST could become aviation's largest market in terms of number of flights, significantly contributing to the growth of connectivity and productivity across population centers. The RST mass market could serve travelers on relatively short trip lengths of less than 160 kilometers. This civil mass market derives from the concept of high proximity aviation - extending air travel operations to numerous very small airparks that are close to where people live and work, so as to reduce ground travel time and thereby save time. This can only be achieved if the aircraft used in RST fulfill stringent limitations on allowable noise emissions that will be essential to high proximity aviation. Examination of the extensive prior research on allowable noise emissions shows that noise issues will dictate both the size of airparks and the concept of operations for RST. This paper reveals why this primacy of noise must be respected, and presents detailed examples of the profound constraints it imposes upon V/ESTOL aircraft designs intended to serve the RST mass market. The barriers to developing the ultra-quiet aircraft necessary to RST along with the most promising strategies for efficiently overcoming those barriers are presented. These strategies include models for how electric propulsion and its energy requirements can best be integrated into Sky Taxis that are suitable for the mission requirements of RST. Those integrations will examine the core science and technologies that affect propulsive noise emission and reveal opportunities for further competitive research. The value and benefits of RST will be compared with the costs of bringing about the necessary noise reduction breakthroughs.

**Subject Areas:** Sky Transit; Reduction of CO<sub>2</sub> emissions; Transport Infrastructure

**Availability:** Seeley, B.A., 2017. *Regional Sky Transit III: The Primacy of Noise*. In 55th AIAA Aerospace Sciences Meeting (p. 0208).

<http://sustainableaviation.org/RST/papers/Regional.Sky.Transit.III.Seeley.SCITECH2017NOISE.pdf>

### **3.3. Title: Comparison of Gasoline Direct-Injection (GDI) and Port Fuel Injection (PFI) Vehicle Emissions: Emission Certification Standards, Cold-Start, Secondary Organic Aerosol Formation Potential, and Potential Climate Impacts**

**Authors:** Saliba, G., Saleh, R., Zhao, Y., Presto, A.A., Lambe, A.T., Frodin, B., Sardar, S., Maldonado, H., Maddox, C., May, A.A. and Drozd, G.T.

**Abstract:** Recent increases in the Corporate Average Fuel Economy standards have led to widespread adoption of vehicles equipped with gasoline direct-injection (GDI) engines. Changes in engine technologies can alter emissions. To quantify these effects, we measured gas- and particle-phase emissions from 82 light-duty gasoline vehicles recruited from the California in-use fleet tested on a chassis dynamometer using the cold-start unified cycle. The fleet included 15 GDI vehicles, including 8 GDIs certified to the most-stringent emissions standard, superultra-low-emission vehicles (SULEV). We quantified the effects of engine technology, emission certification standards, and cold-start on emissions. For vehicles certified to the same emissions standard, there is no statistical difference of regulated gas-phase pollutant emissions between PFIs and GDIs. However, GDIs had, on average, a factor of 2 higher particulate matter (PM) mass emissions than PFIs due to higher elemental carbon (EC) emissions. SULEV certified GDIs have a factor of 2 lower PM mass emissions than GDIs certified as ultralow-emission vehicles ( $3.0 \pm 1.1$  versus  $6.3 \pm 1.1$  mg/mi), suggesting improvements in engine design and calibration. Comprehensive organic speciation revealed no statistically significant differences in the composition of the volatile organic compounds emissions between PFI and GDIs, including benzene, toluene, ethylbenzene, and xylenes (BTEX). Therefore, the secondary organic aerosol and ozone formation potential of the exhaust does not depend on engine technology. Cold-start contributes a larger fraction of the total unified cycle emissions for vehicles meeting more-stringent emission standards. Organic gas emissions were the most sensitive to cold-start compared to the other pollutants tested here. There were no statistically significant differences in the effects of cold-start on GDIs and PFIs. For our test fleet, the measured 14.5% decrease in CO<sub>2</sub> emissions from GDIs was much greater than the potential climate forcing associated with higher black carbon emissions. Thus, switching from PFI to GDI vehicles will likely lead to a reduction in net global warming.

**Subject Areas:** Fuel Economy; Emission standards; Superultra-low-emission vehicles (SULEV)

**Availability:** Saliba, G., Saleh, R., Zhao, Y., Presto, A.A., Lambe, A.T., Frodin, B., Sardar, S., Maldonado, H., Maddox, C., May, A.A. and Drozd, G.T., 2017. *Comparison of Gasoline Direct-Injection (GDI) and Port Fuel Injection (PFI) Vehicle Emissions: Emission Certification Standards, Cold-Start, Secondary Organic Aerosol Formation Potential, and Potential Climate Impacts*. Environmental Science & Technology.

<http://pubs.acs.org/doi/ipdf/10.1021/acs.est.6b06509>

### **3.4. Title: Hitting the Sweet Spot: Variability in Commute Lengths And Vehicle Emissions across a Diverse State**

**Authors:** Mondschein, A. and Parkany, E.

**Abstract:** In this paper we consider travel across Virginia and identify sustainability “sweet spots” where commute lengths and vehicle emissions per mile combine to maximize green travel in terms of total CO<sub>2</sub> emissions associated with commuting. The analysis is conducted across local voter precincts (N = 2373 in the state) because they are a useful proxy for neighborhoods and well-sized for implementing policy designed to encourage sustainable travel behavior. Virginia is especially appropriate for an examination of variability in sustainable travel behavior and technologies because the state’s transportation, demographic, and political patterns are particularly diverse and have been changing rapidly. We identify four Virginia precinct-based sustainability clusters: Sweet Spots, Emerging Sweet Spots, Neutral and Non-sustaining. A model of demographic differences among the clusters shows that sustainability outcomes, understood in terms of both local commute behavior and vehicle emissions, are significantly associated with the diverse demography and politics of the state. We also look at changes in transportation sustainability and socio-demographic trends within the clusters over the past half-decade, showing that differences in sustainability and demographic metrics are actually accelerating within the state over time. We conclude with a discussion of the implications of the differences among the clusters for developing and implementing effective transportation sustainability policies across the state.

**Subject Areas:** Travel choices; Travel behavior; Sustainability; Emissions; Voting precincts; Demographics

**Availability:** Mondschein, A. and Parkany, E., 2017. *Hitting the Sweet Spot: Variability in Commute Lengths And Vehicle Emissions across a Diverse State*. Transportation Research Part D: Transport and Environment, 54, pp.348-359.

<http://pubs.acs.org/doi/ipdf/10.1021/acs.est.6b06509>

### 3.5. Title: More connected Urban Roads reduce US GHG Emissions

**Authors:** Barrington-Leigh, C. and Millard-Ball, A.

**Abstract:** We quantify the importance of early action to tackle urban sprawl. We focus on the long-term nature of infrastructure decisions, specifically local roadways, which can lock in greenhouse gas emissions for decades to come. The location and interconnectedness of local roadways form a near-permanent backbone for the future layout of land parcels, buildings, and transportation options.

We provide new estimates of the environmental impact of low-connectivity roads, characterized by cul-de-sacs and T-intersections, which we dub street-network sprawl. We find an elasticity of vehicle ownership with respect to street connectivity of -0.15 - larger than suggested by previous research. We then apply this estimate to quantify the long-term emissions implications of alternative scenarios for street-network sprawl. On current trends alone, we project vehicle travel and emissions to fall by 3.2% over the 2015-2050 period, compared to a scenario where sprawl plateaus at its 1994 peak. Concerted policy efforts to increase street connectivity could more than triple these reductions to 8.8% by 2050. Longer-term reductions over the 2050-2100 period are more speculative, but could be more than 50% greater than those achieved by 2050. The longer the timescale over which mitigation efforts are considered, the more important it becomes to address the physical form of the built environment.

**Subject Areas:** GreenHouse Gas Emissions; Environment; Vehicle Ownership; Street connectivity

**Availability:** Barrington-Leigh, C. and Millard-Ball, A., 2017. *More connected Urban Roads reduce US GHG Emissions*. Environmental Research Letters, 12(4), p.044008.  
<http://iopscience.iop.org/article/10.1088/1748-9326/aa59ba/meta>

### **3.6. Title: The Unsustainability of Exurban Development in London and New York: Calculating Transport CO<sub>2</sub> Emissions**

**Author:** Focas, C.

**Abstract:** London and New York have often been hailed for their sustainable planning practices. However, when one focuses on the entire city region, there is ever-increasing car-dependent development. This paper focuses on the exurban region of the two cities investigating transport-created CO<sub>2</sub> emissions. The research is based on the analysis of data of the National Travel Surveys of Great Britain and the USA through a quantification of personal travel and a top-down estimation of CO<sub>2</sub> emissions. It is the exurban region that accounts for the vast majority of CO<sub>2</sub> emissions: 77% for London and 87% for New York. In the wider region for both cities there is a policy vacuum and dearth of regional planning mechanisms to deliver policies to reduce CO<sub>2</sub> emissions. The paper argues that transport needs to be planned at the city-regional scale.

**Subject Areas:** Exurbia, London, New York, Transport Emissions

**Availability:** Focas, C., 2017. *The Unsustainability of Exurban Development in London and New York: Calculating Transport CO<sub>2</sub> Emissions*. *Journal of Environmental Planning and Management*, 60(5), pp.901-919.

<http://www.tandfonline.com/doi/abs/10.1080/09640568.2016.1187588>



**3.7. Title: Travel Demand Management Policy Instruments, Urban Spatial Characteristics, and Household Greenhouse Gas Emissions from Travel in the US Urban Areas**

**Author:** Su, Q.

**Abstract:** This paper examines the impact of travel demand management policy instruments and a wide variety of measures of urban spatial characteristics on CO<sub>2</sub> emissions from household travel based on more than 27,000 observations from the 2009 NHTS. The regression results indicate that travel demand management (TDM) instruments and urban spatial characteristics affect CO<sub>2</sub> emissions from household travel in a complicated way. Population-weighted density, rail availability, and TDM instruments such as parking management, promotion of transit use and carpool, and employer-based TDM programs have a moderate but negative impact on CO<sub>2</sub> emissions from household travel. On the other hand, employment and population distribution imbalance and major road network density have a moderate but positive impact on CO<sub>2</sub> emissions from household travel.

**Subject Areas:** Parking management; Promotion of transit use and carpool, employer-based TDM program; CO<sub>2</sub> emissions from household travel; Population-weighted density; Employment and population distribution imbalance

**Availability:** Su, Q., 2017. *Travel Demand Management Policy Instruments, Urban Spatial Characteristics, and Household Greenhouse Gas Emissions from Travel in the US Urban Areas*. International Journal of Energy Economics and Policy, 7(3), pp.157-166.  
<https://econjournals.com/index.php/ijeep/article/view/4305>

**3.8. Title: The Impact of Metropolitan, County, and Local Land Use on Driving Emissions in US Metropolitan Areas: Mediator Effects Of Vehicle Travel Characteristics.**

**Authors:** Choi, K. and Zhang, M.

**Abstract:** Many municipalities in the U.S. pursue compact development to reduce greenhouse gas (GHG) emissions from driving. Despite the efforts, however, recent studies suggest that some land use strategies such as densification and mixed-use development may result in slower vehicle movements, and consequently generate more driving emissions. Since vehicle miles of travel (VMT) is only a proxy and not an exact measure of emissions, reduction in VMT may not lead to a proportional reduction in transportation GHG emissions. Aside from local land use efforts, regional factors also influence vehicle travel and associated emissions.

This study investigates the relationship between land use, vehicle travel, and driving emissions in the selected U.S. metropolitan areas at multiple geographic levels. The study employed structural equation modeling (SEM) techniques to examine how land use influences vehicle travel characteristics and associated emissions. The main data sources for the analyses include the 2009 National Household Travel Survey (NHTS) add-on samples and the Smart Location Database (SLD) from the U.S. Environmental Protection Agency (EPA). The study results show that VMT reduction and the associated environmental benefit do not show a one-on-one relationship due to the emissions penalty of lowered vehicle operating speed. Vehicle travel and associated emissions are not only influenced by local urban form factors but also affected by the greater geographical context.

**Subject Areas:** Smart Location Database; Land use; VMT; driving emissions; NHTS Add-on; SEM

**Availability:** Choi, K. and Zhang, M., 2017. *The Impact of Metropolitan, County, and Local Land Use on Driving Emissions in US Metropolitan Areas: Mediator Effects Of Vehicle Travel Characteristics*. *Journal of Transport Geography*, 64, pp.195-202.

<https://www.sciencedirect.com/science/article/pii/S0966692316300035>

### **3.9. Title: The Public Transport and Urban Pollution.**

**Author:** Borck, R.

**Abstract:** The paper studies the effect of public transport policies on urban pollution. It uses a quantitative equilibrium model with residential choice and mode choice. Pollution comes from commuting and residential energy use. The model parameters are calibrated to replicate key variables for American metropolitan areas. In the counterfactual, I study how free public transport coupled with increasing transit speed affects the equilibrium. In the baseline simulation, total pollution falls by 0.2%, as decreasing emissions from transport are partly offset by rising residential emissions. A second counterfactual compares a city with and without public transit. This large investment decreases pollution by 1.6%. When jobs are decentralized, emissions fall by 0.3% in the first and by 3% in the second counterfactual.

**Subject Areas:** Public Transport; Pollution; Discrete Choice

**Availability:** Borck, R., 2017. *Public Transport and Urban Pollution*. CESifo Working Paper Series No. 6606.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3033475](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3033475)

### **3.10. Title: Household Accessibility to Heat Refuges: Residential Air Conditioning, Public Cooled Space, and Walkability.**

**Authors:** Fraser, A.M., Chester, M.V., Eisenman, D., Hondula, D.M., Pincetl, S.S., English, P. and Bondank, E.

**Abstract:** Access to air conditioned space is critical for protecting urban populations from the adverse effects of heat exposure. Yet there remains fairly limited knowledge of the penetration of private (home air conditioning) and distribution of public (cooling centers and commercial space) cooled space across cities. Furthermore, the deployment of government-sponsored cooling centers is likely to be inadequately informed with respect to the location of existing cooling resources (residential air conditioning and air conditioned public space), raising questions of the equitability of access to heat refuges. We explore the distribution of private and public cooling resources and access inequities at the household level in two major US urban areas: Los Angeles County, California and Maricopa County, Arizona (whose county seat is Phoenix). We evaluate the presence of in-home air conditioning and develop a walking-based accessibility measure to air conditioned public space using a combined cumulative opportunities-gravity approach. We find significant variations in the distribution of residential air conditioning across both regions which are largely attributable to building age and inter/intra-regional climate differences. There are also regional disparities in walkable access to public cooled space. At average walking speeds, we find that official cooling centers are only accessible to a small fraction of households (3% in Los Angeles, 2% in Maricopa) while a significantly higher number of households (80% in Los Angeles, 39% in Maricopa) have access to at least one other type of public cooling resource such as a library or commercial establishment. Aggregated to a neighborhood level, we find that there are areas within each region where access to cooled space (either public or private) is limited which may increase heat-related health risks.

**Subject Areas:** Accessibility; Walkability; Climate change; Extreme heat

**Availability:** Fraser, A.M., Chester, M.V., Eisenman, D., Hondula, D.M., Pincetl, S.S., English, P. and Bondank, E., 2017. *Household Accessibility to Heat Refuges: Residential Air Conditioning, Public Cooled Space, and Walkability*. *Environment and Planning B: Urban Analytics and City Science*, 44(6), pp.1036-1055.

<http://journals.sagepub.com/doi/abs/10.1177/0265813516657342>

### **3.11. Title: The Analysis of CO<sub>2</sub> Emissions by Private Cars in Chinese cities and International Comparison**

**Authors:** Ou, Y., Nakagawa, D., Matsunaka, R. and Oba, T.

**Abstract:** This study aims to explore how city characteristics and the level of transport infrastructure influence car generated CO<sub>2</sub> emissions in Chinese cities and cities in developed countries. Discussion on different types of city grouping was conducted, in order to figure out how they perform differently in different type of cities and discover the factors effecting car CO<sub>2</sub> emission in Chinese cities at present and future. The research targets on 35 Chinese cities, 12 Japanese cities, 7 Korean cities, 34 U.S. metropolitan areas and 26 E.U. metropolitan areas with a population over 1 million. The car CO<sub>2</sub> emissions in this study are calculated by the daily trip data collected from PT survey datasets. Indexes concerning city characteristics and transport infrastructure were considered to effect the car CO<sub>2</sub> emissions inside city. The research conducted intuitive analysis and regression analysis, and the distinct performances of indexes are apperceived between cities in China and developed countries. The study suggests that the minus effect of GRDP on the CO<sub>2</sub> emissions in Chinese cities will weaken in the future, and high level of urban rail system shows the same significance as population density in constructing low carbon society.

**Subject Areas:** Transport infrastructure; CO<sub>2</sub> Emissions; Daily trip data; Low carbon society

**Availability:** Ou, Y., Nakagawa, D., Matsunaka, R. and Oba, T., 2017. *The Analysis of CO<sub>2</sub> Emissions by Private Cars in Chinese cities and International Comparison*. Urban and Regional Planning Review, 4, pp.185-210.

[https://www.jstage.jst.go.jp/article/urpr/4/0/4\\_185/\\_article/-char/ja/](https://www.jstage.jst.go.jp/article/urpr/4/0/4_185/_article/-char/ja/)

### 3.12. Title: Comparing On-road Real-time Simultaneous In-cabin and Outdoor Particulate and Gaseous Concentrations for a Range of Ventilation Scenarios

**Authors:** Leavey, A., Reed, N., Patel, S., Bradley, K., Kulkarni, P. and Biswas, P.

**Abstract:** Advanced automobile technology, developed infrastructure, and changing economic markets have resulted in increasing commute times. Traffic is a major source of harmful pollutants and consequently daily peak exposures tend to occur near roadways or while travelling on them. The objective of this study was to measure simultaneous real-time particulate matter (particle numbers, lung-deposited surface area, PM<sub>2.5</sub>, particle number size distributions) and CO concentrations outside and in-cabin of an on-road car during regular commutes to and from work. Data was collected for different ventilation parameters (windows open or closed, fan on, AC on), whilst traveling along different road-types with varying traffic densities. Multiple predictor variables were examined using linear mixed-effects models. Ambient pollutants (NO<sub>x</sub>, PM<sub>2.5</sub>, CO) and meteorological variables (wind speed, temperature, relative humidity, dew point) explained 5 - 44% of outdoor pollutant variability, while the time spent traveling behind a bus was statistically significant for PM<sub>2.5</sub>, lung-deposited SA, and CO (adj-R<sup>2</sup> values=0.12, 0.10, 0.13). The geometric mean diameter (GMD) for outdoor aerosol was 34 nm. Larger cabin GMDs were observed when windows were closed compared to open (b=4.3, p-value= $\leq$ 0.01). When windows were open, cabin total aerosol concentrations tracked those outdoors. With windows closed, the pollutants took longer to enter the vehicle cabin, but also longer to exit it. Concentrations of pollutants in cabin were influenced by outdoor concentrations, ambient temperature, and the window/ventilation parameters. As expected, particle number concentrations were impacted the most by changes to window position/ventilation, and PM<sub>2.5</sub> the least. Car drivers can expect their highest exposures when driving with windows open or the fan on, and their lowest exposures during windows closed or the AC on. Final linear mixed-effects models could explain between 88 and 97% of cabin pollutant concentration variability. An individual may control their commuting exposure by applying dynamic behavior modification to adapt to changing pollutant scenarios.

**Subject Areas:** Car commuting; Exposure assessment; Ventilation; Pollution; Aerosols

**Availability:** Leavey, A., Reed, N., Patel, S., Bradley, K., Kulkarni, P. and Biswas, P., 2017. *Comparing On-road Real-time Simultaneous In-cabin and Outdoor Particulate and Gaseous Concentrations for a Range of Ventilation Scenarios*. Atmospheric Environment, 166, pp.130-141.  
<https://www.sciencedirect.com/science/article/pii/S1352231017304570>

### 3.13. Title: The Revenue Implications of a Carbon Tax

**Authors:** Yuan, M., Metcalf, G.E., Reilly, J. and Paltsev, S.

**Abstract:** A primary reason for implementing a carbon or greenhouse gas tax is to reduce emissions, but in recent years there has been increased interest in a carbon tax's revenue potential. This revenue could be used for federal deficit reduction, to help finance tax reform, support new spending priorities such as infrastructure spending, offset the burden of the tax on households, or other purposes. With an environmental goal to reduce emissions to very low levels, programs that become dependent on the revenue may come up short when and if carbon revenue begins to decline. To date, the revenue potential of a carbon tax has not been studied in detail. This study focuses on how much carbon tax revenue can be collected and whether there is a carbon "Laffer Curve" relationship, with a point where revenue begins to decline. We employ the MIT U.S. Regional Energy Policy (USREP) model, a dynamic computable general equilibrium model for the U.S. economy, for the numerical investigation of this question. We consider scenarios with different carbon prices and emissions reductions goals to explore how they may affect whether and at what tax rate revenues peak. We find that a sufficiently high tax rate would induce a revenue peak between now and 2050. For the scenarios we study, however, we find that carbon tax revenue is a dependable source of revenue to finance federal fiscal initiatives over a thirty-year period at the minimum. We also explore how the cost of low-carbon technology and existing energy policies interact with tax rates and revenues. Our results indicate that lower costs of abatement technology make emissions more responsive to the tax rate, and removing regulations on renewables and personal transportation results in more carbon tax revenues. Our results also show that either lowering technology costs or removing existing policies would reduce the welfare cost of a carbon policy with specific reduction goals, with a larger offsetting gain from eliminating distortions associated with existing policies.

**Subject Areas:** Greenhouse gas tax; Emission reduction; Revenue; Federal deficit

**Availability:** Yuan, M., Metcalf, G.E., Reilly, J. and Paltsev, S., 2017. *The Revenue Implications of a Carbon Tax*. Report 316, Joint Program on the Science and Policy of Global Change Reports. [https://globalchange.mit.edu/sites/default/files/MITJPSPGC\\_Rpt316.pdf](https://globalchange.mit.edu/sites/default/files/MITJPSPGC_Rpt316.pdf)

### 3.14. Title: Toward Probabilistic Prediction of Flash Flood Human Impacts

**Authors:** Terti, G., Ruin, I., Gourley, J.J., Kirstetter, P., Flamig, Z., Blanchet, J., Arthur, A. and Anquetin, S.

**Abstract:** This article focuses on conceptual and methodological developments allowing the integration of physical and social dynamics leading to model forecasts of circumstance specific human losses during a flash flood. To reach this objective, a random forest classifier is applied to assess the likelihood of fatality occurrence for a given circumstance as a function of representative indicators. Here, vehicle-related circumstance is chosen as the literature indicates that most fatalities from flash flooding fall in this category. A database of flash flood events, with and without human losses from 2001 to 2011 in the United States, is supplemented with other variables describing the storm event, the spatial distribution of the sensitive characteristics of the exposed population, and built environment at the county level. The catastrophic flash floods of May 2015 in the states of Texas and Oklahoma are used as a case study to map the dynamics of the estimated probabilistic human risk on a daily scale. The results indicate the importance of time- and space-dependent human vulnerability and risk assessment for short-fuse flood events. The need for more systematic human impact data collection is also highlighted to advance impact-based predictive models for flash flood casualties using machine-learning approaches in the future.

**Subject Areas:** Dynamic risk mapping; machine-learning predictions; probability of flash flood casualty

**Availability:** Terti, G., Ruin, I., Gourley, J.J., Kirstetter, P., Flamig, Z., Blanchet, J., Arthur, A. and Anquetin, S., 2017. *Toward Probabilistic Prediction of Flash Flood Human Impacts*. Risk Analysis.

<http://onlinelibrary.wiley.com/doi/10.1111/risa.12921/full>

<http://onlinelibrary.wiley.com/doi/10.1111/risa.12921/epdf>



### **3.15. Title: The Role of State Policies under Federal Light-Duty Vehicle Greenhouse Gas Emissions Standards**

**Authors:** Linn, J. and McConnell, V.

**Abstract:** Currently, the US federal government sets fuel economy and greenhouse gas standards for passenger vehicles and promotes innovation for alternative fuel vehicles. Many states are considering their own transportation policies that would reduce the environmental, health, and time costs of driving. In principle, federal and state policies may interact in important ways, either positively or negatively. We find that state policies targeting only emissions of new vehicles and particularly alternative fuel vehicles are unlikely to decrease national greenhouse gas emissions in the short run, primarily due to interactions with federal regulations. We then examine the conditions under which state and federal policies can have positive long-run social benefits. Carefully constructed state policies can complement the federal policies and achieve states' objectives.

**Subject Areas:** New Vehicle Corporate Average Fuel Economy Standards; Carbon Tax; Congestion Charge; Electric Vehicles; Registration Tax; Policy Interactions

**Availability:** Linn, J. and McConnell, V., 2017. *The Role of State Policies under Federal Light-Duty Vehicle Greenhouse Gas Emissions Standards*. Resources For The Future Report (RFF) Report.

<http://www.ourenergypolicy.org/wp-content/uploads/2017/07/RFF-Rpt-Role-of-State-Policies.pdf>

### **3.16. Title: Comparing Greenhouse Gas Reductions and Legal Implementation Possibilities for Pay-to-Save Transportation Price-shifting Strategies and EPA's Clean Power Plan**

**Authors:** Greenberg, A. and Evans, J.J.

**Abstract:** This study models potential greenhouse gas (GHG) emissions reductions from public policy measures to bring about a set of innovative, revenue-neutral transportation pricing reforms including (a) pay-as-you-drive-and-you-save car insurance, (b) parking cash out, and (c) the conversion of fixed state and local vehicle sales taxes into distance based taxes designed to raise equivalent revenue. By converting fixed costs into variable per-mile charges, and automobile-specific subsidies into modal-neutral subsidies (pedestrians, cyclists, carpoolers and public transit passengers receive benefits of equivalent value), these low-cost strategies give travelers significant financial incentives to curtail their driving and provide major co-benefits including reductions in traffic and parking congestion, automobile crashes, and local pollution. The study proposes using the U.S. Environmental Protection Agency's Clean Power Plan regulatory framework to bring about the transportation pricing reforms, and discusses Federal administrative authority to compel states to implement the reforms, or other measures yielding equivalent GHG emissions reductions, through a model State Implementation Plan and Federal Implementation Plan. Also modeled is an alternative Federal policy measure designed to appeal to a growing number of conservatives in Congress who favor non-regulatory approaches to reduce GHGs, such as tax incentives. Estimated reductions are 140 or 257 million metric tons of carbon dioxide equivalent annually, for the tax incentive and regulatory policy, respectively, which equates to 37 or 69% of the Clean Power Plan reductions, or 1.7 or 3.0 times the reductions of a nationwide transportation fuels cap-and-trade program with a permit price at the \$50 per ton year- 2030 social cost of carbon.

**Subject Areas:** Greenhouse Gas (GHG) emissions; Clean Power Plan

**Availability:** Greenberg, A. and Evans, J.J., 2017. *Comparing Greenhouse Gas Reductions and Legal Implementation Possibilities for Pay-to-Save Transportation Price-shifting Strategies and EPA's Clean Power Plan.*

[http://www.vtppi.org/G&E\\_GHG.pdf](http://www.vtppi.org/G&E_GHG.pdf)

### **3.17. Title: Sustainability of Self-Driving Mobility: An Analysis of Carbon Emissions between Autonomous Vehicles and Conventional Modes of Transportation**

**Author:** Mccarthy, John Francis.

**Abstract:** The primary contribution of this paper is to identify the potential variables through which vehicle automation may affect carbon emissions in the transportation sector, and compare modal shifts between conventional vehicles, public transportation, and pilot autonomous vehicles (AVs). AV programs that are rapidly emerging in cities, states, and nations across the globe mark the early stages of the next transportation revolution akin to the steam engine and assembly line. By safely allowing humans to take their hands off the steering wheel, autonomous technology could potential prevent 90% of car collisions every year, save hundreds of billions of dollars, and reduce carbon emissions. In order to examine how a modal shift to autonomous vehicles will impact carbon emissions specifically, I consolidated a literature review of AV factors that both help and hinder energy consumption and designed a carbon emissions model based on the United Nations (UN) Framework Convention on Climate Change.

I conducted various simulations to compare a modal shift away from public transit and toward AVs to address several research questions: Are AVs a viable mitigation strategy to reduce carbon emissions in the transportation sector? And will a modal shift to AV-based travel in urban areas produce more pounds of carbon per passenger mile than traditional modes of public transportation? Through these simulations, I examined two hypotheses. First, in the event that all public transportation passengers shift to traveling by AVs, carbon emissions in the transportation sector will increase compared to baseline emissions. And second, modes of public transportation have a lower emissions rate (pounds of CO<sub>2</sub> per passenger-mile) than AVs.

The scenarios modeled in this paper offer a glimpse into how AV technology might impact carbon emissions at a time when there are already early indicators of a transition to AVs. Based on these scenarios, it appears that Level 4 AVs would reduce emissions more than Level 3. Right-sizing, reduced engine performance, and platooning are AV factors that are available only in Level 4 vehicles and represent an 83.5% improvement in fuel economy. A modal shift to Level 4 AVs coupled with alternative fueled vehicles could substantially reduce carbon emissions. Specifically, emissions from conventional internal combustion engine cars were reduced by 50% as a result of a modal shift to hybrids, electrics, and CNG vehicles. However, a modal shift to public transportation coupled with a clean energy electrical grid reduced emissions by 91% compared to the baseline based on the model, 14% more than a complete modal shift to alternative energy Level 4 AVs.

**Subject Areas:** Vehicle automation; Carbon emissions; Transportation sector

**Availability:** Mccarthy, John Francis., 2017. *Sustainability of Self-Driving Mobility: An Analysis of Carbon Emissions between Autonomous Vehicles and Conventional Modes of Transportation*. Master's thesis, Harvard Extension School.

<https://dash.harvard.edu/handle/1/33813411>

### 3.18. Title: Empirical Fuel Consumption and CO<sub>2</sub> Emissions of Plug-in Hybrid Electric Vehicles

**Authors:** Plötz, P., Funke, S.Á. and Jochem, P.

**Abstract:** Plug-in hybrid electric vehicles (PHEVs) combine electric and conventional propulsion. Official fuel consumption values of PHEVs are based on standardized driving cycles, which show a growing discrepancy with real-world fuel consumption. However, no comprehensive empirical results on PHEV fuel consumption are available, and the discrepancy between driving cycle and empirical fuel consumption has been conjectured to be large for PHEV. Here, we analyze real-world fuel consumption data from 2,005 individual PHEVs of five PHEV models and observe large variations in individual fuel consumption with deviation from test-cycle values in the range of 2% to 120% for PHEV model averages. Deviations are larger for short-ranged PHEVs. Among others, range and vehicle power are influencing factors for PHEV model fuel consumption with average direct carbon dioxide CO<sub>2</sub> emissions decreasing by 2% to 3% per additional kilometer (km) of electric range. Additional simulations show that PHEVs recharged from renewable electricity can noteworthy reduce well-to-wheel CO<sub>2</sub> emissions of passenger cars, but electric ranges should not exceed 200 to 300 km since battery production is CO<sub>2</sub> -intense. Our findings indicate that regulations should (1) be based on real-world fuel consumption measurements for PHEV, (2) take into account charging behavior and annual mileages, and (3) incentivize long-ranged PHEV.

**Subject Areas:** Plug-in hybrid electric vehicles; CO<sub>2</sub> Emissions; Fuel consumption

**Availability:** Plötz, P., Funke, S.Á. and Jochem, P., 2017. *Empirical Fuel Consumption and CO<sub>2</sub> Emissions of Plug-in Hybrid Electric Vehicles*. Journal of Industrial Ecology. <http://onlinelibrary.wiley.com/doi/10.1111/jiec.12623/full>

## 4. Health

### 4.1. Title: Estimating the Effect of Mobility and Food Choice on Obesity in a Rural, Northern Environment

**Authors:** Kolodinsky, J.M., Battista, G., Roche, E., Lee, B.H. and Johnson, R.K.

**Abstract:** The literature suggests that energy balance is shaped by where food is accessed, mobility behaviors, beliefs, preferences, socioeconomic characteristics, and attributes of the built environment. However, the relationship of these factors with energy balance has not been simultaneously considered on a regional scale. Utilizing a social-ecological framework, this study incorporated individual level and geospatial data to estimate a structural equation model (SEM) to examine the complex association of these variables with being overweight or obese. Results indicate that food choice, mobility, demographic characteristics, and normative beliefs are related to energy imbalance. Further, accounting for the endogeneity of food access and mobility changes both the significance and magnitude of factors associated with obesity as compared to treating them as exogenous.

**Subject Areas:** Rural; Mobility; Obesity; Transportation; Public health

**Availability:** Kolodinsky, J.M., Battista, G., Roche, E., Lee, B.H. and Johnson, R.K., 2017. *Estimating the Effect of Mobility and Food Choice on Obesity in a Rural, Northern Environment*. *Journal of Transport Geography*, 61, pp.30-39.

<http://www.sciencedirect.com/science/article/pii/S0966692317302466>

## 4.2. Title: Exploring Parental Perceptions of a Walking-School-bus Initiative in Northern Ontario

**Author:** Atrooshi, D.

### **Abstract:**

**Introduction:** Active transportation to school (ATS) may be a way to increase children's physical activity (PA) levels and achieve health related benefits, however only 24% of Canadian children use active transportation as a mode to travel to and from school (Gray et al., 2014). A walking-school bus (WSB) is a proposed strategy that can afford students a safe, active method of travel to school (Kearns, Collins, & Neuwelt, 2003). Few studies have examined parental perceptions of a WSB. Given that parents are typically the decision makers in regards to methods of school travel, understanding parent perceived barriers and facilitators to using a WSB is warranted.

**Purpose:** The primary purpose of this thesis study was to explore parental perceptions of a WSB in order to inform an effective messaging and promotional strategy. The secondary purpose was to explore barriers and facilitators related to a WSB/ATS and to explore parent ideas about ways for their children to incorporate active travel into their daily routine.

**Methods:** Parents of students (N=16), from three elementary schools located in Northern Ontario were recruited. Semi-structured interviews were conducted, guided by a social marketing approach (Lee & Kotler, 2011). Inductive and deductive analyses were used to identify emerging themes and to explore product, price, promotion and place barriers and/or facilitators related to a WSB. Alternative ATS strategies were compiled.

**Results:** Parents identified the potential for increased levels of PA and positive social interactions as key facilitators of participating in a WSB. Other key facilitators included the opportunity to be supervised while participating in ATS, and promotion of the WSB through electronic platforms such as social media. However, parents expressed concerns regarding the safety of their children and the reliability of adult supervision of the WSB. Concerns related to extreme weather conditions were also present.

**Discussion:** Findings from this study will be used by the North Bay Parry Sound District Health Unit to guide WSB interventions and to develop a messaging strategy to promote WSB uptake at the participating schools as a way to enhance ATS among students.

**Subject Areas:** Physical activity; Walking

**Availability:** Atrooshi, D., 2017. *Exploring Parental Perceptions of a Walking-School-bus Initiative in Northern Ontario*. M.S. Thesis, Queen's University, Ontario, Canada.

[https://qspace.library.queensu.ca/bitstream/handle/1974/15391/Atrooshi\\_Darran\\_J\\_201702\\_MSc.pdf?sequence=7&isAllowed=y](https://qspace.library.queensu.ca/bitstream/handle/1974/15391/Atrooshi_Darran_J_201702_MSc.pdf?sequence=7&isAllowed=y)

**4.3. Title: Using Public Transportation Reduces Obesity and Makes People Healthier**

**Author:** Andrei, M.

**Abstract:** Blog

**Subject Areas:** Public Transit; Obesity

**Availability:** Andrei, M., 2017. *Using Public Transportation Reduces Obesity and Makes People Healthier*. ZMEScience.

<http://www.zmescience.com/medicine/public-transportation-vs-obesity/>

#### **4.4. Title: Are Buffers around Home representative of Physical Activity Spaces among Adults?**

**Authors:** K.M., Howard, A.G., Emch, M., Rodriguez, D.A. and Evenson, K.R.

**Abstract:** Residential buffers are frequently used to assess built environment characteristics relevant to physical activity (PA), yet little is known about how well they represent the spatial areas in which individuals undertake PA. We used System for Observing Play and Recreation in Communities data for 217 adults from five US states who wore an accelerometer and a GPS for three weeks to create newly defined PA-specific activity spaces. These PA spaces were based on PA occurring in bouts of  $\geq 10$  min and were defined as 1) the single minimum convex polygon (MCP) containing all of a participant's PA bout minutes and 2) the combination of many MCPs constructed using each PA bout independently. Participants spent a large proportion of their PA bout time outside of 0.5, 1, and 5 mile residential buffers, and these residential buffers were a poor approximation of the spatial areas in which PA bouts occurred. The newly proposed GPS-based PA spaces can be used in future studies in place of the more general concept of activity space to better approximate built environments experienced during PA.

**Subject Areas:** Physical activity; Accelerometry; Activity space; Global positioning systems; Residential buffers

**Availability:** K.M., Howard, A.G., Emch, M., Rodriguez, D.A. and Evenson, K.R., 2017. *Are Buffers Around Home Representative of Physical Activity Spaces among Adults?* Health & Place, 45, pp.181-188.

<http://www.sciencedirect.com/science/article/pii/S1353829216302106>



#### **4.5. Title: Analyzing the Impact of Public Transit Usage on Obesity**

**Authors:** She, Z., King, D.M. and Jacobson, S.H.

**Abstract:** The objective of this paper is to estimate the impact of county-level public transit usage on obesity prevalence in the United States and assess the potential for public transit usage as an intervention for obesity. This study adopts an instrumental regression approach to implicitly control for potential selection bias due to possible differences in commuting preferences among obese and non-obese populations. United States health data from the 2009 Behavioral Risk Factor Surveillance System and transportation data from the 2009 National Household Travel Survey are aggregated and matched at the county level. County-level public transit accessibility and vehicle ownership rates are chosen as instrumental variables to implicitly control for unobservable commuting preferences. The results of this instrumental regression analysis suggest that a one percent increase in county population usage of public transit is associated with a 0.221 percent decrease in county population obesity prevalence at the  $\alpha = 0.01$  statistical significance level, when commuting preferences, amount of non-travel physical activity, education level, health resource, and distribution of income are fixed. Hence, this study provides empirical support for the effectiveness of encouraging public transit usage as an intervention strategy for obesity.

**Subject Areas:** Obesity; Transportation; Public Transit; Environment design

**Availability:** She, Z., King, D.M. and Jacobson, S.H., 2017. *Analyzing the Impact of Public Transit Usage on Obesity*. Preventive Medicine, 99, pp.264-268.  
<http://www.sciencedirect.com/science/article/pii/S0091743517301093>

#### **4.6. Title: Interrelationships of physical activity in different domains: Evidence from the Geographic Research on Wellbeing (GROW) study**

**Authors:** Lee, R.E., Lorenzo, E., Heck, K., Kohl, H.W. and Cubbin, C.

**Abstract:** Research has rarely distinguished between non-work (NW) and work (W) active transport (AT) or investigated relationships to other domains of physical activity ([PA], like leisure time [LTPA] or work [WPA]). We investigated correlates of AT by employment status, accounting for LTPA and WPA, in a population-based sample of California mothers (N=2906) in the Geographic Research on Wellbeing (GROW) study (2012-2013). AT was measured by the National Household Travel Survey. LTPA was measured using the Stanford Leisure-Time Activity Categorical Item. WPA was measured with the Stanford Brief Activity Survey. Most employed mothers (53%) worked in sedentary jobs, and few (<10%) used NWAT or WAT. Over 20% of unemployed mothers used NWAT, although LTPA levels were similar to employed mothers. Multiple regression models found employed and unemployed with low education and income, and unemployed African American or Latina immigrant mothers had higher odds of using NWAT. Younger employed and unemployed mothers, and unemployed who had  $\geq 4$  children or had light LTPA had lower odds of using NWAT. Multiple regression models demonstrated that low education or income employed mothers, African American mothers, those who worked part time, and those with relatively low LTPA had higher odds of using WAT, while younger women had lower odds of using WAT, compared with reference groups ( $p < 0.05$ ). WPA was associated with WAT in unadjusted models, but not in adjusted models. Different AT patterns were seen for employed vs unemployed women, but women who used AT did so for most trips. LTPA was associated with NWAT among unemployed mothers and with WAT among employed mothers. Most women were underactive across all domains, suggesting no compensatory effect of PA done in one domain reducing PA done in another domain, with few meeting minimal guidelines. Policy and practice strategies should support infrastructure to encourage a variety of domains of PA.

**Subject Areas:** Locomotion; Motor activity; Walking; Bicycling; Mothers; Active commuting

**Availability:** Lee, R.E., Lorenzo, E., Heck, K., Kohl, H.W. and Cubbin, C., 2017. *Interrelationships of physical activity in different domains: Evidence from the Geographic Research on Wellbeing (GROW) study*. Journal of Transport & Health.

<http://www.sciencedirect.com/science/article/pii/S2214140516303292>

#### **4.7. Title: Automobile Dependence and Physical Inactivity: Insights from the California Household Travel Survey**

**Authors:** Chakrabarti, S. and Shin, E.J.

**Abstract:**

Background: Auto-dependence has been linked to the physical inactivity epidemic across U.S. cities, resulting in unprecedented increases in incidences of obesity, cardiovascular diseases, depression, etc. The search for strategies to pull an overwhelming majority of auto-dependents out of their sedentary lifestyles by encouraging them to use transit, walk and bike continues to challenge planners and policy-makers.

Methods: We use the 2012-13 California Household Travel Survey data for analyzing the auto-dependence and physical inactivity connection. We select a sample of employed individuals with access to car in urban California, and classify them as discretionary transit riders (N=390), active auto-dependents (N=1287), or sedentary auto-dependents (N=8754) based on their self-reported travel mode use and time spent in physical activity over a 24-h period. We investigate factors that are associated with significantly high physical activity among some auto-dependents relative to the sedentary majority. We also revisit the transit-physical activity connection, and explore conditions that make transit use unfeasible for some active auto-dependents.

Results: Discretionary transit use is associated with higher physical activity. However, there is large variation in physical activity within auto-dependents; significantly higher physical activity is associated with factors such as higher income, flexible work schedule, shorter work hours, and mixed land use. Kids, inflexibility of work schedule, low residential density, lack of pedestrian and bicycling friendly street design, and long distance to transit stops prohibit otherwise active auto-dependents from choosing transit. Employment sector influences both physical activity and choice of transit.

Conclusion: To get sedentary auto-dependents out of endemic physical inactivity, our research indicates the need for targeting lower-incomes, incentivizing employers to provide flexible work hours, and to continue dense, mixed-use developments that make active travel feasible. In addition, to get active auto-dependents to use transit, transit managers must focus on retaining immigrant riders and non-Hispanic Asians, and attracting people with children.

**Subject Areas:** Physical activity; Public health; Automobile dependence; Public transit policy; Walking; Bicycling

**Availability:** Chakrabarti, S. and Shin, E.J., 2017. *Automobile Dependence and Physical Inactivity: Insights from the California Household Travel Survey*. Journal of Transport & Health. <http://www.sciencedirect.com/science/article/pii/S2214140516303085>

**4.8. Title: Mass Transit Linked to Lower Obesity Rates in Study**

**Author:** Caffrey, M.

**Abstract:** Blog

**Subject Areas:** Public Transit; Obesity

**Availability:** Caffrey, M., 2017. *Mass Transit Linked to Lower Obesity Rates in Study*. AJMC.com  
<http://www.ajmc.com/newsroom/mass-transit-linked-to-lower-obesity-rates-in-study>

#### **4.9. Title: “Transit makes you short”: On Health Impact Assessment of Transportation and the Built Environment**

**Authors:** Ermagun, A. and Levinson, D.

**Abstract:** This study conducts an in-depth analysis to alert policymakers and practitioners to erroneous results in the positive impacts of transit use on health measures. We explore the correlation of transit use and accessibility by transit and walking with self-reported general health, Body Mass Index (BMI), and height. We develop a series of linear regression and binary logit models. We also depict the coefficient-p-value-sample-size chart, and conduct the effect size analysis to scrutinize the practically significant impacts of transit use and accessibility on health measures. The results indicate transit use and accessibility by transit and walking are significantly associated with general health and BMI. However, they are practically insignificant, and the power of the large sample in our particular case causes the statistically insignificant variable to become significant. At a deeper level, a 1% increase in transit use at the county level diminishes the BMI by only 0.0037% on average. The elasticity of transit use also demonstrates that every 1% increase in transit use would escalate the chance of having excellent or very good general health by 0.0003%. We show there is a thin line between false positive and true negative results. We alert both researchers and practitioners to the dangerous pitfalls deriving from the power of large samples and the weakness of p-values. Building the results on just statistical significance and sign of the parameter of interest is worthless, unless the magnitude of effect size is carefully quantified post analysis.

**Subject Areas:** Public transit; BRFSS data; ACS data; General health; p-hacking

**Availability:** Ermagun, A. and Levinson, D., 2017. “*Transit makes you short*”: *On Health Impact Assessment of Transportation and the Built Environment*. *Journal of Transport & Health*, 4, pp.373-387.

<http://www.sciencedirect.com/science/article/pii/S2214140516302390>

#### **4.10. Title: Geographic Variation in Transportation Concerns and Adaptations to Travel-Limiting Health Conditions in the United States**

**Authors:** Henning-Smith, C., Evenson, A., Kozhimannil, K. and Moscovice, I.

**Abstract:** Transportation is a social determinant of health, and rural and urban locations are demonstratively different in their transportation availability and infrastructure. Rural and urban locations in the United States also differ in their socio-demographic and health profiles, with rural populations tending to be older, sicker, and poorer than their urban counterparts. Little is known, however, about how perceptions of transportation in the U.S. and adaptations to travel-limiting health conditions differ by geographic location. Using data from the 2009 National Household Travel Survey (n = 204,035), we found differences by geographic location in transportation concerns. For example, rural residents were more likely to list price of travel as their biggest concern and less likely to list highway congestion, availability of public transportation, and issues with other drivers as their biggest concern, compared with urban residents. Among respondents with health conditions that limit travel (n = 17,332), we found differences by location in adaptations to such conditions, with rural residents being less likely to reduce their travel, even if it may be safer to do so. Urban residents with travel-limiting health conditions were more likely than their rural counterparts to limit travel to daytime hours and to use reduced fare taxis and other specialized transportation services, which are not as readily available in rural locations. These findings call for attention to cost and availability of alternative transportation options for individuals with health conditions that make driving difficult, especially in rural areas.

**Subject Areas:** Transportation; Rural; Urban; Disability

**Availability:** Henning-Smith, C., Evenson, A., Kozhimannil, K. and Moscovice, I., 2017. *Geographic Variation in Transportation Concerns and Adaptations to Travel-Limiting Health Conditions in the United States*. Journal of Transport & Health.

<https://www.sciencedirect.com/science/article/pii/S2214140517305868>

#### **4.11. Title: CTASS: A Framework for Contextualized Travel Behavior Advice to Cardiac Patients**

**Authors:** Batool, T., Vanrompay, Y., Neven, A., Janssens, D. and Wets, G.

**Abstract:** Current cardiac rehabilitation programs intending to increase physical activity of patients suffer from a lack of knowledge about effective patient's activity profiles and their associated behavior. This leads to the fact that therapies are not completely tailored to the patient causing non-adherence to the proposed treatment schedule. An important potential for increasing the physical activity level of patients is available in their daily travel behavior that can be made more active. To validate this potential, we propose a Cardiac Travel Advice Support System (CTASS) digital framework for contextualized travel behavior advice to cardiac patients. The patient's travel behaviour is monitored by a smartphone application which objectify their daily activity schedules. The data from the schedules is analysed semi-automatically by the CTASS. Based on this analysis the doctor can provide a treatment that is personalized to the specific contexts of the patient. In this way, we try to optimize their travel-related physical activity and detect non-adherence to the therapy.

**Subject Areas:** Active travel behaviour; Smart cardiovascular rehabilitation; Physical activity level; Travel behavior

**Availability:** Batool, T., Vanrompay, Y., Neven, A., Janssens, D. and Wets, G., 2017. *CTASS: A Framework for Contextualized Travel Behavior Advice to Cardiac Patients*. *Procedia Computer Science*, 113, pp.303-309.

<https://www.sciencedirect.com/science/article/pii/S1877050917317404>

#### **4.12. Title: Collaboration between Physical Activity Researchers and Transport Planners: A Qualitative Study of Attitudes to Data Driven Approaches**

**Authors:** Crist, K., Bolling, K., Schipperijn, J., Hurst, S., Takemoto, M., Sallis, J.F., Badland, H. and Kerr, J.

**Abstract:** Collaboration between physical activity (PA) researchers and transport planners is a recommended strategy to combat the physical inactivity epidemic. Data collected by PA researchers could be used to identify, implement and evaluate active transport (AT) projects. However, despite aligned interests, researchers and transport planners rarely collaborate. This study utilized qualitative methods to 1) gain an in-depth understanding of the data utilized in AT planning, 2) explore the utility of Global Positioning Systems (GPS) and accelerometer data in supporting the planning process, 3) identify the benefits and barriers of researcher and transport agency collaboration, and 4) identify the facilitators to collaboration for these groups. Semi-structured interviews were conducted with 17 transport modeling, planning or engineering professionals, transport agency directors, and academics with relevant expertise in health or transport planning. A thematic analysis was conducted following structural coding by two researchers. The analysis revealed that geographic and physical activity data that are current, local, objective and specific to individual AT trips would improve upon currently available data sources. Informants believed that research collaboration could increase capacity by providing unbiased data and access to students to assist with targeted research. Collaboration could also increase the relevance of academic research in applied settings. Identified barriers included: setting up contracts, lack of policy and planning mandates that include health, a disconnect between research interests and agency needs, and competing priorities. Researchers may need to initiate discussions with AT practitioners until health is formally included in the planning process as the first step in understanding data needs and identifying mutual research interests. However, regulations that link health and physical activity metrics to funding, as well as training programs that incorporate public health and transport planning, are needed to encourage cross collaboration.

**Subject Areas:** Public health; Active transport; Physical activity; Research translation; Evidence-based practice

**Availability:** Crist, K., Bolling, K., Schipperijn, J., Hurst, S., Takemoto, M., Sallis, J.F., Badland, H. and Kerr, J., 2017. *Collaboration between Physical Activity Researchers and Transport Planners: A Qualitative Study of Attitudes to Data Driven Approaches*. . Journal of Transport & Health.

<https://www.sciencedirect.com/science/article/pii/S2214140517305704>



#### 4.13. Title: Essays on the Economics of Risky Health Behaviors

**Author:** Qiu, Q.

**Abstract:** This dissertation consists of three essays studying the economics of risky health behaviors. Essay 1 estimates the effects of Graduated Driver Licensing (GDL) restrictions on weight status among adolescents aged 14 to 17 in the U.S. The findings suggest that a night curfew significantly raises adolescents' probability of being "overweight or obese" by 1.32 percentage points, corresponding to an increase in "overweight or obesity" rate of 4.8%. A night curfew combined with a passenger restriction increases this rate by 5.8%. Overall, I estimate that nearly 16% of the rise in "overweight or obesity" rate among teenagers aged 14 to 17 in the U.S from 1999 to 2015 can be explained by the presence of the GDL restrictions. In addition, the restrictions reduce teenagers' exercise frequency while increasing their time spent watching TV, which may help to explain the adverse effects on obesity.

Essay 2 exploits the effects of the Graduated Driver Licensing (GDL) restrictions on youth smoking and drinking. It finds that being subject to minimum entry age, a learner stage, or only a night curfew has no statistically significant effect whereas, interestingly, a night curfew combined with a passenger restriction reduces youth smoking and drinking. The estimated effects become more statistically significant and larger in magnitude in the medium run, which is in line with the addictive nature of these substances.

Essay 3 investigates the underlying causes of suicide. It uses data from the U.S. at the county level and the primary methodology is a two-level Bayesian hierarchical model with spatially correlated random effects. The results show that the significant effects of observable factors on suicides found by earlier research may partially stem from excluding small area effects and time trends, without controlling for which the true contribution of unobserved propensities and time trends can be hidden within observable factors. Most importantly, a lot can be learned from unobserved yet persistent propensity toward suicide captured by the spatially correlated county specific random effects. Resources should be allocated to counties with high suicide rates, but also counties with low raw suicide rates but high unobserved propensities of suicide.

**Subject Areas:** Overweight or obesity; Graduated Driver Licensing; Smoking and drinking; Two-level Bayesian hierarchical model

**Availability:** Qiu, Q., 2017. *Essays on the Economics of Risky Health Behaviors*. (Doctoral Dissertation, Georgia State University)

[https://scholarworks.gsu.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1134&context=econ\\_diss](https://scholarworks.gsu.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1134&context=econ_diss)

## 5. Policy and Mobility

### 5.1. Title: U.S. Transportation and Health Tool: Data for Action

**Authors:** Boehmer, T.K., Wendel, A.M., Bowers, F., Robb, K., Christopher, E., Broehm, J.E., Rose, K. and Ralph, J.

**Abstract:** Transportation investments have the potential to improve health, but readily available data to guide transportation decisions that could promote health are limited. In October 2015, the U.S. Department of Transportation (USDOT) and the Centers for Disease Control and Prevention (CDC) released the Transportation and Health Tool (THT). The tool is a resource to help transportation professionals in states and metropolitan areas access data about transportation and health in their jurisdictions and stimulate discussions on how to improve public health through transportation planning and policy. To develop the tool, a multidisciplinary team identified 190 possible data indicators. Using input from expert panel workshops and criteria that addressed data availability, geographic scale, timeliness, feasibility, validity, and topic area, the team selected 14 transportation and health indicators that covered the four priority topic areas of safety, active transportation, air quality, and connectivity. The THT contains the raw values for each indicator and a standardized score to enable comparisons. Additionally, the THT contains 25 evidence-based strategies that can help practitioners in states and metropolitan areas take action to improve health outcomes.

**Subject Areas:** Data; Policy; Indicators; Evidence-based interventions; Public health; Transportation systems

**Availability:** Boehmer, T.K., Wendel, A.M., Bowers, F., Robb, K., Christopher, E., Broehm, J.E., Rose, K. and Ralph, J., 2017. *U.S. Transportation and Health Tool: Data for Action*. *Journal of Transport & Health*.

<http://www.sciencedirect.com/science/article/pii/S2214140516304510>

## **5.2. Title: Exploring the Relationship between Vehicle Type Choice and Distance Traveled: A latent segmentation approach**

**Authors:** Angueira, J., Konduri, K.C., Chakour, V. and Eluru, N.

**Abstract:** In the context of vehicle usage decisions, there are two important choice dimensions namely, the choice of vehicle from household fleet that will be utilized for trips and second, the distance traveled to pursue the planned activities. There are interrelationships between these two choice dimensions with one dimension potentially influencing the other. The direction of the interrelationship has important implications for transportation planning and policy analyses. In an effort to explore the interrelationships, a latent segmentation-based modeling approach is proposed in this paper. The approach allows for exploring alternative interrelationship structures between choice dimensions in the same modeling framework. The methodology is demonstrated using data from the latest wave of the National Household Travel Survey (NHTS) in the United States. The results show the need for accommodating alternative structures between choice dimensions to accurately describe the vehicle usage decision processes exhibited by individuals.

**Subject Areas:** Policy; Latent segmentation models, Short-term vehicle usage decisions, Vehicle type choice, Distance traveled

**Availability:** Angueira, J., Konduri, K.C., Chakour, V. and Eluru, N., 2017. *Exploring the Relationship between Vehicle Type Choice and Distance Traveled: A latent segmentation approach*. Transportation Letters, pp.1-12.

[http://www.people.cecs.ucf.edu/neluru/Papers/VT\\_Distance\\_Paper.pdf](http://www.people.cecs.ucf.edu/neluru/Papers/VT_Distance_Paper.pdf)

### 5.3. Title: The Driving Downturn: A Preliminary Assessment

**Authors:** Manville, M., King, D.A. and Smart, M.J.

**Abstract:**

Problem, research strategy, and findings: We examine why American driving fell between 2004 and 2013, weighing two explanations: that Americans voluntarily moved away from driving (“peak car”), and that economic hardship reduced driving. We analyze aggregate data on travel, incomes, debt, public opinion, and Internet access. These data lack the precision of microdata, but unlike microdata are available annually for years before, during, and after driving’s decline. We find substantial evidence for the economic explanation. During the downturn the cost of driving rose while median incomes fell. The economy grew overall, but did so unequally. Mass driving requires a mass middle class, but economic gains accrued largely to the most affluent. We find less evidence for “peak car”. If Americans voluntarily drove less, they would likely use other modes more. However, despite heavy investment in bicycle infrastructure and public transportation in the 2000s, demand for these modes remained flat while driving fell.

Takeaway for practice: If Americans were voluntarily abandoning automobiles for other modes, planners could reduce investments in automobile infrastructure and increase investments in alternative mobility. Driving’s decline, however, was not accompanied by a transit surge or substantial shift to other modes. The lesson of the driving downturn is that people drive less when driving’s price rises. Planners obviously do not want incomes to fall, but they should consider policies that increase driving’s price. Planners might also rethink the current direction of U.S. transit policy; transit use did not rise even when driving fell at an unprecedented pace.

**Subject Areas:** Public Transit; Driving; Alternative Mobility; Policy

**Availability:** Manville, M., King, D.A. and Smart, M.J., 2017. *The Driving Downturn: A Preliminary Assessment*. Journal of the American Planning Association, 83(1), pp.42-55.

<http://www.tandfonline.com/doi/full/10.1080/01944363.2016.1247653>

**5.4. Title: Beyond Traffic: Trends and Choices 2045 - A National Dialogue About Future Transportation Opportunities and Challenges**

**Authors:** Mendez, V.M., Monje Jr, C.A. and White.

**Abstract:** This paper summarizes the findings of the U.S. DOT's comprehensive report on the current and future conditions of America's transportation system, *Beyond Traffic: Trends and Choices 2045*. The full report, and in turn this paper, discusses long-term and emerging trends in passenger and freight travel and the potential impacts of technological advances, climate change, and evolving governance institutions and funding sources. This analysis provides a framework for a fact-based discussion about the critical transportation policy choices we are faced with to address these long-term challenges. *Beyond Traffic* is intended to stimulate a national dialogue about the nation's future transportation opportunities and challenges.

**Subject Areas:** Passenger and Freight Travel; Transportation Policy; Funding

**Availability:** Mendez, V.M., Monje Jr, C.A. and White, V., 2017. *Beyond Traffic: Trends and Choices 2045 - A National Dialogue About Future Transportation Opportunities and Challenges*. In *Disrupting Mobility* (pp. 3-20), Springer International Publishing.  
[https://link.springer.com/chapter/10.1007/978-3-319-51602-8\\_1](https://link.springer.com/chapter/10.1007/978-3-319-51602-8_1)

### **5.5. Title: Parking for Residential Delivery in New York City: Regulations and Behavior**

**Authors:** Chen, Q., Conway, A. and Cheng, J.

**Abstract:** Increasing demand for direct-to-home deliveries requires frequent delivery of small volumes; these deliveries generate growth in commercial vehicle curb side parking activities in dense urban areas. In New York City, which has extremely densely developed, mixed land uses, this new demand is only exacerbating already challenging conditions for urban delivery. This study utilizes a number of existing “open” datasets from New York City to compare commercial vehicle parking regulations and violations in commercial, mixed-use, and residential land use areas in New York City. Results suggest that parking availability and resulting violation rates vary considerably by area and roadway type, and that current curb parking regulations are not adequate to accommodate growing residential demand.

**Subject Areas:** Urban freight; Residential delivery; Parking; Regulations

**Availability:** Chen, Q., Conway, A. and Cheng, J., 2017. *Parking for Residential Delivery in New York City: Regulations and Behavior*. *Transport Policy*, 54, pp.53-60.  
<http://www.sciencedirect.com/science/article/pii/S0967070X16302414>

## **5.6. Title: Integrating Health and Transportation in Nashville, Tennessee, USA: From Policy to Projects**

**Authors:** Meehan, L.A. and Whitfield, G.P.

**Abstract:** The Nashville Area Metropolitan Planning Organization (MPO) is among the first MPOs in the United States to recognize the interplay of transportation and public health, particularly regarding physical activity, air pollution, and traffic crashes. The Nashville MPO has taken a multifaceted approach to simultaneously improve the transportation system, quality of life, and health status of the region's population. The purpose of this paper is to describe the multiple programs and projects that the MPO has undertaken to this end, so that other cities might learn from Nashville's example.

The MPO's strategy comprised six processes. First, the MPO conducted the Regional Bicycle and Pedestrian Study in 2009 and 2014 that established priority issues to be addressed by bicycle and pedestrian projects in Regional Transportation Plans. Second, the MPO responded to public opinion by adopting new transportation policies in the 2035 and 2040 Regional Transportation Plans, including increasing bicycle and pedestrian options and expanding public transit. Third, the MPO created scoring criteria for proposed roadway projects that prioritized health impacts. Fourth, the MPO reserved funding for projects selected under the new criteria and established a new funding program, the Active Transportation Program. Fifth, the MPO conducted the Middle Tennessee Transportation and Health Study, one of the first regional studies in the nation linking transportation and health. Finally, the MPO implemented the Integrated Transport and Health Impact Model which predicts and monetizes population-level health impacts of shifting the population towards active transportation modes.

Recent inventories of bicycle and pedestrian infrastructure suggest these interrelated processes are increasing opportunities for walking, bicycling, and public transit use in the region. Further, each of these projects has contributed to a growing appreciation in the region of the links between transportation and health, and continued evaluation efforts can determine if transportation behaviors and health outcomes are changing.

**Subject Areas:** Transport projects; Health; Policies

**Availability:** Meehan, L.A. and Whitfield, G.P., 2017. *Integrating Health and Transportation in Nashville, Tennessee, USA: From Policy to Projects*. Journal of Transport & Health.

<http://www.sciencedirect.com/science/article/pii/S2214140516301712>

**5.7. Title: A New Route to Increasing Economic Growth: Reducing Highway Congestion with Autonomous Vehicles**

**Authors:** Winston, C. and Karpilow, Q.

**Abstract:** This paper argues that California's self-help county tax legislation, which funds additional highway spending, amounts to a natural experiment that can be used to construct a valid instrument to determine highway congestion's causal effect on the growth rates of GDP, employment, wages, and commodity freight flows for California counties. Our estimation results indicate that highway congestion has significantly reduced the growth rates of those performance measures. Extrapolating the results to the nation suggests that sizable reductions in highway congestion, which could be achieved with widespread adoption of autonomous (driverless) vehicles, would have large macroeconomic stimulative effects.

**Subject Areas:** Congestion delays; Autonomous Vehicles; Self-help County Taxes

**Availability:** Winston, C. and Karpilow, Q., 2017. *A New Route to Increasing Economic Growth: Reducing Highway Congestion with Autonomous Vehicles*. Mercatus Working Paper, Mercatus Center at George Mason University.

<https://www.mercatus.org/system/files/mercatus-winston-karpilow-autonomous-vehicles-v1.pdf>



## 5.8. Title: Going Nowhere Fast: Urban Mobility and Employment Outcomes

**Author:** Tyndall, J.

**Abstract:** The spatial isolation of workers from firms is frequently considered as a cause of localized unemployment. Increasing the capacity and efficiency of urban transportation systems is a habitually considered solution to worker isolation. This paper will quantify metropolitan level mobility with respect to home-work commuting. Commuter mobility in the US is found to vary substantially across metros in both levels and trends during the 2005-2014 study period. The impact of mobility on locational access is shown to be theoretically ambiguous due to a dispersion effect. Increased commuter mobility has proceeded contemporaneously with increased metropolitan employment dispersion. An instrumental variable method will exploit random variation in the political process governing transportation infrastructure funding. Results provide causal evidence that increased commuter mobility degrades employment outcomes, particularly for black residents and youth. Findings are consistent with increased commuter mobility exacerbating spatial mismatch through employment sprawl.

**Subject Areas:** Access; Mobility; Transportation; Spatial Mismatch

**Availability:** Tyndall, J., 2017. *Going Nowhere Fast: Urban Mobility and Employment Outcomes*. University of British Columbia.

[http://www.justintyndall.com/uploads/2/8/5/5/28559839/tyndall\\_gnf.pdf](http://www.justintyndall.com/uploads/2/8/5/5/28559839/tyndall_gnf.pdf)

**5.9. Title: Linking the 2016 NHTS to Emerging Applications, Uses and Policy Making**

**Author:** Polzin, Steven E.

**Abstract:** Presentation

**Subject Areas:** Travel Behavior; Policy; Governance

**Availability:** Polzin, Steven E., 2017. *Linking the 2016 NHTS to Emerging Applications, Uses and Policy Making*. Center for Urban Transportation Research, TRB Session 864.

<http://www.trb.org/AnnualMeeting/Blurbs/175528.aspx>

**5.10. Title: Change And Innovation in the NHTS: How it all adds up - The MPO Perspective**

**Author:** Mullenix, Dylan.

**Abstract:** Presentation

**Subject Areas:** Policy making; Travel data; Expanding Bike Network

**Availability:** Mullenix, Dylan., 2017. *Change And Innovation in the NHTS: How it all adds up - The MPO Perspective*. Des Moines Area MPO. TRB Session 882.

<http://www.trb.org/AnnualMeeting/Blurbs/175528.aspx>

**5.11. Title: From Gallons to Miles: A Disaggregate Analysis of Automobile Travel and Externality Taxes**

**Authors:** Langer, A., Maheshri, V. and Winston, C.

**Abstract:** Policymakers have prioritized increasing highway revenues as rising fuel economy and a fixed federal gasoline tax have led to highway funding deficits. We use a novel disaggregate sample of motorists to estimate the effect of the price of a vehicle mile traveled on VMT, and we provide the first national assessment of VMT and gasoline taxes that are designed to raise a given amount of revenue. We find that a VMT tax dominates a gasoline tax on efficiency, distributional, and political grounds when policymakers enact independent fuel economy policies and when the VMT tax is differentiated with externalities imposed per mile.

**Subject Areas:** Gasoline tax; VMT tax; Driver heterogeneity

**Availability:** Langer, A., Maheshri, V. and Winston, C., 2017. *From Gallons to Miles: A Disaggregate Analysis of Automobile Travel and Externality Taxes*. *Journal of Public Economics*, 152, pp. 34-46.

<http://www.sciencedirect.com/science/article/pii/S0047272717300798>

**5.12. Title: Intermodal Mobility**

**Authors:** Willing, C., Brandt, T. and Neumann, D.

**Abstract:** Not Available

**Subject Areas:** Intermodal mobility; Multimodal mobility; Mobility markets; Spatial analytics; Location-based services; Sustainable mobility

**Availability:** Willing, C., Brandt, T. and Neumann, D., 2017. *Intermodal Mobility*. Business & Information Systems Engineering, 59(3), pp.173-179.

<http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1419&context=bise>

**5.13. Title: Understanding Changes in Youth Mobility**

**Authors:** Coogan, M., Nygaard, N. and Weinberger, R.

**Abstract:** Not Available

**Subject Areas:** Intermodal mobility; Multimodal mobility; Mobility markets; Spatial analytics; Location-based services; Sustainable mobility

**Availability:** Coogan, M., Nygaard, N. and Weinberger, R., 2017. *Understanding Changes in Youth Mobility*. NCHRP 08-36, Task 132, Prepared for AASHTO Standing Committee on Planning.

[http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36\(132\)\\_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36(132)_FR.pdf)

#### **5.14. Title: Change in Vehicle Occupancy Used in Mobility Monitoring Efforts**

**Author:** Lasley, P.

**Abstract:** Virtually all measures of delay that the Texas A&M Transportation Institute (TTI) incorporate some form of average vehicle occupancy, or how many people, on average, are in any vehicle at any given time on our nation's roadways. In an effort to continually improve the methods and data used and produced by all of TTI's mobility-monitoring efforts, researchers re-examined and updated this factor. Researchers now estimate the average vehicle occupancy from 1.25 persons per vehicle to 1.50 persons per vehicle, based on data from the National Household Travel Survey for all trips. This change will be effective as of July 1, 2017.

**Subject Areas:** Vehicle Occupancy; Mobility-monitoring; Research

**Availability:** Lasley, P., 2017. *Change in Vehicle Occupancy Used in Mobility Monitoring Efforts*. Texas A&M Transportation Institute.

<https://static.tti.tamu.edu/tti.tamu.edu/documents/TTI-2017-9.pdf>

### **5.15. Title: Car-Less or Car-Free? Socioeconomic and Mobility Differences among Zero-Car Households**

**Author:** Brown, A.E.

**Abstract:** Transportation professionals have long identified the important division between choice and constraint in modal decision-making. However, while heterogeneity within some modal groups such as transit riders is well documented, intragroup differences in other groups have been largely ignored. In particular, significant heterogeneity exists among zero-car households, who may not own a car due to choice (car-free) or constraint (car-less). Recognition of intragroup heterogeneity among zero-car households yields policy implications as cities consider where to invest their ever more precious and more limited transportation resources. Using activity diary data from the 2012 California Household Travel Survey, I investigate two research questions: first, how do car-less households compare to car-free households in terms of both their socioeconomic characteristics and their relative share of zero-car households? Second, how do motivations behind not owning a car translate into mobility differences - including daily trip counts and miles traveled? I find that, contrary to media reports that the number of car-free households - that is, households that choose not to own a car - is “booming”, 79 percent of zero-car households do not own a car because of economic or physical constraints. Car-less households in many ways mirror the captive transit population, in that they have significantly lower household incomes, lower educational attainments, and are disproportionately non-white compared to car-free households. Observed socioeconomic variations translate into mobility differences, with car-free travelers taking more trips and traveling more miles per day. Policy makers should consider extending access to carshare services, which are positively associated with more trips and miles traveled among both car-free and car-less households.

**Subject Areas:** Car-free; Car-less; Mobility; Car ownership; Carsharing

**Availability:** Brown, A.E., 2017. *Car-Less or Car-Free? Socioeconomic and Mobility Differences among Zero-Car Households*. *Transport Policy*, 60, pp.152-159.  
<https://www.sciencedirect.com/science/article/pii/S0967070X17302482>



**5.16. Title: Affordable Housing in Transit-Oriented Developments: Impacts on Driving and Policy Approaches**

**Author:** Boarnet, M.G., Bostic, R., Williams, D., Santiago-Bartolomei, R., Rodnyansky, S. and Eisenlohr, A.

**Abstract:** NA

**Subject Areas:** Affordable Housing; Transit-Oriented Developments; Vehicle miles traveled; Metropolitan areas

**Availability:** Boarnet, M.G., Bostic, R., Williams, D., Santiago-Bartolomei, R., Rodnyansky, S. and Eisenlohr, A., 2017. *Affordable Housing in Transit-Oriented Developments: Impacts on Driving and Policy Approaches*. A White Paper from the National Center for Sustainable Transportation.

[https://ncst.ucdavis.edu/wp-content/uploads/2015/10/NCST-TO-027-Boarnet-Bostic-Affordable-TOD-White-Paper\\_FINALv2.pdf](https://ncst.ucdavis.edu/wp-content/uploads/2015/10/NCST-TO-027-Boarnet-Bostic-Affordable-TOD-White-Paper_FINALv2.pdf)

### **5.17. Title: Carless in California: Green Choice or Misery?**

**Author:** Mitra, S.K. and Saphores, J.D.M.

**Abstract:** Approximately 1 million Californian households do not own a motor vehicle (hereafter a “car”). These households, who are often forgotten in transportation policy discussions, can be organized into two groups based on whether they are voluntarily carless or not. Understanding why some households decide to voluntarily forgo cars could inform policies aiming at reducing our dependency on cars. Understanding the plight of households who are not able to own a car is no less important as these households are at greater risk of social exclusion. Unfortunately, our knowledge of carless households is still sketchy so the purpose of this paper is to start filling this gap. We analyze data from the 2012 California Household Travel Survey using univariate tests and Generalized Structural Equation Models (GSEM) that account for residential self-selection to assess the impacts of various socio-economic and built environment variables on the likelihood to be carless, voluntarily or not. Our results (GSEM Model 1) indicate that carless households are more likely to have less education, a lower income, and a smaller number of members than motorized families. They also tend to live in denser, more land-use diverse, and more walkable areas with better transit coverage. Contrasting voluntarily and involuntarily carless households (GSEM Model 3), we find that involuntarily carless households are less affluent on average and they tend to live in areas that are less land-use diverse, less walkable, and with worse transit coverage. Finally, although residential self-selection is present, its impacts are minor.

**Subject Areas:** Mobility; Built environment; Land use; Generalized structural equation modeling

**Availability:** Mitra, S.K. and Saphores, J.D.M., 2017. *Carless in California: Green Choice or Misery?* Journal of Transport Geography, 65, pp.1-12.

<https://www.sciencedirect.com/science/article/pii/S0966692317301874>

## 5.18. Title: Smart Transportation Systems

**Author:** Jimenez, J.A.

**Abstract:** Conventional surface transportation resources, such as vehicles, roads, terminals, and other transportation infrastructure, are aging. Many countries are falling behind in installing new transportation infrastructure in their cities. Thanks to the recent developments in technology and the global connectivity enabled by The Internet, transportation systems are undergoing a profound transformation that will change the way humans and products move around cities. That is, smarter, more autonomous, and safer vehicles that communicate with other vehicles and with the city buildings, traffic signs, and other infrastructure will be the golden standard. It is expected that those cities which use such technology will increase their mobility, boost their economic productivity and reduce their levels of pollution. This new approach to transportation is called Intelligent Transportation Systems, and is the topic of this chapter.

**Subject Areas:** Intelligent transportation systems (ITS); Internet of things; Dedicated short range communications; Vehicle-to-vehicle; Vehicle-to-infrastructure; Carbon emissions; Supply chain management; Sustainability; Mobility

**Availability:** Jimenez, J.A., 2018. *Smart Transportation Systems* Smart Cities: Applications, Technologies, Standards, and Driving Factors, Chapter8, (pp. 123-133), Springer, Cham.  
[https://link.springer.com/chapter/10.1007/978-3-319-59381-4\\_8](https://link.springer.com/chapter/10.1007/978-3-319-59381-4_8)

### 5.19. Title: Potential Fleet Size of Private Autonomous Vehicles in Germany and the US

**Authors:** Trommer, S., Kröger, L. and Kuhnimhof, T.

**Abstract:** There are high expectations on autonomous vehicles promising a safer, more efficient and comfortable (auto)mobility experience. On the other hand it is important to discuss possible rebound effects going along with such a development. New user groups e.g. people who do not hold a driving license today, or are currently unable to drive because of physical and/or age-related constraints suddenly are enabled to “drive” a passenger car. In addition the past has shown that increasing efficiency and enhancing the comfort leads to a higher travel demand and subsequently more vehicle miles traveled. To support the research on the impact of autonomous vehicles on the transport system it is important to analyze the potential share of autonomous vehicles (AVs) on the passenger vehicle fleet in the future. The paper presents results from modelling private autonomous vehicle scenarios for the year 2035 for Germany and the US to estimate the number of vehicles within the fleet equipped with automation technologies Level 4 and higher (SAE in SAE International Standard J3016, 2014). A vehicle technology diffusion model has been developed to model an evolutionary and a rather revolutionary scenario which are distinguished by different market entry dates and AV technology take rates. Differentiating by passenger car segment, we introduce autonomous vehicles among new vehicles from 2022 resp. 2025 onward assuming an s-shaped market-take-up until 2035.

**Subject Areas:** Vehicle automation; Autonomous vehicles; Diffusion rates of autonomous vehicles; Market penetration; Fleet evolution; New car sales; AV

**Availability:** Trommer, S., Kröger, L. and Kuhnimhof, T., 2018. *Potential Fleet Size of Private Autonomous Vehicles in Germany and the US* Road Vehicle Automation 4 (pp. 247-256). Springer, Cham.

[https://link.springer.com/chapter/10.1007/978-3-319-60934-8\\_20](https://link.springer.com/chapter/10.1007/978-3-319-60934-8_20)

## 5.20. Title: On Demand Mobility Commuter Aircraft Demand Estimation

**Authors:** Syed, N.U.S., 2017.

**Abstract:** On-Demand Mobility (ODM) is a concept to address congestion problems. Using electric aircraft and vertical take-off with limited landing (VTOL) capabilities, the ODM concept offers on demand transportation service between designated landing sites at a fraction of driving time. The purpose of this research is to estimate the potential ODM demand and understand the challenges of introducing ODM using the Northern California region (including major cities like San Francisco, Sacramento, and San Jose) as an area of study and a second, less rigorous analysis for the Washington-Baltimore region. A conditional logit model was developed to estimate mode choice behavior and to estimate ODM demand; presenting automobile and public transportation as the two competing modes to ODM. There are significant challenges associated with the service including ability to operate in bad weather, vehicle operating cost, siting and cost of landing sites, and overall public acceptance of small, remotely operated aircraft. Nine scenarios were run varying the input for a base fare, landing fare, cost per-passenger-mile, auto operational costs, and ingress (waiting) times. The results yielded sensitivity of demand to all these parameters and especially showed a great difference in demand when auto costs were decreased from the standard American Automobile Association (AAA) cost per mile to a likely, future auto operating cost. The challenge that aerospace engineers face is designing an aircraft capable of achieving lower operational costs. The results showed that in order for the ODM to be a competitive mode, the cost per passenger-mile should be kept at \$1.

**Subject Areas:** Vehicle automation; Autonomous vehicles; Diffusion rates of autonomous vehicles; Market penetration; Fleet evolution; New car sales; AV

**Availability:** Syed, N.U.S., 2017. *On Demand Mobility Commuter Aircraft Demand Estimation* (Master Thesis, Virginia Tech).

<https://vtechworks.lib.vt.edu/handle/10919/78879>

## 5.21. Title: Smart City as a Tool for Sustainable Mobility and Transport Decarbonisation

**Authors:** Zawieska, J. and Pieriegud, J.

**Abstract:** The sustainable governance of transport systems remains a significant challenge for policy makers worldwide, particularly in cities. Urban areas are developing rapidly from a technological viewpoint, and innovative technologies create new possibilities for smart mobility management. Therefore, this study investigates the relationship between the implementation of the smart city concept and the idea of sustainable transport, particularly with regard to the reduction of transport generated CO<sub>2</sub> emissions. The study estimates CO<sub>2</sub> emissions for different potential scenarios of development for the Warsaw transport system until 2050 using the United Nations' ForFITS (For Future Inland Transport Systems) model. The study also analyses the additional impact on CO<sub>2</sub> emissions of smart city elements as determinants of mobility. The results show that meeting the reduction targets set by the European Union 2011 White Paper on Transport will be challenging, requiring an in-depth transformation of the transport and energy sectors. This study also confirms that smart city solutions can play a crucial role in mitigating transport emissions and meeting reduction goals. The conclusions provide important insights for the design of smart mobility governance and enhance the relationship between transport policy and research.

**Subject Areas:** Sustainable mobility; Governance of transport; Transport policy; Smart cities; GHG emissions; Warsaw

**Availability:** Zawieska, J. and Pieriegud, J., 2018. *Smart City as a Tool for Sustainable Mobility and Transport Decarbonisation*. *Transport Policy*, 63, pp.39-50.

<https://www.sciencedirect.com/science/article/pii/S0967070X17304092>

**5.22. Title: Transportation Cost Index: A Comprehensive Performance Measure for Transportation and Land Use Systems and its Application in OR, FL, and UT**

**Authors:** Wang, L. and Liu, J.H.

**Abstract:** MAP-21 and state laws are placing increasing emphasis on using comprehensive transportation performance measures that include mobility, safety, economy, livability, equity, and environmental to guide transportation decision-making. One of the toughest challenges keeping DOTs and MPOs from adopting comprehensive measures in the decision process is the lack of performance measures allowing consistent comparison of multimodal performance over time and across geographic areas. This project advances a transportation cost index (TCI) initially proposed by Oregon DOT from a proof-of-concept stage to implementation and operational use at the state, MPO, and community levels. After pilot tests and early adoption in Oregon, we test TCI with varying data sources available in different states and make the software more user-friendly. Working with communities in Florida and Utah, we will test and apply TCI to regions in Florida and Utah and compare the patterns of TCI across Oregon, Florida, and Utah.

**Subject Areas:** Mobility; Choice of transportation; Transportation Cost Evaluation; Transport Planning

**Availability:** Wang, L. and Liu, J.H., 2017. *Transportation Cost Index: A Comprehensive Performance Measure for Transportation and Land Use Systems and its Application in OR, FL, and UT*. NITC-RR-758. Portland, OR: Transportation Research and Education Center (TREC). [https://pdxscholar.library.pdx.edu/trec\\_reports/132/](https://pdxscholar.library.pdx.edu/trec_reports/132/)

**5.23. Title: Autonomous or Driver-less Vehicles: Implementation Strategies and Operational Concerns**

**Authors:** Masoud, N. and Jayakrishnan, R.

**Abstract:** Autonomous vehicles are expected to shift not only the driving paradigms but also the notion of vehicle ownership. Although autonomous vehicles are believed to introduce many safety, mobility, and environmental benefits, they will be initially priced relatively highly. This paper assesses the potential for circumventing this barrier by promoting a shared ownership program in which households form clusters that share the ownership and ridership of a set of autonomous vehicles. Such a program will increase the utilization rate of vehicles, making ownership of autonomous vehicles more economical. We study parameters that affect the benefits expected from autonomous vehicles, and introduce policy directions that can boost these benefits.

**Subject Areas:** Mobility; Autonomous vehicles; Driving paradigms; Shared Ownership Program

**Availability:** Masoud, N. and Jayakrishnan, R., 2017. *Autonomous or Driver-less Vehicles: Implementation Strategies and Operational Concerns*. Transportation research part E: logistics and transportation review, 108, pp.179-194.

<https://www.sciencedirect.com/science/article/pii/S1366554517303071>



#### **5.24. Title: Estimating the Presence of People in Buildings using Call Detail Records**

**Author:** Gupta, S.

**Abstract:** As geographic data about individual movement become increasingly available, they open LIP the possibility of understanding and modeling urban mobility patterns. While no all-encompassing dataset regarding mobility is available, this study explores how Call Detail Records (CDRs), a highly ubiquitous dataset, can be leveraged to create models that can reproduce mobility patterns observed from time consuming, capital-intensive and infrequent travel surveys. While mechanisms have been proposed for reproducing particular characteristics of individual mobility, this is the first attempt to generate all mobility patterns at fine spatial and temporal scales at the level of individual buildings. Two shortcomings of any dataset include spatial uncertainty at very high resolution and the presence of high-fidelity traces for only a fraction of the population. While the proposed model addressed the former to some extent by providing high accuracy counts at the level of census tracts, a separate method has been explored to address this along with the latter phenomenon. To achieve this, the study leverages hyper-local datasets such as building footprints and places of interest. In the absence of primary datasets, the study is able to provide a model to estimate of the presence of people at the level of individual buildings. Hence, this study provides a pipeline to proceed from high fidelity location traces from a fraction of the population to building level occupancy profiles using fairly ubiquitous data sources.

**Subject Areas:** Mobility Patterns; Call Detail Records (CDRs);

**Availability:** Gupta, S. *Estimating the Presence of People in Buildings using Call Detail Records*. (Doctoral dissertation, Massachusetts Institute of Technology).

<https://dspace.mit.edu/handle/1721.1/111437>

**5.25. Title: Introducing Urban Transportation**

**Author:** Hanson, S.

**Abstract:** Book Chapter

**Subject Areas:** Mobility; Transportation Planning; Travel activity

**Availability:** Hanson, S., 2017. *Introducing Urban Transportation*. The Geography of Urban Transportation, p.3.

[https://books.google.com/books?hl=en&lr=&id=WE3IDAAQBAJ&oi=fnd&pg=PA3&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=yj3XGBdIY0&sig=FSGOOmnIIGuVHscBgEzUNsGv\\_f8#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%20NHTS&f=false](https://books.google.com/books?hl=en&lr=&id=WE3IDAAQBAJ&oi=fnd&pg=PA3&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=yj3XGBdIY0&sig=FSGOOmnIIGuVHscBgEzUNsGv_f8#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%20NHTS&f=false)

**5.26. Title: Social Equity and Urban Transportation**

**Authors:** Blumenberg, E.

**Abstract:** Book Chapter.

**Subject Areas:** Transportation Policy; Disparity in Mobility; Inequality

**Availability:** Blumenberg, E., 2017. *Social Equity and Urban Transportation*. The Geography of Urban Transportation, p.332.

<https://books.google.com/books?hl=en&lr=&id=WE3IDAAQBAJ&oi=fnd&pg=PA332&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=yj3YxxeL2.&sig=7iAxueJbOK9Vbtj6KHlbRdkFqdg#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%2C%20NHTS&f=false>

## **5.27. Title: Joint Evaluation of Transportation Revenue Generation and Infrastructure Investment Policies with Benefits Redistribution Considerations**

**Author:** Kastrouni, E.

**Abstract:** The purpose of this dissertation is to guide economic policymaking by providing a comprehensive estimation of the effects that transportation revenue generation and infrastructure investment policies have on users. A 10-level integration framework is proposed to capture the complex research question of revenue generation-investment-benefits redistribution, via the use of activity-based modeling and innovative data integration techniques. Revenue policies are not evaluated based on their first-level impacts on payers alone. On the contrary, they are combined with transportation investment outlooks, and their performance is assessed based on how users eventually benefit from the revenues being invested in transportation projects that facilitate their travel experience. The revenue policies explored include the status quo (fuel tax), a fuel tax increase, a flat VMT fee, an income-based VMT fee, a transportation-dedicated property tax, and a transportation-dedicated sales tax. Subsequently, three alternative transportation investment outlooks are explored; these outlooks may be adopted by Maryland in the future, in an effort to redefine the state's purpose, perspective and vision with respect to transportation. The selected outlooks capture some of the most popular and widely discussed future transportation vision directions for the U.S. transportation agencies, and include: (i) network-wide bottleneck removal projects funded by the state fuel tax increase of 2015 in Maryland, (ii) development of a bus-only network funded by a transportation-dedicated property tax that is invested locally, and (iii) infrastructure retrofitting projects to accommodate connected and autonomous vehicles, funded by an income-based VMT fee. The policies' performance is evaluated on the basis of tax incidence, travel behavior and revenue generation metrics, while changes in welfare measures are estimated to assess the benefits redistribution due to the proposed revenue-investment dyads. The redistribution analysis shows that investing in bottleneck removal or CAVs will partially alleviate the burden that users will experience due to the fuel tax increase and variable VMT fee policies. However, in a situation where transportation funding shifts from the status quo to a transportation-dedicated property tax, lower income HHs will bear greater burden, and none of the income groups or counties will be able to recuperate part of their losses via the transit-oriented investment.

**Subject Areas:** Economic Policy; Transportation revenue generation; Inequality

**Availability:** Kastrouni, E., 2017. *Joint Evaluation of Transportation Revenue Generation and Infrastructure Investment Policies with Benefits Redistribution Considerations*. (Doctoral dissertation, University of Maryland).

<https://drum.lib.umd.edu/handle/1903/19967>

## **5.28. Title: Advancements, Prospects, and Impacts of Automated Driving Systems**

**Author:** Chan, C.Y.

**Abstract:** Over the last decade, significant progress has been made in automated driving systems (ADS). Given the current momentum and progress, ADS can be expected to continue to advance and a variety of ADS products will become commercially available within a decade. It is envisioned that automated driving technology will lead to a paradigm shift in transportation systems in terms of user experience, mode choices, and business models. In this paper, we start with a review of the state-of-the-art in the field of ADS and their deployment paths. It is followed by a discussion of the future prospects of ADS and their effects on various aspects of the transportation field. We then identify two specific use cases of ADS where the impacts can be significant - personal mobility services and vehicle automation for aging society. A survey of impact assessment studies and the associated methodologies for evaluating ADS is given, which is followed by concluding remarks at the end of the paper.

**Subject Areas:** Automated Driving Systems (ADS); Paradigm shift; Transportation systems

**Availability:** Chan, C.Y., 2017. *Advancements, Prospects, and Impacts of Automated Driving Systems*. International Journal of Transportation Science and Technology, 6(3), pp.208-216.  
<https://www.sciencedirect.com/science/article/pii/S2046043017300035>

## 5.29. Title: Towards Urban Mobility-based Activity Knowledge Discovery: Interpreting Motion Trajectories

**Author:** Das, R.D.

**Abstract:** Understanding travel behaviour is important for an effective urban planning and to enable different context-aware mobility service provisions. To this end, it is essential to model different mobility-based activities in available trajectory data. However, the semantics of activity varies from context to context, which poses a challenge for developing a connected knowledge flow for different services. Currently, such mobility-based information is typically collected through manual paper-based surveys. These surveys preserve context, but come with their own inherent quality issues, and are expensive in comparison to data analytics methods. To address this issue this research leverages the emerging concept of smartphone-based travel surveys that collect people's movement behaviour in terms of raw trajectories. This research proposes an ontological framework that can model activities in a hierarchical manner adapting to different contexts and thereby addressing the challenges of trajectory data analytics mentioned above. This research also explores how raw trajectories collected by a smartphone can be interpreted to generate mobility information (e.g., transport modes, trips). While interpreting the trajectories this thesis models uncertainties that may exist during people's travel behaviour and interpretation process. In this research, a particular focus is given to knowledge representation, that is understanding urban movement behaviour from detecting transport modes in trajectories. One presented form of knowledge representation is a fuzzy logic based approach to mode detection. The knowledge representation is essential to extract semantics related to a given activity. This research also introduces the concept of near-real time mode detection and investigates the performance of a purely knowledge-driven model works effectively in a near-real time scenario. Since a knowledge-driven model at different temporal granularities while detecting a given transport mode. The knowledge-driven model that works in offline, typically requires kinematic features computed over sufficiently long segments. But in near-real time these segments must be shorter and requires the model to be adaptive. To address this issue a machine learning based model has been deployed, which can learn from the historical data, and work in varied conditions. But machine learning models work as a black box and cannot explain their reasoning scheme owing to a semantic gap in the activity knowledge base. On the other hand, a fuzzy logic based model can explain its reasoning scheme but cannot adapt to varying conditions. To bridge the trade-off between these approaches this research proposes a hybrid knowledge-driven framework that is capable of self-adaptation and explaining its reasoning scheme. The results show the hybrid model performs better than a purely knowledge-driven model and works at par with the machine learning models for transport mode detection. This research also justifies a hybrid approach can model the activity in a consistent and adaptive manner while explaining the semantics related to different mobility-based activities. In this research different uncertainties related to a motion trajectory interpretation process have been addressed. A particular focus is given on modelling the temporal uncertainties that exist between predicted, scheduled and reported trips. Such a temporal uncertainty quantification measures the reliability (or uncertainty) in an inference process in the interest of information retrieval at different contexts. Considering the lack of semantics in GPS trajectories an investigation is also made whether incorporating low sampled IMU information in addition to a GPS trajectory can improve the accuracy. This research also identifies existing trajectory segmentation approaches (e.g., clustering-based or walking-based approaches) are subjective and thus lacks adaptivity. In

order to address these issues a novel state-based bottom-up trajectory interpretation model is developed, which can generate mobility information at different temporal granularities. The model also demonstrates its efficacy, flexibility, and adaptivity over the existing top-down approaches. This research also demonstrates that using a GPS trajectory, it is possible to generate modal state information comparatively at a coarser granularity but shorter than the time required to generate information from a historical GPS trajectory. The response time is subject to a particular application domain. The research presented in this thesis has a potential to improve the background intelligence in smartphone-based travel surveys and smartphone-based travel applications facilitating mobility-based context-aware service provisions where the notion of activity is prevalent at different granularities. However, this research cannot distinguish composite activities, which require future work. With the emergence of Web 2.0 and ubiquitous location sensing technologies, the location information can come from various sources with the different level of inaccuracies and space-time granularities. The models developed in this research currently work best on GPS trajectories sampled at 1 Hz to 2 Hz frequency, which may be enriched with IMU information. However, the models need some adjustments and incorporations of additional features and rules when the location information comes not only from GPS but also from GSM, Wi-Fi, smart-card. The models developed in this research are flexible, transparent and offer provisions for further enrichment of raw trajectories and extract finer activity information. This research has a potential to understand mobility patterns at an aggregate and a disaggregate level, and thereby serve different application domains e.g., personalized activity recommendations during a travel, emergency service provisions, real-time traffic management and long term urban policy making.

**Subject Areas:** Activity; Transport Mode; Fuzzy Logic; Neural Network; GPS; Trajectory; Ontology; Travel Diary; Smartphone Sensors; Mobility; Intelligent Transportation Systems; Context-Aware Computing; Context

**Availability:** Das, R.D., 2017. *Towards Urban Mobility-based Activity Knowledge Discovery: Interpreting Motion Trajectories*. (Doctoral dissertation).

<https://minerva-access.unimelb.edu.au/handle/11343/191824>

### **5.30. Title: Transitioning to a Connected and Automated Vehicle Environment: Opportunities for Improving Transportation**

**Author:** Harper, C.D.

**Abstract:** Over the past few years automotive and technology companies have made significant advances in what has been traditionally a completely human function: driving. Crash avoidance features such as lane departure warning and forward collision warning are becoming increasingly more common and cheaper to obtain, even on non-luxury vehicles. Technology companies and auto manufacturers have announced plans to have self-driving vehicles ready for public use as early as 2020. The mass adoption of automated vehicles (AVs) could significantly change surface transportation as we know it today. This thesis is intended to provide a technical analysis of the potential impacts of AVs on current light-duty vehicle miles traveled (VMT) and parking decisions, the economic desirability of widespread deployment of partially automated technologies, and methods for existing roadways to transition to connected and automated vehicle (CAV) transportation, so that policymakers can make more informed decisions during the transition to CAVs. This work takes a look at AVs from a point in time where vehicles are equipped with driver assistance systems (Level 1) to a point in time where AVs are driverless (Level 5) and can self-park.

The results of this work indicate that the fleet-wide adoption of partially automated crash avoidance technologies could provide net-benefit of about \$4 billion at current system effectiveness and could provide an annual net-benefit up to \$202 billion if all relevant crashes could be prevented. About 25% of all crashes could be addressed by the crash avoidance technologies examined in this dissertation. Over time, as technologies become more effective and cheaper due to economies of scale, greater benefits than the \$4 billion could be realized.

As automated technologies become more advanced and widespread, existing roadways will need to be able to accommodate these vehicles. This work investigates the effects of a dedicated truck platoon lane on congestion on the Pennsylvania Turnpike and provides a method for existing roadways and highways to determine viable platoon demonstration sites. The initial results suggest that there are several sections of turnpike that could serve as commercial truck platoon demonstration site while still providing a high LOS to all other vehicles.

Once AVs can safely and legally drive unoccupied, vehicles will no longer be limited to their driver's destination and can search for cheaper parking in more distant parking locations. This work simulates a fleet of privately owned vehicles (POVs) in search of cheaper parking in Seattle, using a rectangular grid throughout the study area. Model results indicate that we are not likely to see significant increase in vehicle miles traveled (VMT) and energy use from cars moving from downtown parking lots to cheaper parking in distance locations but at higher penetration rates, parking lot revenues could likely decline to the point where operating a lot is unsustainable economically, if no parking demand management policies are implemented.

Driverless vehicles also promise to increase mobility for those in underserved populations. This work estimates bounds on the potential increases in travel in a fully automated vehicle environment due to an increase in mobility from the non-driving and senior populations and people with travel-restrictive medical conditions. Three demand wedges were established in order to conduct a first-order bounding analysis. The combination of the results from all three demand wedges represents an upper bound of 295 billion miles or a 14% increase in annual light-duty VMT for the US population 19 and older. AV technology holds much promise in providing a more accessible



and safe transportation system. This thesis can help policymakers and stakeholders maximize the benefits and minimize the challenges.

**Subject Areas:** Automated Vehicles (AVs); Vehicle miles traveled; Automated crash avoidance

**Availability:** Harper, C.D., 2017. *Transitioning to a Connected and Automated Vehicle Environment: Opportunities for Improving Transportation*. (Doctoral dissertation, Carnegie Mellon University).

<https://search.proquest.com/openview/ee4cbbc69751db4d2e02979c24c14fa4/1?pq-origsite=gscholar&cbl=18750&diss=y>

### **5.31. Title: Factors Influencing the Use of Autonomous and Shared Autonomous Vehicles in Alberta**

**Author:** Ghaffari Targhi, M.

**Abstract:** Autonomous vehicles (AV) are expected to have a wide-ranging affect on traffic congestion, safety, comfort, car ownership, land use and the environment. In this thesis, stated preference survey was designed to examine people's willingness to give up driving control to AVs and their willingness to use them as shared autonomous vehicles (SAV). The results indicate that Level 3 automation should be skipped and the market should move directly to full automation. People are willing to pay \$3529, \$2691 and \$4349 per year for the fixed cost of AVs with Level 2, 3, and 4 automation. The early owners of AVs are males over 50 years old and the early adaptors of SAVs are males younger than 35 years old. Also, the willingness to use higher levels of automation is attributed to people's perception towards AVs.

**Subject Areas:** Autonomous vehicles (AV); Traffic congestion

**Availability:** Ghaffari Targhi, M., 2017. *Factors Influencing the Use of Autonomous and Shared Autonomous Vehicles in Alberta*. (Doctoral dissertation, University of Calgary).

<https://prism.ucalgary.ca/handle/11023/3862>

### **5.32. Title: Application of Vehicle Dynamics in Design and Development of an Autonomous Vehicle for EcoPRT**

**Author:** Patil, N.B.

**Abstract:** Majority of the automotive industry is investing heavily in the research of autonomous vehicles. EcoPRT (Economic Personal Rapid Transit) at NC State is a dedicated research group aspiring to reboot local transportation systems with the benefits and efficiency that autonomous technology has to offer, all with keeping the costs as low as possible. The prototype vehicles are designed and manufactured in-house by student teams and building a small, narrow track, and a lightweight vehicle that can hold two passengers is one of the key objectives of this project. The mechanical team is focused on streamlining the design and manufacturing process for the EcoPRT vehicles, and this thesis discusses the considerations and application of various design principles employed in the process. The work done in this thesis is twofold. The first part covers the design challenges imposed by narrow space and the modifications that were made to the previous designs to develop a custom independent suspension system. Significant emphasis has been given to the geometric parameter determination, kinematic analysis, and design calculations. The second part discusses the impact of the chosen design on various aspects of the vehicle's dynamic behavior. Attention is given to the rollover safety of the vehicle since it possesses a high risk of rollover for being narrow-tracked and relatively tall. Ride analysis is performed to study isolation behavior and compared to the previous design. Furthermore, the cornering stability of the vehicle is determined and compared with the previous model through understeer gradient analysis.

**Subject Areas:** Automotive industry; EcoPRT (Economic Personal Rapid Transit); Autonomous technology; Ride analysis

**Availability:** Patil, N.B., 2017. *Application of Vehicle Dynamics in Design and Development of an Autonomous Vehicle for EcoPRT*. (Masters' Thesis, North Carolina State University). <https://repository.lib.ncsu.edu/bitstream/handle/1840.20/34851/etd.pdf?sequence=1>

### **5.33. Title: The Impact of Geography and Labor upon the Size of Job Agglomerations in Memphis, Tennessee**

**Authors:** Antipova, A.A., Skryzhevskaya, L. and Kung, H.

**Abstract:** This paper is presented as how data-enabled principles can be applied for the field of urban geography. It shows the fundamentals and examples for researchers in other fields to be considered. Specifically, we examine the link between three types of job concentrations and the site's spatial and non-spatial factors using OnTheMap 2011 data. We empirically analyzed spatial and non-spatial attributes, respectively and combined. The logistic and OLS regression analyses indicate that overall job concentrations locate with access to large employment areas, major roads, freight facilities, and White labor, while proximate local roads and Black labor force deter jobs which confirms selective race-based business location decisions. Employment size reflects economic health of an area and is a predictor of growth. We modeled employment magnitude by spatial and non-spatial factors among various employment concentrations. For small and medium job concentrations, areal employment benefits from proximity to Memphis Aerotropolis which offers excellent transportation opportunities. Employment in medium-sized concentrations is associated with experienced older workers as well as female resident workers. Employment size in large job areas is inversely related to the distance to the CBD and is positively associated with available high-earning resident workers. The paper contributes to the field of data-enabled science where real-world systems are modeled quantitatively using extensive economic activities data sets. Although a single-time period data was analyzed, the principles demonstrated in the paper may be considered for analysis of time series discipline-specific problems of urban environment and those arising in other fields of endeavor.

**Subject Areas:** OnTheMap application data; Job concentrations; Spatial factors; Non-spatial factors; Memphis Aerotropolis

**Availability:** Antipova, A.A., Skryzhevskaya, L. and Kung, H., 2017. *The Impact of Geography and Labor upon the Size of Job Agglomerations in Memphis, Tennessee*. Data-Enabled Discovery and Applications, 1(1), p.7.

<https://link.springer.com/article/10.1007/s41688-017-0009-7>

### 5.34. Title: Smart City in a Box: A Strategic Playbook for Igniting Civic Innovation

**Authors:** Chin, K.

**Abstract:** The smart city landscape is a complex and dynamic space. In a rapidly changing environment, transportation leaders are in need of a way to readily identify local mobility challenges, narrow in on the solutions that will maximize prospects for success, and connect with peer cities to advance an agenda of collective action. Building upon the experiences of the USDOT Smart City Challenge, the proposed Smart City Playbook represents an advance in the mobility conceptualization of smart cities. Using clustering as a means for organizing cities along multiple dimensions, the Playbook composes a selected landscape of 36 cities into four dominant clusters - Reimagining Cities, Dense & Dynamic Cities, Renaissance Cities, and College Towns - each comprised of different combinations of micro-foundations. The clusters facilitate development of solutions among analogous cities, while the micro-foundations provide insight into a city's unique character and indicate places in other cities that are experiencing similar conditions. Driven by the analysis, the Playbook outlines a systematic framework for generating use cases and proposes short-listed solution sets for each of the four clusters. Together cities have the power to leverage their talent, expertise, and solutions to shape the evolving marketplace and direct investment towards the communities most in need.

**Subject Areas:** Mobility challenges; USDOT Smart City Challenge; Clusters; Smart City Playbook

**Availability:** Chin, K., 2017. *Smart City in a Box: A Strategic Playbook for Igniting Civic Innovation*. (Doctoral dissertation).

<https://repositories.lib.utexas.edu/handle/2152/62981>

### 5.35. Title: Environmental and Policy Implications of Vehicle Automation and Electrification

**Authors:** Mersky, A.C.

**Abstract:** Mobility and transport underpin a society's economic and physical life. Travel, however, has significant external costs, not solely borne by those performing or requesting the service. In addition to the direct cost of building and maintaining the necessary infrastructure, an individual's decision to travel or transport goods affects the time others must travel, via congestion; injuries and fatalities; environmental health; and national energy security. When fueled by oil, for example, these costs add up to approximately \$4.00 a gallon, depending on the specific vehicle. Two sets of technologies have the potential to drastically reduce the externalities associated with passenger travel: vehicle electrification and automation.

Ensuring a socially optimal outcome from changes in vehicle technology requires four components. The first is determining whether adopting a set of new technologies would provide a net social benefit. The second is knowing how to effectively encourage adoption of a technology that has been determined to provide a net social benefit. The third is knowing how to optimally construct necessary infrastructure for the technology, while considering how future changes in the technology or other technologies may affect this process. The fourth component is being able to effectively regulate a technology. This dissertation addresses each of these issues by focusing on specific novel applications and case studies. It then discusses the joint implications and questions raised by these chapters.

Chapter I introduces the environmental and safety externalities associated with passenger vehicle mobility. Chapter II focuses on the issue of determining the social value of implementing a new technology. A municipality evaluating a potential transition to an electrified vehicle fleet has its own set of decision criteria, which may be different than other actors. Of the passenger vehicle models that the City of Pittsburgh is considering, battery electric vehicles (BEVs), but not plug-in hybrid electric vehicles, were found to have lower life-cycle GHG emissions than conventional vehicles in Pittsburgh. However, vehicle electrification was found likely to have higher total social emissions costs than conventional options. Chapter III focuses on technology adoption by investigating the statistical significance of demographics and incentives on electric vehicle sales in Norway. Chapter III shows that access to BEV charging infrastructure, being adjacent to major cities, and regional incomes have the greatest predictive power for the growth of BEV sales. While Chapter III does not test for causation, vehicle chargers are necessary for BEV adoption and the results show that charging infrastructure is significantly correlated with BEV adoption in Norway. This suggests the need to plan for charging infrastructure concurrently with BEV adoption.

Chapter IV focuses on how to optimally construct necessary infrastructure for electric vehicles when accounting for vehicle automation. For our simulation of about 2,000 trips in the greater Seattle, Washington area, moving from levels 0-3 to level 4 reduced peak electric load by about one-third and level 5 automation about two-thirds. Moving from no automation to level 4 automation nearly halved operator costs, while not having any significant effect on commuter costs. Moving to level 5 automation decreased operator costs by about 75% due to reduced number of charging stations, but shifted a portion of this reduction onto commuters. Chapter V focuses on how to effectively regulate technologies so that their future development increases social value, focusing on the specific problem of measuring the fuel economy of autonomous vehicles. The

results showed that autonomous vehicles following algorithms designed without considering efficiency could degrade fuel economy by up to 3%, while efficiency-focused control strategies may equal or slightly exceed the existing EPA fuel economy test results by up to 5%, when compared to the base EPA cycles that they were simulated as following.

**Subject Areas:** Passenger Vehicle Mobility; Vehicle electrification and automation; Social benefit

**Availability:** Mersky, A.C., 2017. *Environmental and Policy Implications of Vehicle Automation and Electrification*. (Doctoral dissertation, Carnegie Mellon University).

<https://search.proquest.com/openview/f6d2f40729643a9d020d8816d79fe8c9/1?pq-origsite=gscholar&cbl=18750&diss=y>

### **5.36. Title: Mobility in History through the Lens of Transport**

**Author:** Pooley, C.G.

**Abstract:** All mobility requires some form of transport, whether that be human powered (walking, cycling), animal powered, or driven by steam, oil or electricity. All forms of transportation also make demands upon the environment through which they pass: competing for road space, requiring management and in the case of most non-human powered transport polluting the environment. There is much research on transport history but for the most part it remains separate from studies of migration and mobility. This chapter explores the benefits of greater interaction between these fields of enquiry, examines some of the ways in which planners and policy makers have sought to manage transport and travel over time, and considers the implications that this has both for the environment and for social equity.

**Subject Areas:** Transport infrastructure; Transport technologies; Traveling to school; Traveling to work; Traveling for leisure; Transport planning

**Availability:** Pooley, C.G., 2017. *Mobility in History through the Lens of Transport*. Migration and Transport (pp. 79-102). Springer International Publishing.

[https://link.springer.com/chapter/10.1007/978-3-319-51883-1\\_4](https://link.springer.com/chapter/10.1007/978-3-319-51883-1_4)



**5.37.** Title: A Decomposition Algorithm to Solve the Multi-hop Peer-to-Peer Ride-Matching Problem

**Authors:** Masoud, N. and Jayakrishnan, R.

**Abstract:** In this paper, we mathematically model the multi-hop Peer-to-Peer (P2P) ride-matching problem as a binary program. We formulate this problem as a many-to-many problem in which a rider can travel by transferring between multiple drivers, and a driver can carry multiple riders. We propose a pre-processing procedure to reduce the size of the problem, and devise a decomposition algorithm to solve the original ride-matching problem to optimality by means of solving multiple smaller problems. We conduct extensive numerical experiments to demonstrate the computational efficiency of the proposed algorithm and show its practical applicability to reasonably-sized dynamic ride-matching contexts. Finally, in the interest of even lower solution times, we propose heuristic solution methods, and investigate the trade-offs between solution time and accuracy.

**Subject Areas:** Ride sharing; Ride matching algorithm; Dynamic ride sharing; On-demand transportation; Passenger transportation; Sharing economy; Multi-modal transportation

**Availability:** Masoud, N. and Jayakrishnan, R., 2017. *A Decomposition Algorithm to Solve the Multi-hop Peer-to-Peer Ride-Matching Problem*. Transportation Research Part B: Methodological, 99, pp.1-29.

<http://www.sciencedirect.com/science/article/pii/S019126151730019X>

### **5.38. Title: Shared Automated Vehicles: Review of Business Models**

**Authors:** Stocker, A. and Shaheen, S.

**Abstract:** This paper provides an introduction to the current state of vehicle automation and shared mobility. The paper discusses current shared mobility business models to foster a better understanding of these systems at present and to set the stage for possible future shared automated vehicle (SAV) business models. The discussion covers current SAV pilot projects around the world and then explores potential SAV business and service models considering high or full automation (Level 4 and higher). The paper ends with a discussion of the literature regarding projected SAV impacts. Although the future of SAVs is uncertain, this briefing paper begins the dialogue around SAV business models that may develop, which are informed by current shared mobility services.

**Subject Areas:** Vehicle automation; Shared mobility; Business models

**Availability:** Stocker, A. and Shaheen, S., 2017. *Shared Automated Vehicles: Review of Business Models*. The International Transport Forum, Discussion Paper No. 2017-09.  
<https://www.itf-oecd.org/sites/default/files/docs/shared-automated-vehicles-business-models.pdf>

## 6. Special Population Group

### 6.1. Title: An Analysis of the Time-of-Day Choices of the Elderly for Non Work Travel

**Authors:** Fariborzi, K. and Srinivasan, S.

**Abstract:** Pedestrian exposure refers to a pedestrian's contact with vehicular traffic that can create opportunities for collisions. A myriad of metrics exist to estimate pedestrian exposure, but no consensus has been reached on what metrics should be adopted. Hence, this study attempted to synthesize previous studies and offer best practices for estimating pedestrian exposure (with a focus for rural and small urban areas). Four general types of exposure metrics emerged from area-based measures (e.g., zonal walk miles traveled), through more granular metrics at the point or segment level, to advanced metrics that utilize the behavioral attributes of walk trips (e.g., space-time prism and discrete choice). In addition, the study utilized home-based walk-only trips from nine states in the National Household Travel Survey (NHTS) (2009) data to estimate a household-level pedestrian exposure measure for rural and small urban settings. The model accounted for household characteristics (e.g., income and vehicle ownership), regional factor, and block-group-level attributes (e.g., population density and school density), with an overall goodness-of-fit of 0.41. The results can be used to infer number of walk trips at as small as the block group level or be inserted into four-step travel demand model to create point or segment-based measures where pedestrian network is defined.

**Subject Areas:** Age groups; Choice models; Travel behavior; Travel demand; Trip purpose; Planning and Forecasting; Transportation (General)

**Availability:** Fariborzi, K. and Srinivasan, S., 2017. *An Analysis of the Time-of-Day Choices of the Elderly for Non Work Travel*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-05725).

<https://trid.trb.org/view.aspx?id=1439275>

## **6.2. Title: The Multimodal Behavior of Millennials: Differences in Travel Choices between Young Adults and Gen Xers in California**

**Authors:** Circella, G., Alemi, F., Berliner, R., Tiedeman, K., Lee, Y., Fulton, L., Handy, S.L. and Mokhtarian, P.L.

**Abstract:** Millennials are increasingly reported to behave, and travel, differently from previous generations at the same stage in life. Among the observed changes, they postpone the time they obtain a driver's license, often live in urban locations and do not own a car, drive less if they own one, and use alternative travel modes more often. However, the reasons behind these trends, and their long-term impacts on travel demand and the future growth of cities, are still largely unclear. This study investigates millennials' mobility through the analysis of a comprehensive dataset collected among 2,155 young adults and members of the preceding Generation X who live in California, as part of a panel study of millennials' residential choices, lifestyles, travel behavior and adoption of new technologies. This paper presents an overview of the research, and discusses preliminary results from the analysis of the California Millennials Dataset. We focus on the adoption of multimodality among the members of the two generations, and compare it to measures of accessibility by various travel modes of the respondents' residential location. The study highlights differences in travel behavior between those that travel by car by necessity (e.g. because they live in locations where few travel options are available) and those that do so by choice (e.g. despite the availability of other modes). The study provides useful insights for planners and policy-makers, through improving the understanding of millennials' choices and the impact of lifecycle, period and generational effects on future travel.

**Subject Areas:** Millennials, Travel Behavior, Lifestyles, Multimodality, Accessibility

**Availability:** Circella, G., Alemi, F., Berliner, R., Tiedeman, K., Lee, Y., Fulton, L., Handy, S.L. and Mokhtarian, P.L., 2017. *The Multimodal Behavior of Millennials: Exploring Differences in Travel Choices between Young Adults and Gen Xers in California*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-06827).  
<http://docs.trb.org/prp/17-06827.pdf>

### **6.3. Title: Driving Self-Regulation and Ride Service Utilization in a Multicommunity, Multistate Sample of U.S. Older Adults**

**Authors:** Bird, D.C., Freund, K., Fortinsky, R.H., Staplin, L., West, B.A., Bergen, G. and Downs, J.

**Abstract:**

Objectives: This study examined a multicommunity alternative transportation program available 24 hours a day, 7 days a week, for any purpose, offering door-through-door service in private automobiles to members who either do not drive or are transitioning away from driving. Specific aims were to describe the characteristics of members by driving status and ride service usage of these members.

Methods: Data came from administrative records maintained by a nonprofit ride service program and include 2,661 individuals aged 65+ residing in 14 states who joined the program between April 1, 2010, and November 8, 2013. Latent class analysis was used to group current drivers into 3 classes of driving status of low, medium, and high self-regulation, based on their self-reported avoidance of certain driving situations and weekly driving frequency. Demographics and ride service use rate for rides taken through March 31, 2014, by type of ride (e.g., medical, social, etc.) were calculated for nondrivers and drivers in each driving status class.

Results: The majority of ride service users were female (77%) and aged 65-74 years (82%). The primary method of getting around when enrolling for the transportation service was by riding with a friend or family member (60%). Among the 67,883 rides given, nondrivers took the majority (69%) of rides. Medical rides were the most common, accounting for 40% of all rides.

Conclusions: Reported ride usage suggests that older adults are willing to use such ride services for a variety of trips when these services are not limited to specific types (e.g., medical). Further research can help tailor strategies to encourage both nondrivers and drivers to make better use of alternative transportation that meets the special needs of older people.

**Subject Areas:** Driving; Older Adult; Motor Vehicle; Mobility; Self-Regulation; Senior Transportation

**Availability:** Bird, D.C., Freund, K., Fortinsky, R.H., Staplin, L., West, B.A., Bergen, G. and Downs, J., 2017. *Driving Self-Regulation and Ride Service Utilization in a Multicommunity, Multistate Sample of U.S. Older Adults*. *Traffic Injury Prevention*, 18(3), pp.267-272.

<http://www.tandfonline.com/doi/abs/10.1080/15389588.2016.1198008>

#### **6.4. Title: Ethnic Neighborhoods, Social Networks, and Inter-Household Carpooling: A Comparison Across Ethnic Minority Groups**

**Author:** Shin, E.J.

**Abstract:** The implications of racial residential segregation on travel behavior have remained understudied, despite the persistent existence of segregation. Using the 2009 National Household Travel Survey, I investigate whether residence in a co-ethnic neighborhood affects the likelihood that ethnic minorities will form inter-household carpools, and if so, how such effects differ across race or ethnic groups. Inter-household carpooling requires arrangements and interactions between people living in geographical proximity, so it will likely reflect the social networks of a neighborhood. The results show that Hispanics and Asians who reside in their co-ethnic neighborhoods, regardless of immigrant status, are more likely to use inter-household carpools for non-work purposes than their counterparts living outside co-ethnic neighborhoods. In contrast, black neighborhood residency is not associated with the likelihood that African Americans will do inter-household carpooling, regardless of trip purpose. These differences across racial/ethnic groups suggest that the role of neighborhoods in promoting social ties as reflected by activities such as external carpooling is complex. Residence in a black neighborhood may be less of a choice than residence in a Hispanic or Asian neighborhood due to the long history of black segregation in the US. With less residential choice, the propensity to develop local social ties may be weaker.

**Subject Areas:** Racial Segregation; Travel Behavior; Carpooling; Ethnic Groups

**Availability:** Shin, E.J., 2017. *Ethnic Neighborhoods, Social Networks, and Inter-Household Carpooling: A Comparison Across Ethnic Minority Groups*. *Journal of Transport Geography*, 59, pp.14-26.

<http://www.sciencedirect.com/science/article/pii/S0966692316300497>

**6.5. Title: Hidden Costs of Carpooling in Family Life: Travel Behavior of Hispanic Families with Children in the USA**

**Author:** Matsuo, M.

**Abstract:** In the U.S., Hispanic immigrant households who have low access to private vehicles typically depend on carpooling rather than taking transit, the tendency that is not observed for immigrants of other race/ethnicity groups. Moreover, my previous paper reveals that females of Hispanic immigrants are heavily dependent on others' mobility and delay becoming drivers, even though they seem to choose auto-dependent lifestyle at household level. These findings leave a question how much time is wasted by dependence on carpooling when many household members are transportation disadvantaged, such as children under driving age. This paper explores travel characteristics of Hispanic immigrant households with children in the following points; (1) whether they are lower mobility at household level, (2) whether adult members' time is wasted for transporting children, and (3) whether children's total travel time and active non-commuting trip frequency are different by the number of drivers and/or vehicles in the household, using the National Household Travel Survey data of 2009.

**Subject Areas:** Mobility; Immigrants; Hispanics; Children

**Availability:** Matsuo, M., 2017. *Hidden Costs of Carpooling in Family Life: Travel Behavior of Hispanic Families with Children in the USA*. Discussion Paper Series, Research Institute for Economics and Business Administration, Kobe University. (No. DP2017-13).  
<http://www.rieb.kobe-u.ac.jp/academic/ra/dp/English/DP2017-13.pdf>

## **6.6. Title: Achieving Mobility Access for Older Adults Through Group Travel Instruction**

**Authors:** Lubin, A., Alexander, K. and Harvey, E.

**Abstract:** It is anticipated that the number of older adults in the United States will reach 70 million before midcentury. Although the majority currently meet their transport needs by driving, one in five older adults does not drive. That statistic is expected to rise as senior drivers experience disability, health-related issues, or both, that negatively affect their driving ability. For many older adults accessible public transportation can be a viable transport option provided they are aware of and familiar with available transit services, trip planning, and how to safely and independently utilize transit systems. Findings are presented from a group travel instruction program piloted with older adults in New Jersey that encompassed classroom training and a field trip. A robust survey evaluation protocol was implemented that yielded findings that included the important role of transportation to older adult quality of life; high participant program satisfaction; evidence of participant knowledge and skills gained after program completion; and participant interest, willingness, and actual usage of public transit after the program. Survey respondents also confirmed several quality-of-life indicators experienced from program participation. In total, these findings offer evidence of the benefits of group travel instruction for older adults with and without a disability as they seek to meet some or all of their travel needs via accessible public transportation. The findings also support the value of offering both classroom and field trip components in older adult travel instruction programs.

**Subject Areas:** Older adults; Driving; Travel Instruction

**Availability:** Lubin, A., Alexander, K. and Harvey, E., 2017. *Achieving Mobility Access for Older Adults Through Group Travel Instruction*. Transportation Research Record: Journal of the Transportation Research Board, (2650), pp.18-24.

<http://trjournalonline.trb.org/doi/abs/10.3141/2650-03>



**6.7. Title: Driving the Poor into Debt? Automobile Loans, Transport Disadvantage, and Automobile Dependence**

**Author:** Walks, A.

**Abstract:** The disadvantages relating to the financialization of household transport and transport-related debt have yet to receive sufficient attention, partly due to a general lack of data on household-level transport-related liabilities, particularly at small scales of analysis. This issue has risen in importance with increases in households debt levels and changes in the ways automobile purchases are financed. This paper examines the level of automobile-related debt among lower-income households, and the effects of living in automobile-dependent neighbourhoods, using seven of the largest Canadian metropolitan areas as case studies. Detailed household survey data pertaining to both automobile loans and other forms of debt in 2012 are analyzed and compared with census data related to automobile dependence at the neighbourhood (census tract) level. Descriptive and inferential analyses are presented, demonstrating relationships between levels of automobile dependence and higher relative burdens of household indebtedness, particularly for automobile loans, although the relationships are dependent on, and mediated by, local context. The implications for transport policy are discussed.

**Subject Areas:** Automobile dependence; Financial vulnerability; Debt; Transport disadvantage; Transport exclusion; Suburbanization

**Availability:** Walks, A., 2017. *Driving the Poor into Debt? Automobile Loans, Transport Disadvantage, and Automobile Dependence*. Transport Policy.

<http://www.sciencedirect.com/science/article/pii/S0967070X17300112>

**6.8. Title: The Impact of Employment Status on the Travel Behaviour of Millennials: Assessing the Potential for Promoting Sustainable Transportation in the Greater Toronto and Hamilton Area**

**Author:** Giallonardo Michael.

**Abstract:** Millennials are known to drive automobiles less than their preceding generations; this behaviour has been attributed the Great Recession and the disproportionate effect it has had on them. The validity of this theory in the Greater Toronto and Hamilton Area is assessed in this report through an exploration of the association between employment status and three indicators of travel behaviour: mode share, daily auto trips, and daily vehicle kilometres travelled. Data used in this report are from 2001, 2006, and 2011 Transportation Tomorrow Surveys and results were geographically split to assess differences between the City of Toronto and its suburbs. The data confirm an association between employment status and travel behaviour in the GTHA although individuals with full-time employment did not maintain stable automobility patterns during the study period suggesting that unique Millennial travel behaviour cannot be wholly attributed to the negative economic conditions brought on by the Great Recession. Nevertheless, Millennial travel behaviour patterns were determined to have been affected by this event in a manner that was not observed among Generation Xers. Thus, the data suggest that Millennials can be expected to drive more as they age, especially with improved employment fortunes, although perhaps not as much as their elders did at similar lifecycle stages. Planners and policymakers can interpret these results as an opportunity and challenge. While it is unlikely for automobile demand to be eliminated, the usage of this travel mode can be reduced by further promoting ridesharing, ride-hailing, and carsharing as substitutes to car ownership. Employer-based transportation demand management programs should be embraced. Compact and mixed use developments are necessary but should be combined with efforts to reduce the convenience of automobile usage to facilitate reductions in automobile demand. Finally, policymakers should capitalize on increased transit usage among Millennials by improving marketing and education about this alternative travel option.

**Subject Areas:** Millennials; Travel Behaviour; Automobility patterns

**Availability:** Giallonardo Michael, 2017. *The Impact of Employment Status on the Travel Behaviour of Millennials: Assessing the Potential for Promoting Sustainable Transportation in the Greater Toronto and Hamilton Area.* (Master's Thesis) Queens University.

[https://qspace.library.queensu.ca/bitstream/handle/1974/15651/Giallonardo\\_Michael\\_C\\_201704\\_MPL.pdf.pdf?sequence=1](https://qspace.library.queensu.ca/bitstream/handle/1974/15651/Giallonardo_Michael_C_201704_MPL.pdf.pdf?sequence=1)

## **6.9. Title: Commuting Patterns of Immigrant workers in Indian Eateries: Focusing on Latino and Indian Immigrants**

**Author:** Doravari, A.

**Abstract:** This inductive research study aimed to understand commuting patterns of low-income immigrant workers in 3 cities located in Los Angeles County and San Bernardino County. The study identified 35 potential participants from the Indian Restaurant Industry and conducted a research study at three mid-sized cities namely Pomona, Diamond Bar and Upland. The study employed mixed methods for ethnographic research using Delphi and Grounded Theory for data collection and analysis. The study enquired about three main topics: Travel Experiences in the region (2) Housing location and rationale (3) Worker dynamics and interpersonal relationships at the work place. The data was collected in the form of Travel Surveys and in-depth structured interviews. The raw data was analyzed and several inferences based on demographic and social factors became evident. There seemed to be a large number of Indian people in this sample when compared to Mexicans or Central Americans. There were also emerged a reasonable number of unauthorized immigrant workers in the sample. The part-time working community comprised majority of the unauthorized workers since these workers were full-time International students at local universities. The commute mode for this sample is drastically different from that of Native born groups. This difference is mostly due to the lack of single occupancy vehicles in this sample. More specifically, Mexicans follow some resemblance to white commute patterns, whereas the Indian community displays a multimodal commute mode patterns. The second major commute mode for this sample was car-pooling, a category that became dominant in both part-time and full-time groups. Social networks also played an important role in enhancing transportation or mobility in this sample, since strong personal relationships and mutual dependence were observed.

**Subject Areas:** Commuting patterns; Low-income Immigrants

**Availability:** Doravari, A., 2017. *Commuting Patterns of Immigrant workers in Indian Eateries: Focusing on Latino and Indian Immigrants*. MS dissertation, California State Polytechnic University, Pomona.

[https://broncoscholar.library.cpp.edu/bitstream/handle/10211.3/189853/DoravariAnupama\\_Thesis2017.pdf?sequence=4](https://broncoscholar.library.cpp.edu/bitstream/handle/10211.3/189853/DoravariAnupama_Thesis2017.pdf?sequence=4)

**6.10. Title: What Explains the Decline in Driving Among Young People?**

**Author:** Schmitt, A.

**Abstract:** Blog

**Subject Areas:** Travel behavior; Young generation

**Availability:** Schmitt, A., 2017. *What Explains the Decline in Driving Among Young People?*  
StreetsBlog USA.

<http://usa.streetsblog.org/2017/03/29/what-explains-the-decline-in-driving-among-young-people/>

**6.11. Title: Multimodal Millennials? The Four Traveler Types of Young People in the United States in 2009**

**Author:** Ralph, K.M.

**Abstract:** Are young Americans embracing a mix of travel modes? This article identifies four types of travelers to answer that question. Drivers travel almost exclusively by automobile; Long-distance Trekkers drive great distances; Multimodals use a mix of modes; and the Car-less rely on nonautomobile modes and make very few trips. Multimodals were exceedingly rare and eight in ten Millennials used an automobile for nearly every trip as a Driver or Long-distance Trekker. By incorporating multiple facets of travel into a single variable, this research provides valuable information for addressing twenty-first-century policy challenges such as encouraging multimodality and alleviating transportation disadvantage.

**Subject Areas:** Travel modes; Drivers; Millennials

**Availability:** Ralph, K.M., 2017. *Multimodal Millennials? The Four Traveler Types of Young People in the United States in 2009*. *Journal of Planning Education and Research*, 37(2), pp.150-163.

<http://journals.sagepub.com/doi/abs/10.1177/0739456X16651930>

**6.12. Title: Humboldt Bay Trail Could Use Your Support**

**Author:** Hughes, R.

**Abstract:** Blog

**Subject Areas:** Adult-bikers; Baby boomers; Funding

**Availability:** Hughes, R., 2017. *Humboldt Bay Trail Could Use Your Support*. Times Standard Columns.

<http://www.times-standard.com/opinion/20170622/humboldt-bay-trail-could-use-your-support>

**6.13. Title: Gender Differences in the Commute to School and Work through Time and Space in the Greater Toronto and Hamilton Area, Canada**

**Author:** Colley, M.E.

**Abstract:** Previous research on gender and mobility has pointed to differences between male and female travel patterns, but little attention has been paid in transportation planning practice to gender differences in travel demand. This thesis explores gender differences in the school and work commute through the life cycle and over time and space in effort to inform policies that begin to address the needs of a diverse population. The results suggest that school-aged males use active modes more than females, but females use active modes more than males during the years of labour force participation. Adult men continue to use the automobile to travel to work, while females make up a greater proportion of transit riders than males. Mode share differences increase with age, but have decreased since the 1980s. The relationship between male and female travel mode also differs depending on many factors including distance, time, and place.

**Subject Areas:** Gender differences; Commute

**Availability** Colley, M.E., 2017. *Gender Differences in the Commute to School and Work through Time and Space in the Greater Toronto and Hamilton Area, Canada*. M.S. Thesis, University of Toronto (Canada).

[https://tspace.library.utoronto.ca/bitstream/1807/76664/1/Colley\\_Michele\\_E\\_201703\\_MA\\_thesis.pdf](https://tspace.library.utoronto.ca/bitstream/1807/76664/1/Colley_Michele_E_201703_MA_thesis.pdf)

#### **6.14. Title: Declining Function in Older Adults: Influencing not only Community Mobility Options but also Wellbeing**

**Authors:** Silverstein, N.M., Macàrio, R. and Sugiyama, T.

**Abstract:** People experience decline in physical and cognitive functioning as they age. The functional decline has a major implication on the way they move within a local environment. This issue of *Journal of Transport and Health* contains three articles on how functional capacity influences older adults' mobility choice and experience, and how the subsequent limited mobility options can affect their wellbeing. With reduced capacity to walk (primary mobility), older adults need to rely on motorized mobility options such as cars and public transport (secondary mobility). The limited availability and access to motorized transport can cause a constricted "life space", which is known to be associated with adverse health outcomes (Polku et al., 2015). However, two articles in this issue illustrate that such motorized mobility options also pose a challenge for older adults with impaired physical and cognitive function. Age changes the cognitive reaction to stimulus and phasing out of professional active life changes also quality criteria assessing services.

Schubert et al. (2017) examined the physical demand involved when riding a bus. As fatalities due to crash involvement are typically measured as death within 30 days (USDOT, 2016), the gerontological story is likely far more complex. That is, serious long term injury sustained from crash involvement may result in death later than 30 days; or lead to longer term rehabilitation or institutionalization. Schubert et al. add another dimension to this story, that is, the non-collision accidents related to use of buses: specifically, injuries due to boarding and exiting, and standing or moving during acceleration or deceleration. Their study focused on the high level of biomechanical demands that passengers who are standing must sustain and concluded that the thresholds to maintain postural control are often exceeded during acceleration and deceleration leading to a fall or degradation of the bus travel experience. This can be a major deterrence for older adults with limited physical function (e.g., balance, grip, leg muscle) in using buses for travel. Frequent and reliable bus services are often considered a key factor to promote bus ridership (Redman et al., 2013). However, for older adults, the physical demand in dealing with acceleration and deceleration is another factor that can influence the choice of this travel mode. Research investigating more innovative solutions to mitigate the biomechanical demand may help encourage older adults' bus use. While Schubert et al. focus on the physical demands, an implication of their study is the need for further research on impairments related to cognitive demands and the use of transportation options where travel-related incidents may emerge that are even more difficult to measure, such as wandering and getting lost when traveling unescorted. More research is encouraged to better understand the broader range of non-collision accidents in older adults that are associated with transportation.

Pavlou et al. (2017) examined how the self-regulation patterns of drivers with brain pathologies (Alzheimer's disease, Parkinson's disease, and mild cognitive impairment) are different from those of healthy drivers. In a matched control study, they found that the healthy controls reported a greater number of motor vehicle accidents, "near" accidents, and violations in the past two years than did persons with brain pathologies; although the healthy controls were more likely to report greater seatbelt usage. The study suggests that older drivers with cognitive problems are able to drive a car safely, but they are concerned with their deterioration in driving performance and this perception leads them to conservative driving or driving avoidance, a theme echoed by the third article authored by Deka (2017) who observed that the loss of mobility by car use negatively



influences wellbeing in older adults. Collateral data from family members and stage of disease process would have been helpful for the authors to report and also to include in future studies as these findings seem to contradict others that suggest that the lack of insight in persons with dementia may impact driving performance (Eby et al., 2012).

The third article, by Deka, examined the effect of mobility loss and car ownership on older adults' wellbeing (depression, happiness, and loneliness). This study found that developing walking difficulty had an adverse impact on depression and happiness, while not having a car was associated with depression. Interestingly, he concluded that cross-sectional models show more conclusive effects of mobility impairment than cohort models with climbing stairs and walking more significantly associated with depression; walking ability associated with happiness; and climbing stairs significantly related to loneliness. His results further revealed that the effect of automobile ownership was significant in the analytic model for depression but not for happiness or loneliness. He suggests, and we agree, that additional questions on subjective well-being, utilization of mobility options, and more health variables need to be included on national datasets such as the National Household Travel Survey (NHTS). We note that the National Health and Aging Trends Study (NHATS) is already beginning to include such modules.

In summary, the three articles suggest that older adults with impaired physical and cognitive functioning are at risk of losing both non-motorized and motorized modes of mobility, which has a detrimental impact on their mental wellbeing. Reduced physical function is clearly related to walking difficulty and may discourage bus use due to the strength needed to withstand sudden movement. Older adults with cognitive decline often relinquish driving once they are concerned with their driving performance. The loss of primary and secondary mobility means a dramatic reduction of life space leading to adverse health outcomes and social isolation. On-demand transport may be an alternative travel mode for those who are losing functional abilities. However, the availability, accessibility, and affordability of such services may be limited. An underlying issue that should be addressed is how to delay or slow the decline of functional capacities among older adults so that they can remain active and keep using a range of transport options. Promoting age-friendly communities, where older adults maintain healthy and active lifestyles in a supportive built environment, may be an effective strategy to prevent functional decline.

**Subject Areas:** Functional decline and mobility; Older adults; Wellbeing

**Availability** Silverstein, N.M., Macàrio, R. and Sugiyama, T., 2017. *Declining Function in Older Adults: Influencing not only Community Mobility Options but also Wellbeing*. Journal of Transport & Health, 4, pp.4- 5.

<http://www.sciencedirect.com/science/article/pii/S2214140517300701>

**6.15. Title: Does Economic Vulnerability Moderate the Association between Transportation Mode and Social Activity Restrictions in Later Life?**

**Authors:** Lehning, A., Kim, K., Smith, R. and Choi, M.

**Abstract:** Transportation is critical to older adults' ability to participate in social activities in their community. We examined the association between modes of transportation and restrictions in social activity (i.e. visiting with others, religious attendance, clubs and organized activities, and going out for enjoyment), with particular attention to the moderating effects of economic vulnerability. We used logistic regression to analyze data from 7,197 community-dwelling older adults from the 2011 wave of the National Health and Aging Trends Study, a representative sample of adults aged 65 and over in the United States of America. Economic vulnerability moderated the association between transportation mode and social activity restrictions. Findings suggest that even when economically vulnerable older adults have access to driving, walking or public transit, they may be at a higher risk for social exclusion than their counterparts with more financial resources.

**Subject Areas:** Older adults; Economic vulnerability

**Availability:** Lehning, A., Kim, K., Smith, R. and Choi, M., 2017. *Does Economic Vulnerability Moderate the Association between Transportation Mode and Social Activity Restrictions in Later Life?* *Ageing & Society*, pp.1-20.

<https://www.cambridge.org/core/journals/ageing-and-society/article/does-economic-vulnerability-moderate-the-association-between-transportation-mode-and-social-activity-restrictions-in-later-life/62E4FF5F183C513A8B69B2B85183A934>

## 6.16. Title: Elderly's Travel Patterns and Trends: The Empirical Analysis of Beijing

**Authors:** Liu, W., Lu, H., Sun, Z. and Liu, J.

**Abstract:** Travel by the elderly is generally characterized by relatively short distances and low frequencies. However, with social development, the travel patterns of the elderly are lacking in sustainability. In some European countries, the elderly are increasingly dependent on cars while traveling. In addition, the influencing factors of the elderly's travel behavior are also changing. At present, most foreign and domestic studies focus on the impact of individual and household socioeconomic attributes, travel attributes, and policy factors on the travel frequency, travel mode choice, and travel demand of the elderly, but they lack an analysis of the regional differences of the elderly's travel behavior characteristics and related countermeasures. The studies excessively focus on the influencing factors but overlook the difference between the elderly's travel characteristics and young people's travel characteristics, as well as the interactions at the household level. Based on data from the Fifth Travel Survey of Residents in Beijing 2014, this paper uses variance analysis, Spearman's correlation analysis, and descriptive and comparative analysis to study the difference in travel frequency over 24 hours between the elderly and middle-aged/young people in Beijing, the impact of household, individual, and travel attributes on the travel frequency difference, and the regional difference in the elderly's travel behavior characteristics. The results show that there is a significant difference in travel frequency between the elderly group and the middle-aged/young group in Beijing; the main reason is the individual difference between travelers. Travelers' attributes all exert an influence on the travel frequency of both groups, but the degree and direction of the influence are different. At the household level, middle-aged/young people with a higher household income travel less frequently, whereas the case is completely the opposite for the elderly. In terms of personal attributes, gender has a significant negative effect on the elderly's travel frequency; that is, women travel less than men, whereas there is no difference between men and women in middle-aged/young people. Regarding travel attributes, travel distance and travel duration have a significant negative effect on the two groups' travel frequencies. The elderly in some European countries are more dependent on cars, whereas a large proportion of elderly people in Beijing walk on foot, but the degree of dependence on cars of the "new generation" of the elderly in Beijing will increase rapidly, which will bring the lack of sustainability of travel patterns, further bringing new challenges to policymakers and transport planning departments.

**Subject Areas:** Elderly; Mobility; Sustainability; Frequency; Beijing

**Availability:** Liu, W., Lu, H., Sun, Z. and Liu, J., 2017. *Elderly's Travel Patterns and Trends: The Empirical Analysis of Beijing*. *Sustainability*, 9(6), p.981.

<http://www.mdpi.com/2071-1050/9/6/981/htm>

### **6.17. Title: Transportation Barriers and Use of Dental Services among Medicaid-Insured Adults**

**Authors:** McKernan, S.C., Reynolds, J.C., Ingleshwar, A., Pooley, M., Kuthy, R.A. and Damiano, P.C.

**Abstract:** This study explores how travel distance and other transportation barriers are associated with dental utilization in a Medicaid expansion population. We analyzed data from the Iowa Dental Wellness Plan (DWP), which provides comprehensive dental benefits for low-income adults aged 19 to 64 y as part of Iowa's Medicaid expansion. Transportation and geographical characteristics were evaluated as enabling factors within the framework of Andersen's behavioral model of health services use. In March 2015, a random sample of DWP members (n = 4,800) was surveyed; adjusted survey response rate was 30% (n = 1,258). The questionnaire was based on the Consumer Assessment of Healthcare Providers and Systems (CAHPS) Dental Plan Survey and assessed need for dental care, use of dental services and transportation to visits, and self-perceived oral health status. Respondent and dentist addresses were geocoded and used to calculate distance to the nearest DWP general dentist. A logistic regression model predicting utilization of dental care was developed using variables representing each domain of the behavioral model. Most respondents (57%) reported a dental visit since enrolling. Overall, 11% of respondents reported unmet dental need due to transportation problems. Median distance to the nearest general dentist was 1.5 miles. In the adjusted model, travel distance was not significantly associated with the likelihood of dental utilization. However, other transportation-related issues were significantly associated with utilization, including concern about cost of transportation and driver/passenger status. As concern about transportation cost increased, likelihood of having a dental visit decreased. Targeted approaches to assisting low-income populations with transportation barriers should be considered in designing policies and interventions to improve access to dental care.

**Subject Areas:** Transportation Barriers; Travel distance; Dental health; Low-income adults

**Availability:** McKernan, S.C., Reynolds, J.C., Ingleshwar, A., Pooley, M., Kuthy, R.A. and Damiano, P.C., 2017. *Transportation Barriers and Use of Dental Services among Medicaid-Insured Adults*. JDR Clinical & Translational Research, p.2380084417714795.  
<http://journals.sagepub.com/doi/abs/10.1177/2380084417714795>

**6.18. Title: Understanding Immigrants' Mode Choice Behavior in Florida: Analysis of Neighborhood Effects and Cultural Assimilation**

**Authors:** Asgari, H., Zaman, N. and Jin, X.

**Abstract:** The goal of this study is to develop Multinomial Logit models for mode choice behaviour of immigrants, with key focuses on neighbourhood effects and behavioural assimilation. The first aspect assumes a linkage between social network ties and immigrants' chosen mode of transportation, while the second dimension explores the gradual propensity towards alternative mode usage with regard to immigrants' settlement period in the United States. Factor analysis was carried out to establish neighbourhood typologies based on income, family structure, and education. Mode choice models were then developed for work, shopping, social and recreational, and other trip purposes to evaluate the impacts of various land use patterns, neighbourhood typology, and socioeconomic and demographic attributes on immigrants' travel behaviour. Estimated coefficients for each alternative mode (i.e., high-occupancy vehicle, public transit, and non-motorized transport) were compared to single-occupancy vehicles (SOV). The model results revealed significant influences of neighbourhood and land use variables on the usage of alternative modes among immigrants. Incorporating these indicators into the demand forecasting process is expected to provide a better understanding of diverse travel patterns for the unique composition of population groups in Florida.

**Subject Areas:** Immigrants'; Travel Behavior; Mode Choice Modeling; Neighborhood Effects; Principal Component Analysis

**Availability:** Asgari, H., Zaman, N. and Jin, X., 2017. *Understanding Immigrants' Mode Choice Behavior in Florida: Analysis of Neighborhood Effects and Cultural Assimilation*. Transportation Research Procedia, 25, pp.3083-3099.

<http://www.sciencedirect.com/science/article/pii/S2352146517306269>

## 6.19. Title: Measuring and Improving Seniors' Access to Medical Facilities

**Author:** Zygo, A.

**Abstract:** The travel behaviors of older adults often shift as they retire, begin second careers and make residence location choices geared towards aging in place. Those who rely on transit as their primary mode of transportation can face many accessibility and connectivity challenges when traveling to basic amenities due to their unique travel behaviors and declining mobility with advanced age. First chapter of this thesis focuses on a subset of these travel behaviors through a literature review then evaluates the ability of public transportation to meet the specific mobility needs of older adults (defined in three ways: as those adults >65 years of age, >75 and >85). The ability of transit to provide older adults with access to medical facilities is measured using a pair-wise Transit Opportunity Index (TOI), a comprehensive measure of transit accessibility between origin-destination pairs. In particular, this study focuses on assessing whether seniors in various age groups have better or worse access to medical facilities than the general population. This analysis focuses on CT Transit New Haven, a fixed-route bus system operating in New Haven, Connecticut. Although might be varying based on time of day, the results suggest that seniors within the transit service area have better access to medical facilities than the general population in the same area.

Second chapter focuses on access improvement. Equitable access became a concern with passing of non-discrimination requirements specified in Title IV of Civil Rights Act of 1964 and Executive Order 12898 on environmental justice. Increasing need for new methodologies to incorporate equity into network design quickly gained interest of transportation researchers. Although very few methodologies have been developed on the subject, the second chapter builds on available tools on transit network optimization. It develops a frequency setting model for equitable access to medical facilities with respect to elderly population. This research is motivated by findings related to travel characteristics of this particular group, mainly, the time of day of travel and trip purpose. Seniors tend to travel during off peak hours at a rate higher than the rest of the population. Seniors also tend to have a different travel purpose than the rest of the population. Research shows that they make frequent medical trips, along with shopping and running errands all done during off peak hours. Based on the recognition of the need for more frequent service during off peak hours to accommodate the needs of increasing population of seniors' worldwide, a frequency setting model is applied to the transit network for the City of New Haven, Connecticut. The model is tested on two demand scenarios: a base case in which all demand is treated equally, and a scenario in which a population weight factor is included in the objective function to prioritize the demand of protected populations. Results show improved access by shifting bus frequency to routes serving areas with higher population of seniors.

**Subject Areas:** Travel Behavior; Older adults; Transit Opportunity Index (TOI)

**Availability:** Zygo, A., 2017. *Measuring and Improving Seniors' Access to Medical Facilities*. Master's Theses. 1042.

[http://digitalcommons.uconn.edu/gs\\_theses/1042/](http://digitalcommons.uconn.edu/gs_theses/1042/)

**6.20. Title: Reducing Vehicle Travel for the Next Generation: Lessons from the 2001 and 2009 National Household Travel Surveys**

**Authors:** Choi, K., Jiao, J. and Zhang, M.

**Abstract:** In the United States, per capita vehicle miles traveled (VMT) displayed a general declining trend in the new millennium. This paper focuses on identifying the factors that drove the recent VMT trend. Using sample data from the 2001 and 2009 National Household Travel Surveys (NHTS), this study investigated differences in travel patterns by age groups over time and explored factors associated with the recent decrease in per-capita VMT. The study results show that the daily auto mileage and number of auto trips significantly decreased in 2009, although the change was uneven across different age groups. Increased travel by public transit and walking and biking, along with urbanization efforts, partly explained the recent decrease in automobile use. The findings also suggest that population-specific strategies such as improving public transit services for younger people and upgrading walking facilities for the elderly may help reduce automobile travel demand. In addition, applications of information and communication technologies (ICTs) can offer promising alternatives to automobile travel.

**Subject Areas:** Age groups; Automobile travel; Households; Modal shift; Travel patterns; Travel surveys; Vehicle miles of travel

**Availability:** Choi, K., Jiao, J. and Zhang, M., 2017. *Reducing Vehicle Travel for the Next Generation: Lessons from the 2001 and 2009 National Household Travel Surveys*. Journal of Urban Planning and Development, 143(4), p.04017017.

<http://ascelibrary.org/doi/abs/10.1061/%28ASCE%29UP.1943-5444.0000405>

**6.21. Title: What Affects Millennials' Mobility? PART II: The Impact of Residential Location, Individual Preferences and Lifestyles on Young Adults' Travel Behavior in California**

**Authors:** Circella, G., Alemi, F., Tiedeman, K., Berliner, R.M., Lee, Y., Fulton, L., Mokhtarian, P.L. and Handy, S.

**Abstract:** Young adults ('millennials', or members of 'Generation Y') are increasingly reported to have different lifestyles and travel behavior from previous generations at the same stage in life. They postpone the time at which they obtain a driver's license, often choose not to own a car, drive less if they own one, and use alternative non-motorized means of transportation more often. Several explanations have been proposed to explain the behaviors of millennials, including their preference for urban locations closer to the vibrant parts of a city, changes in household composition, and the substitution of travel for work and socializing with telecommuting and social media. However, research in this area has been limited by a lack of comprehensive data on the factors affecting millennials' residential location and travel choices (e.g. information about individual attitudes, lifestyles and adoption of shared mobility is not available in the U.S. National Household Travel Survey and most regional household travel surveys).

**Subject Areas:** Age groups; Automobile travel; Households; Modal shift; Travel patterns; Travel surveys; Vehicle miles of travel

**Availability:** Circella, G., Alemi, F., Tiedeman, K., Berliner, R.M., Lee, Y., Fulton, L., Mokhtarian, P.L. and Handy, S., 2017 *What Affects Millennials' Mobility? PART II: The Impact of Residential Location, Individual Preferences and Lifestyles on Young Adults' Travel Behavior in California*. National Center for Sustainable Transportation. (No. NCST-201703).  
[https://ncst.ucdavis.edu/wp-content/uploads/2015/09/NCST\\_Report\\_Millennials\\_Part\\_II\\_2017\\_March\\_31\\_FINAL.pdf](https://ncst.ucdavis.edu/wp-content/uploads/2015/09/NCST_Report_Millennials_Part_II_2017_March_31_FINAL.pdf)



## **6.22. Title: Changing Travel Behavior of Asian Immigrants in the U.S.**

**Author:** Hu, L.

**Abstract:** Travel of Asian immigrants in the U.S. has rarely been investigated, although their transportation assimilation process could be different from other immigrant groups. This research uses the 2001 and 2009 National Household Travel Survey (NHTS) data to examine how Asian immigrant travel behavior changes over time. Based on cohort analysis and regression analysis, two types of temporal changes are analyzed: The first type of change occurs as immigrants stay in the U.S. for several years, and the second type of change happens in the initial status between the more recent arrivals and those who arrived earlier. Along the first temporal dimension, this research finds travel differences between recent Asian immigrants who have lived in the U.S. for fewer than four years and native-born Asian Americans, but the differences are inconsistent between 2001 and 2009. Meanwhile, established Asian immigrants who have lived in the U.S. for more than four years assimilate into the automobile culture with similar travel patterns as native-born Asian Americans. Along the second temporal dimension, recent immigrants in 2009 do not have greater transportation mobility than recent immigrants in 2001: travel differences between recent immigrants and native-born Asians were smaller in 2001 than in 2009. The results indicate that Asian immigrant travel behavior differs from that of other immigrant groups and shed light on how to improve transportation services for a diverse and multicultural population.

**Subject Areas:** Longitudinal research; Cohort analysis; Commute; Household travel

**Availability:** Hu, L., 2017. *Changing Travel Behavior of Asian Immigrants in the U.S.* Transportation Research Part A: Policy and Practice, 106, pp.248-260.  
<http://www.sciencedirect.com/science/article/pii/S0965856416311612>

**6.23. Title: Travel Patterns and Characteristics of Low-Income Subpopulation in New York State.**

**Authors:** Reuscher, T., Hwang, H.L. and Lim, H.

**Abstract:** Studies have shown that people residing in poverty face more mobility challenges in their daily travels as compared to those living in higher income households. In many cities, the lack of a public transportation systems and investments in low-income areas are making it difficult for those living in poverty to access jobs, goods, and services (schools, groceries, health cares, etc. In this study, Oak Ridge National Laboratory was tasked by the New York State (NYS) Department of Transportation to conduct a detailed examination of the travel behaviors and identify patterns and trends of the low-income residents within NYS. The 2009 National Household Travel Survey data was used as the primary information source to analyze subjects associated with poverty and mobility, as well as to address questions such as are there differences in traveler demographics between the low-income population and those of others who live in various NYS regions (e.g., New York City, other urban areas of NYS)? How do they compare with the population at large (e.g., rest of the country) or with findings from previous years (i.e., trend)? Are there any regional differences (e.g., urban versus rural)? Do any unique travel characteristics or patterns exist within the low-income group? Through this study, various key findings on low-income population sizes, household characteristics, travel patterns, and mobility limitations were identified and summarized in this report.

**Subject Areas:** Public transportation; Poverty; Mobility

**Availability:** Reuscher, T., Hwang, H.L. and Lim, H., 2017. *Travel Patterns and Characteristics of Low-Income Subpopulation in New York State*. (No. ORNL/TM-2017/234). Oak Ridge National Lab.(ORNL), Oak Ridge, TN (United States).

<https://www.osti.gov/scitech/biblio/1407797>

**6.24. Title: The Decline in Active School Transportation (AST): A Systematic Review of the Factors Related to AST and Changes in School Transport Over Time in North America.**

**Authors:** Rothman, L., Macpherson, A.K., Ross, T. and Buliung, R.N.

**Abstract:** Active travel to school has declined during the last 50 years in North America. During the last decade, the children's active school transportation (AST) literature has grown. This systematic review provides an updated examination of AST correlates, and discusses why school travel mode (STM) share may have changed over time. AST trends are described and a systematic literature review of AST correlates in North America for the period 1990-2016 was conducted. Strength of association between correlates and AST, and relationship direction are assessed and reported. Graphical presentation of correlates included in  $\geq 5$  studies were included. Sixty-three studies were identified and reviewed. Distance to school was most strongly associated with AST. Individual, parental and societal correlates had moderate positive associations with AST including: child age, lower parental education, income and other income related factors, race and positive perceptions of AST. Longitudinal studies were few in number, as were studies about exceptional populations, policy, and interventions. AST intervention should focus on key AST correlates. Social and environmental diversity calls for local solutions to school travel challenges. Changes in AST correlates over time should be considered for evaluating existing policy approaches, and to support development of new policy, regulation, design, and program interventions.

**Subject Areas:** Walking; Environment and public health; Schools; Child; City planning; School travel

**Availability:** Rothman, L., Macpherson, A.K., Ross, T. and Buliung, R.N., 2017. *The Decline in Active School Transportation (AST): A Systematic Review of the Factors Related to AST and Changes in School Transport Over Time in North America*. Preventive Medicine. <https://www.sciencedirect.com/science/article/pii/S0091743517304590>

**6.25. Title: A Cross-Sectional Study of Travel Patterns of Older Adults in the USA During 2015: Implications For Mobility and Traffic Safety.**

**Authors:** Shen, S., Koech, W., Feng, J., Rice, T.M. and Zhu, M.

**Abstract:** Background: With an ever increasing population of older adults (65+ years) in the USA, a better understanding of this population's travel patterns is needed to improve travel mobility and transportation safety.

Objective: In this study, we described the travel patterns of older adults in the USA during 2015.

Methods: Travel patterns of older adults (65-74 and 75+ years) were compared with younger adults (25-64 years) by frequency and proportion of daily trips. The daily trips of various age groups were estimated using the 2015 American Time Use Survey. Results The percentage of daily travellers was 88% for adults (25-64 years), 75% for adults (65-74 years) and 68% for adults (75+ years). While the percentage of privately owned vehicle (POV) drivers and average time of driving POVs decreased, the percentage of POV passengers increased as adults aged. Females were less likely to drive POVs and had decreased average daily driving time, but they were more likely to ride in POVs as passengers and had longer average daily riding times than their male counterparts across all age groups. Older adults were more likely to travel in the mornings and early afternoons (from 8:00 to 15:59) while younger adults were more likely to travel in the late afternoons and early evenings (from 16:00 to 19:59).

Conclusions: POV use is the predominant mode of transit in the USA. As adults age, the percentages of daily travellers and POV drivers decrease. This pattern is more apparent among females than males. This study delineated travel patterns of older adults using a 2015 national survey, and the findings facilitate traffic systems designers and policy-makers to develop and implement initiatives to accommodate older adults' mobility needs and improve traffic safety.

**Subject Areas:** Travel patterns; Older adults; Schools; POV

**Availability:** Shen, S., Koech, W., Feng, J., Rice, T.M. and Zhu, M., 2017. *A Cross-Sectional Study of Travel Patterns of Older Adults in the USA During 2015: Implications For Mobility and Traffic Safety*. *BMJ open*, 7(8), p.e015780.

<http://bmjopen.bmj.com/content/7/8/e015780>

**6.26. Title: Characteristics and Travel Patterns of New York Residents: Foreign Born Subpopulations in New York State.**

**Authors:** Chin, S.M., Hwang, H.L., Reuscher, T. and Wilson, D.W.

**Abstract:** According to the 2010 Census, over 22% of total New York State (NYS) residents were foreign-born and over one in three persons living in New York City (NYC) were foreign-born. Foreign-born and their dependents impact local economies in many different ways, including purchasing power, transportation service needs, business sales and receipts generated, and workforce. To allow better policy decision making and program planning of transportation developments and investments in NYS, a clear understanding of the foreign-born population's travel characteristics and behaviors, as well as their unique transportation service needs, are necessary. This report documents the characteristics of the foreign-born population and identified differences in travel behaviors and mobility issues between foreign-born residents of NYS and their U.S.-born counterparts.

**Subject Areas:** Foreign-born; Transportation developments; Travel Patterns;

**Availability:** Chin, S.M., Hwang, H.L., Reuscher, T. and Wilson, D.W., 2017. *Characteristics and Travel Patterns of New York Residents: Foreign Born Subpopulations in New York State*. (No. ORNL/TM-2017/484). Oak Ridge National Lab.(ORNL), Oak Ridge, TN (United States). <http://info.ornl.gov/sites/publications/Files/Pub103168.pdf>

**6.27. Title: (Millennial) Cities of Tomorrow.**

**Authors:** Vinodrai, T., Moos, M. and Pfeiffer, D.

**Abstract:** Book Chapter

**Subject Areas:** Millennial; Travel Patterns

**Availability:** Vinodrai, T., Moos, M. and Pfeiffer, D., 2017. *(Millennial) Cities of Tomorrow*. The Millennial City: Trends, Implications, and Prospects for Urban Planning and Policy, Chapter 20. <https://books.google.com/books?hl=en&lr=&id=nqAvDwAAQBAJ&oi=fnd&pg=PT376&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=ycfzEmS0eq&sig=czNF5I64Nm5GauN3aAWkeaeEwME#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%2C%20NHTS&f=false>

**6.28. Title: Carless or Car Later? Declining Car Ownership of Millennial Households in the Puget Sound Region, Washington State.**

**Authors:** Zhong, L. and Lee, B.

**Abstract:** Driving has been declining since the mid-2000s after six decades of constant growth, and millennials are allegedly leading the trend. This study investigates the decline of car mobility by using vehicle ownership data in the Puget Sound region of Washington State, where transit ridership is increasing faster than in most other large metropolitan areas. Poisson regression and simple simulation results show that millennial-specific impacts such as changing location and mobility preferences were associated with about 15% to 32% of the reduction in car ownership by young adults between 2002 and 2014; this impact is comparable to the effect of sociodemographic shifts (20% to 28%) and the impact of lowering income and employment (16% to 24%). The combination of the increasing influence of urban form and the increasing share of young adults living in compact neighborhoods was associated with the remaining 6% to 7% of the change. These findings suggest that declining car mobility observed in the past decade or so is likely to persist in coming decades, and the trend will be reinforced where smart growth policies to make more livable and sustainable cities receive further momentum.

**Subject Areas:** Millennial; Declining car mobility; Compact Neighborhood

**Availability:** Zhong, L. and Lee, B., 2017. *Carless or Car Later? Declining Car Ownership of Millennial Households in the Puget Sound Region, Washington State*. Transportation Research Record: Journal of the Transportation Research Board, (2664), pp.69-78.  
<http://trjjournalonline.trb.org/doi/abs/10.3141/2664-08>

**6.29. Title: Urban Revival in America, 2000 to 2010.**

**Authors:** Couture, V. and Handbury, J.

**Abstract:** This paper documents and explains the striking rise in the proclivity of college-educated individuals to reside near city centers. We show that this recent urban revival is driven entirely by younger cohorts in larger cities. With a residential choice model, we quantify the role of jobs, amenities, and house prices in explaining this trend. We find that changing preferences of young college graduates for non-tradable service amenities like restaurants, bars, gyms, and personal services account for more than 50 percent of their growth near city centers. Complementary datasets confirm that the young and college-educated are indeed spending more on and taking more trips to non-tradable service establishments. Our investigation into the causes of rising preferences for non-tradable services highlights their expanding role in generating socializing opportunities with other young college graduates, but also indicates roles played by delayed family formation, rising incomes, and improvements in the quality and diversity of non-tradable services.

**Subject Areas:** College-educated individuals; Residential choice model; Trips to non-tradable service

**Availability:** Couture, V. and Handbury, J., 2017. *Urban Revival in America, 2000 to 2010*. No. w24084). National Bureau of Economic Research.  
<http://www.nber.org/papers/w24084>



**6.30. Title: Tired of Commuting? Relationships among Journeys to School, Sleep, and Exercise among American Teenagers**

**Authors:** Voulgaris, C.T., Smart, M.J. and Taylor, B.D.

**Abstract:** Public education policies that aim to improve educational outcomes can have the effect of increasing the distance that many students must travel to attend school. In this article, we use American Time Use Survey data to examine whether longer school commutes influence time spent on important health-promoting activities. We find school commute time to be strongly inversely related to time spent sleeping, and negatively related to time spent exercising for those with long commutes. Thus, increasing journey to school distances may have troubling public health implications for teens.

**Subject Areas:** Transportation; Neighborhood Planning; Public Health; Education; American teens

**Availability:** Voulgaris, C.T., Smart, M.J. and Taylor, B.D., 2017. *Tired of Commuting? Relationships among Journeys to School, Sleep, and Exercise among American Teenagers* Journal of Planning Education and Research, p.0739456X17725148.

<http://journals.sagepub.com/doi/abs/10.1177/0739456X17725148>

**6.31. Title: Does Transport Accessibility Increase Travel in Older Age? Analyzing Travel For Discretionary and Non-Discretionary Purposes in Aging Canadians**

**Authors:** Bezirgani, A. and Lachapelle, U.

**Abstract:** Travel in aging individuals has been declining, but it is important for social inclusion and subjective well-being. The present study analyzed times spent traveling, and factors associated with travel for discretionary and non-discretionary purposes in older adults. The Canadian General Social Survey (2010) provided representative data on socio-demographics, transport accessibility, participation in travel and time traveled on a surveyed day in Canadians aged 60 years old or older (n = 4765). Binary dependent variables of participation in maintenance, leisure time, and socializing activities were assessed with three logistic regressions. Independent variables included age, gender, marital status, retirement status, access to transport measures and activity impairments. While a high proportion of individuals did not travel for discretionary purposes, travel times for those traveling hovered near an hour for each purpose studied. Age, being retired from work and access to transport repeatedly explained differences in travel across all three purposes. While the odds ratio of traveling decreased with progressive age, they increased when individuals had access to transport. Being retired increased travel for leisure, and decreased travel for maintenance purposes. Activity impairments reduced travel for maintenance purposes. Results confirm that the older one gets, they engage in progressively less travel. Travel is even likelier to decrease in individuals who are retired, who have limited access to transport, and who have activity impairments. Evidence-based transport planning should consider declining travel as a decisive indicator for social exclusion and especially non-discretionary travel as a rising challenge for social disadvantage in aging adults.

**Subject Areas:** Older adults; Travel; Public Health; Discretionary and non-discretionary purposes

**Availability:** Bezirgani, A. and Lachapelle, U., 2017. *Does Transport Accessibility Increase Travel in Older Age? Analyzing Travel For Discretionary and Non-Discretionary Purposes in Aging Canadians* Transportation Research Board 97<sup>th</sup> Annual Meeting.  
<http://www.archipel.uqam.ca/10718/>

### **6.32. Title: What drives Sustainable Student Travel? Mode Choice Determinants in the Greater Toronto Area**

**Authors:** Moniruzzaman, M. and Farber, S.

**Abstract:** Examination of mode choice behavior is an important step in accurately predicting future travel demand. Despite having somewhat unique travel needs and challenges, there is a lack of knowledge in understanding the mode use behavior of university student population. The existing studies on university populations relied on a relatively smaller sample in investigating the behavior. Therefore, using world's largest university student's travel database, this study examines the factors affecting the mode choice behavior of a diverse university student population with student samples from four universities and their seven campuses located across the Greater Toronto Area (GTA) in Canada. Additionally, stratifying this diverse population using their attitudinal responses towards numerous travel modes, this study also estimates three additional mode choice models to obtain a more comprehensive understanding of how students in different markets, with different latent attitudes towards transportation, vary in terms of sustainable mode choice. A cluster analysis based on fourteen attitudinal responses, was conducted to stratify the sample whereas the popular multinomial logit approach was used to estimate the mode choice models. This study finds transit pass and bike ownership as important determinants that govern sustainable mode choice among the students in the region. The findings of this study could facilitate the sustainability offices at the four universities in making an informed policy decision in shifting the mode use behavior of students towards sustainable modes.

**Subject Areas:** Mode choice; Modelling; Stratification; Travel behavior; University students

**Availability:** Moniruzzaman, M. and Farber, S., 2017. *What drives Sustainable Student Travel? Mode Choice Determinants in the Greater Toronto Area* International Journal of Sustainable Transportation.

<http://www.tandfonline.com/doi/abs/10.1080/15568318.2017.1377326>

### **6.33. Title: Transportation, Accessibility, and Accommodation in Rural Communities**

**Authors:** McDaniels B.W., Harley D.A., Beach D.T.

**Abstract:** Lack of transportation is an intransigent problem in rural, frontier, and territory communities. As a result, individuals have limited access to services adversely affecting health and quality of life while limiting opportunities for community engagement, participation, and employment. Moreover, adults with disabilities are more likely than those without disabilities to have inadequate access to transportation. This chapter presents general and specific transportation barriers to underscore the necessity for developing innovative ways to respond to an ineffective transportation infrastructure and disparities in access in rural communities. A review of federal transportation policy is presented, and we describe effective strategies for collaboration between local, state, and federal transportation agencies and private companies to remove unnecessary transportation impediments for persons with disabilities in rural, frontier, and territory communities.

**Subject Areas:** Accessibility; Accommodation; Disability; Rural Transportation

**Availability:** McDaniels B.W., Harley D.A., Beach D.T., 2018. *Transportation, Accessibility, and Accommodation in Rural Communities* Harley D., Ysasi N., Bishop M., Fleming A. (eds) Disability and Vocational Rehabilitation in Rural Settings. Springer, Cham  
[https://link.springer.com/chapter/10.1007/978-3-319-64786-9\\_3#citeas](https://link.springer.com/chapter/10.1007/978-3-319-64786-9_3#citeas)

**6.34. Title: Coping with the Costs Of Car Dependency: A System Of Expedients Used By Low-Income Households On the Outskirts Of Dijon and Paris**

**Authors:** Chevallier, L.B., Motte-Baumvol, B., Fol, S. and Jouffe, Y.

**Abstract:** Living on low incomes and in a car-dependent area is often interpreted as a double burden for households, even if the two characteristics are often interdependent. While their capacity for mobility is lower, low-income households in outer suburban areas are nonetheless mobile. Their capacities in this domain should not be underestimated or overlooked. They can command a set of alternative practices or expedients to deal with car-related economic stress by a set of resources derived essentially from spatial proximity. This article aims to present and analyse the diversity of these expedients for the case of outer suburban areas around Paris and Dijon. The analysis of mobility adjustments by low-income households is based on interviews of 45 households in 2011.

Our results show that mobility expedients make it possible for low-income households to continue to reside in car-dependent areas by reducing their trips and by using local resources and networks to lower the costs of their car dependency. The contribution of our work is to show the intensity of these practices, which create a structured and collectively or socially built alternative system to solo car use.

**Subject Areas:** Car dependency; Low-income households; Daily mobility; Expedients

**Availability:** Chevallier, L.B., Motte-Baumvol, B., Fol, S. and Jouffe, Y., 2017. *Coping with the Costs Of Car Dependency: A System Of Expedients Used By Low-Income Households On the Outskirts Of Dijon and Paris* Transport Policy.

<https://www.sciencedirect.com/science/article/pii/S0967070X17304213>

### **6.35. Title: Uber for Seniors? Exploring Transportation Options for the Future**

**Authors:** Leistner, D.L. and Steiner, R.L.

**Abstract:** By 2030, the number of adults 65 and older in the United States will surpass 72 million, almost doubling the number in 2010. This population continues to rely on automobiles to satisfy transportation needs; however, with the onset of aging, physical, cognitive, and motor abilities decline and affect those people's ability to drive and their level of mobility and independence. Lack of mobility and accessibility affect the quality of life and the ability to age in place and could lead to social isolation and a reduction in activity level. The shift to transit is often difficult because of a lack of familiarity and accessibility. Dynamic ridesharing is surging as a viable transportation alternative. This study investigated a unique integration of a dynamic ridesharing system into a local government transportation portfolio to satisfy the mobility needs of older adults by subsidizing the cost of trips on the basis of income level. Over a 9-month period, 40 older adults enrolled in the program. Older women constituted 83% of the people enrolled and were less likely to discontinue use. The majority of trips over the first 6 months were for social purposes, followed by shopping and medical purposes. Fear of driver variability did not seem to affect the level of use. The use of dynamic ridesharing seems to be a feasible low-cost transportation alternative to meet the transportation challenges of older adults and may have policy implications for the future of public transportation systems. Enhanced levels of outreach and training could lead to higher enrollment.

**Subject Areas:** Ridesharing; Older adults; Shift to Transit

**Availability:** Leistner, D.L. and Steiner, R.L., 2017. *Uber for Seniors? Exploring Transportation Options for the Future* Transportation Research Record: Journal of the Transportation Research Board, (2660), pp.22-29.

<http://trrjournalonline.trb.org/doi/abs/10.3141/2660-04>

**6.36. Title: Formal Alternative Transportation Options for Older Adults: An Assessment of Need**

**Authors:** Turner, J.J., Adams-Price, C.E. and Strawderman, L.

**Abstract:** This study measured the need for formal alternative modes of transportation among older adults by applying traditional factors of the Behavioral Model. Survey participants who regularly drove were compared to those who could no longer drive. Race/ethnicity and self-reported health were significant predictors of perceived need for transportation services for both groups. However, income and service awareness were significant predictors only for drivers, while family proximity was a significant predictor only for non-drivers. Results suggest the importance of gaining a better understanding of the factors associated with need for senior-focused transportation services to more effectively plan such programs.

**Subject Areas:** Older adults; Transportation; Perceived need; Behavioral model

**Availability:** Turner, J.J., Adams-Price, C.E. and Strawderman, L., 2017. *Formal Alternative Transportation Options for Older Adults: An Assessment of Need*. Journal of gerontological social work, pp.1-28.

<http://www.tandfonline.com/doi/abs/10.1080/01634372.2017.1375590>

**6.37. Title: Factors Influencing Travel Mode Choice among Families With Young Children (aged 0-4): A Review of the Literature**

**Authors:** McCarthy, L., Delbosc, A., Currie, G. and Molloy, A.

**Abstract:** Life events, such as the birth of a child, disrupt habitual travel behaviour provide a valuable opportunity to influence the adoption of sustainable transport practices. However, in order for sustainable travel practices to be adopted, an understanding is required of the factors that influence travel mode choice among families with young children. Research in this field is particularly timely given many in the millennial generation, a comparably large cohort, are approaching this life stage. This comprehensive literature review develops a framework of factors influencing travel mode choice among families with young children. The findings reveal a multitude of factors influence decisions about mode choice, and, in particular, encourage travel by car, when travelling with young children. The paper concludes with an agenda for future research about travel among families with young children, a largely overlooked group of transport users.

**Subject Areas:** Young children's travel; Travel behaviour change; Life events; ParenthoodD; Car dependence; Public transport

**Availability:** McCarthy, L., Delbosc, A., Currie, G. and Molloy, A., 2017. *Factors Influencing Travel Mode Choice among Families With Young Children (aged 0-4): A Review of the Literature*. *Transport Reviews*, 37(6), pp.767-781.

<http://www.tandfonline.com/doi/abs/10.1080/01441647.2017.1354942>



### **6.38. Title: Students Social Based Mobility Model for MANET-DTN Networks**

**Authors:** Hrabčák, D., Matis, M. and Papaj, J.

**Abstract:** In the real world, wireless mobile devices are carried by humans. For this reason, it is useful if mobility models as simulation tools used to test routing protocols and other MANET-DTN features follow the behaviour of humans. In this paper, we propose a new social based mobility model called Students Social Based Mobility Model (SSBMM). This mobility model is inspired by the daily routine of student's life. Since many current social based mobility models give nodes freedom in terms of movement according to social feeling and attractivity to other nodes or places, we focus more on the mandatory part of our life, such as going to work and school. In the case of students, this mandatory part of their life is studying in university according to their schedule. In their free time, they move and behave according to attractivity to other nodes or places of their origin. Finally, proposed SSBMM was tested and verified by Tools for Evaluation of Social Relation in Mobility Models and compared with random based mobility models. At the end, SSBMM was simulated to examine the impact of social relations on routing protocols.

**Subject Areas:** Social Based Mobility Model (SSBMM); Students; Tools for Evaluation of Social Relation; Mobility Models

**Availability:** Hrabčák, D., Matis, M. and Papaj, J., 2017. *Students Social Based Mobility Model for MANET-DTN Networks*. Mobile Information Systems.  
<https://www.hindawi.com/journals/misy/2017/2714595/abs/>

### **6.39. Title: The Rising Value of Time and the Origin of Urban Gentrification**

**Author:** Su, Y.

**Abstract:** In the past three decades, American central city neighborhoods have experienced an influx of high-income, highly skilled residents and an exodus of low-income, low-skilled residents. This gentrification of central city neighborhoods has reversed decades of decline in urban centers. In this paper, I test the hypothesis that an important driving force behind gentrification is the rise in the value of highly skilled workers' time. To perform the test, I estimate a spatial equilibrium model of neighborhood choice. In the model, workers choose the neighborhood in which they live based on their value of time, commute times, rents, and amenities. I measure the differential growth in the value of time for each occupation by analyzing changes in the cross-sectional relationship between residual earnings and hours worked in Census data. My empirical strategy exploits the variation in the spatial distribution of jobs in different occupations. This allows me to separate the demand for shorter commute times from the demand for local amenities. I find that workers in occupations that experience greater growth in the value of time are more likely to locate in neighborhoods with shorter commute times. The initial shock to demand for central city housing by high-skilled workers creates endogenous amenity improvement in the affected neighborhoods, which furthers gentrification because additional high-skilled workers are attracted by the improved amenities. While the estimates of my model indicate that changes in the value of time are likely an important driving force behind gentrification, the effects are substantially magnified by endogenous amenity improvement. The estimates also imply that the welfare gap between high- and low-skilled workers (which takes into account not just earnings but also the value of time, rents, and amenities) has grown more than the earnings gap between high- and low-skilled workers.

**Subject Areas:** Gentrification; Commute time; Worker's travel behavior

**Availability:** Su, Y., 2017. *The Rising Value of Time and the Origin of Urban Gentrification*. Stanford University.

[http://web.stanford.edu/~suyichen/jmp\\_yichensu.pdf](http://web.stanford.edu/~suyichen/jmp_yichensu.pdf)

**6.40. Title: A Dynamic Field: Transportation for Older Adults Who Don't Drive**

**Authors:** Walker, E.T. and Miedzianowski, S.

**Abstract:** Alternate transportation that is easily available, affordable and reliable helps older adults who stop driving keep their independence and quality of life.

**Subject Areas:** Older adults; Alternate transport; Mobility management

**Availability:** Walker, E.T. and Miedzianowski, S., 2017. *A Dynamic Field: Transportation for Older Adults Who Don't Drive*. CSA Journal (1)68.

[http://c.ymcdn.com/sites/www.csa.us/resource/resmgr/docs/journals/journal\\_68/Author/Erika-Walker.pdf](http://c.ymcdn.com/sites/www.csa.us/resource/resmgr/docs/journals/journal_68/Author/Erika-Walker.pdf)

**6.41. Title: How will Millennials Impact Freight Flows in Texas?**

**Author:** Overmyer, S.

**Abstract:** NA

**Subject Areas:** Millennials; Freight; Consumer behavior; Online Shopping

**Availability:** Overmyer, S., 2017. *How will Millennials Impact Freight Flows in Texas?* Final Report, PRC 16-63F, Texas A&M Transportation Institute.

<https://ntl.bts.gov/lib/62000/62300/62376/PRC-16-63-F.pdf>

**6.42. Title: Would Congestion Pricing Harm the Poor? Do Free Roads Help the Poor?**

**Authors:** Manville, M. and Goldman, E.

**Abstract:** Congestion pricing could reduce urban congestion, but might disproportionately benefit the affluent and burden the poor. We show that this common concern also applies to free roads. Free urban highways primarily subsidize richer people, and the resulting congestion creates pollution that disproportionately burdens poorer people. Furthermore, the poor drivers burdened by peak-hour road pricing would be a small minority of total peak-hour drivers and a minority of the poor. These facts suggest that the revenue generated by pricing could compensate any poor drivers harmed. Free roads, in contrast, generate no revenue to compensate the people they harm.

**Subject Areas:** Congestion; Poor; Mobility

**Availability:** Manville, M. and Goldman, E., 2017. *Would Congestion Pricing Harm the Poor? Do Free Roads Help the Poor?* Journal of Planning Education and Research, p.0739456X17696944. <http://journals.sagepub.com/doi/abs/10.1177/0739456X17696944>

## 7. Survey, Data Synthesis, and Other Applications

### 7.1. Title: Applying Geographic-Based Demographic Targeting in Household Travel Survey Sampling Plans: Case Study from the Phoenix, Arizona Region

**Authors:** Selby, B., Komanduri, A., Brown, E. and Livshits, V.

**Abstract:** Response rates in household travel surveys are declining nationwide, yet data requirements to support model estimation continue to become more complex - especially in areas that are migrating to activity-based models (ABM). Segments with complex travel behaviors, such as transit users, large households, auto-deficient households, increasingly need to be oversampled to support ABM frameworks. In response, a slew of operational improvements have been considered, including higher incentives, use of new technology, relational databases that minimize respondent burden, and design of questionnaires that only focus on the most needed information. However, there has been limited focus to-date in the US on the development of more fine-grained sampling plans, and on the ways to refine sample purchase that could help stratify the geographic area and identify the concentration of key markets of interest. The authors showcase a sampling plan that builds on the best practices of geography-based sampling and introduces two new concepts: the use of demographics/groups of interest and the use of non-contiguous boundaries to help enhance survey efforts. This method employs oversampling and block-group based monitoring integrated into the survey plan. The objective is efficiency in getting sufficient representation of hard-to-reach or low responding populations as well as supplying models with enough information on the choices of those with more complex behavioral patterns or choices.

**Subject Areas:** Household travel survey; Sampling plan; Household demographics; hard-to-reach populations; Address-based Sampling

**Availability:** Selby, B., Komanduri, A., Brown, E. and Livshits, V., 2017. *Applying Geographic-Based Demographic Targeting in Household Travel Survey Sampling Plans: Case Study from the Phoenix, Arizona Region*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-04635). <http://docs.trb.org/prp/17-04635.pdf>

**7.2. Title: Measuring the Spatial Dimension of Automobile Ownership and Its Associations with Household Characteristics and Land Use Patterns: A Case Study in Three Counties, South Florida (USA)**

**Authors:** Song, J. and Wang, R.

**Abstract:** Motorization and increased levels of car ownership have partly contributed to traffic congestion and air pollution, which is a prime concern in the era of climate change. Therefore, vehicle ownership-related topics have been extensively explored by transportation scholars, economists, and planning researchers. However, relatively fewer scientists have investigated the spatial patterns and socioeconomic factors of car ownership simultaneously within a large geographic scale. Thus, the goal of this article is to illuminate how high levels of auto ownership may cluster spatially and what factors relate to such phenomena by developing an integrative framework and applying it in three counties in South Florida (US). Specifically, this study first evaluated whether vehicle ownership is spatially autocorrelated using Global and Local Moran's I statistics. It then justified significant factors associated with car ownership by employing Poisson and Corrected Poisson regression models. The findings, using raw data, show that there exist locally spatial clusters of the households with high levels of automobile ownership, while globally the patterns of auto ownership are statistically random. Furthermore, the results suggest that the number of drivers, the number of workers, household income level, housing tenure, the proximity to schools, and net house density significantly influence car ownership levels. The results can assist urban planners and local governments in developing planning schemes that aim at transit, cycling, walking, and other non-motorized travel modes, thereby furthering environmentally friendly communities.

**Subject Areas:** Number of Cars; Autocorrelation; Spatial Distribution; Regression; Automobile; Metropolitan Region

**Availability:** Song, J. and Wang, R., 2017. *Measuring the Spatial Dimension of Automobile Ownership and Its Associations with Household Characteristics and Land Use Patterns: A Case Study in Three Counties, South Florida (USA)*. *Sustainability*, 9(4), p.558.  
<http://www.mdpi.com/2071-1050/9/4/558/htm>

### **7.3. Title: Testing Spatial Transferability of Activity-Based Travel Forecasting Models**

**Authors:** Bowman, J.L. and Bradley, M.

**Abstract:** This paper reports results from the second phase of a two-phase FHWA-sponsored project to empirically test and demonstrate the transferability of activity-based (AB) model systems between regions. Using data obtained through the 2008-2009 National Household Travel Survey “add-on” program, the principal investigators estimated activity-based models simultaneously for thirteen metropolitan regions in seven U.S. states. Statistical tests were used to test transferability, including tests of regional differences in the model coefficients, likelihood ratio tests of model equivalence, and Transferability Indexes that measure the degree of model differences. In addition, differences in prediction sensitivity between locally estimated and transferred models was tested. The project overall found evidence in favor of transferability, and that parameters associated with land use, log sum accessibilities and travel time and cost cause the biggest problems with transferability. Finally, and the primary focus of this paper, it found that transferring within a state or between regions with similar urban density improves transferability. This paper presents the data, models and testing methods used in the project, followed by details of all tests and results related to the improved transferability associated with model transfers from regions within the same state or with similar urban density. The conclusion is that agencies considering transfer of an AB model from another region would do well to find one within the same state or with similar urban density that has a model well-supported by a large household travel survey data set.

**Subject Areas:** Travel Demand Models; Transferability; Travel Time; Cost; Region

**Availability:** Bowman, J.L. and Bradley, M., 2017. *Testing Spatial Transferability of Activity-Based Travel Forecasting Models*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-02964).

<http://docs.trb.org/prp/17-02964.pdf>



#### **7.4. Title: Regional Differences in the Determinants of Oregon VMT**

**Authors:** Ke, Y. and McMullen, B.S.

**Abstract:** Road user charges (RUCs) in the form of per mile charges have been suggested as an alternative to fuel taxes to help keep up with the costs of maintaining and expanding public road systems. The success of a RUC in providing for the long term stability of highway finance depends partly on how drivers respond to changes in the tax structure and also other determinants of driving behavior. Region specific characteristics, such as public transit accessibility and biking infrastructure, may also affect vehicle miles traveled (VMT) demand. This paper uses econometric techniques to examine the determinants of VMT using data from the Oregon Household Activities Survey (OHAS). We use standard OLS regression to examine the impact of urban density, household income, fuel cost, transit mileage, household location, and additional household characteristics on VMT. Preliminary results show that statewide Oregon demand for VMT is positively and significantly impacted by household income. Statewide, fuel price, transit use and population density are all found to be statistically significant and negatively related to household VMT. However, at the regional level some of these variables lose significance. Holding all factors constant, household VMT is found to differ by region as well as by population density.

**Subject Areas:** VMT Determinants; Road Use Charge; Location Type

**Availability:** Ke, Y. and McMullen, B.S., 2017. *Regional Differences in the Determinants of Oregon VMT*. Research in Transportation Economics.  
<http://www.sciencedirect.com/science/article/pii/S0739885917300422>

**7.5. Title: A Practical Method to Test the Validity of the Standard Gumbel Distribution in Logit-Based Multinomial Choice Models of Human Travel Behavior**

**Authors:** Ye, X., Garikapati, V.M., You, D. and Pendyala, R.M.

**Abstract:** Most multinomial choice models, particularly in practice (e.g., multinomial logit model), assume an extreme-value Gumbel distribution for the random components of utility functions. The use of this distribution offers a closed-form likelihood expression when the utility maximization principle is applied to model choice behaviors. The maximum likelihood estimation method can be easily applied to estimate model coefficients. However, maximum likelihood estimators are consistent and efficient only if distributional assumptions on the random error terms are valid. It is therefore important to test the validity of underlying distributional assumptions that form the basis of parameter estimation and policy evaluation. In this paper, a practical but strict method is proposed to test the distributional assumption of the random component of utility functions in both the multinomial logit (MNL) model and multiple discrete-continuous extreme value (MDCEV) model. Based on a semi-nonparametric approach, a closed-form likelihood function that nests the MNL or MDCEV model being tested is derived. Then, the traditional likelihood ratio test can be applied to test violations of the standard Gumbel distribution assumption. Simulation experiments are conducted to show that the test yields acceptable Type-I and Type-II error probabilities at commonly available sample sizes. The test is then applied to three real-world discrete and discrete-continuous choice models. For all three models, the proposed test rejects the validity of the standard Gumbel distribution in most utility functions, calling for the development of approaches that overcome adverse effects of violations of distributional assumptions.

**Subject Areas:** Travel Behavior Models; Discrete Choice Models; Test of Validity of Distributional Assumption; Multinomial Logit Model; Multiple Discrete-Continuous Extreme Value Model

**Availability:** Ye, X., Garikapati, V.M., You, D. and Pendyala, R.M., 2017. *A Practical Method to Test the Validity of the Standard Gumbel Distribution in Logit-Based Multinomial Choice Models of Human Travel Behavior*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-05407). <http://docs.trb.org/prp/17-05407.pdf>

## **7.6. Title: Long-Term Impacts of the Universal Helmet Law Changes on Motorcyclist Fatal Crashes: Comparison Group and Empirical Bayes Approaches**

**Authors:** Lee, J., Abdel-Aty, M., Wang, J.H. and Lee, C.

**Abstract:** A motorcyclist helmet is considered a very important safety equipment as it prevents or minimizes head and brain injuries which are often fatal. Hence, most of the states in the United States have enacted a law requiring all motorcyclists to wear helmets in the 1960s and 1970s, which is also known as the universal helmet law. Many researchers have examined the impact of the helmet law changes by far using before-and-after study, and found that repealing the law has a negative effect on motorcyclists. In this study, the authors have attempted to explore the long-term impacts of repeal and reinstatement of the universal helmet law using 13 to 16 years-data. A before-and-after study with comparison group and Empirical Bayes (EB) methods were adopted to account for the passage of time and its effect on other factors such as exposure, maturation, trend, and regression- to-the-mean bias. A range of safety performance functions were developed based on counties and calculated the expected motorcycle fatal crashes. The results showed that the universal helmet law repeal still has significant effects on motorcycle fatal crash counts even 7-12 years after the universal helmet law repeal. The crash modification factors showed that the UHL repeal has increased the number of motorcycle fatal crashes by 15% to 41% whereas the UHL reinstatement has decreased it by 21% to 27%. It is expected that the results from this study could be helpful for states' policy makers to clearly understand the effects of the UHL on reducing motorcycle fatal crashes.

**Subject Areas:** Motorcycle Safety; Motorcycle Helmet-Use; Before- And-After Study With Empirical Bayes Method; Transportation Policy

**Availability:** Lee, J., Abdel-Aty, M., Wang, J.H. and Lee, C., 2017. *Long-Term Impacts of the Universal Helmet Law Changes on Motorcyclist Fatal Crashes: Comparison Group and Empirical Bayes Approaches*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No.17-00917). <http://docs.trb.org/prp/17-00917.pdf>

**7.7. Title: Incorporating Activity Space and Trip Chaining onto Facility Siting for Accessibility Maximization**

**Authors:** Li, R. and Tong, D.

**Abstract:** Location models have been widely used to support locational decisions for various service provision. One common objective of location models has been to ensure maximal accessibility of sited facilities to demand populations. Accessibility evaluation in location models often assumes that trips originate from fixed locations (usually home) and are single purpose. These assumptions contradict the empirical evidence that suggests trips also commonly originate from non-home locations and may involve multiple stops. In this study, a new multi-objective location model is developed that extends the classic p-median problem (PMP) to account for a more realistic assessment of accessibility. Based on the individual accessibility assessment, notions of trip chaining and activity space are incorporated into the model development. In addition to fixed home locations, stops along chained trips are allowed for potential service site visits, and activity space is introduced as an additional dimension to evaluate accessibility of alternative opportunities. The effectiveness of the new model is demonstrated using an application in Tucson, AZ.

**Subject Areas:** Location modeling; Accessibility; Activity space; GIS

**Availability:** Li, R. and Tong, D., 2017. *Incorporating Activity Space and Trip Chaining onto Facility Siting for Accessibility Maximization*. Socio-Economic Planning Sciences.  
<http://www.sciencedirect.com/science/article/pii/S0038012116301215>

## 7.8. Title: A Walk Trip Generation Model for Portland, OR

**Authors:** Tian, G. and Ewing, R.

**Abstract:** This study proposes a home-based walk trip generation model, based on the built environment around households, controlling for sociodemographic influences. Two-stage hurdle models are estimated based on a household travel survey in Portland, Oregon. The first stage predicts the probability of households making any home-based walk trips. The second stage predicts the number of home-based walk trips for the subset of households that make such trips. The study also tests built environment variables for three different buffer widths around household locations to see which scale best explains walking behavior. The results show that sociodemographic characteristics are strong predictors of walk trip generation. Specifically, household size, income, and number of workers in the household influence the probability of a household having any walk trips, while household size and number of children in the household affect the number of walk trips made by the subset of households making walk trips. Characteristics of the built environment are also significant. Activity density, transit stop density, employment accessibility, intersection density, and most interestingly, sidewalk quality are associated with the decision to walk as a mode of travel, while land-use entropy, transit stop density, employment accessibility, sidewalk quality, and traffic calming and signal are predictors of the number of walk trips made by households making walk trips. Sidewalk quality is represented by a single principal component that neatly captures the common variance in an array of sidewalk variables. To our knowledge, this is the first walk trip generation model to include a measure of sidewalk quality.

**Subject Areas:** Walk; Trip generation; D variables; Street quality; Hurdle model

**Availability:** Tian, G. and Ewing, R., 2017. *A Walk Trip Generation Model for Portland, OR*. *Transportation Research Part D: Transport and Environment*, 52, pp.340-353.

<http://www.sciencedirect.com/science/article/pii/S1361920917302328>

**7.9. Title: Commute Mode Diversity and Public Health: A Multivariate Analysis of 148 U.S. Cities**

**Authors:** Frederick, C., Riggs, W. and Gilderbloom, J.H.

**Abstract:** Urban sprawl has a negative relationship with regional health outcomes, such as high obesity and chronic diseases related to physical inactivity. At the same time, literature has shown that walkable built environments are connected to lower obesity rates and decreased physical activity. Less understood is the association of modal diversity with those health outcomes. This research studies a range of public health outcomes to determine their associations with commute mode diversity. Researchers adapted the methodology of urban sociologists Harvey Molotch and Richard Appelbaum to explore twelve different health measures in 148 U.S. counties and their metropolitan statistical areas. The test measure is the percentage of commuters who use some means other than a single-occupant vehicle. The percentage of such commuters ranges from a low of 11% in Houston County, Alabama to a high of 36% in Honolulu County, Hawaii. Using bivariate and multivariate analysis, we find better health outcomes in counties and metropolitan areas that have fewer workers commuting by single-occupant vehicle. These findings underscore the positive impact of sustainable transportation policies on community health and open up a new direction for public health research and the built environment.

**Subject Areas:** Modal Diversity; Sustainable Urban Development; Public Health; Automobile Dependency

**Availability:** Frederick, C., Riggs, W. and Gilderbloom, J.H., 2017. *Commute Mode Diversity and Public Health: A Multivariate Analysis of 148 U.S. Cities*. International Journal of Sustainable Transportation.

<http://www.tandfonline.com/doi/ref/10.1080/15568318.2017.1321705?scroll=top>

### **7.10. Title: A Microsimulation Model of Population Heat Exposure**

**Authors:** Swarup, S., Gohlke, J.M. and Bohland, J.R

**Abstract:** Exposure to extreme heat is an important cause of morbidity and mortality throughout the world. The elevation of temperatures and increases in extended periods of high temperatures due to climate change means that heat exposure as a health concern will increase. Thus, methodologies that researchers and practitioners can use to assess heat exposure among various population groups will become increasingly important. Human exposure to heat can be measured by wearable sensors and the maintenance of activity logs of a sample of individuals over the course of their daily activities. We introduce an alternative methodology that we believe offers great promise for evaluating heat exposure of the entire population of a city, region or state. Microsimulation modeling of the daily activity patterns of a synthetic population for the state of Alabama demonstrates the efficacy of this approach in measuring “potential” heat exposure, and in evaluating the significance of demographic attributes, in this case household income, that correlate with different exposure levels.

**Subject Areas:** Synthetic population; Heat Exposure

**Availability:** Swarup, S., Gohlke, J.M. and Bohland, J.R., 2017. *A Microsimulation Model of Population Heat Exposure*.

<http://staff.vbi.vt.edu/swarup/papers/abmus2017-heat-exposure-final.pdf>

### 7.11. Title: Surveillance Systems to Track and Evaluate Obesity Prevention Efforts

**Authors:** Hoelscher, D.M., Ranjit, N. and Pèrez, A.

**Abstract:** To address the obesity epidemic, the public health community must develop surveillance systems that capture data at levels through which obesity prevention efforts are conducted. Current systems assess body mass index (BMI), diet, and physical activity behaviors at the individual level, but environmental and policy-related data are often lacking. The goal of this review is to describe US surveillance systems that evaluate obesity prevention efforts within the context of international trends in obesity monitoring, to identify potential data gaps, and to present recommendations to improve the evaluation of population-level initiatives. Our recommendations include adding environmental and policy measures to surveillance efforts with a focus on addressing underserved populations, harmonizing existing surveillance systems, including more sensitive measures of obesity outcomes, and developing a knowledgeable workforce. In addition, the widespread use of electronic health records and new technologies that allow self-quantification of behaviors offers opportunities for innovative surveillance methods.

**Subject Areas:** Population health; Obesity Policy; Surveillance; Evaluating Progress of Obesity Prevention Efforts

**Availability:** Hoelscher, D.M., Ranjit, N. and Pèrez, A., 2017. *Surveillance Systems to Track and Evaluate Obesity Prevention Efforts*. Annual Review of Public Health, (0).

<http://www.annualreviews.org/doi/pdf/10.1146/annurev-publhealth-031816-044537>



## 7.12. Title: A Generative Model of Urban Activities from Cellular Data

**Authors:** Yin, M., Sheehan, M., Feygin, S., Paiement, J.F. and Pozdnoukhov, A.

**Abstract:** Activity based travel demand models are becoming essential tools used in transportation planning and regional development scenario evaluation. They describe travel itineraries of individual travelers, namely what activities they are participating in, when they perform these activities, and how they choose to travel to the activity locales. However, data collection for activity based models is performed through travel surveys that are infrequent, expensive, and reflect the changes in transportation with significant delays. Thanks to the ubiquitous cell phone data, we see an opportunity to substantially complement these surveys with data extracted from network carrier mobile phone usage logs, such as call detail records (CDRs). In this paper, we develop Input-Output Hidden Markov Models (IO-HMMs) to infer travelers' activity patterns from CDRs. We apply the model to the data collected by a major network carrier serving millions of users in the San Francisco Bay Area. Our approach delivers an end-to-end actionable solution to the practitioners in the form of a modular and interpretable activity-based travel demand model. It is experimentally validated with three independent data sources: aggregated statistics from travel surveys, a set of collected ground truth activities, and the results of a traffic micro-simulation informed with the travel plans synthesized from the developed generative model.

**Subject Areas:** Cellular data; Generative models; Activity recognition; Demand forecasting; Activity-based models

**Availability:** Yin, M., Sheehan, M., Feygin, S., Paiement, J.F. and Pozdnoukhov, A., 2017. *A Generative Model of Urban Activities from Cellular Data*. IEEE Transactions in ITS.  
[http://faculty.ce.berkeley.edu/pozdnoukhov/papers/IEEE\\_ITS\\_cellular\\_abm.pdf](http://faculty.ce.berkeley.edu/pozdnoukhov/papers/IEEE_ITS_cellular_abm.pdf)

### 7.13. Title: National Data Sets: How to Choose Them, How to Use Them

**Author:** Weinberger, P.Z.

**Abstract:** The US population is around the 323 million mark today (and grows by 4 a minute). Transportation planners who serve this enormous population are dependent on only two national surveys for the bulk of travel data that informs infrastructure, planning and decision making: 1) The US Census Bureau's ongoing American Community Survey (ACS), from which the Census Transportation Planning Products (CTPP) data is derived, and 2) The USDOT's National Household Travel Survey (NHTS). The ACS asks a series of commute based questions that give a robust picture of the trip to work for the nation. The ACS is based on a sample of about 8 percent of households over five years. The CTPP commissions a customized tabulation of ACS data tailored for transportation planning applications. This data set is used for travel model validation and calibration; an input to the long range plans required of the 408 metropolitan areas and 50 states as a condition of Federal aid. Other uses of the CTPP range from generating demographic profiles to corridor planning to Environmental Justice analysis to trend analysis, including national commute trends detailed in *Commuting in America*. The smaller and more infrequent but more in depth NHTS is a diary based survey that has been collected seven times between 1969 and 2009 with an eighth iteration scheduled for 2016. In 2001, the NHTS collected all household travel from a national core of 26,000 households, with regional add-ons adding 43,000 more households constituting about 0.06% of total US households. In 2009, the core sample remained the same, but the national add-ons totaled nearly 125,000 households, bring the sample to about 0.13% of the total. The CTPP is better suited to assess phenomena in small geographies, while the NHTS captures all trips, not just commute trips. Both data sets are used to inform transportation policy and assess how previous transportation investments have performed. This paper is a comparative analysis of the two data sets; it discusses their methodology and statistical nuances, subjects covered, weaknesses, strengths, and uses. This work is aimed to inform practitioners dealing with large and varied data sets and give some insight into how to evaluate, how to assess, and what types of analyses are appropriate for given data.

**Subject Areas:** Data and Information Technology; Highways; Pedestrians and Bicyclists; Planning and Forecasting; Public Transportation

**Availability:** Weinberger, P.Z., 2016. *National Data Sets: How to Choose Them, How to Use Them*. European Transport Conference 2016, Association for European Transport (AET).  
<https://trid.trb.org/view.aspx?id=1455180>

#### **7.14. Title: Demographic Factors, Workplace Factors and Active Transportation Use in the USA: A Secondary Analysis of 2009 NHTS Data**

**Authors:** Quinn, T.D., Jakicic, J.M., Fertman, C.I. and Gibbs, B.B.

##### **Abstract:**

**Background** While active transportation has health, economic and environmental benefits, participation within the USA is low. The purpose of this study is to examine relationships of demographic and workplace factors with health-enhancing active transportation and commuting.

**Methods:** Participants in the 2009 National Household Travel Survey reported demographics, workplace factors (time/distance to work, flextime availability, option to work from home and work start time) and active transportation (for any purpose) or commuting (to and from work, workers only) as walking or biking ( $\geq 10$  min bouts only). Multiple logistic regression examined cross-sectional relationships between demographics and workplace factors with active transportation and commuting.

**Results:** Among 152,573 participants, active transportation was reported by 1.11% by biking and 11.74% by walking. Among 111,808 working participants, active commuting was reported by 0.80% by biking and 2.76% by walking. Increased odds ( $p < 0.05$ ) of active commuting and transportation were associated with younger age, lower income, urban dwelling, and the highest and lowest education categories. Males had greater odds of commuting and transporting by bike but decreased odds of walk transporting. Inconsistent patterns were observed by race, but whites had greater odds of any biking ( $p < 0.05$ ). Odds of active commuting were higher with a flexible schedule ( $p < 0.001$ ), the option to work from home ( $p < 0.05$ ), shorter time and distance to work (both  $p < 0.001$ ), and work arrival time between 11:00 and 15:59 (walking only,  $p = 0.001$ ).

**Conclusions:** Active transportation differed across demographic and workplace factors. These relationships could inform infrastructure policy decisions and workplace wellness programming targeting increased active transportation.

**Subject Areas:** Demographic factors; Workplace factors; Secondary analysis; Commuting; Transportation

**Availability:** Quinn, T.D., Jakicic, J.M., Fertman, C.I. and Gibbs, B.B., 2016. *Demographic Factors, Workplace Factors and Active Transportation Use in the USA: A Secondary Analysis of 2009 NHTS Data*. J Epidemiol Community Health, pp.jech-2016.

<http://jech.bmj.com/content/early/2016/12/16/jech-2016-207820.short>

### **7.15. Title: Examining Multimodal Transportation in the El Paso, Texas, Region: Regional Transportation Survey Results**

**Authors:** Sener, I.N., Lee, R.J., Simek, C., Sánchez, A. and Aldrete, R.M.

**Abstract:** This paper summarizes a component of a multimodal transportation study conducted for the El Paso Metropolitan Planning Organization of Texas, which included a regional population survey. The El Paso Regional Multimodal Transportation Survey was implemented between September and October 2015, and the study area included all of El Paso County, Texas, and parts of Doña Ana and Otero Counties, New Mexico. The survey specifically examined the behaviors or motivations to use or not to use various modes of transportation, with a particular focus on alternative modes (i.e., walking, bicycling, and using public transportation). As one of the first known regional transportation surveys in the United States, this survey contributed to the emerging area of health and transportation through the integration of several elements of health and well-being. The results indicate that an understanding of regional and population characteristics, as well as behavioral barriers and motivators, is an important first step in the design of effective alternative travel programs and interventions. Several factors, including neighborhood environment variables, personal and social characteristics, and attitudes and habits toward health and transportation, worked together to influence residents' participation in alternative transportation. Although the personal automobile is the dominant travel mode in El Paso, residents saw great value in the extension of public transportation infrastructure in the future. Improvements of connectivity, safety, and the neighborhood environment were found to be particularly essential to encourage walking and bicycling in the region.

**Subject Areas:** Survey results; Alternative modes

**Availability:** Sener, I.N., Lee, R.J., Simek, C., Sánchez, A. and Aldrete, R.M., 2017. *Examining Multimodal Transportation in the El Paso, Texas, Region: Regional Transportation Survey Results*. Transportation Research Record: Journal of the Transportation Research Board, (2654), pp.55-64.

<http://trrjournalonline.trb.org/doi/abs/10.3141/2654-07>

**7.16. Title: The Drive to Work : The Relationship between Transportation Access, Housing Assistance, and Employment among Participants in the Welfare to Work Voucher Program**

**Authors:** Blumenberg, E. and Pierce, G.

**Abstract:** Transportation enables low-income individuals to find and travel to employment. This article analyzes the relationship between access to automobiles and public transit and employment outcomes of low-income households. We use longitudinal survey data from participants in the Welfare to Work Voucher Program, which was conducted in five US metropolitan areas between 1999 and 2005. Multinomial logistic regression shows that baseline access to automobiles has a strong positive relationship to follow-up employment but public transit access and receipt of housing assistance do not. Our findings suggest that enhancing car access will notably improve employment outcomes among very-low-income adults, but other assistance will have, at best, marginal effects.

**Subject Areas:** Multinomial logistic regression; Low-income households; Public-transit access; Employment

**Availability:** Blumenberg, E. and Pierce, G., 2017. *The Drive to Work : The Relationship between Transportation Access, Housing Assistance, and Employment among Participants in the Welfare to Work Voucher Program*. Journal of Planning Education and Research, 37(1), pp.66-82.

<http://journals.sagepub.com/doi/abs/10.1177/0739456X16633501>

**7.17. Title: Two Perspectives on Commuting: A Comparison of Home to Work Flows Across Job-Linked Survey and Administrative Files**

**Authors:** Green, A.S., Kutzbach, M.J. and Vilhuber, L.

**Abstract:** Commuting flows and workplace employment data have a wide constituency of users including urban and regional planners, social science and transportation researchers, and businesses. The U.S. Census Bureau releases two, national data products that give the magnitude and characteristics of home to work flows. The American Community Survey (ACS) tabulates households' responses on employment, workplace, and commuting behavior. The Longitudinal Employer-Household Dynamics (LEHD) program tabulates administrative records on jobs in the LEHD Origin-Destination Employment Statistics (LODES). Design differences across the datasets lead to divergence in a comparable statistic: county-to-county aggregate commute flows. To understand differences in the public use data, this study compares ACS and LEHD source files, using identifying information and probabilistic matching to join person and job records. In our assessment, we compare commuting statistics for job frames linked on person, employment status, employer, and workplace and we identify person and job characteristics as well as design features of the data frames that explain aggregate differences. We find a lower rate of within-county commuting and farther commutes in LODES. We attribute these greater distances to differences in workplace reporting and to uncertainty of establishment assignments in LEHD for workers at multi-unit employers. Minor contributing factors include differences in residence location and ACS workplace edits. The results of this analysis and the data infrastructure developed will support further work to understand and enhance commuting statistics in both datasets.

**Subject Areas:** Work flows; ACS; LEHD

**Availability:** Green, A.S., Kutzbach, M.J. and Vilhuber, L., 2017. *Two Perspectives on Commuting: A Comparison of Home to Work Flows Across Job-Linked Survey and Administrative Files*. Working Paper 17-34, Center for Economic Studies, U.S. Census Bureau.  
<https://ecommons.cornell.edu/handle/1813/50976>

### **7.18. Title: Day Pattern Generation System for Jointly Modeling Tours and Stops: Bi-Level Multiple Discrete Continuous Probit Model**

**Authors:** Enam, A. and Konduri, K.C.

**Abstract:** The primary objective of this study was to contribute to the literature on activity pattern generation. In this paper, a new framework is proposed for simultaneously modeling the following tour and stop-making decisions: the number and purpose of tours conducted in a day, time allocated to different tours, number and purpose of stops conducted within each tour, and time allocated to different stops. The framework represents time as a continuous entity and explicitly considers the time constraints within which an individual operates when generating tours and stops. In addition, the framework is capable of accounting for the interrelationships across different tour- and stop-level decisions. The model formulation that operationalizes the proposed framework imitates a bi-level structure in which the participation (whether to pursue) and time allocation (how much time) decisions for daily tours are modeled at the upper level. Within each tour, participation and time allocation decisions for different stops are modeled at the lower level. The model formulation for the bi-level structure builds on the utility theoretic multiple discrete continuous probit modeling approach. The proposed framework and model formulation are demonstrated with an empirical case study using data from the 2008 - 2009 National Household Travel Survey. Replication and forecasting results are presented to demonstrate the feasibility and applicability of the proposed framework and model formulation. The results provide evidence in support of the bi-level structure and its ability to capture the various constraints and interrelationships across tour- and stop-level participation and time allocation decisions.

**Subject Areas:** Activity pattern generation; Bi-level structure; Time-allocation; Probit modeling approach

**Availability:** Enam, A. and Konduri, K.C., 2017. *Day Pattern Generation System for Jointly Modeling Tours and Stops: Bi-Level Multiple Discrete Continuous Probit Model*. Transportation Research Record: Journal of the Transportation Research Board, (2665), pp.69-79.  
<http://trjournalonline.trb.org/doi/abs/10.3141/2665-08>

**7.19. Title: Designing the All-in-One Vermont Transportation Survey**

**Authors:** Aultman-Hall, L. and Dowds, J.

**Abstract:** Final Report.

**Subject Areas:** Transportation Planning; Travel Diary survey

**Availability:** Aultman-Hall, L. and Dowds, J., 2017. *Designing the All-in-One Vermont Transportation Survey*. Transportation Research Record: TRC Report 17-003, Transportation Research Center, University of Vermont Farrell Hall.

[http://transctr.w3.uvm.edu/wp-content/uploads/2014/03/All-in-One-FinalReport\\_Aultman-Hall-and-Dowds-1.pdf](http://transctr.w3.uvm.edu/wp-content/uploads/2014/03/All-in-One-FinalReport_Aultman-Hall-and-Dowds-1.pdf)



**7.20. Title: Simulation, Numerical Approximation and Closed Forms for Joint Discrete Continuous Models with an Application to Household Vehicle Ownership and Use**

**Authors:** Cirillo, C., Liu, Y. and Tremblay, J.M.

**Abstract:** Integrated models for multiple decision variables, not necessarily from the same family, are becoming possible thanks to the advances in econometrics and in the estimation techniques. Recently, probit type models have been proposed to model joint decisions for the flexibility offered by the multivariate normal to capture correlations across the different dependent variables. Ordered probit models are in general preferred to unordered probit for the saving in computational costs deriving from the closed mathematical form of the choice probabilities. In this study, we compare results obtained from unordered probit models estimated with simulation and numerical computation to those obtained from ordered discrete-continuous probit. The analysis is performed on household decisions concerning vehicle holding and mileage travelled and using data extracted from the 2009 National Household Travel Survey. Estimation results show that discrete-continuous unordered probit are superior to ordered structures in terms of goodness of fit, but produce comparable results when applied to predict behavioral changes. Model applications for policy analysis also reveal that income and density only affects marginally vehicle holding decisions and annual miles driven, while driving cost has a more significant effect on annual household mileage.

**Subject Areas:** Discrete-continuous model; Ordered mechanism; Unordered mechanism; Vehicle ownership; Vehicle miles travelled

**Availability:** Cirillo, C., Liu, Y. and Tremblay, J.M., 2017. *Simulation, Numerical Approximation and Closed Forms for Joint Discrete Continuous Models with an Application to Household Vehicle Ownership and Use*. *Transportation*, 44(5), pp.1105-1125.

<https://link.springer.com/article/10.1007/s11116-016-9696-4>

### **7.21. Title: Use of Smartphone Panels for Viable and Cost-Effective GPS Data Collection for Small and Medium Planning Agencies**

**Authors:** Flake, L., Lee, M., Hathaway, K. and Greene, E.

**Abstract:** Historically, small and medium-sized metropolitan planning organizations (MPOs) have been at a disadvantage when investing in new technologies to aid in the collection of household travel data, primarily because of funding limitations. One such new technology is GPS data collection via smartphone, which provides benefits in data quality compared with traditional methods. While state and large metropolitan planning agencies have begun fielding household travel studies primarily using GPS data collection, smaller MPOs may be reluctant to incur the associated costs. However, improvements in mobile data collection, specifically use of personal smartphones, create opportunities for MPOs to benefit from GPS travel data collection without the expense of purchasing and deploying GPS devices. In 2016, Resource Systems Group conducted a household travel study on behalf of the North Carolina State University Institute for Transportation Research and Education, in which 4,194 households participated in a 1-day travel diary online or by phone. The household travel study was supplemented by a 351-household panel that completed a 3-day GPS study using a smartphone app in addition to the 1-day diary. In the smartphone panel, higher trip rates were found among young adults and high-income households compared with those collected in the online diary, demonstrating the advantages of passively collected trip data and near-real-time recall offered by the smartphone approach. This paper outlines the methodology of the smartphone panel effort, compares trip rates between the online diary and the smartphone panel, and briefly discusses the application of these results toward weighting the overall trip data set.

**Subject Areas:** Household travel data; Metropolitan planning agencies; GPS data collection; Smartphones

**Availability:** Flake, L., Lee, M., Hathaway, K. and Greene, E., 2017. *Use of Smartphone Panels for Viable and Cost-Effective GPS Data Collection for Small and Medium Planning Agencies*. Transportation Research Record: Journal of the Transportation Research Board, (2643), pp.160-165.

<http://trjournalonline.trb.org/doi/abs/10.3141/2643-17>

**7.22. Title: Federal Highway Administration Research and Technology Evaluation: National Household Travel Survey Program Final Report**

**Authors:** Chajka-Cadin, L., Petrella, M., Timmel, C., Fatcher, E. and Mittleman, J.

**Abstract:** This evaluation of the National Household Travel Survey (NHTS) Program addresses three key questions: 1) What is the breadth and depth of NHTS usage? 2) What impact does the NHTS Program have on policy, project, or regulatory decision making? 3) How responsive is the NHTS Program to its user community? Although it is difficult to trace the specific impacts of the NHTS data, the evaluation found many examples demonstrating that NHTS data inform a range of policy and legislative decisions, both within transportation and in other fields (e.g., health, energy). In some cases, NHTS provides context and understanding for how, when, and why Americans travel, as well as trends in travel. This context helps make the case for particular policy or legislative initiatives. In other cases, NHTS is an important data input to a model or statistical analysis, which is used, in turn, to influence policy or legislation. At the State and local levels, NHTS has its greatest impact in developing, calibrating, or validating travel demand models that are used to inform transportation planning and project selection. The report also identifies challenges and lessons learned regarding survey planning, survey administration, and outreach and offers a set of recommendations to improve program effectiveness.

**Subject Areas:** Highways; Planning and Forecasting;

**Availability:** Chajka-Cadin, L., Petrella, M., Timmel, C., Fatcher, E. and Mittleman, J., 2017. *Federal Highway Administration Research and Technology Evaluation: National Household Travel Survey Program Final Report*. (No. FHWA-HRT-16-082).

<https://trid.trb.org/view/1481398>

### **7.23. Title: Introduction of Car Sharing into Existing Car Fleets in Microscopic Travel Demand Modelling**

**Authors:** Heinrichs, M., Krajzewicz, D., Cyganski, R. and von Schmidt, A.

**Abstract:** Microscopic travel demand models take the characteristics of every individual person of the modelled population into account for computing the travel demand for the modelled region. Car sharing is an old concept, but the combination of a car sharing fleet parked in a public space with smartphone services to find available cars nearby offers a new mobility service. It enables people to use a fleet operator's cars by providing individual mobility on demand. However, integrating this mobility option into microscopic travel demand models still is a difficult task due to a lack of data. This paper shows an integrated approach to model car sharing as a new mode for transport within a travel demand model using disaggregated car fleets with car-specific attributes. The necessary parameters for mode choice are estimated from various surveys and integrated into an existing multinomial logit model. The proposed work is used to simulate the travel demand of a synthetic population for the German capital of Berlin. A comparison with the survey results shows that the proposed integration of car sharing meets the real-world data. Furthermore, it is shown that the mode choice reacts well for access restrictions for specific car segments and local accessibility influencing the trip lengths.

**Subject Areas:** Car sharing; Travel demand; Microscopic modelling; Car fleet; Disaggregated cars; Agent-based modelling

**Availability:** Heinrichs, M., Krajzewicz, D., Cyganski, R. and von Schmidt, A., 2017. *Introduction of Car Sharing into Existing Car Fleets in Microscopic Travel Demand Modelling*. *Personal and Ubiquitous Computing*, 21(6), pp.1055-1065.

<https://link.springer.com/article/10.1007/s00779-017-1031-3>

**7.24. Title: Modeling Green Vehicle Adoption: An Integrated Approach for Policy Evaluation**

**Author:** Liu, Y. and Cirillo, C.

**Abstract:** This paper employs an integrated discrete-continuous car ownership model to jointly forecast households' future preferences on vehicle type, quantity and use, and to estimate greenhouse gas (GHG) emissions. The model system is estimated on a dataset collected from a web-based stated preference survey conducted in Maryland in 2014. The data contains vehicle purchase decisions and socio-demographic information of 456 households who were requested to state their future preferences over a nine-year period (2014 - 2022). In each time period, a respondent is faced to four alternatives that include the current vehicle, a new gasoline vehicle, a new hybrid electric vehicle, and a new battery electric vehicle. Inter-temporal choices between conventional and "green" vehicles such as hybrid and electric cars capture dynamics in vehicle purchase decisions. Short run and medium-long run situations were predicted and compared based on the first four-year data and the entire nine-year data of the dynamic panel. Vehicle GHG emissions were calculated correspondingly. We find the introduction of "green" vehicles makes a positive impact on car ownership and use, especially in a medium-long run. Two "green" taxation policies, gasoline tax and ownership tax, were proposed and their impact on vehicle use and emission reductions was evaluated. Results indicate that: (a) gasoline tax is a more effective way to reduce vehicle miles traveled and GHG emissions; and (b) gasoline tax makes a higher impact on car use and emission reductions in the medium-long run, while ownership tax makes a higher impact in the short run.

**Subject Areas:** Car ownership model; Electric vehicle; Greenhouse gas emission; Green vehicle; Policy evaluation; Stated preference data

**Availability:** Liu, Y. and Cirillo, C., 2017. *Modeling Green Vehicle Adoption: An Integrated Approach for Policy Evaluation* International Journal of Sustainable Transportation, (just-accepted). <http://www.tandfonline.com/doi/abs/10.1080/15568318.2017.1393584>

## **7.25. Title: Estimating Freeway Route Travel Time Reliability from Data on Component Links and Associated Cost Implications**

**Author:** Jha, K., Wikander, J.P., Eisele, W.L., Burris, M.W. and Schrank, D.L.

**Abstract:** Typically, data on travel time (speed) and traffic volume are collected for relatively short homogenous links of a roadway (e.g. every 1/2 to 2 miles or 0.8-3.2 km) and not for particular routes from origins to destinations. To accurately estimate a traveller's trip, there is a need to build information on an entire route from data collected at the link level. Because it can be resource-intensive to define specific routes for the entire network of interest, route reliability performance measures are sometimes estimated using a vehicle-miles of travel (VMT)-weighted average of performance indices from links.

In performance measurement, travel time index (TTI) is the ratio of average travel time and free-flow travel time while planning time index (PTI) is the ratio of 95<sup>th</sup> percentile travel time and free-flow travel time. TTI is considered a mobility measure while PTI reflects system reliability. Using indices based on free-flow (uncongested) travel time, this study finds that the VMT-weighting of link indices to get the corresponding route index gives reasonable results for the travel time index (TTI). However, this approach overestimates the planning time index (PTI). This highlights the statistical insufficiency of estimating route PTI values from link PTI values weighted by VMT. It points to the subsequent need to incorporate factors for dispersion and skewness characteristics of travel time distributions on constituent links. This paper introduces a promising method to estimate freeway route reliability considering these dispersion and skewness properties.

For statewide Virginia Interstates considered here, economic analyses based on the value of travel time demonstrate that incorrect travel time reliability estimates result in upwards of 200% higher user costs. Researchers anticipate that the information documented in this paper will be useful for those conducting performance monitoring activities to estimate route reliability with limited resources when only link data are available.

**Subject Areas:** Travel time reliability; Probe data; skew; Dispersion; Cost of congestion; Transportation performance measurement

**Availability:** Jha, K., Wikander, J.P., Eisele, W.L., Burris, M.W. and Schrank, D.L., 2017. *Estimating Freeway Route Travel Time Reliability from Data on Component Links and Associated Cost Implications*. International Journal of Urban Sciences, pp.1-17.

<http://www.tandfonline.com/doi/abs/10.1080/12265934.2017.1403364>

**7.26. Title: A Natural Experiment to Measure the Consequences of a Binding Interest Rate Cap**

**Authors:** Lukongo, O.E.B. and Miller, T.W.

**Abstract:** In the U.S., Arkansas has the lowest interest rate cap on small-dollar installment loans, 17 percent. No small-dollar installment lenders operate within Arkansas, while they do in all six states bordering Arkansas. These facts provide a natural experiment to examine the effects of a binding interest rate cap because Arkansas residents actually obtain installment loans from out-state lenders. Arkansas residents in the perimeter counties hold 96.8 percent of these loans. Overall, Arkansas residents borrow \$1,051, on average, and pay an average annual percentage rate (APR) of 80 percent. Incorporating estimated travel costs, the average APR is 93 percent.

**Subject Areas:** Installment Loans; Access to Credit; Interest Rate Cap

**Availability:** Lukongo, O.E.B. and Miller, T.W., 2017. *A Natural Experiment to Measure the Consequences of a Binding Interest Rate Cap*. Mercatus Working Paper, Mississippi State University.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3059563](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3059563)

**7.27. Title: The Interaction between Land Use and Transportation in the Era of Shared Autonomous Vehicles: A Simulation Model**

**Author:** Zhang, W.

**Abstract:** The promising Shared Autonomous Vehicle (SAV) system will inevitably lead to changes in urban land use. Despite recent proliferating studies regarding SAVs, it remains unclear how this affordable and environmentally friendly travel mode will influence residential and commercial location choices and potentially transform urban form. This dissertation develops a discrete event based SAV simulation and implements the model using the transportation network, travel demand, and land use data from Atlanta Metropolitan area. The model is then integrated with residential and employment (re)location choice models to explore how the SAV system will affect urban parking, residential land use, as well as employment agglomeration patterns. The results suggest SAV can significantly reduce parking demand by over 90%. Additionally, the simulation results also indicate the system will not induce residential sprawl into rural areas. Finally, it appears that SAV will accelerate the existing deindustrialization process in cities. The results of this study can provide implications for devising more sustainable land use policies in the era of SAVs.

**Subject Areas:** Shared Autonomous Vehicle (SAV); Travel mode; Simulation Model

**Availability:** Zhang, W., 2017. *The Interaction between Land Use and Transportation in the Era of Shared Autonomous Vehicles: A Simulation Model*. (Doctoral dissertation, Georgia Institute of Technology).

<https://smartech.gatech.edu/handle/1853/58665>



## 7.28. Title: Improving the Fit of Structural Models of Congestion

**Author:** Hall, J.D.

**Abstract:** We need structural models of traffic congestion to answer a wide variety of questions, but the standard models fail to match the data on travel times across the day. I establish the nature and magnitude of the problem, and show its source lies in how we model agent preferences, not in the specifics of the congestion technology. The poor fit of the models suggests that we are abstracting away from features with a first-order impact on model predictions, which limits our ability to use these models to evaluate counterfactuals quantitatively and - when agents are heterogeneous - qualitatively as well. I explore several ways of improving the fit of these models, concluding with recommendations for tractable and intuitive ways of doing so.

**Subject Areas:** Structural model; Congestion; Model fit; Calibration; Dynamic; Bottleneck Model, Traffic

**Availability:** Hall, J.D., 2017. *Improving the Fit of Structural Models of Congestion*. Working Paper 590, University of Toronto.

<https://www.economics.utoronto.ca/public/workingPapers/tecipa-590.pdf>

**7.29. Title: Integration of the National Long Distance Passenger Travel Demand Model with the Tennessee Statewide Model and Calibration to Big Data**

**Authors:** Bernardin Jr, V.L., Ferdous, N., Sadrsadat, H., Trevino, S. and Chen, C.C.

**Abstract:** The Tennessee Department of Transportation chose to replace their quick-response-based long distance component in their statewide model by integrating FHWA's new national long distance passenger travel demand model into their new statewide model and calibrating it to long distance trips observed in cell-phone based origin-destination data from AirSage. The new national long distance model is a national scale, tour-based simulation model developed from FHWA research on long distance travel behavior and patterns. The tool allows the evaluation of many different policy scenarios including fare or service changes for various modes including commercial air travel, intercity bus, and Amtrak as well as highway travel. The availability of this new tool represents a new opportunity for state DOTs developing statewide models. Commercial cell-phone based big data on long distance trips also represents a new opportunity and a new data source on long distance travel patterns which have previously been the subject of very limited data collection in the form of surveys. This project is the first to seize on both of these new opportunities by integrating the new national long distance model with the new Tennessee statewide model and by processing big data for use as a calibration target for long distance travel in a statewide model. The paper demonstrates the feasibility of integrating the new national model with statewide models, the ability of the national model to be calibrated to new data sources, the ability to combine multiple big data sources, the value of big data on long distance travel as well as important lessons on its expansion.

**Subject Areas:** Long Distance Travel; Statewide Model; Travel Demand Forecasting

**Availability:** Bernardin Jr, V.L., Ferdous, N., Sadrsadat, H., Trevino, S. and Chen, C.C., 2017. *Integration of the National Long Distance Passenger Travel Demand Model with the Tennessee Statewide Model and Calibration to Big Data*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-00513).

<http://docs.trb.org/prp/17-00513.pdf>

## 8. Traffic Safety

### 8.1. Title: Linking Transportation and Population Health to Reduce Racial and Ethnic Disparities in Transportation Injury: Implications for Practice and Policy

**Authors:** McAndrews, C., Beyer, K., Guse, C. and Layde, P.

**Abstract:** In both developing and advanced economies, it is commonly believed that lower income and minority populations are disproportionately at risk of being injured or killed in a motor vehicle crash, especially as pedestrians. However, this risk is rarely quantified with information about exposure. We argue that a combined transportation-population health framework is one way to quantify, and therefore prioritize, equity considerations in transportation safety decision-making. We illustrate this approach with an analysis that compares age-adjusted fatal and nonfatal injury rates per 100 million person-trips by race/ethnicity and sex for motor vehicle occupants, bicyclists, and pedestrians. We found that, per trip, whites are equally safe as pedestrians and motor vehicle occupants, whereas other racial and ethnic groups for whom we have data are less safe when they walk. In addition, black/African-American female motor vehicle occupants and pedestrians have higher inpatient injury risk than female travelers of other races and ethnicities (for whom we had sufficient data). Such differences in transportation injury risk by race and ethnicity warrant deeper analysis to understand the underlying reasons, such as whether certain groups of travelers are exposed to qualitatively different hazards when they travel. We discuss frameworks for including information about injury disparities in decision-making.

**Subject Areas:** Population Health, Race and Ethnicity, Road Safety, Transportation Equity, Walking

**Availability:** McAndrews, C., Beyer, K., Guse, C. and Layde, P., 2017. *Linking Transportation and Population Health to Reduce Racial and Ethnic Disparities in Transportation Injury: Implications for Practice and Policy*. International Journal of Sustainable Transportation, 11(3), pp.197-205.

<http://www.tandfonline.com/doi/abs/10.1080/15568318.2016.1231354>

## **8.2. Title: Review of Regulatory Emphasis on Transportation Safety in the United States, 2002-2009: Public versus Private Modes**

**Authors:** Waycaster, G.C., Matsumura, T., Bilotkach, V., Haftka, R.T. and Kim, N.H.

**Abstract:** The U.S. Department of Transportation is responsible for implementing new safety improvements and regulations with the goal of ensuring limited funds are distributed to where they can have the greatest impact on safety. In this work, we conduct a study of new regulations and other reactions (such as recalls) to fatal accidents in several different modes of transportation implemented from 2002 to 2009. We find that in the safest modes of commercial aviation and bus transport, the amount of spending on new regulations is high in relation to the number of fatalities compared to the regulatory attention received by less safe modes of general aviation and private automobiles. Additionally, we study two major fatal accident investigations from commercial aviation and two major automotive recalls associated with fatal accidents. We find differences in the cost per expected fatality prevented for these reactions, with the airline accident investigations being more cost effective. Overall, we observe trends in both the automotive and aviation sectors that suggest that public transportation receives more regulatory attention than private transport. We also observe that the types of safety remedies utilized, regulation versus investigation, have varying levels of effectiveness in different transport modes. We suggest that these differences are indicative of increased public demand for safety in modes where a third party may be held responsible, even for those not participating in the transportation. These findings have important implications for the transportation industry, policymakers, and for estimating the public demand for safety in new transport modes.

**Subject Areas:** Automobile; Transport Industry; Safety Improvements; Funding

**Availability:** Waycaster, G.C., Matsumura, T., Bilotkach, V., Haftka, R.T. and Kim, N.H., 2017. *Review of Regulatory Emphasis on Transportation Safety in the United States, 2002-2009: Public versus Private Modes*. Risk Analysis.

<http://onlinelibrary.wiley.com/doi/10.1111/risa.12693/full>

### **8.3. Title: Safer or Cheaper? Traffic Safety, Vehicle Choices and the Effect of New Corporate Average Fuel Economy Standards**

**Author:** Liu, Y.

**Abstract:** The new Corporate Average Fuel Economy (CAFE) Standards increase fuel economy to 54.5 MPG by model year 2025 and determine fuel economy targets based on vehicle sizes. This paper examines the effect of the new CAFE standards on consumer choices and composition of vehicle sales, accounting for the impact of traffic safety. We first formulate and estimate a mixed logit model of consumer demand using micro-level data. Two measures of traffic safety, consumers' safety concerns and traffic fatalities, are included and interacted with two vehicle characteristics that matter most for traffic safety: weight and size. Further, we conduct simulations of three extreme firm responses to assess the potential impact of the new CAFE standards: light weighting, paying CAFE fines, and size increase. Simulation results suggest that the sales impact will fall almost entirely on the SUV and light truck segments and on US automakers that use light weighting. Moreover, consumers in states with more traffic fatalities are the most responsive, shifting away from passenger cars. In addition, the new CAFE standards could result in an increase of 8.1 percent in the share of SUV and light trucks, which will cause as many as 347 more equivalent fatalities on roads each year.

**Subject Areas:** Economy Standards; MPG Targets; Light Weighting; Traffic Safety; Automobile Demand

**Availability:** Liu, Y., 2017. *Safer or Cheaper? Traffic Safety, Vehicle Choices and the Effect of New Corporate Average Fuel Economy Standards*. Resource and Energy Economics. [https://cb363a75-a-62cb3a1a-s-sites.googlegroups.com/site/yizaoliu/paper\\_safety\\_cafe\\_2015\\_11\\_13\\_s.pdf?](https://cb363a75-a-62cb3a1a-s-sites.googlegroups.com/site/yizaoliu/paper_safety_cafe_2015_11_13_s.pdf?)

#### **8.4. Title: Advertising Spending and Media Bias: Evidence from News Coverage of Car Safety Recalls**

**Author:** Beattie, G., Durante, R., Knight, B. and Sen, A.

**Abstract:** Do media outlets bias news content in favor of advertisers? We study this question by examining the relationship between advertising spending by car manufacturers in U.S. newspapers and news coverage of major safety recalls issued between 2000 and 2014. Examining car safety recalls allows us to separate the effect of advertisers' influence from that of readers' tastes which, in this case, should lead to more coverage as owners of recalled vehicles demand more information about the safety risks associated with the recall. Consistent with the predictions of our theoretical model, we find that recalls involving a given manufacturer receive significantly less coverage on newspapers in which that manufacturer advertised more over the previous two years. We find that pro-advertiser bias is more pronounced in markets with a single newspaper, which indicates that competition - and the related reputational concerns - mitigates capture by advertisers. Finally, increased competition for advertising revenues from online platforms makes newspapers more vulnerable to the pressure of advertisers.

**Subject Areas:** Media Bias; Car Manufacturers; Safety Recalls

**Availability:** Beattie, G., Durante, R., Knight, B. and Sen, A., 2017. *Advertising Spending and Media Bias: Evidence from News Coverage of Car Safety Recalls*. National Bureau of Economic Research.

[https://www.cemfi.es/ftp/pdf/papers/pew/ads\\_recalls\\_draft\\_NBER.pdf](https://www.cemfi.es/ftp/pdf/papers/pew/ads_recalls_draft_NBER.pdf)

## 8.5. Title: Life-threatening Motor Vehicle Crashes in Bright Sunlight

**Author:** Redelmeier, D.A. and Raza, S.

**Abstract:** Bright sunlight may create visual illusions that lead to driver error, including fallible distance judgment from aerial perspective. We tested whether the risk of a life-threatening motor vehicle crash was increased when driving in bright sunlight.

This longitudinal, case-only, paired-comparison analysis evaluated patients hospitalized because of a motor vehicle crash between January 1, 1995 and December 31, 2014. The relative risk of a crash associated with bright sunlight was estimated by evaluating the prevailing weather at the time and place of the crash compared with the weather at the same hour and location on control days a week earlier and a week later.

The majority of patients (n=6962) were injured during daylight hours and bright sunlight was the most common weather condition at the time and place of the crash. The risk of a life-threatening crash was 16% higher during bright sunlight than normal weather (95% confidence interval: 9-24, P<0.001). The increased risk was accentuated in the early afternoon, disappeared at night, extended to patients with different characteristics, involved crashes with diverse features, not apparent with cloudy weather, and contributed to about 5000 additional patient-days in hospital. The increased risk extended to patients with high crash severity as indicated by ambulance involvement, surgical procedures, length of hospital stay, intensive care unit admission, and patient mortality. The increased risk was not easily attributed to differences in alcohol consumption, driving distances, or anomalies of adverse weather.

Bright sunlight is associated with an increased risk of a life-threatening motor vehicle crash. An awareness of this risk might inform driver education, trauma staffing, and safety warnings to prevent a life-threatening motor vehicle crash.

**Subject Areas:** Crash; Motor Vehicle; Patients

**Availability:** Redelmeier, D.A. and Raza, S., 2017. *Life-threatening Motor Vehicle Crashes in Bright Sunlight*. *Medicine*, 96(1), p.e5710.

[http://journals.lww.com/md-journal/Fulltext/2017/01060/Life\\_threatening\\_motor\\_vehicle\\_crashes\\_in\\_bright.28.aspx](http://journals.lww.com/md-journal/Fulltext/2017/01060/Life_threatening_motor_vehicle_crashes_in_bright.28.aspx)

## 8.6. Title: Spatial Investigation of Aging-involved Crashes: A GIS-based Case Study in Northwest Florida

**Author:** Ulak, M.B., Ozguven, E.E., Spainhour, L. and Vanli, O.A.

**Abstract:** This study attempts to understand the unique nature of crashes involving aging drivers, unlike many previous crash-focused traffic safety studies mostly focusing on the general population. The utmost importance is given to answering the following question: How do the crashes involving aging drivers vary compared to crashes involving other age groups? To achieve this objective, a three-step spatial analysis was conducted using geographic information systems (GIS) with a case study application on three urban counties in the Northwest Florida region, based on crash data obtained from the Florida Department of Transportation (FDOT). First, crash clusters were investigated using a kernel density estimation (KDE) approach. Second, a crash density ratio difference (DRD) measure was proposed for comparing maxima-normalized crash densities for two different age groups. Third, a population factor (PF) was developed in order to investigate effect of spatial dependency by incorporating the effect of both number and percent of 65+ populations in a region. This spatial analysis was followed by a logistic regression-based approach in order to identify the statistically significant factors that can help investigate the distinct patterns of crashes involving aging drivers. Results of this study indicate that crashes involving aging drivers differ from other age group crashes both spatially and temporally. Further, the DRD and PF factors are useful metrics to identify and investigate important regions of study. The GIS-based knowledge gained from this research can contribute to the development of more reliable aging-focused safety plans and models.

**Subject Areas:** Crash; GIS; Aging driver

**Availability:** Ulak, M.B., Ozguven, E.E., Spainhour, L. and Vanli, O.A., 2017. *Spatial Investigation of Aging-involved Crashes: A GIS-based Case Study in Northwest Florida*. Journal of Transport Geography, 58, pp.71-91.

[https://www.researchgate.net/profile/Mehmet\\_Ulak/publication/311449226\\_Spatial\\_investigation\\_of\\_aging-involved\\_crashes\\_A\\_GIS-based\\_case\\_study\\_in\\_Northwest\\_Florida/links/58488be508ae95e1d1665e04.pdf](https://www.researchgate.net/profile/Mehmet_Ulak/publication/311449226_Spatial_investigation_of_aging-involved_crashes_A_GIS-based_case_study_in_Northwest_Florida/links/58488be508ae95e1d1665e04.pdf)



### 8.7. Title: A New Spatial and Flexible Multivariate Random-Coefficients Model for the Analysis of Pedestrian Injury Counts by Severity Level

**Author:** Bhat, C.R., Astroza, S. and Lavieri, P.S.

**Abstract:** We propose in this paper a spatial random coefficients flexible multivariate count model to examine, at the spatial level of a census tract, the number of pedestrian injuries by injury severity level. Our model, unlike many other macro-level pedestrian injury studies in the literature, explicitly acknowledges that risk factors for different types of pedestrian injuries can be very different, as well as accounts for unobserved heterogeneity in the risk factor effects. We also recognize the multivariate nature of the injury counts by injury severity level within each census tract (as opposed to independently modeling the count of pedestrian injuries by severity level). In concrete methodological terms, our model: (a) allows a full covariance matrix for the random coefficients (constant heterogeneity, or CH, and slope heterogeneity, or SH, effects) characterizing spatial heterogeneity for each count category, (b) addresses excess zeros (or any other excess count value for that matter) within a multivariate count setting in a simple and elegant fashion, while recognizing multivariateness engendered through covariances in both the CH and SH effects, (c) accommodates spatial dependency through a spatial autoregressive lag structure, allowing for varying spatial autoregressive parameters across count categories, and (d) captures spatial drift effects through the spatial structure on the constants and the slope heterogeneity effects. To our knowledge, this is the first time that such a general spatial multivariate model has been formulated. For estimation, we use a composite marginal likelihood (CML) inference approach that is simple to implement and is based on evaluating lower-dimensional marginal probability expressions.

The data for our analysis is drawn from a 2009 pedestrian crash database from the Manhattan region of New York City. Several groups of census tract-based risk factors are considered in the empirical analysis based on earlier research, including (1) socio-demographic characteristics, (2) land-use and road network characteristics, (3) activity intensity characteristics, and (4) commute mode shares and transit supply characteristics. The empirical analysis sheds light on both engineering as well as behavioral countermeasures to reduce the number of pedestrian vehicle crashes by severity of these crashes.

**Subject Areas:** Multivariate count model; Spatial dependence; Pedestrian injuries in traffic crashes

**Availability:** Bhat, C.R., Astroza, S. and Lavieri, P.S., 2017. *A New Spatial and Flexible Multivariate Random-Coefficients Model for the Analysis of Pedestrian Injury Counts by Severity Level*. University of Texas.

[http://www.caee.utexas.edu/prof/bhat/ABSTRACTS/Spatial\\_Count.pdf](http://www.caee.utexas.edu/prof/bhat/ABSTRACTS/Spatial_Count.pdf)

**8.8. Title: Texting and Driving: A Look at Self-Control, Social Learning Theory, Knowledge, and Adherence to the Law among Young Drivers**

**Author:** Green, F.L.

**Abstract:** Despite all the safety features the motor vehicle industry has designed over the years, many car accidents still occur here in the United States. In 2014, the National Highway Traffic Safety Association announced approximately 10% of the total 32,675 people who died on United States highways was due to distracted driving, while over 400,000 were injured in a distracted driving incident. One reason for distracted driving is the use of one's cellphone during driving. Over the past thirty years the phone industry has made many advances and introduced new ways to communicate with one another. One prominent form of communication, especially with the younger generations is text messaging. This study looks to explain texting while driving behavior through two theoretical frameworks, The General Theory of Crime and Social Learning Theory. In addition, this study explores whether knowledge of the law means adherence to the law. Four hypotheses were created including parental and peer influence derived from Social Learning Theory, self-control derived from the General Theory of Crime, and knowledge of the law to explore if these were significant predictors in texting while driving behavior. All four analyses failed to reach significance. Explanations for these findings and future research are discussed within.

**Subject Areas:** Traffic Safety; Cellphones and texting; Distracted driving

**Availability:** Green, F.L., 2017. *Texting and Driving: A Look at Self-Control, Social Learning Theory, Knowledge, and Adherence to the Law among Young Drivers*. M.S. Thesis, University of Central Missouri.

[http://centralspace.ucmo.edu/bitstream/handle/123456789/493/Green\\_Thesis.pdf?sequence=1&isAllowed=y](http://centralspace.ucmo.edu/bitstream/handle/123456789/493/Green_Thesis.pdf?sequence=1&isAllowed=y)

### **8.9. Title: Crash Analysis and Road User Survey to Identify Issues and Countermeasures for Older Drivers in Kansas**

**Authors:** Chathuranga, S. and Kankanamge, K.

**Abstract:** The percentage of the U.S. population aged 65 years or older is increasing rapidly. Statistics also show this age group was 14.9 percent of the population in 2015 and is expected to be 20.7 to 21.4 percent for the years 2030-2050. Kansas has similar statewide trends with its aging population. Therefore, identifying issues, concerns, and factors associated with severity of older-driver crashes in Kansas is necessary. The Kansas Crash Analysis and Reporting System (KCARS) database maintained by Kansas Department of Transportation was used in this study to identify older-driver crash characteristics, compare older drivers with all drivers, and develop crash severity models. According to KCARS data, older drivers were involved in more than one in five fatal injuries out of all drivers in Kansas from 2010 to 2014. When compared with all drivers, older drivers were overly represented in fatal and incapacitating injuries. The percentage of older-driver fatal injuries was more than the twice that of all drivers. When compared with all drivers, older drivers were involved more often in crashes at four-way intersections, on straight and level roads, in daylight hours, and at a stop or yield signs.

An in-depth crash severity analysis was carried out for the older drivers involved in crashes. Three separate binary logistic regression models were developed for single-vehicle crashes where only the older driver was present (Model A), single-vehicle crashes involving an older driver with at least one passenger (Model B), and multi-vehicle crashes involving at least one older driver (Model C). From the crash severity analysis, it was found that left turns were significant in changing the crash severity for Model A, but it was not significant in model B, meaning that older drivers may be safer with passengers. For Model B, none of the passenger attributes were significant, though it was originally developed to identify passenger attributes. Gender of the older driver was not significant in any model. For all models, variables such as safety equipment use, crash location, weather conditions, driver ejected or trapped, and light conditions distinguished crash severity. Number of vehicles, speed, collision type, maneuver, and two-lane roads were significant in Model C.

A road-user survey was also conducted to identify habits, needs, and concerns of Kansas' aging road users since it was not advisable to conclude safety factors solely on crash data. Then a contingency table analysis was carried out to identify relationships among variables. Findings of this research gave an understanding of older-driver crashes and associated factors. Since more than 85 percent of crash contributory causes were related to drivers, driver awareness programs, driver licensing restrictions, providing public transportation, and law enforcement can be used as countermeasures. Accordingly, results of this study can be used to enhance older-driver safety and awareness programs.

**Subject Areas:** Older driver safety; Crash severity modeling

**Availability:** Chathuranga, S. and Kankanamge, K., 2017. *Crash Analysis and Road User Survey to Identify Issues and Countermeasures for Older Drivers in Kansas*. M.S. Thesis, Kansas State University.

<http://krex.k-state.edu/dspace/bitstream/handle/2097/35452/SameeraChathurangaKoththigodaKankanamge2017.pdf?sequence=3>

**8.10. Title: The Effect of Passengers on Driver-Injury Severities in Single-Vehicle Crashes: A Random Parameters Heterogeneity-in-means Approach**

**Authors:** Behnood, A. and Mannering, F.

**Abstract:** This paper seeks to investigate the effects of passengers on driver-injury severities. Using single-vehicle crashes, a random parameters logit model with heterogeneity in parameter means is estimated to explore the differences in driver-injury severities in three distinct subgroups; vehicles with one occupant (driver-only), vehicles with two occupants (driver and a passenger), and vehicles with three occupants (driver and two passengers). In addition to considering age, gender and the presence of the passenger(s), a wide range of variables that potentially affect driver-injury severity were considered, including weather conditions, roadway characteristics, vehicle characteristics and driver attributes. Estimation results show that both the age and the gender of the passenger(s) significantly affected driver-injury severities. The findings of this research point toward the need to further study the potentially complex interactions between drivers and passengers.

**Subject Areas:** Random parameters logit model; Heterogeneity in means; Driver-injury severity; Single-vehicle crashes; Vehicle passenger; Age; Gender

**Availability:** Behnood, A. and Mannering, F., 2017. *The Effect of Passengers on Driver-Injury Severities in Single-Vehicle Crashes: A Random Parameters Heterogeneity-in-means Approach*. *Analytic Methods in Accident Research*, 14, pp.41-53.  
<http://www.sciencedirect.com/science/article/pii/S2213665717300040>

### **8.11. Title: Assessing Route Choice to Mitigate Older Driver Risk**

**Authors:** Payyanadan, R.P., Sanchez, F.A. and Lee, J.D.

**Abstract:** Older drivers face decline in perceptual, cognitive, and motor abilities, and yet, increased fragility largely explains their increased risk of fatal crashes. Adaptation and self-regulation explain why older drivers can be safe drivers in the face of declining ability. Left turns and U-turns are particularly challenging, accounting for 10% of crashes for drivers aged 60-69 and increasing to 32% for those over 80. To mitigate these driving challenges through more effective adaptation, a route risk measure was developed. The route risk measure quantifies the risk of driving challenges such as left turns, U-turns, and trip length using older driver crash statistics from the General Estimates System. We applied the risk measure to 1253 trips taken by 39 urban and rural older drivers residing in Wisconsin. A search for a low-risk alternative route was conducted by applying the measure to corresponding routes suggested by Google Maps. Results showed that the low-risk alternative reduced risk for 77.7% of the older drivers' trips, on average, by 61.4%. The low-risk alternative had 1.50 fewer left turns and 0.23 fewer U-turns and were 0.44 mi shorter. Thus, selecting low-risk alternatives from the routes suggested by Google could help drivers avoid challenging maneuvers, potentially reducing their crash risk by promoting more effective adaptation to their declining abilities.

**Subject Areas:** Route risk; Risk measure; Older drivers; Crash risk

**Availability:** Payyanadan, R.P., Sanchez, F.A. and Lee, J.D., 2017. *Assessing Route Choice to Mitigate Older Driver Risk*. IEEE Transactions on Intelligent Transportation Systems, 18(3), pp.527-536.

<http://ieeexplore.ieee.org/abstract/document/7534844/>

## 8.12. Title: Epidemiology of Injuries Sustained by Rear-Seat Passengers in Frontal Motor Vehicle Crashes

**Authors:** Bose, D., Crandall, J., Forman, J., Longhitano, D. and Arregui-Dalmases, C.

### **Abstract:**

**Objective:** Advanced occupant protection systems in motor-vehicles (e.g., seat belts and airbags), while widely adopted for front-seat passengers, are either absent or offer disproportionately lower safety to rear-seat passengers in similar crashes. Optimization of advanced restraint systems for the rear-seat environment will require a detailed understanding of epidemiology and associated risk factors for injuries sustained by rear-seat passengers. Thus, the objective of the study is to use national level motor-vehicle travel and crash data to quantify rear-seat travel exposure, and determine the descriptive characteristics and the injury outcomes for rear-seat passengers involved in frontal collisions.

**Methods:** While U.S. travel data from the 2009 National Household Travel Survey was used to determine rear-seat travel estimates, crash data from 2001 to 2010 National Automotive Sampling System Crash Worthiness Data System was used to enroll rear-seat passengers injured in a frontal crash. The descriptive epidemiology of rear-seat crash victims was separately done for the three age-groups: children (8-15 years old), adults (16-59 years old), and senior adults (60+).

**Results:** The study indicated that senior adults in rear-seats were associated with a significantly higher rate of sustaining fatal (6%) and severe injuries (16% for MAIS 3+ injuries) in comparison to the younger cohorts. The distribution of severe injuries further indicated that the thorax was the most frequently injured region across all age groups irrespective of the belt-use status.

**Conclusions:** Findings of the study conclude that while rear-seat travel in the U.S. is still very low and improving belt usage is a primary concern among rear-seat passengers; however, the epidemiology supports the need for adapting rear-seat restraint performance for effective protection for all groups of rear-seat passengers.

**Subject Areas:** Rear seat passenger; Seat belt; Motor vehicle crash; Airbag; Frontal crash; Optimized restrain systems

**Availability:** Bose, D., Crandall, J., Forman, J., Longhitano, D. and Arregui-Dalmases, C., 2017. *Epidemiology of Injuries Sustained by Rear-Seat Passengers in Frontal Motor Vehicle Crashes*. Journal of Transport & Health, 4, pp.132-139.

<http://www.sciencedirect.com/science/article/pii/S221414051630175X>

### **8.13. Title: Comparison of US Metropolitan Region Pedestrian and Bicyclist Fatality Rates**

**Authors:** Schneider, J., Vargo, J. and Sanatizadeh, A.

**Abstract:** Annual US pedestrian and bicyclist fatalities involving motor vehicles have each increased by 30% in just six years, reaching their highest levels in two decades. To provide information to reverse this trend, we quantified pedestrian and bicyclist fatality rates in 46 of the largest US metropolitan statistical areas (MSAs) during two five-year time periods: 1999-2003 and 2007-2011. We divided the annual average number of pedestrian and bicyclist fatalities during 1999-2003 from the Fatality Analysis Reporting System by the annual estimates of pedestrian and bicycle trips, kilometers traveled, and minutes traveled from the 2001 National Household Travel Survey (NHTS) and the annual average number of fatalities from 2007 to 2011 by similar estimates from the 2009 NHTS. The five most dangerous regions for walking during 2007-2011 averaged 262 pedestrian fatalities per billion trips while the five safest averaged 49 pedestrian fatalities per billion trips. The five most dangerous regions for bicycling averaged 458 bicyclist fatalities per billion trips while the five safest averaged 75 bicyclist fatalities per billion trips. Random-effects meta-analysis identified eight metropolitan regions as outliers with low pedestrian fatality rates, six with high pedestrian fatality rates, one with a low bicyclist fatality rate, and five with high bicyclist fatality rates. MSAs with low pedestrian and bicycle fatality rates tended to have central cities recognized as Walk Friendly Communities and Bicycle Friendly Communities for investing in pedestrian and bicycle projects and programs. Random-effects meta-regression showed that certain socioeconomic characteristics and high pedestrian and bicyclist mode shares were associated with lower MSA fatality rates. Results suggest that pedestrian and bicycle infrastructure and safety programs should be complemented with strategies to increase walking and bicycling. In particular, safety initiatives should be honed to reduce pedestrian and bicyclist fatality risk in immigrant communities and to make pedestrian travel safer for the growing senior-age population.

**Subject Areas:** Pedestrian; Bicycle; Metropolitan region; Fatality rates; Road safety; Active transportation

**Availability:** Schneider, J., Vargo, J. and Sanatizadeh, A., 2017. *Comparison of US Metropolitan Region Pedestrian and Bicyclist Fatality Rates*. *Accident Analysis & Prevention*, 106, pp.82-98. <http://www.sciencedirect.com/science/article/pii/S0001457517301550>

#### **8.14. Title: Understanding the Role of Driver, Vehicle, Environment, and Policy Factors in Crash Injury Severity among Older Adults in the United States**

**Author:** Lee, C.M.

**Abstract:** Driving is related to quality of life and health outcomes. Older drivers involved in car crashes have a higher risk of experiencing a severe injury or fatality. Understanding factors related to injury severity may identify points of intervention to promote road safety. The purpose of this study is to investigate how individual characteristics, vehicle elements, environmental elements, and driving licensing policy are associated with level of injury severity from no injury to fatal injury resulting from car crashes. Furthermore, this dissertation research utilizes the Geographic Information System (GIS) process to visualize the location of crashes and to identify the hot spots of crashes in state of Massachusetts.

This dissertation utilized motor vehicle crash data of 2010 to 2012 from General Estimate System (GES) and Fatality Analysis Reporting System (FARS) administrated by National Highway Traffic Safety Administration (NHTSA). Using the GES crash data, multinomial logistic regression analysis was performed. Results indicated that older drivers (age 65 and older) were more likely to have fatality and severe injury in a crash compared to younger drivers (age 35 to 59). Impaired drivers had a much greater likelihood of fatal and severe injuries compared to drivers with normal conditions. Drivers with sedans compared to pick-up trucks were more likely to have severe injuries. In terms of policy factors, drivers involved in a crash in states with mandatory medical reporting for at a risk driver had decreased risk of fatal and severe injuries. Also, drivers in states requiring the vision test at license renewal had reduced risk of fatal and minor injuries. Using the FARS crash data, results provided an explanation of both the identification and the visual representation of the hot spots of crash locations in MA observed by performing spatial analysis of the GIS application.

In conclusion, among adult drivers involved in crashes, those who are older or impaired (physical or mental) have a significantly greater risk of fatality or serious injury. The results suggest that license renewal policies that limit driving of those risky drivers may be an effective early intervention to enhance safety on the roads.

**Subject Areas:** Crashes; GIS; Older Adults

**Availability:** Lee, C.M., 2017. *Understanding the Role of Driver, Vehicle, Environment, and Policy Factors in Crash Injury Severity among Older Adults in the United States*. Doctoral Thesis, University of Massachusetts Boston.

[http://scholarworks.umb.edu/cgi/viewcontent.cgi?article=1331&context=doctoral\\_dissertations](http://scholarworks.umb.edu/cgi/viewcontent.cgi?article=1331&context=doctoral_dissertations)



## **8.15. Title: Guidance to Support Vulnerable Road Users in the State of Alabama**

**Author:** Gajkowski, T.

**Abstract:** Over the past decade, communities across Alabama and the United States experienced significant increases in multi-modal traffic. While this growth has been shown to promote sustainable and livable communities, reduce traffic congestion, foster healthy environments, and boost local economies, there are still meaningful concerns about maintaining roadway safety for all users. Of particular interest are vulnerable road users (VRUs), defined by FHWA as “road users who are most at risk for serious injury or death when they are involved in a motor-vehicle related collision”. This thesis provides guidance for improving Alabama state highways to support the safe travel of vulnerable road users. While the guidance presented herein is focused on Alabama and its specific needs, the recommendations were derived based on a synthesis of all the existing federal, state, and major city VRU documentation. This thesis provides information on: (a) Understanding VRU Considerations, (b) Trends in Alabama VRU Safety, (c) Models of Alabama Highway Factors Influencing VRU Safety, (d) Guidance on Selecting VRU Countermeasures, and (e) VRU Countermeasure Characteristics. This thesis provides guidance on pedestrians, bicyclists, motorcyclists and scooter users, younger drivers, older drivers, farm equipment, golf carts, and transport-service animals. Additionally, this thesis recognizes that guidance should vary based on the highway environment, so countermeasure suggestions are tailored based on urban/suburban/rural communities, roadway type, posted speeds, traffic volumes, and VRU volumes.

**Subject Areas:** Roadway safety; FHWA; Injury

**Availability:** Gajkowski, T., 2017. *Guidance to Support Vulnerable Road Users in the State of Alabama*. M.S. Thesis, University of Auburn.

<https://etd.auburn.edu/handle/10415/5687>

### **8.16. Title: An On-Road Evaluation of the Impact of Explicit and Implicit Cognitive Training Protocols on Safety-Related Senior Driver Behaviors**

**Author:** Antin, J., Owens, J. and Wotring, B.

**Abstract:** This study presents a long-term examination of the effects of two types of perceptual-cognitive brain training programs on senior driver behavior and on-road driving performance. Seniors over the age of 69 engaged in either a Toyota-designed in-vehicle training program based on implicit learning principles or a commercially available computer-based training program developed by Posit Science. Another group served as a control group and received no training; total enrollment was 55 participants. Participants completed a series of four experimental sessions: (1) baseline pre-training, (2) immediate post-training, (3) 6-9 months post-training, and (4) 12-16 months post-training. Experimental metrics taken at each session included a laboratory metrics portion, a target-detection performance on a closed-road course, and a public-road portion examining vehicle control and glance behavior. These sessions were designed to examine not only whether training provided immediate benefit to senior drivers, but also whether any improvements persisted after training or precluded decrements in performance found in untrained individuals. The results found few statistically significant improvements in performance with either type of training. However, there were non-significant trends toward improved glance behavior at risky intersections for participants in the Car Training group, suggesting that this might be a valuable target of future research using experimental designs with increased statistical power. In addition, several tests of training improvements examined by individual differences suggested that drivers with particular deficits on physical and cognitive metrics could benefit differentially from this type of training, leading to future research questions on appropriate targeting and the potential benefits of refresher training.

**Subject Areas:** Road safety; FHWA; Injury

**Availability:** Antin, J., Owens, J. and Wotring, B., 2017. *An On-Road Evaluation of the Impact of Explicit and Implicit Cognitive Training Protocols on Safety-Related Senior Driver Behaviors*. National Surface Transportation Safety Center for Excellence Reports, Virginia Tech Transportation Institute.

<https://vtechworks.lib.vt.edu/handle/10919/77431>

### **8.17. Title: Modeling Bicycle-Vehicle Crash Frequency on Urban Roads**

**Author:** Mukoko, K.K.

**Abstract:** Bicyclists and motorists make mistakes that contribute to traffic crashes involving bicyclists on urban roads. The likelihood of a bicyclist being severely injured or killed daily in traffic crashes is creating fear, anxiety, and becoming a potential danger to the increasing number of Americans using bicycle as a mode of transportation. It is also making bicycling to work or for other purposes less lucrative. Building bicycling friendly and safe environment is, therefore, vital to encourage and have more people use bicycle as a mode of transportation. Therefore, the main goal of this research is to improve safety of bicyclists on urban roads. The main objectives are to understand the role of explanatory variables on risk to bicyclists on urban roads and to develop macroscopic bicycle-vehicle crash frequency models (safety performance functions) for urban roads.

**Subject Areas:** Bicycle; Traffic crashes; GIS

**Availability:** Mukoko, K.K., 2017. *Modeling Bicycle-Vehicle Crash Frequency on Urban Roads*. Doctoral dissertation, The University of North Carolina at Charlotte.

<http://search.proquest.com/openview/fdc10ab9ef18432a9872f455c8c21803/1?pq-origsite=gscholar&cbl=18750&diss=y>

**8.18. Title: Study suggests Investment pays off in Safety for Walkers, Bikers**

**Author:** Walz-Chojnacki, G.

**Abstract:** Newspaper Article

**Subject Areas:** Bicycle; Pedestrian; Safety; Infrastructure

**Availability:** Walz-Chojnacki, G., 2017. *Study suggests Investment pays off in Safety for Walkers, Bikers*. Phys.org.

<https://phys.org/news/2017-07-investment-safety-walkers-bikers.html>

### 8.19. Title: Driving in Search of Analyses

**Author:** Simons-Morton, B.

**Abstract:** Although transportation safety has greatly improved over the past 2 decades, motor vehicle crash injuries remain a leading cause of morbidity and mortality, particularly among young drivers. Driver errors and behaviors such as speeding and distraction contribute disproportionately to crashes among inexperienced novices, who develop safe driving judgment only with substantial driving experience, commonly described as the “young driver problem.” Research on young drivers has applied a range of research methods, including analyses of national archival data (mainly from police reports), crash analyses, observation of driver behavior, surveys of driver behavior and dispositions, and experimental research on driver behavior and vehicle crash worthiness. Prominent research questions regarding young driver safety include what and how do novices learn to drive safely, what are the predictors of young driver crashes, what is the variability and overtime trajectories of young driver performance and outcomes, and to what extent is the young driver problem due mainly to average population risk or high-risk groups? Current research on young drivers is complicated by small sample sizes, relatively rare events, high within and between group variability, missing data, the need to estimate exposure, and the lack of longitudinal and experimental designs, problems that require complex analytic methods. In this paper, we provide an overview of driving research methods, examples of research addressing the young driver problem, and examples of statistical collaboration on young driver research, focusing particularly on estimating prediction of crash risk and estimating variability in young driver performance and outcomes.

**Subject Areas:** Adolescence; Crash risk; Distraction; injury; Longitudinal analyse; Naturalistic driving

**Availability:** Simons-Morton, B., 2017. *Driving in Search of Analyses*. *Statistics in Medicine*, 36(24), pp.3763-3771.  
<https://www.ncbi.nlm.nih.gov/pubmed/28699210>

## **8.20. Title: Characteristics of Single Vehicle Crashes with a Teen Driver in South Carolina, 2005 - 2008**

**Authors:** Shults, R.A., Bergen, G., Smith, T.J., Cook, L., Kindelberger, J. and West, B.

**Abstract:** Objective: Teens' crash risk is highest in the first years of independent driving. Circumstances surrounding fatal crashes have been widely documented, but less is known about factors related to nonfatal teen driver crashes. This study describes single vehicle nonfatal crashes involving the youngest teen drivers (15-17 years), compares these crashes to single vehicle nonfatal crashes among adult drivers (35-44 years) and examines factors related to nonfatal injury producing crashes for teen drivers.

Methods: Police crash data linked to hospital inpatient and emergency department data for 2005 - 2008 from the South Carolina Crash Outcomes Data Evaluation System (CODES) were analyzed. Nonfatal, single vehicle crashes involving passenger vehicles occurring on public roadways for teen (15-17 years) drivers were compared with those for adult (35-44 years) drivers on temporal patterns and crash risk factors per licensed driver and per vehicle miles traveled. Vehicle miles traveled by age group was estimated using data from the 2009 National Household Travel Survey. Multivariable log-linear regression analysis was conducted for teen driver crashes to determine which characteristics were related to crashes resulting in a minor/moderate injury or serious injury to at least one vehicle occupant.

Results: Compared with adult drivers, teen drivers in South Carolina had 2.5 times the single vehicle nonfatal crash rate per licensed driver and 11 times the rate per vehicle mile traveled. Teen drivers were nearly twice as likely to be speeding at the time of the crash compared with adult drivers. Teen driver crashes per licensed driver were highest during the afternoon hours of 3:00-5:59 pm and crashes per mile driven were highest during the nighttime hours of 9:00 -11:59 pm. In 66% of the teen driver crashes, the driver was the only occupant. Crashes were twice as likely to result in serious injury when teen passengers were present than when the teen driver was alone. When teen drivers crashed while transporting teen passengers, the passengers were >5 times more likely to all be restrained if the teen driver was restrained. Crashes in which the teen driver was unrestrained were 80% more likely to result in minor/moderate injury and 6 times more likely to result in serious injury compared with crashes in which the teen driver was restrained.

Conclusions: Despite the reductions in teen driver crashes associated with Graduated Driver Licensing (GDL), South Carolina's teen driver crash rates remain substantially higher than those for adult drivers. Established risk factors for fatal teen driver crashes, including restraint nonuse, transporting teen passengers, and speeding also increase the risk of nonfatal injury in single vehicle crashes. As South Carolina examines strategies to further reduce teen driver crashes and associated injuries, the state could consider updating its GDL passenger restriction to either none or one passenger <21 years and dropping the passenger restriction exemption for trips to and from school. Surveillance systems such as CODES that link crash data with health outcome data provide needed information to more fully understand the circumstances and consequences of teen driver nonfatal crashes and evaluate the effectiveness of strategies to improve teen driver safety.

**Subject Areas:** Teen driving; Motor vehicle crashes; Graduated driver licensing; Speeding; Seat belt use; CODES

**Availability:** Shults, R.A., Bergen, G., Smith, T.J., Cook, L., Kindelberger, J. and West, B., 2017.

*Characteristics of Single Vehicle Crashes with a Teen Driver in South Carolina, 2005 - 2008.*  
Accident Analysis & Prevention.

<http://www.sciencedirect.com/science/article/pii/S0001457517302774>

## 8.21. Title: Risk-Exposure Density and Mileage Bias in Crash Risk for Older Drivers

**Authors:** Rolison, J.J. and Moutari, S

**Abstract:** Crash rates per mile indicate a high risk of vehicle crash in older drivers. A reliance on mileage alone may underestimate the risk exposure of older drivers because they tend to avoid highways and travel more on nonfreeways (e.g., urban roads), which present greater hazards. We introduce risk-exposure density as an index of exposure that incorporates mileage, frequency of travel, and travel duration. Population-wide driver fatalities in the United States during 2002-2012 were assessed according to driver age range (in years: 16-20, 21-29, 30-39, 40-49, 50-59, 60-69,  $\geq 70$ ) and sex. Mileage, frequency, and duration of travel per person were used to assess risk exposure. Mileage-based fatal crash risk increased greatly among male (relative risk (RR) = 1.73; 95% CI: 1.62, 1.83) and female (RR = 2.08; 95% CI: 1.97, 2.19) drivers from ages 60-69 years to ages  $\geq 70$  years. Adjusting for their density of risk exposure, fatal crash risk increased only slightly from ages 60-69 years to ages  $\geq 70$  years among male (RR = 1.09; 95% CI: 1.03, 1.15) and female (RR = 1.22; 95% CI: 1.16, 1.29) drivers. While ubiquitous in epidemiologic research, mileage-based assessments can produce misleading accounts of driver risk. Risk-exposure density incorporates multiple components of travel and reduces bias caused by any single indicator of risk exposure.

**Subject Areas:** Crash Risk; Mileage Bias; Older Drivers; Risk Exposure; Road Safety; Young Drivers

**Availability:** Rolison, J.J. and Moutari, S., 2017. *Risk-Exposure Density and Mileage Bias in Crash Risk for Older Drivers*. American Journal of Epidemiology, pp.1-7.  
<https://academic.oup.com/aje/advance-article/doi/10.1093/aje/kwx220/3865622>



## 8.22. Title: A Validation of the Low Mileage Bias Using Naturalistic Driving Study Data

**Authors:** Antin, J.F., Guo, F., Fang, Y., Dingus, T.A., Perez, M.A. and Hankey, J.M.

**Abstract:** Introduction: This paper evaluated the low mileage bias (LMB) phenomenon for senior drivers using data mined from the Second Strategic Highway Research Program (SHRP 2) Naturalistic Driving Study. Supporters of the LMB construct postulate that it is only those seniors who drive the lowest annual mileage who are primarily responsible for the increased crash rates traditionally attributed to this population in general.

Method: The current analysis included 802 participants, all aged 65 or older who were involved in 163 property damage and injury crashes, and deemed to be at-fault in 123 (75%) of those instances. Poisson regression models were used to evaluate the association between annualized mileage driven and crash risk.

Results: Results show that the crash rate for drivers with lower annualized mileage (i.e., especially for those driving fewer than approximately 3000 miles per year) was significantly higher than that of drivers with higher annualized mileage, and that 25% of the overall sample were low-mileage drivers according to this criterion. Data were also evaluated by gender and meta-age group (i.e., younger-old: 65-74 and older-old: 75-99), and the results were consistent across these sub-groups.

Conclusions: This study provides strong support for the existence of the LMB.

**Subject Areas:** Senior drivers; Mileage Bias; Crash Rates

**Availability:** Antin, J.F., Guo, F., Fang, Y., Dingus, T.A., Perez, M.A. and Hankey, J.M., 2017. *A Validation of the Low Mileage Bias Using Naturalistic Driving Study Data*. Journal of Safety Research.

<https://www.sciencedirect.com/science/article/pii/S0022437516303279>

**8.23. Title: Estimated Total Costs from Non-Fatal and Fatal Bicycle Crashes in the USA: 1997-2013**

**Authors:** Gaither, T.W., Sanford, T.A., Awad, M.A., Osterberg, E.C., Murphy, G.P., Lawrence, B.A., Miller, T.R. and Breyer, B.N.

**Abstract:** Introduction: Emergency department visits and hospital admissions resulting from adult bicycle trauma have increased dramatically. Annual medical costs and work losses of these incidents last were estimated for 2005 and quality-of-life losses for 2000.

Method: We estimated costs associated with adult bicycle injuries in the USA using 1997-2013 non-fatal incidence data from the National Electronic Injury Surveillance System with cost estimates from the Consumer Product Safety Commission's Injury Cost Model, and 1999-2013 fatal incidence data from the National Vital Statistics System coded by similar methods.

Results: Approximately 3.8 million non-fatal adult bicycle injuries were reported during the study period and 9839 deaths. In 2010 dollars, estimated adult bicycle injury costs totalled \$24.4 billion in 2013. Estimated injury costs per mile bicycled fell from \$2.85 in 2001 to \$2.35 in 2009. From 1999 to 2013, total estimated costs were \$209 billion due to non-fatal bicycle injuries and \$28 billion due to fatal injuries. Inflation-free annual costs in the study period increased by 137% for non-fatal injuries and 23% for fatal injuries. The share of non-fatal costs associated with injuries to riders age 45 and older increased by 1.6% (95% CI 1.4% to 1.9%) annually. The proportion of costs due to incidents that occurred on a street or highway steadily increased by 0.8% (95% CI 0.4% to 1.3%) annually.

Conclusions: Inflation-free costs per case associated with non-fatal bicycle injuries are increasing. The growth in costs is especially associated with rising ridership, riders 45 and older, and street or highway crashes.

**Subject Areas:** Adult bicycle trauma; Bicycle Injuries; Medical costs

**Availability:** Gaither, T.W., Sanford, T.A., Awad, M.A., Osterberg, E.C., Murphy, G.P., Lawrence, B.A., Miller, T.R. and Breyer, B.N., 2017. *Estimated Total Costs from Non-Fatal and Fatal Bicycle Crashes in the USA: 1997-2013*. Injury prevention, pp.injuryprev-2016.

<http://injuryprevention.bmj.com/content/early/2017/04/24/injuryprev-2016-042281>

## 8.24. Title: Teens' Distracted Driving Behavior: Prevalence and Predictor

**Authors:** Gershon, P., Zhu, C., Klauer, S.G., Dingus, T. and Simons-Morton, B.

**Abstract:** Introduction: Teen drivers' over-involvement in crashes has been attributed to a variety of factors, including distracted driving. With the rapid development of in-vehicle systems and portable electronic devices, the burden associated with distracted driving is expected to increase. The current study identifies predictors of secondary task engagement among teenage drivers and provides basis for interventions to reduce distracted driving behavior. We described the prevalence of secondary tasks by type and driving conditions and evaluated the associations between the prevalence of secondary task engagement, driving conditions, and selected psychosocial factors.

Methods: The private vehicles of 83 newly-licensed teenage drivers were equipped with Data Acquisition Systems (DAS), which documented driving performance measures, including secondary task engagement and driving environment characteristics. Surveys administered at licensure provided psychosocial measures.

Results: Overall, teens engaged in a potentially distracting secondary task in 58% of sampled road clips. The most prevalent types of secondary tasks were interaction with a passenger, talking/singing (no passenger), external distraction, and texting/dialing the cell phone. Secondary task engagement was more prevalent among those with primary vehicle access and when driving alone. Social norms, friends' risky driving behaviors, and parental limitations were significantly associated with secondary task prevalence. In contrast, environmental attributes, including lighting and road surface conditions, were not associated with teens' engagement in secondary tasks.

Conclusions: Our findings indicated that teens engaged in secondary tasks frequently and poorly regulate their driving behavior relative to environmental conditions. Practical applications: Peer and parent influences on secondary task engagement provide valuable objectives for countermeasures to reduce distracted driving among teenage drivers.

**Subject Areas:** Distracted driving; Crashes; Data Acquisition Systems (DAS); Secondary task engagement

**Availability:** Gershon, P., Zhu, C., Klauer, S.G., Dingus, T. and Simons-Morton, B., 2017. *Teens' Distracted Driving Behavior: Prevalence and Predictor*. Journal of Safety Research,(63), pp.157-161.

<https://www.sciencedirect.com/science/article/pii/S002243751730097X>

## 8.25. Title: Climate Change, Weather and Road Deaths

**Author:** Robertson, L.

**Abstract:** In 2015, a 7% increase in road deaths per population in the USA reversed the 35-year downward trend. Here I test the hypothesis that weather influenced the change in trend. I used linear regression to estimate the effect of temperature and precipitation on miles driven per capita in urbanised areas of the USA during 2010. I matched date and county of death with temperature on that date and number of people exposed to that temperature to calculate the risk per persons exposed to specific temperatures. I employed logistic regression analysis of temperature, precipitation and other risk factors prevalent in 2014 to project expected deaths in 2015 among the 100 most populous counties in the USA. Comparison of actual and projected deaths provided an estimate of deaths expected without the temperature increase.

**Subject Areas:** Bicycle; Motor vehicle occupant; Motorcycle; Pedestrian; Public health

**Availability:** Robertson, L., 2017. *Climate Change, Weather and Road Deaths*. Injury Prevention, pp.injuryprev-2017.

[https://www.safetylit.org/citations/index.php?fuseaction=citations.viewdetails&citationIds\[\]=citjournalarticle\\_559716\\_19](https://www.safetylit.org/citations/index.php?fuseaction=citations.viewdetails&citationIds[]=citjournalarticle_559716_19)

**8.26. Title: Demographic Variation in the Injury Patterns of Adult Cyclists Admitted to a Large US Healthcare Network: A Five-Year Review**

**Author:** Williams, S.E., Nelson, R., Kashif, R., Goff, T., Simon, L. and Janse, M.

**Abstract:** Background: Despite considerable health and environmental benefits, cycling is also associated with a risk of injury. Yet, variation in the patterns of cycling trauma which manifests by gender, age, and race/ethnicity is ill-defined. This retrospective study aims to characterize injury patterns in different demographic groups of bicyclists admitted to the Greenville Health System in South Carolina.

Patients and methods: In this IRB-approved, retrospective study, five years of patient data (2010-2014) were gathered from seven emergency departments associated with the Greenville Health System. A total of 155 adult patients hospitalized for bicycle-related trauma were examined in terms of demographics (age, gender, and race) and injury. Injuries were categorized by type, region, and severity. Non-parametric tests were performed to study the effect of demographic characteristics on injury presentation.

Results: Spinal cord ( $p=0.003$ ) and internal organ injuries ( $p=0.000$ ) were significantly more common in men. External body injuries were also more prevalent and severe in men ( $p=0.05$ ), while injury to the extremities and pelvic region was more common and severe in women ( $p=0.02$ ). Herniations ( $p=0.028$ ), internal organ injuries ( $p=0.000$ ), and abrasions ( $p=0.04$ ) occurred more often in White cyclists. This group was also more likely to be wearing a helmet at the time of accident ( $p=0.00$ ). Finally, while hematomas were more prevalent in older adults ( $\geq 55$  years) cyclists ( $p=0.01$ ), this population was also more also likely to wear a helmet than young adults (18-34 years) cyclists ( $p=0.025$ ).

Conclusion: Demographic differences exist in the types and severity of cycling trauma. These differences should be considered during the identification and management of bicycle-related trauma.

**Subject Areas:** Cycling; Demographics; Trauma

**Availability:** Williams, S.E., Nelson, R., Kashif, R., Goff, T., Simon, L. and Janse, M., 2017. *Demographic Variation in the Injury Patterns of Adult Cyclists Admitted to a Large US Healthcare Network: A Five-Year Review*. Trauma, p.1460408617740903.

<http://journals.sagepub.com/doi/abs/10.1177/1460408617740903>

**8.27. Title: Social Inequalities in Child Pedestrian Traffic Injuries: Differences in Neighborhood Built Environments Near Schools in Austin, TX, USA**

**Author:** Hwang, J., Joh, K. and Woo, A.

**Abstract:** There have been many efforts to enhance pedestrian safety for children because school-aged children are one of the most vulnerable groups to traffic injury. However, we have limited understanding as to how the built environment affects child pedestrian safety around schools. Further, most previous studies have overlooked the fact that the built environment that support child pedestrian safety may vary across neighborhood heterogeneity. This study addresses these gaps by examining the impacts of the built environments on child pedestrian crashes around schools in Austin, Texas, USA. We use the binary logistic regression model with Firth's penalized likelihood method to estimate the impacts of built environments on child pedestrian crashes at the street segment level. This study finds that longer block lengths, missing sidewalks, crosswalk density, and commercial land uses around schools may hinder child pedestrian safety. Moreover, we find that socioeconomically disadvantaged children may have little to no protection against the risk of pedestrian crashes, especially due to lack of sidewalks and well-designed crosswalks. Our results may help planners, policymakers, and public health professionals better understand how to enhance child pedestrian safety around schools by improving surrounding built environments based on different neighborhood characteristics.

**Subject Areas:** Child pedestrian safety; Built environment; Street segment; Neighborhood heterogeneity; Firth's penalized likelihood method

**Availability:** Hwang, J., Joh, K. and Woo, A., 2017. *Social Inequalities in Child Pedestrian Traffic Injuries: Differences in Neighborhood Built Environments Near Schools in Austin, TX, USA*. . Journal of Transport & Health.

<http://www.sciencedirect.com/science/article/pii/S2214140516304169>

## 8.28. Title: Risk Analysis of Autonomous Vehicles in Mixed Traffic Streams

**Authors:** Bhavsar, P., Das, P., Paugh, M., Dey, K. and Chowdhury, M.

**Abstract:** The introduction of autonomous vehicles in the surface transportation system could improve traffic safety and reduce traffic congestion and negative environmental effects. Although the continuous evolution in computing, sensing, and communication technologies can improve the performance of autonomous vehicles, the new combination of autonomous automotive and electronic communication technologies will present new challenges, such as interaction with other nonautonomous vehicles, which must be addressed before implementation. The objective of this study was to identify the risks associated with the failure of an autonomous vehicle in mixed traffic streams. To identify the risks, the autonomous vehicle system was first disassembled into vehicular components and transportation infrastructure components, and then a fault tree model was developed for each system. The failure probabilities of each component were estimated by reviewing the published literature and publicly available data sources. This analysis resulted in a failure probability of about 14% resulting from a sequential failure of the autonomous vehicular components alone in the vehicle's lifetime, particularly the components responsible for automation. After the failure probability of autonomous vehicle components was combined with the failure probability of transportation infrastructure components, an overall failure probability related to vehicular or infrastructure components was found: 158 per 1 million mi of travel. The most critical combination of events that could lead to failure of autonomous vehicles, known as minimal cut-sets, was also identified. Finally, the results of fault tree analysis were compared with real-world data available from the California Department of Motor Vehicles autonomous vehicle testing records.

**Subject Areas:** Autonomous vehicles; Risks; Fault tree model; Traffic Safety

**Availability:** Bhavsar, P., Das, P., Paugh, M., Dey, K. and Chowdhury, M., 2017. *Risk Analysis of Autonomous Vehicles in Mixed Traffic Streams*. Transportation Research Record: Journal of the Transportation Research Board, (2625), pp.51-61.

<http://trrjournalonline.trb.org/doi/abs/10.3141/2625-06>

**8.29. Title: Understanding International Road Safety Disparities: Why is Australia so much Safer than the United States?**

**Author:** Marshall, W.E.

**Abstract:** Despite similarities to the US in terms of transportation, land use, and culture, Australia kills 5.3 people per 100,000 population on the roads each year, as compared to the US rate of 12.4. Similar trends hold when accounting for distance driven and the number of registered cars. This paper seeks to understand what is behind the road safety disparities between these two countries. The results suggest that a number of inter-related factors seem to play a role in the better road safety outcomes of Australia as compared to the US. This includes Australia's strategies related to seat belt usage and impaired driving as well as their efforts to help curb vehicle speeds and reduce exposure. Design-related differences include a much greater reliance on roundabouts and narrower street cross-sections as well as guidelines that encourage self-enforcing roads. Policy-related differences include stronger and more extensive enforcement programs, restrictive licensing programs, and higher driving costs. Combined with a more urban population and multimodal infrastructure, Australia tends to discourage driving mileage and exposure while encouraging safer modes of transportation such as transit, at least more so than in most of the US. Australia also enacted their version of Vision Zero - called the Safe System Approach - more than a decade before similar policies began cropping up in US cities. While it is difficult to attribute recent road safety successes to any specific policy, Australia continues to expand their lead on the US in terms of safety outcomes and is a road safety example worthy of consideration.

**Subject Areas:** Road safety; Built environment; Street and intersection design; Safe system approach; Vision zero; Towards zero

**Availability:** Marshall, W.E., 2018. *Understanding International Road Safety Disparities: Why is Australia so much Safer than the United States?* Accident Analysis & Prevention, 111, pp.251-265.

<https://www.sciencedirect.com/science/article/pii/S000145751730427X>



**8.30. Title: Graduated Driver Licensing (GDL) in the United States in 2016: A Literature Review and Commentary**

**Author:** Williams, A.F.

**Abstract:** This is the sixth in a series of reviews of research on graduated driver licensing (GDL) published in the Journal of Safety Research, the present review covering the period mid-2012 through 2016. In the two decades since GDL programs began to be introduced on a widespread basis in the United States, a vast amount of research has been published. The current review discusses recent research and the present state of knowledge on the following topics: characteristics of the novice driver population; effects of GDL on crashes for ages 16-19; the learner and intermediate periods; night and passenger restrictions; cellphone laws; GDL for older novices; enforcement of GDL rules; and programs attempting to influence GDL compliance and safe driving practices in general. GDL stands out as a successful policy for reducing teen driver crashes and is worth building on to extend its benefits. Strengthening existing GDL programs has the most potential for producing further crash reductions.

**Subject Areas:** Driver licensing; Novice drivers; Young drivers; Motor vehicle crashes; Graduated driver licensing

**Availability:** Williams, A.F., 2017. *Graduated Driver Licensing (GDL) in the United States in 2016: A Literature Review and Commentary*. Journal of safety research, 63, pp.29-41.

<https://www.sciencedirect.com/science/article/pii/S0022437517303493>

### **8.31. Title: Development of Curriculum for the Virginia Driver's Licensing Ceremony**

**Authors:** Duke, R., Klauer, C. and Baker, S.

**Abstract:** In Virginia, to receive the actual driver's license (as opposed to the temporary driving permit), both a parent and the teenage driver must appear before a family district court judge and participate in the Virginia Driver's Licensing Ceremony. This is an opportune moment when safety information is disseminated to parents and their novice drivers. These ceremonies are written and created primarily by district court judges. While some judges have taken a great deal of time and compiled excellent information, others are unsure about the information that should be relayed. The purpose of this project was to develop a PowerPoint presentation and handout based on contemporary teen driving research and to disseminate the materials to district court judges throughout the state of Virginia for use in their licensing ceremonies. The PowerPoint presentation included the slides but also was accompanied with a script for the judges to use during the presentation. The slides and script provide parents and teens with key safety information, including the driving risks teens face, the Graduated Driver Licensing (GDL) laws in Virginia, and how to use a parent-teen driving contract as a mechanism for risk reduction and parental management.

**Subject Areas:** Driver's license; Safety information; Driving risks; Parent-teen driving

**Availability:** Duke, R., Klauer, C. and Baker, S., 2017. *Development of Curriculum for the Virginia Driver's Licensing Ceremony*. National Surface Transportation Safety Center for Excellence Reports (NSTSCE, VTTI) [61]

<https://vtechworks.lib.vt.edu/handle/10919/81069>

### **8.32. Title: Statewide Analysis of Bicycle Crashes**

**Authors:** Alluri, P., Raihan, Md. A., Saha, D., Wu, W., Huq, A., and Nafis, S.

**Abstract:** Bicycle crashes are a major traffic safety concern in Florida. In 2014, Florida led the nation with 139 bicyclist fatalities, representing approximately 20% of the nation's total. This project aims to improve bicycle safety on Florida's state roads by conducting a comprehensive study focusing on both statewide and site-specific analyses. The specific project objectives include: (1) review and summarize existing literature on bicycle safety; (2) identify specific contributing causes and patterns of bicycle crashes; (3) identify and analyze bicycle hot spots for crash causes and potential countermeasures; and (4) develop Florida-specific Crash Modification Factors (CMFs) to assess the safety effects of common engineering treatments on bicycle safety.

In this study, an extensive literature review focusing on the methods to identify bicycle hot spots and findings on bicycle crash causes, crash contributing factors, and potential countermeasures was first conducted. A descriptive trend analysis was then conducted based on a total of 26,036 bicycle crashes that occurred during 2011-2014. The top five bicycle crash hot spots in each Florida Department of Transportation (FDOT) district were then identified using spatial analysis in ArcGIS. These hot spots experienced a total of 2,954 bicycle crashes during the four-year analysis period. Police reports of these crashes were reviewed in detail to identify specific bicycle crash types. Crash contributing factors related to each crash type along with specific countermeasures were then identified. Macroscopic spatial analysis was conducted to model the relation between demographic, socio-economic, roadway, traffic, and bicycle activity data at the census block group level and bicycle crash frequencies in Florida. Finally, cross-sectional analysis was conducted to develop Florida-specific CMFs for bicycle crashes for different roadway segment and intersection facility types.

**Subject Areas:** Bicycle crashes; Road Safety; Florida-specific Crash Modification Factors (CMFs)

**Availability:** Alluri, P., Raihan, Md. A., Saha, D., Wu, W., Huq, A., and Nafis, S., 2017. *Statewide Analysis of Bicycle Crashes*. Final Report, FDOT Contract No. BDV29-977-23. <https://ntl.bts.gov/lib/61000/61900/61987/FDOT-BDV29-977-23-rpt.pdf>

### **8.33. Title: Drivers' Attitudes and Behaviors Toward Bicyclists: Intermodal Interactions and Implications for Road Safety**

**Author:** Goddard, T.B.

**Abstract:** Road safety concerns are a legitimate concern when promoting increased bicycle use. Currently, bicyclist traffic fatalities and injuries present both a public health concern and a disincentive to people taking up or continuing to bicycle for transportation. Bicycling is not an inherently a dangerous activity; automobile drivers pose the most risk of harm in crashes with bicyclists. Despite that, drivers' attitudes and behaviors toward bicyclists have not enjoyed much systematic study, particularly in the United States. This research explored the dimensions of drivers' attitudes toward bicyclists, including implicit bias and social attitudes, and examined the relationships between these attitudes and drivers' self reported behaviors. The online survey included a cognitive test of respondents' implicit preference between drivers and bicyclists. The research questions are detailed in the introduction, followed by a review of selected literature (Chapter 2) and detailed methodology (Chapter 3). The first set of results (Chapter 4) explores the potential usefulness of the implicit method and the attitude measures developed for this research, and presents an analysis of drivers' attitudes and what predicts more positive attitudes toward bicyclists. The second set of results (Chapter 5) extends the analysis to drivers' self-report behaviors, and how demographics, individual travel behavior, attitudes, and the built environment predict drivers' behaviors related to bicyclist safety. The dissertation concludes with a discussion of the contribution to the literature on driver attitudes and behaviors, and the implications for both practice and research.

**Subject Areas:** Bicyclist safety; Drivers' attitudes; Individual travel behavior

**Availability:** Goddard, T.B., 2017. *Drivers' Attitudes and Behaviors Toward Bicyclists: Intermodal Interactions and Implications for Road Safety*. (Doctoral dissertation, Portland State University).

<https://search.proquest.com/openview/093678b58cf03c25eb3d4f88c228a4e6/1?pq-origsite=gscholar&cbl=18750&diss=y>

**8.34. Title: Crowdsourcing Data-driven Development of Bicycle Safety Performance Functions (SPFs): Microscopic and Macroscopic Scales**

**Author:** Chen, C.

**Abstract:** While riding bicycles has been promoted for its health, economic, and environmental benefits, it also complements other modes to complete a safe, efficient, and reliable transportation system. However, the dramatic increase of bicycle usage in the U.S. is accompanied by a growth of bicycle crashes. The U.S. Department of Transportation, therefore, is focusing on providing safer riding environments. Providing a more bicycle friendly environment means more investment in (but not limited to) bicycle infrastructure. A correct prediction of bicycle crashes can increase the return on this investment. One useful tool to understand the causality and predict crashes is Safety Performance Functions (SPFs), but no sophisticated SPFs have been established for bicycles. Therefore, the objective of this thesis is to establish SPFs for microscopic (intersection) and macroscopic (corridor) scales in medium and large size cities using crowdsourced bicycle data, with a case study in the Portland and Eugene-Springfield metropolitan, which overcomes the challenge of insufficient bicycle volume data and crash data. Specifically, in this research 1) bicycle SPFs are created for intersections and corridors that have not been sufficiently studied; 2) bicycle crash severity distributions are used the first time to predict the number of bicycle crashes with different crash severity levels; 3) affordable crowdsourced bicycle volume data - STRAVA is chosen to solve the problem of limited data; 4) STRAVA data was verified to be able to represent general bicyclists by comparison with automatic bike count station data; 5) a general framework for building SPFs was developed for jurisdictions.

**Subject Areas:** Bicycle crashes; Safety Performance Functions (SPFs); Intersections; Corridors

**Availability:** Chen, C., 2017. *Crowdsourcing Data-driven Development of Bicycle Safety Performance Functions (SPFs): Microscopic and Macroscopic Scales*. (Masters' Thesis).

[https://ir.library.oregonstate.edu/concern/graduate\\_thesis\\_or\\_dissertations/4b29bb16z](https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/4b29bb16z)

## 9. Transit Planning

### 9.1. Title: Transit Corridor Livability: Realizing the Potential of Transportation and Land Use Integration

**Authors:** Appleyard, B., Ferrell, C.E. and Taecker, M.

**Abstract:** In recent years, strategies to promote transportation and land use integration have gained prominence in planning-related, believed to yield many potential benefits toward travel, health, welfare and sustainability goals. And while livability has been identified as an important outcome of this approach as well, little guidance exists on what livability actually is, how to measure it, or how transportation and land use integration strategies can promote it. This paper reports on the findings of a multi-year study of the livability literature, theory, and practice, followed by an extensive quantitative and qualitative study of over 350 transit corridors including thousands of stations throughout the US. While often dismissed as subjective, this research shows that livability can be understood in well-defined and measurable ways, which are validated through an innovative GIS approach using detailed national travel survey other data. The findings in this paper show how more integrated and livable transit corridors can yield multiple benefits toward regarding our travel, health, welfare and sustainability. The findings herein show how livability goals and their measures can inform planning decisions to promote equitable access to opportunities locally and regionally yielding multiple benefits. Therefore, livability can be seen as an organizing principle for determining when and how to deploy integrated transportation and land use planning strategies. This paper also introduces a practical Handbook and Calculator for Building Livable Transit Corridors, both designed to empower practitioners and members of the public to equitably achieve higher levels of livability at both the local and regional scales.

**Subject Areas:** Transit Corridors; Transport; Landuse,; Livability

**Availability:** Appleyard, B., Ferrell, C.E. and Taecker, M., 2017. *Transit Corridor Livability: Realizing the Potential of Transportation and Land Use Integration*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-03490).

<http://www.sciencedirect.com/science/article/pii/S0091743517301093>

## **9.2. Title: Risk and Resilience Analysis for Highway Assets**

**Authors:** Herrera, E.K., Flannery, A. and Krimmer, M.

**Abstract:** Transportation agencies own tens of thousands of assets, providing essential mobility and economic services to the communities they serve. Moving Ahead for Progress in the 21st Century and subsequent legislation require asset managers to implement risk-based asset management. A discussion is presented on the application of one quantitatively based framework - the American Society of Mechanical Engineers Innovative Technology Institute's Risk and Resilience Analysis and Management for Critical Asset Protection - for analyzing risks posed by physical threats to highway transportation systems and assets. The application of this particular risk analysis framework by the Colorado Department of Transportation following the 2013 floods is recounted; the analysis was used to support requests for federal emergency response funding. Finally, the potential benefits of such analysis for highway transportation project planning and strategic planning are also examined.

**Subject Areas:** Highway; Transportation Agencies; Risk Analysis

**Availability:** Herrera, E.K., Flannery, A. and Krimmer, M., 2017. *Risk and Resilience Analysis for Highway Assets*. Transportation Research Record: Journal of the Transportation Research Board, (2604), pp.1-8.

<http://trrjournalonline.trb.org/doi/abs/10.3141/2604-01>

### **9.3. Title: Modeling Vehicle Miles Traveled on Local Roads Using Classification Roadway Spatial Structure**

**Authors:** Wang, X.B., Cao, X., Yin, K. and Adams, T.M.

**Abstract:** This paper models the relationship between vehicle miles traveled (VMT) on local and collector roads with an objective to predict local road VMT by using collector road VMT. Through a continuous approximation method typically used for vehicle routing, it first analytically reveals this relationship mainly as a function of roadway density ratios between multiple roadway classifications. This structural relationship suggests regression equations using density ratios or logarithmic values of them as the explanatory variables. The use of regression equations enables to account for varying spatial distributions of roadways and demand through parameter calibration. The proposed regression equations are proved good fits through computer simulation using distinct community road network topologies. In addition, practical data from Hennepin County of Minnesota, U.S.A. that encompasses Minneapolis indicates that our developed regression equations can work well.

**Subject Areas:** Vehicle miles traveled; Roadway classification

**Availability:** Wang, X.B., Cao, X., Yin, K. and Adams, T.M., 2017. *Modeling Vehicle Miles Traveled on Local Roads Using Classification Roadway Spatial Structure*. Networks and Spatial Economics, pp.1-23.

<https://link.springer.com/article/10.1007/s11067-017-9341-6>



**9.4. Title: Development of an Accessibility Formulation to Measure Customers' Evaluations of Demand-Responsive Transit (DRT) Systems: Final Report**

**Authors:** Astroza, S., Hoklas, M., Wang, T., Loftus-Otway, L., Bhat, C.R., Castro, M. and Born, K.

**Abstract:** This report discusses the application of the paratransit microsimulation patron accessibility analysis tool developed by the University of Texas researchers. The research team worked on updating the DRT Accessibility Tool developed by the Texas Department of Transportation's Public Transportation Division in Project 5-5178. The primary objectives of this research are (1) classifying the rural transit districts into five distinct categories, (2) updating the DRT Accessibility Tool to make it customizable for each of the five categories, and (3) developing "what if" scenarios for the tool to test. The customization of the tool will make it functional for applications in all the rural transit districts in Texas.

**Subject Areas:** Rural transit; Demand responsive transit; Accessibility

**Availability:** Astroza, S., Hoklas, M., Wang, T., Loftus-Otway, L., Bhat, C.R., Castro, M. and Born, K., 2017. *Development of an Accessibility Formulation to Measure Customers' Evaluations of Demand-Responsive Transit (DRT) Systems: Final Report*. CTR Technical Report, The University of Texas at Austin, (No. FHWA/TX-17/0-6768-1).  
<http://docs.trb.org/prp/17-00318.pdf>

## **9.5. Title: Doors Opening: An Analysis of Equity and Accessibility on Public Transportation Services in The United States**

**Authors:** Williams, E.

**Abstract:** Despite the essential role transportation plays in most people's daily lives, the ways in which our interactions and experiences with transportation systems affect our well-being is often overlooked. Transportation is an issue more significant than the political battles over infrastructure and urban planning generally acknowledge. Existing research has shown that people's access to reliable, high-quality transportation options as well as the degree to which these options provide timely and convenient access to destinations of civic, social, educational, and recreational opportunity varies across race and income lines. As made clear through social science frameworks like social exclusion theory, these variations in accessibility can have significant consequences not only on individuals, but on entire communities. Despite the strong body of research that finds evidence of inequities in the degree to which people can use public transit services to access certain destinations, several questions have gone unanswered. Only a handful of analyses have sought to establish macro-level trends that tell us about overall social patterns regarding variations on the quality and utility of public transit service. Further, much of this work has failed to probe the sources of these variations or looked into the institutional drivers that might explain why some people have different experiences riding transit than others.

This dissertation project is comprised of three empirical research articles that respond to these oversights by introducing a sociological lens to the study of public transportation services broadly, and destination accessibility research specifically. In the first paper, I generate and describe patterns of transit-based access to destinations of opportunity across twelve cities nationwide. In the second paper, I investigate the organizational elements native to transit agencies that have been shown to impact the effectiveness of public services and the degree to which users can reap their benefits. Finally, in the third paper I evaluate the use and utility of traditional and alternative transportation planning paradigms for engendering robust accessibility outcomes. While the three analyses engage three unique research questions with their own theoretical foundation, hypotheses, and methodological technique, there is an overarching question that guides my analysis: how useful is public transportation service when it comes to actually meeting people's accessibility needs, and in what ways do public transit agencies themselves affect these accessibility outcomes?

Results of this analysis demonstrates there are macro-level, observable differences in people's ability to use public transportation to access the places they need or want to go, and that particular elements of an agency's organizational structure do in fact impact the utility of transit to various destinations in ways that are both straightforward and complex across cities and between social groups. This work also demonstrates that although transportation-based planning initiatives are currently incorporated in transit agency planning standards and guidelines, the impact of this approach is limited. Collectively, results across the three studies provide solid evidence that the physical outcomes of transit systems are reflections of institutional conditions in transit agencies. In reinforcing the role and impact of public institutions for shaping social service delivery outcomes, this research is an important contribution to both urban sociology and urban transportation planning literatures.

**Subject Areas:** Public transport; Transit agencies; Transportation planning

**Availability:** Williams, E., 2017. *Doors Opening: An Analysis of Equity and Accessibility on Public Transportation Services in The United States*. M.S. Thesis, Northeastern University.  
[http://search.proquest.com/openview/2d8aca488fd7ccb656201a62d585abe5/1?  
pq-origsite=gscholar&cbl=18750&diss=y](http://search.proquest.com/openview/2d8aca488fd7ccb656201a62d585abe5/1?pq-origsite=gscholar&cbl=18750&diss=y)

**9.6. Title: Transportation Inclusion and Community Wellbeing: Exploring Public Transit Accessibility of Winnipeg's North End Neighbourhoods**

**Author:** Chandran, D.

**Abstract:** Analyzing public transit accessibility to marginalized communities is critical to exploring the link between transportation inclusion and wellbeing in automobile-centered cultures. This study is an attempt to examine public transit accessibility to Indigenous residents in Winnipeg's North End. Apart from analyzing the current level of transit accessibility, the study explores barriers that hinder the use of public transit in the North End and examines strategies to improving transit accessibility to its residents.

This study adopts a holistic approach to understanding 'accessibility' and recognizes the importance of socio-economic, perceptual, and demographic factors in shaping the demand for transit facilities in an area. Findings of the study illustrate the need to include transportation inclusion as an essential component of the urban Indigenous welfare policies in the country. The lessons learned will also provide an initial framework to understand the link between community wellbeing and transportation inclusion of other socio-economically vulnerable communities.

**Subject Areas:** Indigenous communities; Transit accessibility; Transportation equity

**Availability:** Chandran, D., 2017. *Transportation Inclusion and Community Wellbeing: Exploring Public Transit Accessibility of Winnipeg's North End Neighbourhoods*. M.S. Thesis, University of Manitoba, Winnipeg.

[https://mspace.lib.umanitoba.ca/bitstream/handle/1993/31978/CHANDRAN\\_DEEPA.pdf?sequence=1](https://mspace.lib.umanitoba.ca/bitstream/handle/1993/31978/CHANDRAN_DEEPA.pdf?sequence=1)

**9.7. Title: Why Tiny Electric Planes and \$25 Tickets could be the Future of Regional Air Travel**

**Author:** Wang A.B.

**Abstract:** Blog

**Subject Areas:** Transit Planning; High-speed regional transit; Short-haul air system

**Availability:** Wang A.B., 2017. *Why Tiny Electric Planes and \$25 Tickets could be the Future of Regional Air Travel*. Washington Post.

[https://www.washingtonpost.com/news/innovations/wp/2017/04/08/why-tiny-electric-planes-and-25-tickets-could-be-the-future-of-air-travel/?utm\\_term=.c4dd0b54ece7](https://www.washingtonpost.com/news/innovations/wp/2017/04/08/why-tiny-electric-planes-and-25-tickets-could-be-the-future-of-air-travel/?utm_term=.c4dd0b54ece7)

**9.8. Title: Riding Transit Takes Almost Twice as Long as Driving**

**Author:** Maciag, M.

**Abstract:** Blog

**Subject Areas:** Public Transportation; Commuting times; Ridership; Operating speed

**Availability:** Maciag, M., 2017. *Riding Transit Takes Almost Twice as Long as Driving*. Infrastructure & Environment, Governing the States and Localities Blog.

<http://www.governing.com/topics/transportation-infrastructure/gov-transit-driving-times.html>

**9.9. Title: Uber's Mildly Helpful Data Tool Could Help Cities Fix Streets**

**Author:** Davies, A.

**Abstract:** Blog

**Subject Areas:** Public Transportation; Commuting patterns; Traffic planning

**Availability:** Davies, A., 2017. *Uber's Mildly Helpful Data Tool Could Help Cities Fix Streets*. Transportation, Wired.com.

<https://www.wired.com/2017/01/uber-movement-traffic-data-tool/>

### **9.10. Title: CatCharger: Deploying Wireless Charging Lanes in a Metropolitan Road Network through Categorization and Clustering of Vehicle Traffic**

**Authors:** Yan, L., Shen, H., Zhao, J., Xu, C., Luo, F. and Qiu, C.

**Abstract:** The future generation of transportation system will be featured by electrified public transportation. To fulfill metropolitan transit demands, electric vehicles (EVs) must be continuously operable without recharging downtime. Wireless Power Transfer (WPT) techniques for in-motion EV charging is a solution. It however brings up a challenge: how to deploy charging lanes in a metropolitan road network to minimize the deployment cost while enabling EVs' continuous operability.

In this paper, we propose CatCharger, which is the first work that handles this challenge. From a metropolitan-scale dataset collected from multiple sources of vehicles, we observe the diversity of vehicle passing speed and daily visit frequency (called traffic attributes) at intersections (i.e., landmarks), which are important factors for charging lane deployment. To select landmarks for deployment, we first group landmarks with similar traffic attribute values using the entropy minimization clustering method, and choose better candidate landmarks from each group suitable for deployment. To determine the deployment locations from the candidate landmarks, we infer the expected vehicle residual energy at each landmark using a Kernel Density Estimator fed by the vehicles' mobility, and formulate and solve an optimization problem to minimize the total deployment cost while ensuring a certain level of expected residual energy of EVs at each landmark. Our trace-driven experiments demonstrate the superior performance of CatCharger over other methods.

**Subject Areas:** Public Transportation; Transit demands, Electric vehicles

**Availability:** Yan, L., Shen, H., Zhao, J., Xu, C., Luo, F. and Qiu, C., 2017. *CatCharger: Deploying Wireless Charging Lanes in a Metropolitan Road Network through Categorization and Clustering of Vehicle Traffic*. In Proc. of INFOCOM.

[http://www.people.virginia.edu/~ly4ss/papers/conference/CatCharge\\_poster.pdf](http://www.people.virginia.edu/~ly4ss/papers/conference/CatCharge_poster.pdf)

[https://www.researchgate.net/publication/310829188\\_CatCharger\\_Deploying\\_Wireless\\_Charging\\_Lanes\\_in\\_a\\_Metropolitan\\_Road\\_Network\\_through\\_Categorization\\_and\\_Clustering\\_of\\_Vehicle\\_Traffic](https://www.researchgate.net/publication/310829188_CatCharger_Deploying_Wireless_Charging_Lanes_in_a_Metropolitan_Road_Network_through_Categorization_and_Clustering_of_Vehicle_Traffic)



### 9.11. Title: 18 Equity Analysis of California High-Speed Rail

**Author:** Nuworsoo, C.

**Abstract:** The California high-speed rail (HSR) project, which began construction in 2014, plans to link the state's four largest metropolitan areas (Sacramento and San Francisco to the north; Los Angeles and San Diego to the south) with the first true high-speed train system in United States. According to studies by the California High Speed Rail Authority (CHSRA), the high-speed rail network is projected to carry between 22.6 and 32.6 million passengers per year by 2030. Who will be the main beneficiaries of this new transport system? Are there particular groups that will benefit little? This chapter presents an overview of the debates about equity that have surrounded the project and an analysis of the relative social equity of California's high-speed rail system for different segments of the population. Equity is defined here as 'fairness in the distribution of goods and services among the people in an economy'.

**Subject Areas:** Public Transportation; High-speed Rail, Long-distance travelers; Travel patterns

**Availability:** Nuworsoo, C., 2017. *18 Equity Analysis of California High-Speed Rail*. High-Speed Rail and Sustainability: Decision-Making and the Political Economy of Investment, p.299. <https://books.google.com/books?hl=en&lr=&id=2i4lDwAAQBAJ&oi=fnd&pg=PA299&dq=#v=onepage&q&f=false>

## 9.12. Title: Transit System Design and Vulnerability of Riders to Heat

**Authors:** Fraser, A.M. and Chester, M.V.

**Abstract:** In the United States public transit utilization has increased significantly in the last decade and is considered a critical component in reducing energy use and greenhouse gas emissions in urban areas. Despite public transit's climate change mitigation potential, the use of transit necessitates environmental exposure which may be a health hazard during periods of extreme heat. Transit system design, which includes stop location and schedules, is shown to contribute to environmental exposure resulting from access and waiting. Using Los Angeles Metro (Los Angeles County, CA) and Valley Metro (Maricopa County, AZ) as case studies of systems operating in extreme heat conditions, the research demonstrates how system design contributes to heat exposure times that vary significantly between neighborhoods. Household level access (walking) time estimates are developed using a shortest path algorithm to nearby transit stops. Waiting time estimates for individual transit stops are derived from published transit schedules and on-board survey responses. The results show that transit users from areas with low residential density, limited high capacity roadways and irregular street networks, and not located along direct paths between major activity centers are likely to experience prolonged access and/or waiting times. Public transit may help mitigate climate change impacts but transit proponents, agencies and planners should be cognizant of the impact an uncertain climate future may have on a growing base of transit riders. These insights can allow us to proactively govern and adapt transit systems to protect people from a growing health concern.

**Subject Areas:** Transit; Heat; Urban; Health; Climate

**Availability:** Fraser, A.M. and Chester, M.V., 2017. *Transit System Design and Vulnerability of Riders to Heat*. Journal of Transport & Health, 4, pp.216-225.

<http://www.sciencedirect.com/science/article/pii/S2214140516302122>

**9.13. Title: Benchmarking a Transit System on Time-Constrained Trip Chain Access: A Comparative GIS Analysis of Two University Towns**

**Author:** Lachman, M.A.

**Abstract:** Strong network planning is a prerequisite for mode shift to transit. One way that planners compare design alternatives is to apply accessibility metrics to them. However, many metrics currently in use do not account for human tendencies to plan travel as a whole-day unit, nor do they adequately account for constraints on time spent traveling.

In this research, a metric is developed that involves choosing a typical daily chain of trips that are tested at specific time intervals for the entire area population. The trip chain is run for transit systems in two similar university towns using GIS network analysis, and benchmarking from the literature on average daily travel time budgets is applied. Results show substantial time accessibility differences that are positively associated with relative ridership levels and explained by the frequency, schedule span, and spatial configuration of the transit network.

**Subject Areas:** Transit; Trip Chain; Accessibility metrics

**Availability:** Lachman, M.A., 2017. *Benchmarking a Transit System on Time-Constrained Trip Chain Access: A Comparative GIS Analysis of Two University Towns*. Doctoral dissertation, Ohio University.

[https://etd.ohiolink.edu/pg\\_10?0::NO:10:P10\\_ACCESSION\\_NUM:ohiou1483613270824226](https://etd.ohiolink.edu/pg_10?0::NO:10:P10_ACCESSION_NUM:ohiou1483613270824226)

**9.14. Title: First Mile-Last Mile, Intermodalism, and Making Public Transit More Attractive**

**Author:** Polzin, S.

**Abstract:** Blog.

**Subject Areas:** Urban Public transit; First mile-last mile

**Availability:** Polzin, S., 2017. *First Mile-Last Mile, Intermodalism, and Making Public Transit More Attractive*. Planetizen.

<https://www.planetizen.com/node/93909/first-mile-last-mile-intermodalism-and-making-public-transit-more-attractive>

**9.15. Title: Effects of Additional Capacity on Vehicle Kilometers of Travel in the U.S.: Evidence from National Household Travel Surveys**

**Author:** Zolnik, E.J.

**Abstract:** Adding capacity is one policy mechanism to alleviate congestion. However, the empirical evidence strongly suggests that additional capacity only makes congestion worse. This study analyzes the differential effects of additional freeway capacity versus additional arterial capacity on vehicle kilometers of travel (VKT) in metropolitan areas across the U.S. The analysis uses vehicle data and household data from the 2001 and the 2009 National Household Travel Surveys (NHTS) and includes stock and flow measures of road capacity, road congestion, commuter demand, and economic growth for metropolitan areas. Taking into account differences between metropolitan areas on each measure, the study adopts a novel multilevel model approach to estimate how additional capacity affects VKT. Results indicate that adding more arterial capacity slightly decreases VKT over a lag period from six years (1995 to 2001) to eight years (2001 to 2009), probably because adding arterials shortens routes between origins and destinations more so than adding freeways. Consistent with expectations, VKT is lower in more congested metropolitan areas, and in metropolitan areas that got more congested. Results also indicate that rebound effects (higher fuel-economy vehicles are driven much more than lower fuel-economy vehicles) will at least partially offset the demand management benefits of (gasoline) price sensitivity (higher gasoline prices decrease VKT).

**Subject Areas:** Induced demand; Vehicle kilometers of travel; Capacity; Multilevel models

**Availability:** Zolnik, E.J., 2017. *Effects of Additional Capacity on Vehicle Kilometers of Travel in the U.S.: Evidence from National Household Travel Surveys*. Journal of Transport Geography, 66, pp.1-9.

<https://www.sciencedirect.com/science/article/pii/S0966692317307020>

## 9.16. Title: The CTPP Workplace Data for Transportation Planning: A Systematic Review

**Authors:** Seo, J.H., Vo, T., Lee, S., Wen, F. and Choi, S.

**Abstract:** The Census Transportation Planning Products (CTPP) data has been a valuable resource for transportation planning community, providing information about where people live and work, their journey-to-work commuting patterns, and their socioeconomic and travel characteristics. While the CTPP data has been widely utilized by transportation planning agencies and researchers as a key input for various transportation planning subject areas including, but not limited to, travel demand modeling, descriptive statistics, policy and planning strategies, environmental analyses, and survey and sampling methods, the CTPP Oversight Board believes that the CTPP workplace data is underutilized. To understand the potential enhancements to the CTPP workplace data for better utilization in the future, this paper provides an overview of the CTPP and other data products that have been widely utilized in transportation planning and research, such as the Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) and the National Household Travel Survey (NHTS), and then, discusses the strengths and limitations of the CTPP workplace data as compared to those two data products. In addition, this paper summarizes the previous and current utilization of the CTPP data by reviewing over 300 studies that cited the use of the CTPP data, and identifies the key subject areas and the emerging topics of those studies.

**Subject Areas:** Transportation Planning; Workplace data; Commuting patterns; Census Transportation Planning Products (CTPP)

**Availability:** Seo, J.H., Vo, T., Lee, S., Wen, F. and Choi, S., 2017. *The CTPP Workplace Data for Transportation Planning: A Systematic Review*. Commissioned Paper for 2017 Applying Census Data for Transportation Conference.

<http://onlinepubs.trb.org/onlinepubs/conferences/2017/censusdata/WorkplaceData.pdf>

### **9.17. Title: Utilizing Student Schedule Data to Develop Travel Matrices for Transit and Pedestrian Travel Demand Models**

**Author:** Fisher, B.S.

**Abstract:** Problem Statement: Transportation planners apply travel demand models to aid in the prediction of the impacts regarding a proposed infrastructure or land use change. The four-step model is an example of a widely used model that uses the socioeconomic status of the encompassing region to calculate the demand for individuals to utilize transportation infrastructure. Within the four-step model, distinct steps occur: trip generation, trip distribution, mode choice and trip assignment. Trip generation is the most general process, defining the total number of journeys that will occur across the entire study area. Trip distribution builds upon this by assigning each trip a beginning and an end, creating a theoretical origin-destination matrix. Mode choice determines the method, or mode, of transportation by which each trip will be completed. Lastly, Trip assignment determines the exact route each trip will traverse, producing a path reflecting optimal usage. When analyzing the introduction of a transit system to a university campus, however, socioeconomic data is an unreliable source of determining trip frequency. One solution involves maintaining the existing process, which requires data collection using a local travel survey to replace socioeconomic information. A more feasible approach, however, involves replacing the trip generation and trip distribution steps with a preconstructed origin-destination (OD) matrix. This thesis analyzes known student locations to produce an exact OD matrix, and explains its integration with the four-step travel demand model.

Motivation: Among literature focusing on travel demand modeling, many methods have been developed to gather travel pattern information. Little research, however, has looked at the application of gathering data unique to a university setting.

Objective: This analysis provides the framework necessary to accurately analyze the feasibility of operating a public transit system on a university campus. The primary objective of this research is to provide an alternative to using national data within a travel model's trip characteristic assumptions. The secondary objective of this research is to provide an example of using existing data to automatically construct a travel matrix, reducing the required resources.

**Subject Areas:** Travel Demand Models; Transit system; Travel Matrices

**Availability:** Fisher, B.S., 2017. *Utilizing Student Schedule Data to Develop Travel Matrices for Transit and Pedestrian Travel Demand Models*. Doctoral dissertation, University of Delaware. <https://search.proquest.com/openview/35b5b73bbb8f54c350d04a9598eef2f6/1?pq-origsite=scholar&cbl=18750&diss=y>

**9.18. Title: Conceptual Models of the Effect of Information and Communications Technology on Long-Distance Travel Demand**

**Author:** Erhardt, G.D.

**Abstract:** Rapidly evolving information and communications technology (ICT) poses a risk to the accuracy of long-distance travel (LDT) demand forecasts. The nature of this risk is multifaceted: ICT could reduce demand if people substituted virtual for physical travel, or it could serve as a complement and thereby induce more demand. This paper presents two conceptual models for better understanding the nature of those relationships. Both models start from an existing LDT model and envision how that model can be adapted to capture ICT effects, with one considering the effects explicitly and the other implicitly. When the effects of future technology are being forecast, data collected in the past or in the present, when the future technology does not exist, are inherently limited. In such situations, conceptual models such as these can be applied by using a scenario-based approach to explore a range of reasonable outcomes. This strategy can be an important tool not just for ICT, but also for understanding the risks posed by other future technologies, such as autonomous vehicles.

**Subject Areas:** Transportation Planning; Information and Communications Cechnology (ICT); Long-Distance Travel (LDT) Models; Autonomous vehicles

**Availability:** Erhardt, G.D., 2017. *Conceptual Models of the Effect of Information and Communications Technology on Long-Distance Travel Demand*. Transportation Research Record: Journal of the Transportation Research Board, (2658), pp.26-34.

<http://onlinepubs.trb.org/onlinepubs/conferences/2017/censusdata/WorkplaceData.pdf>



### **9.19. Title: High-Speed Rail and Sustainability**

**Authors:** Deakin, E. and Henríquez, B.L.P.

**Abstract:** High speed rail (HSR) is being touted as a strategic investment for connecting people across regions, while also fostering prosperity and smart urban growth. However, as its popularity increases, its implementation has become contentious with various parties contesting the validity of socioeconomic and environmental objectives put forward as justification for investment. *High Speed Rail and Sustainability* explores the environmental, economic and social effects of developing a HSR system, presenting new evaluations of the proposed system in California in the US as well as lessons from international experience. Drawing upon the accumulated experience from past HSR system development around the world, leading experts present a diverse set of perspectives as well as diverse contexts of implementation. Assessments of the California case as well as cases from Japan, France, Germany, Italy, Spain, Taiwan, China, and the UK show how governments and stakeholders have bridged the gap between the vision and the realities of connecting metropolitan regions through HSR. This is a valuable resource for academics, researchers and policy-makers in the areas of urban planning, civil engineering, transportation and environmental design.

**Subject Areas:** Transit Planning; Smart urban growth; High speed rail (HSR)

**Availability:** Deakin, E. and Henríquez, B.L.P., 2017. *High-Speed Rail and Sustainability*. High-Speed Rail and Sustainability: Decision-Making and the Political Economy of Investment, p.354. [https://www.researchgate.net/publication/310802466\\_High-Speed\\_Rail\\_and\\_Sustainability\\_Decision-making\\_and\\_the\\_political\\_economy\\_of\\_investment](https://www.researchgate.net/publication/310802466_High-Speed_Rail_and_Sustainability_Decision-making_and_the_political_economy_of_investment)

## 9.20. Title: Rail-transit-induced Gentrification and the Affordability Paradox of TOD

**Author:** Dong, H.

**Abstract:** Numerous studies have shown that rail transit has a positive effect on raising property values and tax revenues. Such an effect is widely viewed as an economic benefit for property owners and is key to justifying the high cost of building rail transit infrastructure. In recent years, however, concerns have been raised about rail transit acting as a gentrification trigger and causing the affordability paradox. In this study, I evaluate whether rail transit in suburban Portland caused neighborhood gentrification and reduced home affordability through a longitudinal quasi-experimental design. I use the propensity score matching method to identify control neighborhoods for rail-transit-served neighborhoods. I then make pretest-posttest comparisons between rail-transit-served neighborhoods and their control neighborhoods at multiple observation points. In general, I did not find consistent evidence for rail-transit-induced gentrification in suburban Portland. I did not find evidence that rail transit reduced home affordability for tenants and home owners in rail transit-served neighborhoods either. I observed more changes in the neighborhoods served by the Eastside line (the oldest rail transit line in Portland) than their control neighborhoods in the past three decades: socially, they attracted older and less-educated population; physically, they experienced densification and faster increases of the share of rental units in their housing stock. Rail transit was more likely to be installed along low-income neighborhoods in suburban Portland, confirming the necessity of constructing appropriate control neighborhoods while evaluating the neighborhood and social effects of rail transit.

**Subject Areas:** Transportation equity; Transit-oriented development; Gentrification; Affordability; Propensity score matching

**Availability:** Dong, H., 2017. *Rail-transit-induced Gentrification and the Affordability Paradox of TOD*. *Journal of Transport Geography*, 63, pp.1-10.

<https://www.sciencedirect.com/science/article/pii/S0966692316300941>

### **9.21. Title: How Does Transportation Affordability Vary Among TODs, TADs, and Other Areas?**

**Authors:** Scheer, B.C., Ewing, R., Park, K., and Khan, S.S.

**Abstract:** Transit-oriented development (TOD) has gained popularity worldwide as a sustainable form of urbanism; it concentrates development near a transit station so as to reduce auto-dependency and increase ridership. Existing travel behavior studies in the context of TOD, however, are limited in terms of small sample size, inconsistent TOD classification methods, and failure to control for residential self-selection. Thus, this study has three research questions. First, how can we distinguish between Transit-oriented development (TOD) and Transit-adjacent development (TAD)? Second, how do travel behaviors vary between TODs and TADs? Third, how does transportation affordability vary between TODs and TADs? This study utilizes cluster analysis to classify station area types and propensity score matching to control residential self-selection.

From cluster analysis with built-environment factors - density, diversity, and walkability - in a half-mile buffer, this study classifies existing station areas as TOD, TAD or Hybrid types. After controlling for residential self-selection, it shows that a TOD motivates its residents to walk more and take transit more while using personal vehicles less. The significant difference between TOD and TAD in both VMT and the number of auto trips demonstrates that TODs make the personal vehicle trips shorter and fewer. Travel behavior in the Hybrid type demonstrates the possibility of gradual and practical change. Finally, the percentage of household income spent on transportation is lower in TOD households than TAD households. This shows that a TOD household is likely to save enough money on vehicle ownership and use that, while it likely spends more on transit, the final result is a significantly lower financial burden from transportation.

**Subject Areas:** Transit-oriented development; Transportation Planning; Bus rapid transit; Street-railroads

**Availability:** Scheer, B.C., Ewing, R., Park, K., and Khan, S.S., 2017. *How Does Transportation Affordability Vary Among TODs, TADs, and Other Areas?* NITC-RR-859. Portland, OR: Transportation Research and Education Center (TREC).

[https://pdxscholar.library.pdx.edu/trec\\_reports/143/](https://pdxscholar.library.pdx.edu/trec_reports/143/)

**9.22. Title: Improving Last-Mile Connections to Transit: An Exploration of Data and Analysis Tools**

**Author:** McCahill, C.

**Abstract:** Last-mile connections are the critical links between an existing transit service and its potential users. New Urbanist principles such as connected street networks, walkable design, and transit oriented development (TOD) are important for improving these last-mile connections and ensuring the success of transit systems. However, to date there are no widely accepted methods for identifying gaps in transit accessibility, evaluating solutions, and prioritizing improvements. This paper explores the potential for two emerging fields - accessibility measurement and trip-making data - to help inform decisions focused on improving last-mile connections.

Based on three case studies of light rail transit corridors in Sacramento, this paper demonstrates the following: 1) the use of accessibility measures in scanning for poor connections and evaluating potential solutions, 2) the use of passive GPS data for understanding vehicle trip generation and travel patterns along transit corridors, and 3) the preliminary use of passive GPS data for understanding pedestrian travel patterns to and from transit stations. With some additional work, these tools will be useful for decision-makers as they work toward improving travel options, increasing transit ridership, coordinating with other key players, and communicating concepts with the public.

**Subject Areas:** Last-mile connections ; Transit service; Transit corridors

**Availability:** McCahill, C., 2017. *Improving Last-Mile Connections to Transit: An Exploration of Data and Analysis Tools* State Smart Transportation Initiative, University of Wisconsin-Madison. [https://www.cnu.org/sites/default/files/2017\\_NewUrbanResearch.ImprovingLastMileConnectionsToTransit\\_McCahill.pdf](https://www.cnu.org/sites/default/files/2017_NewUrbanResearch.ImprovingLastMileConnectionsToTransit_McCahill.pdf)

**9.23. Title: Attitudinal Variables Influencing Transit Ridership: Measuring the Impact of Express Bus Service in Kingston, Ontario**

**Author:** MacFarlane, R.

**Abstract:** This report explores transportation behaviour in a mid-sized Canadian city context during a major change in service. Scholars have analyzed the many factors that influence transit ridership amongst populations, including: built form variables; demographic characteristics; mode specific factors; trip characteristics; transportation demand management; and psychological factors. However, the degree to which these factors predict transit ridership is not clearly understood or agreed upon, particularly in mid-sized cities. This report discusses how these six categories of variables influenced transit ridership amongst staff commuting to Queen's University in Kingston, Ontario between 2013 and 2016. The findings of this research indicate that Queen's University employees have gradually begun to adopt Kingston Transit as a primary means to commute to work, and attitudes towards transit similarly experience moderate change over time. Factors within four of the six variable categories were found to have significant influence towards predicting transit shifting amongst the subject population.

**Subject Areas:** Transportation behaviour ; Transit ridership; Transportation demand management

**Availability:** MacFarlane, R., 2017. *Attitudinal Variables Influencing Transit Ridership: Measuring the Impact of Express Bus Service in Kingston, Ontario*. Department of Geography and Planning Graduate Projects.

<http://qspace.library.queensu.ca/handle/1974/15873>

## 10. Travel Behavior

### 10.1. Title: Travel and the Built Environment: Insights Using Activity Densities, the Sprawl Index, and Neighborhood Type

**Authors:** Ralph, K., Voulgaris, C.T. and Brown, A

**Abstract:** There are many ways to evaluate the built environment, including measures of observable individual characteristics (such as activity density), continuous composite measures (such as the sprawl index), and categorically measured variables (such as neighborhood types). However, a systematic comparison of how well each of these three measurement types captures the influence of the built environment on travel behavior has not yet been undertaken. This lack presents a quandary for both researchers and practitioners who seek to quantify and describe the effects of the built environment on travel behavior. This paper assesses whether continuous, composite, or categorical measures provide more information and better-fitting models compared with measures of observable individual characteristics across four travel behaviors: vehicle miles traveled, walk trips, transit trips, and trip length. For each travel variable, four multivariate regression models were estimated with various measures of the built environment: activity density, sprawl index, neighborhood type, and combined sprawl index and neighborhood type. Both the sprawl index and the neighborhood-type models outperformed the activity density model. Moreover, a combined model with both the sprawl index and neighborhood types provided the best fit for all four travel behavior variables. These results suggest that both continuous and categorical composite variables provide unique and complementary information about how the built environment influences travel behavior. These findings underscore the importance of researchers' decisions on how to represent the built environment quantitatively in models, because measurement decisions influence the understanding of how the built environment affects travel behavior.

**Subject Areas:** Travel Behavior; Built environment; Sprawl Index; Density

**Availability:** Ralph, K., Voulgaris, C.T. and Brown, A., 2017. *Travel and the Built Environment: Insights Using Activity Densities, the Sprawl Index, and Neighborhood Types*. Transportation Research Record: Journal of the Transportation Research Board, (2653), pp.1-9.  
<http://trrjournalonline.trb.org/doi/pdf/10.3141/2653-01>

## **10.2. Title: Influence of Personal Concerns About Travel on Travel Behavior**

**Authors:** Jeong, K., Hyun, K.K. and Ritchie, S.G.

**Abstract:** This study estimated unobservable personal travel concerns using a structural equation modeling (SEM) approach and investigated recursive and complex relationships among travel concerns, travel behavior and individual socioeconomic status. The model was developed using 54,552 individual survey responses obtained from the 2009 US National Household Travel Survey (NHTS). The unobservable concerns about travel were categorized into cost-concerns and safety-concerns and estimated by using measurable indicators that specify the most important transportation issue to the survey respondents. Travel behavior for auto and public transit trips were represented by daily vehicle miles traveled (VMT) and public transit usage, respectively. Results showed that people who have higher safety concerns more likely reduced their daily VMT while those who have higher cost concerns tended to use more public transit. State level models with the four most populated states in the U.S., “California, Texas, Florida and New York” were further compared to consider geographical impacts on travel concerns and travel behavior. The most influential concerns and their impact on travel behavior varied amongst the states, implying that the transportation environment in different geographic regions influences psychological characteristics on travel behavior.

**Subject Areas:** Highways; Planning and Forecasting; Policy; Public Transportation

**Availability:** Jeong, K., Hyun, K.K. and Ritchie, S.G., 2017. *Influence of Personal Concerns About Travel on Travel Behavior*. Transportation Research Board 96<sup>th</sup> Annual Meeting (No. 17-06826).

<https://trid.trb.org/view.aspx?id=1439738>

**10.3. Title: Impacts of standardizing school start time on children and household workers  
- An examination with NHTS data**

**Author:** Deka, D.

**Abstract:** Due to demonstrated health, safety, and performance benefits to children from delayed school start time, academics and government agencies in the United States are increasingly insisting on starting schools at or after 8:30 AM - the time recommended by the American Academy of Pediatrics. Despite this urging, schools across the country continue to start well before that time. A common argument against the change is potential negative impacts on working household members. Using data from the 2009 National Household Travel Survey (NHTS), this paper therefore examines the potential impacts of nationally standardizing school start time at 8:30 AM with a focus on household members who give children rides to/from school and their travel patterns before and after escorting children. In addition to estimating the number of household members and workers that may be directly affected by delayed school start time, the paper examines through multinomial logit and probit models the individual and household characteristics of children who take rides from household members and the workers who may be adversely affected by delayed school start time of household children. Analysis showed that around 4% of the country's population may have to adjust their trips before and after escorting children to/from school. Around 65% of them are workers. A comparison of adversely affected workers with other workers revealed that the delay of school start time is not likely to have disparate impacts on disadvantaged populations, but the impacts may be more significant in some regions of the country than others.

**Subject Areas:** Travel patterns; household workers; multinomial logit models; School children

**Availability:** Deka, D., 2017. *Impacts of standardizing school start time on children and household workers - An examination with NHTS data*. *Journal of Transport Geography*, 59, pp.40-48.  
<http://www.sciencedirect.com/science/article/pii/S0966692317300352>



**10.4. Title: Neighborhood Density and Travel Mode: New Survey Findings for High Densities**

**Author:** Lewis, S., 2017.

**Abstract:** At high densities, land uses get close enough to each other to support walk, bike, and transit modes above 60% of total trips. The San Francisco Bay Area census was used to define five density levels: rural, exurban, suburban, central city, and urban core. The urban core definition, over 50 persons per neighborhood acre, is much denser than in other research. The California Household Transportation Survey supplied new data on block group area, population, trip stages, trip distances, trip time, and travel mode by density. The National Household Transportation Survey supplied block group population, density, travel mode, and income data. Both sources show a strong nonlinear relationship going from rural to urban core: auto miles and trips decrease as walk and transit miles and trips increase. With density, people travel fewer miles and spend less time traveling. High-income households in dense areas travel far fewer miles than those living at higher densities. With sufficient density, complementary features play a role in furthering mode shift. For planning purposes, the need for parking greatly declines. The findings are a basis for similar research elsewhere on high densities and complementary features.

**Subject Areas:** Neighborhood density; Travel mode; Household travel surveys; Walkable neighborhood systems; Sustainability

**Availability:** Lewis, S., 2017. *Neighborhood Density and Travel Mode: New Survey Findings for High Densities*. International Journal of Sustainable Development & World Ecology, pp.1-14.  
<http://www.tandfonline.com/doi/ref/10.1080/13504509.2017.1321052?scroll=top>

### **10.5. Title: School Transportation Mode, by Distance between Home and School, United States, Consumer Styles 2012**

**Authors:** Beck, L.F. and Nguyen, D.D.

**Abstract:**

Background: Motor-vehicle crashes are a leading cause of death among children in the United States, and almost one-fourth of all trips by school-aged children are trips to and from school. This study sought to determine how children (5-18 years) travel to and from school and, among those living  $\leq 1$  mile of school, to explore the role of school bus service eligibility on school travel mode.

Methods: We used national 2012 survey data to determine prevalence of usual school travel mode, stratified by distance from school. For those living  $\leq 1$  mile of school, multivariable regression was conducted to assess the association between bus service eligibility and walking or bicycling.

Results: Almost half (46.6%) of all children rode in passenger vehicles (PV) to school and 41.8% did so for the trip home. Results were similar among those living  $\leq 1$  mile (48.1%, PV to school; 41.3%, PV to home). Among those living  $\leq 1$  mile, 21.9% and 28.4% of children walked or bicycled to and from school, respectively. Ineligibility for school bus service was strongly associated with walking or bicycling to school [adjusted prevalence ratio (aPR): 5.36;  $p < 0.001$ ] and from school (aPR: 5.36;  $p < 0.001$ ).

Conclusions: Regardless of distance from school, passenger vehicles were a common mode of travel. For children who live close to school, the role that school bus service eligibility plays in walking or bicycling deserves further consideration.

**Subject Areas:** Motor vehicle; Travel Pattern; Child passenger safety; Children; Pedestrians; Bicyclists

**Availability:** Beck, L.F. and Nguyen, D.D., 2017. *School Transportation Mode, by Distance between Home and School, United States, Consumer Styles 2012*. Journal of Safety Research. <http://www.tandfonline.com/doi/ref/10.1080/13504509.2017.1321052?scroll=top>

**10.6. Title: Exploring the Influence of Built Environment on Travel Mode Choice Considering the Mediating Effects of Car Ownership and Travel Distance**

**Authors:** Ding, C., Wang, D., Liu, C., Zhang, Y. and Yang, J.

**Abstract:** Though there is a growing literature on the connection between the built environment and travel behavior, limited efforts have been made to consider the intermediary nature of car ownership and travel distance simultaneously while modeling the relationship between the built environment and travel mode choice behavior. The mediating effects from car ownership and travel distance, as an important piece, are not sufficiently investigated. To fill this gap, in this study the relationships among travel mode choice, car ownership and travel distance were described using a framework of integrated structural equation model (SEM) and discrete choice model (DCM). Drawing on a rich dataset of National Household Travel Survey (NHTS) and numerous built environment measurements in Baltimore metropolitan area, this research applied the integrated SEM and DCM approach to investigate how the built environment affects travel mode choice through influencing car ownership and travel distance. Therefore, the direct and indirect effects of built environment on travel mode choice were revealed. This study hopes to give transportation planners a better understanding on how the built environment influences travel mode choice, and consequently develop effective and targeted countermeasures to reduce car use.

**Subject Areas:** Built environment; Travel behavior; Car ownership; Mediating effect

**Availability:** Ding, C., Wang, D., Liu, C., Zhang, Y. and Yang, J., 2017. *Exploring the Influence of Built Environment on Travel Mode Choice Considering the Mediating Effects of Car Ownership and Travel Distance*. . Transportation Research Part A: Policy and Practice, 100, pp.65-80.

<http://www.sciencedirect.com/science/article/pii/S0965856416303391>

### **10.7. Title: Active Travel Behavior in a Border Region of Texas and New Mexico: Motivators, Deterrents and Characteristics**

**Authors:** Sener, I.N. and Lee, R.J.

**Abstract:**

Background: Active travel has been linked with improved transportation and health outcomes, such as reduced traffic congestion and air pollution, improved mobility, accessibility and equity, and increased physical and mental health. The purpose of this study was to better understand active travel characteristics, motivators, and deterrents in the El Paso, Texas region.

Methods: A multimodal transportation survey brought together elements of transportation and health, with a focus on attitudinal characteristics. The analysis consisted of an initial descriptive analysis, spatial analysis, and multivariate binary and ordered-response models of walking and bicycling behavior.

Results: The motivators and deterrents of active travel differed for walkers, bicyclists, and non-cyclists interested in bicycling. The link between active travel and life satisfaction was moderated by age, with a negative association for older travelers. This effect was stronger for bicycling than it was for walking.

Conclusions: Based on the findings, several interventions to encourage walking and bicycling were suggested. These included infrastructure and built environment enhancements, workplace programs, and interventions targeting specific sub-populations.

**Subject Areas:** Travel behavior; Walking; Bicycling; Health

**Availability:** Sener, I.N. and Lee, R.J., 2017. *Active Travel Behavior in a Border Region of Texas and New Mexico: Motivators, Deterrents and Characteristics*. Journal of Physical Activity and Health, pp.1-30.

<http://journals.humankinetics.com/doi/abs/10.1123/jpah.2016-0503>

**10.8.** Title: Synergistic Neighborhood Relationships with Travel Behavior: An Analysis of Travel in 30,000 US Neighborhoods

**Authors:** Voulgaris, Carole Turley, Brian D. Taylor, Evelyn Blumenberg, Anne Brown, and Kelcie Ralph.

**Abstract:** A now substantial body of literature finds that land use and urban form have a statistically significant, albeit relatively modest, effect on travel behavior. Some scholars have suggested that various built-environment characteristics influence travel more in concert than when considered in isolation. Yet few previous studies have combined built-environment measures to create holistic descriptions of the overall character of neighborhoods, and fewer still have related these neighborhoods to residents' travel decisions. To address this gap in the literature, we develop a typology of seven distinct neighborhood types by applying factor analysis and then cluster analysis to a set of 20 variables describing built-environment characteristics for most census tracts in the United States. We then include these neighborhood types in a set of multivariate regression models to estimate the effect of neighborhood type on the travel behavior of neighborhood residents, controlling for an array of personal and household characteristics. We find relatively little variation in the number of daily trips among neighborhood types, but there is substantial neighborhood variation in both person miles of travel and mode choice. Travel by residents of one particular neighborhood type is notably distinguished from all others by a very low number of miles traveled, little solo driving, and high transit use. However, this neighborhood type is found almost exclusively in just a few very large metropolitan areas, and its replicability is uncertain.

**Subject Areas:** Neighborhood classification; Travel Behavior

**Availability:** Voulgaris, Carole Turley, Brian D. Taylor, Evelyn Blumenberg, Anne Brown, and Kelcie Ralph, 2017. *Synergistic Neighborhood Relationships with Travel Behavior: An Analysis of Travel in 30,000 US Neighborhoods*. Journal of Transport and Land Use, 10(1): 437-461.

<https://www.jtlu.org/index.php/jtlu/article/view/840/856>

**10.9.** Title: The Role of Destination's Built Environment on Nonmotorized Travel Behavior: A Case of Long Beach, California

**Authors:** Kim, D., Park, J. and Hong, A.

**Abstract:** This study examines how built environment factors at trip destinations influence non-motorized travel behavior in the City of Long Beach, California. Using 2008-2009 National Household Travel Survey with California Add-Ons, we found that nonmotorized users tend to choose more clustered destinations than motorized users, and that density, diversity, and design at destinations significantly affect mode choice decisions. Transportation networks and nonmotorized facilities at trip destinations are especially important factors for nonmotorized mode choice. Future policy and research need to consider built environment factors at trip destinations to effectively accommodate nonmotorized travel within a city.

**Subject Areas:** Built-in Environment; Nonmotorized Travel; Transport Network; Trip Destinations

**Availability:** Kim, D., Park, J. and Hong, A., 2017. *The Role of Destination's Built Environment on Nonmotorized Travel Behavior: A Case of Long Beach, California*. Journal of Planning Education and Research, p.0739456X16688765.

<http://journals.sagepub.com/doi/abs/10.1177/0739456X16688765>

**10.10. Title: Determinants of Route Choice Behavior: A Comparison of Shop versus Work Trips using the Potential Path Area - Gateway (PPAG) algorithm and Path-Size Logit**

**Authors:** Dalumpines, R. and Scott, D.M.

**Abstract:** This paper presents an in-depth comparison of route choice models for work and shop vehicle trips - with emphasis on the interactions between route attributes and individual characteristics to better understand the route choice determinants that are assumed to vary by trip purpose. Insights into the route choice behavior involving two dominant vehicle trip purposes - work and shop trips - will help in the design of traffic facilities and implementation of measures to influence route choice in the desired direction.

In this study, we show that the utility and scale parameters for separate models of work and shop trips differ by direct comparison using a sequential scaling estimation method and likelihood ratio tests, and highlight the differences in route choice behavior by considering the interaction of route attributes and individual characteristics using Path-Size Logit modeling. In the process, we used Potential Path Area - Gateway (PPAG) algorithm - that generates feasible route choice sets for route choice modeling from GPS trajectories of observed routes.

The results show that, indeed, route choice behavior varies by trip, which suggests that drivers attach value to route choice determinants relative to trip purpose. The inclusion of interaction terms in model specifications further indicates that work route choice behavior tends to be restrictive compared to the nonrestrictive route choice for shop trips - a generalization consistent with the mandatory and discretionary nature of work and shop trips, respectively. Specifically, individual characteristics such as personal income, age, gender, tenure, household size, and access to public transit affect route choice behavior.

**Subject Areas:** Route choice; Path size logit; GPS; Travel behavior

**Availability:** Dalumpines, R. and Scott, D.M., 2017. *Determinants of Route Choice Behavior: A Comparison of Shop versus Work Trips using the Potential Path Area - Gateway (PPAG) algorithm and Path-Size Logit*. Journal of Transport Geography, , 59, pp.59-68.

<http://www.sciencedirect.com/science/article/pii/S096669231630357X>

### **10.11. Title: Modeling the Choice of Time-of-day for Joint Social-Recreational Activities**

**Authors:** Lim, K.K. and Srinivasan, S.

**Abstract:** In modeling time of day choice, constructing choice alternatives in the case of joint tours requires the temporal synchronization of travel of all members of the travel party. This study describes how the time constraints of multiple persons can be effectively accommodated into determining the choice set and, subsequently, the choice of timing for joint social/recreational tours. Many previous studies on time-of-day choice modeling have been dominated by dividing the continuous time variable into discrete time intervals. Although the continuous representation of time in the method was proposed, their relative complexity in the estimation over the discrete choice methods is a drawback from practical perspectives. In this study, an alternate two-step approach is proposed. The first model predicts the time-window chosen for pursuing the joint discretionary tour, and the second model locates the tour within the chosen time window by determining the start- and end-hours of the tour simultaneously on a continuous scale. A MNL model within the discrete contexture is also estimated as for the predictive assessment comparison. A wide set of explanatory variables were included in the model estimations. The models developed are used to assess predictive abilities using validation samples. Overall, the fractional-split model is shown to be effective from the standpoint of predictive accuracy over the reference model based on the discrete time representations.

**Subject Areas:** Time-of-day Choice; Social-Recreational Activity; Fractional-Split Model

**Availability:** Lim, K.K. and Srinivasan, S., 2017. *Modeling the Choice of Time-of-day for Joint Social-Recreational Activities*. KSCE Journal of Civil Engineering, pp.1-9.

<https://link.springer.com/article/10.1007/s12205-017-0807-3>



**10.12. Title: A Largely Unnoticed Impact on Real Estate - Self-Driven Vehicles**

**Authors:**Levine, M.L., Segev, L.L. and Thode, S.F.

**Abstract:** Motor vehicles are very important in the United States and throughout the world. Certainly, motor vehicles for personal and business use are a major piece of the transportation system. Such activity impacts the use of real estate, be that for commercial buildings in the form of offices, retail, residential complexes, recreation activities, warehouses, or otherwise. Autos and buses are also important parts of residential living and the personal lives of most residents in the United States. Included with in these uses is the implied position of a driver for such vehicle. But, if a driver was no longer necessary for the use of an auto, a bus, or a truck how could this impact the use of real estate for personal and commercial uses? How could such change influence the choice of a residence, job, parking, zoning, and types of services currently employed to support the use of the vehicles? These issues are examined in this Note with a focused examination of the impact of driverless vehicles as they relate to real estate uses and activity.

**Subject Areas:** Driver-less Vehicle; Real estate; Travel activity

**Availability:** Levine, M.L., Segev, L.L. and Thode, S.F., 2017. *A Largely Unnoticed Impact on Real Estate - Self-Driven Vehicles*. Appraisal Journal, 85(1).

<http://web.a.ebscohost.com.proxygw.wrlc.org/ehost/pdfviewer/pdfviewer?sid=39ad3511-fc6c-4eb9-8501-7daeba2819f5%40sessionmgr4010&vid=1&hid=4107>

### **10.13. Title: Improving Trip Generation Methods for Livable Communities**

**Authors:** Clifton, K., Larco, N., Currans, K.M. and Wettach-Glosser, J.

**Abstract:** Recent efforts to improve trip generation data available for transportation impact analysis of new development include the collection of multimodal trip generation data, development of models that account for the built environment, and new recommendations for practice. Building on a long line of research on transportation and built environment, many studies have identified important features of the surrounding built environment that most impact trip rates and mode shares, building on a long line of research on transportation and the built environment. Despite these improvements in data and methods, less attention is placed on identifying the conditions of the site itself and the immediate surrounding environment that influence trip generation and mode choice. To fill this gap, this study builds upon previous work (Contextual Influences on Trip Generation (Project Number: OTREC 2011-407), 2012), re-examines the information collected in that study, and includes new site-level observations. The objective of this study is to examine establishment multimodal trip generation more closely from a finer-grained scale and identify site-level attributes of the built environment that help explain multimodal trip generation. From this, we have the additional objective of developing a framework for trip generation analysis that takes findings from this study into consideration. We placed emphasis on those sites in our previous study with a discord between the expected travel patterns, based upon the larger urban context and built environment of the site, and the observed. The research approach will make use of mixed methods. In addition to using archived data from the previous study, site visits provided direct observation of the overall performance of the site, including travel patterns on and around the site as well as specific site configuration, urban design details and traffic operations. The analysis of this combination of data provided a more complete picture of site-level trip generation and our findings highlight the influence of: people living nearby and using the site; the nature of the land use on the site; the development along arterial roadways; site permeability and access; and the local culture around walking and cycling. Finally, this report ends by reflecting on the numerous concerns identified from practice, the research findings from various recent studies, and the need for a sustainable process for evaluating the transportation impacts of new land development. We present a potential framework to advance the methods for how site plans fit into neighborhood and regional planning, using locally defined standards and goals. Here, we de-emphasize the site and its immediate environs as the primary (and only) scale of analysis and lessen the reliance on the problematic methodologies for estimating site-level travel demand. Rather, we argue that transportation impact analysis would benefit by first taking a district, neighborhood or area-wide approach with attention to the urban context - the built and social environment - where a site is located.

**Subject Areas:** Traffic surveys; Trip generation; Transportation Planning; Statistical methods; Urban transportation; Travel patterns

**Availability:** Clifton, K., Larco, N., Currans, K.M. and Wettach-Glosser, J., 2017. *Improving Trip Generation Methods for Livable Communities*. NITC-RR-757. Portland, OR: Transportation Research and Education Center (TREC).

[http://pdxscholar.library.pdx.edu/trec\\_reports/124/](http://pdxscholar.library.pdx.edu/trec_reports/124/)

#### **10.14. Title: Tour Complexity, Variability and Pattern using Longitudinal GPS Data**

**Author:** Shi, X.

**Abstract:** Trip chaining is a common phenomenon generally known as linking multiple activities and trips in one travel process. A good understanding about trip chaining complexity is important for travel demand model development and for transportation policy design. However, most of the existing studies on trip chaining limit the complexity classification scheme on number of trips chained and neglect other dimensions that also elevate the degree of complexity. The purpose of this study is to develop a new approach, Tour Complexity Index (TCI), that integrates the multi-dimensional nature of trip chaining into the complexity assessment. The study contains three analysis components. The first component introduces the TCI approach as a trip chaining complexity measure that not only considers number of trips chained but also includes the spatial relationship across destinations, the route arrangement, and the urban environment of the destinations. By comparing descriptive statistics and generalized linear model results from TCI approach with those from traditional approach, we find that the TCI approach offers more information regarding trip chaining and mode choice. The application of TCI is further demonstrated in the following components. The second component investigates the intra-personal daily and weekly travel variability with travel characterized by TCI and mode choice. The result reinforces an argument in current literature that the common single-day travel survey may produce biased estimation due to the day-to-day variance in travel behavior. Result also finds that proximity to a new transit service from place of residence is connected with a decline in variability. The third component explores a framework for travel pattern recognition where pattern is characterized by TCI as well. The discrepancy analysis which is a generalized analysis of variance (ANOVA) method is applied to associate individual characteristics with travel pattern. In addition, both components use Sequential Alignment Method (SAM) for travel pattern representation. The TCI approach and proposed analysis frameworks are validated using the longitudinal GPS trajectory data collected between 2011 and 2013 at west Los Angeles area for Expo Study.

**Subject Areas:** Trip chaining; Travel behavior; Travel demand model; Tour Complexity Index

**Availability:** Shi, X., 2017. *Tour Complexity, Variability and Pattern using Longitudinal GPS Data*. Doctoral dissertation, University of California, Irvine.

<http://search.proquest.com/openview/6d87457fa19f8503313615644e00dc80/1?pq-origsite=gscholar&cbl=18750&diss=y>

### 10.15. Title: Zipf's Power Law in Activity Schedules and the Effect of Aggregation

**Authors:** Ectors, W., Kochan, B., Janssens, D., Bellemans, T. and Wets, G.

**Abstract:** Modeling people's behavior in e.g. travel demand models is an extremely complex, multidimensional process. However, the frequency of occurrence of day-long activity schedules obeys a ubiquitous power law distribution, commonly referred to as Zipf's law. This paper discusses the role of aggregation within the phenomenon of Zipf's law in activity schedules. Aggregation is analyzed in two dimensions: activity type encoding and the aggregation of individual data in the dataset. This research employs four datasets: the household travel survey (HTS) NHTS 2009, two six-week travel surveys (MobiDrive 1999 and Thurgau 2003) and a 24-week set of trip data which was donated by one individual. Maximum-likelihood estimation (MLE) and the Kolmogorov- Smirnov (KS) goodness-of-fit (GOF) statistic are used in the "PowerLaw" R package to reliably fit a power law. To analyze the effect of aggregation in the first dimension, the activity type encoding, five different activity encoding aggregation levels were created in the NHTS 2009 dataset, each aggregating the activity types somewhat differently. To analyze aggregation in the second dimension, the analysis moves from study area-wide aggregated data to subsets of the data, and finally to individual (longitudinal) data.

**Subject Areas:** Travel Behavior; Zipf; Power law; Activity schedules; Data aggregation; Activity type classes

**Availability:** Ectors, W., Kochan, B., Janssens, D., Bellemans, T. and Wets, G., 2017. *Zipf's Power Law in Activity Schedules and the Effect of Aggregation*. *Procedia Computer Science*, 109, pp.225-232.

<http://www.sciencedirect.com/science/article/pii/S1877050917310049>

**10.16.** Title: Investigating the impacts of Built Environment on Vehicle Miles Traveled and Energy Consumption: Differences between Commuting and Non-Commuting Trips

**Authors:** Ding, C., Liu, C., Zhang, Y., Yang, J. and Wang, Y.

**Abstract:** This research contributes to the understanding of the impacts of the built environment on vehicle miles traveled (VMT) and energy consumption by considering the mediating effects from vehicle type and travel speed. Meanwhile, whether the relationships among the built environment, VMT and energy consumption vary between commuting and non-commuting trip was examined by applying the multiple-group structural equation model (SEM). The primary travel data used in the research is drawn from the National Household Travel Survey (NHTS) Baltimore Add-on data. In this study, the built environment was measured for each residential location based on various external sources. By controlling for the socio-demographic factors, the model results show that the effects of the built environment on travel speed, VMT and vehicle energy consumption significantly vary between commuting and non-commuting trips. For the two different travel types, the direct, indirect, and total effects of the built environment measurements on VMT and vehicle energy consumption were discussed. The model results confirmed the important roles played by the built environment in influencing VMT and vehicle energy consumption. The results are expected to give urban planners and policy makers a better understanding on how the built environment factors can impact the VMT and energy consumption, and consequently develop more effective and targeted countermeasures.

**Subject Areas:** Built environment; VMT; Energy consumption; Multiple-group SEM; Commuting trip

**Availability:** Ding, C., Liu, C., Zhang, Y., Yang, J. and Wang, Y., 2017. *Investigating the impacts of Built Environment on Vehicle Miles Traveled and Energy Consumption: Differences between Commuting and Non-Commuting Trips*. *Cities*, 68, pp.25-36.

<http://www.sciencedirect.com/science/article/pii/S0264275116304887>

**10.17.** Title: Commuting in America; Developing a National Report from National Survey Sources

**Author:** Weinberger, P.Z.

**Abstract:** The Commuting in America (CIA) series of reports describing travelers and their commutes to work began in April 1984, using US census data to describe the emerging patterns of commuting. The original intent of CIA was to serve as a common resource of factual information upon which policymakers could draw in shaping transportation development actions and policies. The fourth iteration of CIA, CIA 2013, consists of 16 briefs in topical areas of commuting, including The Role of Commuting in Overall Travel, Population and Worker Trends, Population and Worker Dynamic, The Nature and Pattern of Jobs, Job Dynamics, Vehicle and Transit Availability, Consumer Spending on Transportation, How Commuting Influences Travel, Commuting Mode Choice, Commuting Departure Time and Trip Time, Auto Commuting, Transit Commuting, Bicycling and Walking Commuting and Commuting Flow Patterns. The project was completed in January 2014. Understanding commuting is a critical component of understanding total travel. Commuting travel patterns often define a large share of a household's total trip-making as measured in share of trips. As work trips are slightly longer than trips for other purposes, work-trip commuting comprises a slightly larger share of total person travel miles. Work trips most often occur during congested time periods and are the largest contributor to travel time delay. Work trips are sensitive to and suffer the consequences of travel delay and large variations in travel time reliability. CIA once relied on the US Census Bureau's decennial long form data to develop reports on national commuting patterns and trends. With the advent of the American Community Survey (ACS) and subsequent discontinuation of the Decennial Long Form, the methodology for discerning national commuting trends has had to change. The two chief sources for data for CIA 2013 were the ACS and the USDOT's National Household Travel Survey (NHTS). Additional national survey sources include the American Housing Survey of the Department of Housing and Urban Development, the Consumer Expenditure Survey of the Bureau of Labor Statistics, the administrative records-based Longitudinal Employment Household Dynamics (LEHD), the Transportation Energy Data Book, and FTA's National Transit Database (NTD). The US Census collects the largest, most comprehensive national data set on commuting with the "Journey to Work" questions now in the ACS. While the ACS is not a travel survey in the traditional sense, it is the source of data most used by transportation planners and modelers for demographic and commute travel behavior. This paper follows the history of Commuting in America with an emphasis on which data were used, and how. The paper discusses the introduction and history of the journey to work question, changes from the long form to the ACS, the inclusion of other US Census and non-census data sets to discern travel trends, and ways the ACS data were used to generate information on the topics. While the paper is not a traditional research paper, it provides an historic scan and concepts for how these types of data sets can be employed to generate important, topical, accessible information for consumption by decision makers and the public. This work is of use to data providers who wish to make their data more useful and to practitioners faced with large data sets needing ideas to help turn them into information.

**Subject Areas:** Commuting; Data analysis; Data collection; Travel behavior; Travel patterns; Travel surveys; Travel time; Work trips

**Availability:** Weinberger, P.Z., 2016. *Commuting in America; Developing a National Report*

*from National Survey Sources.* In European Transport Conference 2016, Association for European Transport (AET).

<http://abstracts.aetransport.org/paper/index/id/5078/confid/21>

**10.18.** Title: Investigating the Influence of Trip Distance on Travel Behaviour of Non-Motorized Transport (NMT) Users

**Authors:** Mondal, S., Mitra, S. and Majumdar, B.B.

**Abstract:** Non-Motorized Transport (NMT) modes can only be used for trips of relatively short lengths; hence it is essential to know the spatial extent of the trips taken by such modes and their variation in various land-use and geographic setup. For this exercise, good quality comprehensive data consisting of regions is a must; hence the choice of National Household Travel Survey (NHTS) data from United States. This data consists of household travel survey records from multiple urban and rural areas of all states of the United States for the year 2009 and has been used in this research. Using the mentioned dataset, this study seeks to answer the following research questions of interest: (1) How far users walk or use bicycle typically? (2) How the trip lengths varied across various populations sub-groups? and (3) How the trip lengths varied with variation of size of city, land-use and geography?

With these questions in mind, this paper analyses the nature of trips made by NMT modes and investigates the influence of trip length on travel behavior of NMT users' across various population subgroups. To start with, the average trip lengths made by walk and bicycles across various geographic locations are estimated. Additionally, estimates of drop in trip patronage with increased trip lengths are obtained using the concept of distance-decay. These distance-decay functions are also estimated for different geographic locations with varying population and land uses, using which it is possible to obtain travel impedance or deterrence of walking and bicycling with increases trip lengths.

As expected the overall results reveal that with an increase in trip length, users are less willing to walk than bicycle with as estimated impedance or level of deterrence of 0.259 for bicycle and 0.687 for walk in urban area. Similarly, the impedance values of 0.254 and 0.679 are estimated for bicycle and walk respectively for rural area. The impedance caused by trip length is observed to vary significantly among different user groups for both pedestrians and bicycle users. For example, in urban area "Shopping" trips made by bicycle users are found to have the maximum impedance of 0.371 and bicycle trips made by users with "Professional, managerial, or technical" occupation are found to be least influenced by trip length with the lowest impedance of 0.136.

**Subject Areas:** Non-Motorized Transport (NMT), Distance-Decay, Impedance, Trip Length Frequency Distribution, Commuting; Data analysis; Data collection; Travel behavior; Travel patterns; Travel surveys; Travel time; Work trips

**Availability:** Mondal, S., Mitra, S. and Majumdar, B.B. *Investigating the Influence of Trip Distance on Travel Behaviour of Non-Motorized Transport (NMT) Users*. 3<sup>rd</sup> Conference of Transportation Research Group of India (3rd CTRG).

[https://www.researchgate.net/profile/Bandhan\\_Majumdar/publication/288786922\\_Investigating\\_the\\_influence\\_of\\_Trip\\_Distance\\_on\\_Travel\\_Behaviour\\_of\\_Non-Motorized\\_Transport\\_NMT\\_users/links/57b2e8e80aeb2cf17c73b7f.pdf](https://www.researchgate.net/profile/Bandhan_Majumdar/publication/288786922_Investigating_the_influence_of_Trip_Distance_on_Travel_Behaviour_of_Non-Motorized_Transport_NMT_users/links/57b2e8e80aeb2cf17c73b7f.pdf)



**10.19.** Title: Estimating Motorized Travel Mode Choice using Classifiers: An Application for High-Dimensional Multicollinear Data

**Authors:** Lindner, A., Pitombo, C.S. and Cunha, A.L.

**Abstract:** Studies in the field of discrete choice analysis are crucial for transportation planning. Generally, travel demand models are based on the maximization of the random utility and straightforward mathematical functions, such as logit models. These assumptions lead to a continuous model that presents constraints concerning fitting the data. Artificial Neural Networks (ANN) and Classification Trees (CT) are classification techniques that can be applied to discrete choice models. These techniques can overcome some disadvantages of traditional modeling, especially the drawback of not being able to model high-dimensional multicollinear data. This research paper compares the performance of estimating motorized travel mode choice through ANN and CT with a binary logit in a multicollinear study case (aggregated and disaggregated covariates). The dataset refers to an Origin-Destination Survey carried out in São Paulo Metropolitan Area, Brazil in 2007. Classification techniques have shown a good ability to forecast (approximately 80% match rate), as well as to recognize travel behavior patterns. Furthermore, by using the classifier application, the most important covariates within all the datasets can be selected. These covariates can be related to households, as well as to Traffic Analysis Zones.

**Subject Areas:** Artificial Neural Networks; Decision tree algorithms; Travel mode choice; Multicollinear data

**Availability:** Lindner, A., Pitombo, C.S. and Cunha, A.L., 2017. *Estimating Motorized Travel Mode Choice using Classifiers: An Application for High-Dimensional Multicollinear Data*. *Travel Behaviour and Society*, 6, pp.100-109.

<http://www.sciencedirect.com/science/article/pii/S2214367X16300291>

**10.20.** Title: Tracking a System of Shared Autonomous Vehicles across the Austin, Texas Network using Agent-Based Simulation 2

**Authors:** Liu, J., Kockelman, K.M., Boesch, P.M. and Ciari, F.

**Abstract:** This study provides a large-scale micro-simulation of transportation patterns in a metropolitan area when relying on a system of shared autonomous vehicles (SAVs). The six-county region of Austin, Texas is used for its land development patterns, demographics, networks, and trip tables. The agent-based MATSim toolkit allows modelers to track individual travelers and individual vehicles, with great temporal and spatial detail. MATSim's algorithms help improve individual travel plans (by changing tour and trip start times, destinations, modes, and routes). Here, the SAV mode requests were simulated through a stochastic process for four possible fare levels: \$0.50, \$0.75, \$1, and \$1.25 per trip-mile. These fares resulted in mode splits of 50.9%, 12.9%, 10.5%, and 9.2% of the region's person-trips, respectively. Mode choice results show longer-distance travelers preferring SAVs to private, human-driven vehicles (HVs) - thanks to the reduced burden of SAV travel (since one does not have to drive the vehicle). For travelers whose households do not own an HV, SAVs (rather than transit, walking and biking) appear preferable for trips under 10 miles, which is the majority of those travelers' trip-making. It may be difficult for traditional transit services and operators to survive once SAVs become available in regions like Austin, where dedicated rail lines and bus lanes are few. Simulation of SAV fleet operations suggest that higher fare rates allow for greater vehicle replacement (ranging from 5.6 to 7.7 HVs per SAV, assuming that the average SAV serves 17 to 20 person-trips per day); this is due to travel demands shifting away from longer trip distances, when fares rise. Empty vehicle miles traveled by the fleet of SAVs ranged from 7.8 percent to 14.2 percent, across the scenarios in this study. Implications of mobility and sustainability benefits of SAVs are also discussed in the paper.

**Subject Areas:** Shared Autonomous Vehicles; Car-sharing; Agent-Based Simulation; Mode Choice; Travel Demand Modeling

**Availability:** Liu, J., Kockelman, K.M., Boesch, P.M. and Ciari, F., 2017. *Tracking a System of Shared Autonomous Vehicles across the Austin, Texas Network using Agent-Based Simulation 2*. Transportation Research Part C: Emerging Technologies.

[http://www.cae.utexas.edu/prof/kockelman/public\\_html/TRB17SAVs\\_acrossAustin.pdf](http://www.cae.utexas.edu/prof/kockelman/public_html/TRB17SAVs_acrossAustin.pdf)

**10.21.** Title: Developing a Data Transferability Framework for Evaluating National-level Impacts of Connected Automated Vehicles

**Authors:** Shabanpour R, Golshani N, Auld J, Mohammadian AK, Stephens TS.

**Abstract:** Connected autonomous vehicles (CAVs) are getting road tested and they may become available for public use not in a far future. However, their potential impacts on travel behavior have yet to be understood and incorporated into transportation plans. Specifically, there is yet to be any literature published on large-scale travel demand models that account for CAVs benefits. This study aims to develop a methodological framework based on data transferability techniques to use data and models from a smaller geographical area (Chicago metropolitan area) and generate disaggregate data in national level. To achieve this goal, POLARIS activity-based framework is leveraged to estimate the potential impacts of CAV technologies both on travel demand and traffic flow in Chicago metropolitan area. Transferable variables such as total daily trip rates and travel times for each individual are also derived from POLARIS simulation results for CAV scenario. We then apply a two-step clustering algorithm to assign people into homogeneous groups through which various types of lifestyles are captured, followed by estimating joint models of number of daily trips and total travel time within each cluster. Finally, using an artificial neural network model, cluster membership rules are transferred to the national level data and the estimated joint models are simulated within the corresponding clusters. Comparison of distributions of transferred variables in the regional and national contexts indicate that the platform is capable of transferring travel behavior to the national level with high level of accuracy. This platform can be utilized to test various policies and scenarios that may affect the use of CAV and their national impacts.

**Subject Areas:** Connected automated vehicles; Travel behavior; Model transferability; Data fusion; Neural Networks.

**Availability:** Shabanpour R, Golshani N, Auld J, Mohammadian AK, Stephens TS., 2017. *Developing a Data Transferability Framework for Evaluating National-level Impacts of Connected Automated Vehicles*. Paper is submitted to the 97th Transportation Research Board and is currently under review.

**10.22. Title: Understanding Travel Behavior: How Good Are Our Data Sources for Addressing Travel Behavior Information Needs?**

**Authors:** Tawfik, A.M. and Zohdy, I.

**Abstract:** The diversity of new vehicle technology and fuel markets, the governments' sustainable call to reduce energy consumption and air pollution lead to a change in the personal vehicle market. Considering the impact of these factors, a stated preference survey approach is adopted to analyze household future preferences for gasoline, hybrid electric, and battery electric vehicles in a dynamic marketplace. The stated choice experiment places respondents in a nine-year hypothetical time window with dynamically changing attributes including vehicle purchasing price, fuel economy, recharging range, and fuel price. A web-based survey was performed during 2014 in the state of Maryland. The collected data include household social-demographics, primary vehicle characteristics, and vehicle purchasing preferences of 456 respondents during the year of 2014-2022. Mixed Multinomial logit (MMNL) models are employed to predict vehicle preferences based on households' socio-demographics and vehicle characteristics. The estimation results show that young people are more likely to buy vehicles with new technology, especially battery electric vehicles (BEV). Women with a high education level (bachelor degree or higher) prefer to choose hybrid electric vehicle (HEV) while men with a high education level are more likely to buy BEV. The estimated vehicle market elasticities with respect to vehicle price are from -1.1 to -1.8 for HEV and BEV, higher than those for gasoline vehicles from -0.6 to -1.0. The vehicle market cross-elasticities estimated by MMNL models range from 0.2 to 0.6. In addition, willingness to pay (WTP) of vehicle characteristics estimated by MMNL models provide a good understanding of household future vehicle preferences.

**Subject Areas:** Data quality; Methodology; Multiple criteria decision making; Traffic data; Traffic forecasting; Traffic models; Travel behavior

**Availability:** Tawfik, A.M. and Zohdy, I., 2017. *Understanding Travel Behavior: How Good Are Our Data Sources for Addressing Travel Behavior Information Needs?* Transportation Research Board. 96<sup>th</sup> Annual Meeting (No. 17-06385).  
<https://trid.trb.org/view.aspx?id=1439545>

**10.23. Title: Statewide Tourism Travel Demand Forecasting: A Behavior-Based Modeling Framework for the State of Florida**

**Authors:** Pourabdollahi, Z., Tillery, R., Gawade, M., Hill, T., Mathews, G. and Worrell, J.

**Abstract:** Tourism travel comprises a significant portion of the total annual long distance travels of individuals in the U.S. According to the National Household Travel Survey, of all long distance trips, about 56% are for pleasure purposes. Florida with more than 106.3 million visitors in 2015 is one of the top tourist destinations in the world and tourism is one of the state's most significant sources of economic revenue and employment. Moreover, seasonal tourist travels in Florida are considered a major source of congestion, maintenance, security, and environmental costs that need to be considered by planners and decision makers. A comprehensive and specific framework that is required for accurate estimation and forecast of tourism trips in order to better address policy and planning concerns. However, similar to most states, tourism travels are forecasted as a secondary component in the statewide travel demand models using a straightforward process such as applying national trip rates. In this paper, an advanced behavior-based tourism modeling framework is presented which is able to incorporate important behavioral elements of tourism travels and capture the specific characteristics of tourism trips such as seasonality. The modeling framework can be easily integrated into the statewide travel demand model and used for more accurate forecast of tourism travel demand.

**Subject Areas:** Forecasting; Tourism; Travel demand; Planning and Forecasting; Transportation (General)

**Availability:** Pourabdollahi, Z., Tillery, R., Gawade, M., Hill, T., Mathews, G. and Worrell, J., 2017. *Statewide Tourism Travel Demand Forecasting: A Behavior-Based Modeling Framework for the State of Florida*. Transportation Research Board. 96<sup>th</sup> Annual Meeting (No. 17-03511). <https://pubsindex.trb.org/view/2017/C/1438404>

#### **10.24. Title: Tour-Based Mode Choice Study Through Support Vector Machine Classifiers**

**Authors:** Pirra, M. and Diana, M.

**Abstract:** A new approach in recognizing travel mode choice patterns is proposed in this paper. A classification technique, Support Vector Machine (SVM), is used to analyze a tour-based travel demand dataset derived from the 2009 National Household Travel Survey and reporting tours done during a day in the New York State. Three main categories of travel means are considered, i.e. individual motorized means, public transport, bicycle and walking, together with their combinations. Nine variables, both socioeconomic and travel-related, are defined for each personal tour and are then used to build the features space in which the SVM operated its classification process. Results obtained considering different combinations of both kinds of features demonstrate how SVM is able to predict to some extent, in a real settings where car use dominates, which tours are likely to be made by public transport or non-motorized means. Moreover, the flexibility of the technique allows assessing the predictive power of each feature according to the combination of travel means used in different tours. Potential applications of this innovative approach range from activity-based travel choices simulators to search engines supporting personalized travel planners, in general whenever “best guesses” on mode choice patterns have to be quickly made on large amount of data prejudicing the possibility of setting up a statistical model.

**Subject Areas:** Highways; Pedestrians and Bicyclists; Planning and Forecasting; Public Transportation

**Availability:** Pirra, M. and Diana, M., 2017. *Tour-Based Mode Choice Study Through Support Vector Machine Classifiers*. Transportation Research Board. 96<sup>th</sup> Annual Meeting (No. 17-01885).

<https://pubsindex.trb.org/view/2017/C/1437790>

## **10.25. Title: Unraveling the Effects of Land Use Planning and Energy Policy on Travel Behavior**

**Author:** Dillon, H.S.

**Abstract:** This three-essay dissertation focuses on understanding linkages between urban form, travel behavior, ownership of alternative fuel vehicles, active commuting, congestion, fuel consumption, and air pollution (including greenhouse gas emissions). These essays estimated different specifications of Generalized Structural Equation Models (GSEM) to explicitly account for residential self-selection and vehicle choice endogeneities.

The first essay analyzes the influence of land use policies and gasoline prices on driving patterns. I estimated a Generalized Structural Equation Model (GSEM) with a Tobit-link specification on a Southern California subsample of the 2009 National Household Travel Survey (NHTS). These data have a quasi-experimental nature thanks to large exogenous variation in gasoline price during the survey period. I analyzed separately home-based work trips and non-work trips under the hypothesis that households have more flexibility to adjust their non-work trips when gasoline prices change, whereas most of the literature does not take trip purpose into account. To measure urban form, which is treated as a latent construct, I used fine-grained geospatial information including population density, land use mix, employment density, distance to employment centers and transit availability. I found that, in the short run, households drive 0.171% less for non-work trips when gasoline prices increase by 1%, while work trips are not responsive to gasoline price changes. This suggests that, in the short term, higher fuel prices reduce discretionary driving such as shopping and recreational trips, but they do not affect non-discretionary driving such as commuting trips. My results also suggest that policies that seek to increase transit service and housing opportunities near employment centers will reduce driving.

The second essay investigates the impact of government incentives such as access exemption to High Occupancy Vehicle (HOV) lanes and parking privileges on household ownership of Alternative Fuel Vehicles (AFVs) using Generalized Structural Equation Models (GSEM), and accounts for residential self-selection, household demographics and ambient political-environmentalism. I analyzed geocoded travel diary data from the 2012 California Household Travel Survey (CHTS), linked with fueling station data from the US Department of Energy Alternative Fuels Data Center and precinct level election data from the UC Berkeley Statewide Database. My findings suggest that, on average, households with alternative fuel vehicles drive approximately 10 miles more on weekdays and about 0.5 miles more on non-discretionary trips than otherwise similar households. In addition, households who live closer to a freeway with HOV lanes, work closer to an AFV charging facility (that provides free parking), and are likely supportive of pro-environmental measures are more likely to own alternative fuel vehicles.

The third essay examines the influence of urban form on transit use and non-motorized travel (NMT, including biking and walking) for households (with at least one employed adult) in Los Angeles and Orange Counties in California based on 2009 National Household Travel Survey (NHTS) data. The objectives of the research are (1) to assess several methods for measuring urban form features in the near-residence and near-workplace environments and (2) to assess the importance of these urban form features on transit use and NMT after accounting for the influence of these features on household vehicle ownership and residential selection. Results provide insights into the relative influence of several specifications of population density, transit access and walkability measures on transit use and NMT for commute and non-work trips. Reduced form models

suggest that the dominant determinant of discretionary travel is household socio-demographic status. In terms of residential selection, lower income, younger, and smaller households are more likely to choose a dense, pedestrian friendly, and transit rich neighborhood. In terms of vehicle ownership, households living in high density, pedestrian friendly, and transit rich neighborhoods are less likely to own vehicles. After accounting for the influence of urban form on vehicle ownership and residential selection, workplace transit accessibility has greater influence on transit commuting than transit access near a household's residence. Results vary by how urban form is specified and by the source of travel data. Finally, there is some evidence that population density affects active travel for discretionary purposes.

**Subject Areas:** Travel Behavior; Fuel-consumption; Government incentives; Generalized Structural Equation Models (GSEM); Non-motorized travel

**Availability:** Dillon, H.S., 2017. *Unraveling the Effects of Land Use Planning and Energy Policy on Travel Behavior*. Doctoral dissertation, UC Irvine.

<https://escholarship.org/uc/item/4m28823m#main>



**10.26. Title: Addressing the Joint Occurrence of Self-Selection and Simultaneity Biases in the Estimation of Program Effects Based on Cross-Sectional Observational Surveys: Case Study of Travel Behavior Effects in Carsharing**

**Authors:** Mishra, G.S., Mokhtarian, P.L., Clewlow, R.R. and Widaman, K.F.

**Abstract:** We estimate the effect of carsharing on travel behavior (specifically, household vehicle holdings, frequency of transit usage, and frequency of biking and walking) using data from the 2011-2012 California Household Travel Survey (CHTS). The effect of carsharing on vehicle ownership is a dynamic process that plays out over a period of time - past ownership influences enrollment decisions, which in turn influence holdings in a later period. Representing this process using cross-sectional data conflates causal effects with simultaneity bias. Further, members and non-members differ in various observed and unobserved ways - demographics, built environment of residential and workplace location, and attitudes-raising the potential for self-selection bias in comparing travel behavior between the two groups given the observational nature of the data. Drawing on established methods for dealing with each bias individually, we develop a method to help control for this joint occurrence of self-selection and simultaneity biases. Restricting the analysis to employed respondents residing in the San Francisco Bay Area, we find that 80% of the observed difference of 0.9 units in average vehicle holdings between carsharing non-members and members may be explained by the biases listed above. The remaining difference of 0.17 units reflects the estimated effect of carsharing, which is the equivalent of shedding one vehicle by about one out of every six households whose member(s) are enrolled in carsharing. The effect on transit usage and walking and biking frequency is positive, albeit small and statistically non-significant. We identify factors that may affect the internal and external validity of our results. Our methods cannot completely replace randomized experiments or panel data. However, the methods used here provide a way to help control for the joint occurrence of self-selection and simultaneity biases, and provide a ballpark estimate of causal effects, for large-scale, general-purpose, cross-sectional datasets such as the CHTS.

**Subject Areas:** Future mobility; Program evaluation; Omitted variable bias; Treatment effects; Vehicle ownership; Selection on unobservables; Emerging mobility Sustainability

**Availability:** Mishra, G.S., Mokhtarian, P.L., Clewlow, R.R. and Widaman, K.F., 2017. *Addressing the Joint Occurrence of Self-Selection and Simultaneity Biases in the Estimation of Program Effects Based on Cross-Sectional Observational Surveys: Case Study of Travel Behavior Effects in Carsharing*. Transportation, pp.1-29.

<https://link.springer.com/article/10.1007/s11116-017-9791-1>

**10.27. Title: Do Young Children Affect Travel Behavior for Parents in Atlanta?**

**Author:** Estes, E.

**Abstract:** It is well researched that the physical environment can influence mode choices such as transit or walking. However, does having dependent children also play a significant role in mode choice? This paper will investigate how having children five years old and younger can affect the travel behavior of parents in Metro Atlanta. Travel survey data from the Atlanta Regional Commission is used to delineate what variables lead to different mode choices, with specific attention to transit and walk trips in the region. Due to the significant role accessible child care facilities plays on the working population, spatial mapping is used to illustrate the distribution of child care facilities in the City of Atlanta. Finally, this report will highlight how gender plays an overall role in the travel behavior of parents and recommend policies to help offset associated challenges.

**Subject Areas:** Physical environment; Mode choice; Travel behavior

**Availability:** Estes, E., 2017. *Do Young Children Affect Travel Behavior for Parents in Atlanta?* School of City and Regional Planning Applied Research Papers, Georgia Tech.  
<https://smartech.gatech.edu/handle/1853/58523>

**10.28. Title: Why You Go Reveals Who You Know: Disclosing Social Relationship by Cooccurrence**

**Authors:** Yi, F., Li, H., Wang, H. and Sun, L.

**Abstract:** The popularity of location-based services (LBS) and the ubiquity of sensor device have resulted in rich spatiotemporal data. A large number of human behaviors had been recorded including cooccurrence which refers to the phenomenon that two people have been to the same places at the same time. These data enable attackers to infer people's social relationship based on their cooccurrences and many attack models were proposed. However, current attack models still cannot effectively address the following two challenges: How to distinguish cooccurrences between acquaintances and strangers? What kind of cooccurrence contributes to strong social strength? In this paper, we present a novel social relationship attack model - the Mobility Intention-based Relationship Inference (MIRI) model - which can solve the above two issues. Firstly, we extract mobility intentions and adopt them to characterize cooccurrences. A classification model is trained for attacking social relationship. The experimental results on two real-world datasets demonstrate that the proposed MIRI model can properly differentiate cooccurrences by simultaneously considering spatial and temporal features. The comparison results also indicate that MIRI model significantly outperforms state-of-the-art social relationship attack models.

**Subject Areas:** Location-based services; Mobility intentions; Cooccurrence

**Availability:** Yi, F., Li, H., Wang, H. and Sun, L., 2017. *Why You Go Reveals Who You Know: Disclosing Social Relationship by Cooccurrence*. *Wireless Communications and Mobile Computing*,(2017),Article ID 3787089.

<https://www.hindawi.com/journals/wcmc/2017/3787089/abs/>

**10.29. Title: Potentials of Using Social Media to Infer the Longitudinal Travel Behavior: A Sequential Model-Based Clustering Method**

**Authors:** Zhang, Z., He, Q. and Zhu, S.

**Abstract:** This study explores the possibility of employing social media data to infer the longitudinal travel behavior. The geo-tagged social media data show some unique features including location-aggregated features, distance-separated features, and Gaussian distributed features. Compared to conventional household travel survey, social media data is less expensive, easier to obtain and the most importantly can monitor the individual's longitudinal travel behavior features over a much longer observation period. This paper proposes a sequential model-based clustering method to group the high-resolution Twitter locations and extract the Twitter displacements. Further, this study details the unique features of displacements extracted from Twitter including the demographics of Twitter user, as well as the advantages and limitations. The results are even compared with those from traditional household travel survey, showing promises in using displacement distribution, length, duration and start time to infer individual's travel behavior. On this basis, one can also see the potential of employing social media to infer longitudinal travel behavior, as well as a large quantity of short-distance Twitter displacements. The results will supplement the traditional travel survey and support travel behavior modeling in a metropolitan area.

**Subject Areas:** Longitudinal travel behavior; Social media; Travel survey; Clustering

**Availability:** Zhang, Z., He, Q. and Zhu, S., 2017. *Potentials of Using Social Media to Infer the Longitudinal Travel Behavior: A Sequential Model-Based Clustering Method*. Transportation Research Part C: Emerging Technologies, 85, pp.396-414.

<https://www.sciencedirect.com/science/article/pii/S0968090X17302784>

**10.30. Title: Telecommuting and Its Impact on Activity - Time Use Patterns of Dual-Earner Households**

**Authors:** Paleti, R. and Vukovic, I.

**Abstract:** Telecommuting choices of workers in multiworker households are likely to be interdependent. These telecommuting choices may also affect the activity - time use choices of all people in the household. From the standpoint of travel behavior and travel demand forecasting, it is important to test these hypotheses and quantify the relationship between telecommuting choices and activity-time use patterns. To do this, the present study developed a generalized extreme value-based joint count model for analyzing the monthly frequency of choosing to telecommute of workers in dual-earner households. A panel multiple discrete continuous extreme value model was also developed to study activity-time use decisions while accounting for household-level interaction effects. The study findings confirm the presence of strong intrahousehold interaction effects in both the telecommuting and activity-time use choices of workers. Telecommuting choices were found to have a significant influence on daily activity-time use decisions for both mandatory and nonmandatory activities.

**Subject Areas:** Telecommuting; Travel behavior; Travel demand forecasting; Dual-Earner Households

**Availability:** Paleti, R. and Vukovic, I., 2017. *Telecommuting and Its Impact on Activity - Time Use Patterns of Dual-Earner Households*. Transportation Research Record: Journal of the Transportation Research Board, (2658), pp.17-25.

<http://trjjournalonline.trb.org/doi/abs/10.3141/2658-03>

**10.31. Title: Analysis of the Effects of Connected-Automated Vehicle Technologies on Travel Demand**

**Authors:** Auld, J., Sokolov, V. and Stephens, T.S.

**Abstract:** Connected-automated vehicle (CAV) technologies are likely to have significant effects not only on how vehicles operate in the transportation system, but also on how individuals behave and use their vehicles. While many CAV technologies - such as connected adaptive cruise control and ecosignals - have the potential to increase network throughput and efficiency, many of these same technologies have a secondary effect of reducing driver burden, which can drive changes in travel behavior. Such changes in travel behavior - in effect, lowering the cost of driving- have the potential to increase greatly the utilization of the transportation system with concurrent negative externalities, such as congestion, energy use, and emissions, working against the positive effects on the transportation system resulting from increased capacity. To date, few studies have analyzed the potential effects on CAV technologies from a systems perspective; studies often focus on gains and losses to an individual vehicle, at a single intersection, or along a corridor. However, travel demand and traffic flow constitute a complex, adaptive, nonlinear system. Therefore, in this study, an advanced transportation systems simulation model - POLARIS - was used. POLARIS includes cosimulation of travel behavior and traffic flow to study the potential effects of several CAV technologies at the regional level. Various technology penetration levels and changes in travel time sensitivity have been analyzed to determine a potential range of effects on vehicle miles traveled from various CAV technologies.

**Subject Areas:** Connected-automated vehicle (CAV); Transportation system; Travel behavior

**Availability:** Auld, J., Sokolov, V. and Stephens, T.S., 2017. *Analysis of the Effects of Connected-Automated Vehicle Technologies on Travel Demand*. Transportation Research Record: Journal of the Transportation Research Board, (2625), pp.1-8.

<http://trrjournalonline.trb.org/doi/abs/10.3141/2625-01>

**10.32. Title: Evaluation of Ridesharing Impacts using an Integrated Transport Landuse Model: A Case Study for the Paris Region**

**Authors:** Yin, B., Liu, L., Coulombel, N. and Viguié, V.

**Abstract:** Ridesharing has attracted considerable attention in recent years, as a simple, relatively inexpensive, yet efficient way to curb greenhouse gas emissions in the private transport sector. This is in particular the case in the Paris region: as the road network is increasingly congested, leading to more and more frequent heavy air pollution episodes, local authorities seek to promote ridesharing in order to improve travel conditions and mitigate the environmental impact of road traffic. This research seeks to assess through sensitivity analysis what is the potential of ridesharing regarding these two points, namely reducing congestion and mitigating pollutant emissions, in the case of the Paris region. The effects of various ridesharing scenarios will be investigated by using an integrated transport land-use model and by considering each of the following mechanisms successively: 1) traffic assignment, 2) mode choice, 3) distribution. Results include a quantitative assessment of what level of ridesharing is reached to observe significant improvements regarding congestion and pollutant emissions, and on which trip segments (e.g., purpose and range) should one focus the efforts to do so. A step by step decomposition of the effects will also help better understand the various implications of ridesharing on the urban system as a whole.

**Subject Areas:** Ridesharing; Transport and land-use; Traffic congestion; Pollutant emissions; Mode choice

**Availability:** Yin, B., Liu, L., Coulombel, N. and Viguié, V., 2017. *Evaluation of Ridesharing Impacts using an Integrated Transport Landuse Model: A Case Study for the Paris Region*. Science Direct, 20th EURO Working Group on Transportation Meeting, EWGT 2017, 4-6 September 2017, Budapest, Hungary.

[https://www.researchgate.net/profile/Nicolas\\_Coulombel/publication/317256101\\_Evaluation\\_of\\_ridesharing\\_impacts\\_using\\_an\\_integrated\\_transport\\_land-use\\_model\\_a\\_case\\_study\\_for\\_the\\_Paris\\_region/links/59ca03c80f7e9bbfdc366620/Evaluation-of-ridesharing-impacts-using-an-integrated-transport-land-use-model-a-case-study-for-the-Paris-region.pdf](https://www.researchgate.net/profile/Nicolas_Coulombel/publication/317256101_Evaluation_of_ridesharing_impacts_using_an_integrated_transport_land-use_model_a_case_study_for_the_Paris_region/links/59ca03c80f7e9bbfdc366620/Evaluation-of-ridesharing-impacts-using-an-integrated-transport-land-use-model-a-case-study-for-the-Paris-region.pdf)

**10.33. Title: The Impact of Demographic Shifts on Automobile Travel in the United States: Three Empirical Essays**

**Author:** Wang, X.

**Abstract:** This research quantitatively examines whether the current demographic changes in the United States are linked to changes in automobile travel using comprehensive datasets. Specifically, this research focuses on the impact of three major demographic shifts: immigration, Millennials entering adulthood, and aging. The findings of the three essays suggest that these aforementioned demographic changes significantly influence the demand of automobile travel, controlling for socio-economic, vehicle ownership, time-specific and regional-specific factors. Understanding the link from demographics to automobile travel creates opportunities for policy makers to transform American cities to be more sustainable and to more effectively predict future travel patterns based on demographic trends.

**Subject Areas:** Demographic trends; Automobile travel; Travel patterns

**Availability:** Wang, X., 2017. *The Impact of Demographic Shifts on Automobile Travel in the United States: Three Empirical Essays*. (Doctoral dissertation, University of Southern California).

<https://search.proquest.com/openview/d2f30b199a66bfac4e6db652f0b22d1e/1?pq-origsite=gscholar&cbl=18750&diss=y>



**10.34. Title: Potential of Converting Short Car Trips to Active Trips: the Role of the Built Environment in Tour-Based Travel**

**Authors:** Lee, J., He, S.Y. and Sohn, D.W.

**Abstract:** Objective: To better understand trip-chaining patterns and mode choice of various urban forms, this study examines the effects of land use on travel mode choice and analyzes the concept of neighborhood design in the substitution of short car trips by other transportation modes.

Methods: A 'tour' is defined as a home-to-home loop of individual trips, including all the stops made along the way. This paper develops tour-based, mode-choice models and conducts integrative assessments to determine the relative influences of the various factors associated with tour-based travel and activity space environments for short round trips.

Results: The short round trips most likely to require a car tended to be either commuting trips, trips involving heavy goods, or trips that link two or more stops. Transit trips for short-distance travel were likely to involve trip chaining, while most shopping trips comprised a single outing with no trip chaining. A key to increasing travel by walking was a concentration of retail shops and service providers near people's homes whereas street networks and a good regional accessibility encouraged cycling and transit use respectively, although potential spurious effects cannot be fully determined.

Conclusions: Policymakers in LA who hope to increase walking should focus on the concentration of business activity in a compact commercial core in residential areas, while transit agencies in LA should consider trends like chained trip-making and restructure communities and central places with much greater transit accessibility. These strategies for local urban design and regional accessibility are likely to affect people's decisions concerning travel mode mostly in non-work travel without intervening stops; therefore, personal vehicle use can be reduced more easily by focusing on trips for leisure time activities and personal business activities near residential locations rather than on work commutes.

**Subject Areas:** Built environment; Short trips; Tour-based approach; Travel behavior; Urban design

**Availability:** Lee, J., He, S.Y. and Sohn, D.W., 2017. *Potential of Converting Short Car Trips to Active Trips: the Role of the Built Environment in Tour-Based Travel*. Journal of Transport & Health (7),Part B, pp.(134-148).

<https://www.sciencedirect.com/science/article/pii/S2214140516302468>

### **10.35. Title: Investigating the Use of Anonymous Cellular Data for Intercity Travel Patterns in Alberta**

**Author:** Hui, T.Y.

**Abstract:** Intercity trips or long-distance trips have been understudied and overlooked by researchers and public agencies in comparison to routine trips that are relatively shorter and often within an urban area. Currently, intercity travel demand is increasing, and accounts for a significant portion of total mileage travelled. This increasing demand also leads to increasing issues such as congestion, energy consumption, and emissions. Governments are recognizing the need to understand current intercity travel patterns for infrastructure investments and environmental policies, and data such as origin-destination (OD) flows and intercity demand are valuable for strategic planning of the highway networks. However, traditional methods of data collection to estimate OD demands and/or flows through household or roadside surveys are time consuming and expensive, and public agencies have historically prioritized survey data collection within their jurisdiction, typically urban boundaries. An emerging (albeit imperfect) alternative is passive data sources, such as anonymous cellular data. Anonymous cellular data can provide large random samples with reduced bias and provide results much faster and at much lower cost than travel surveys. It also has a low deployment cost, as it does not require any additional equipment installation or measuring devices. The purpose of this thesis is to investigate how anonymous cellular data may be used to extract more information and features about intercity travel patterns. In this research, two days of anonymous cellular data for the province of Alberta, Canada are used to extract intercity trips and infer trip modes used. Intercity trips were first extracted between the two major cities - Edmonton and Calgary. The extracted data show that most trips take between 2 - 3 hrs, as well as a smaller portion that take between 0-1 hrs. This shows that anonymous cellular data provides a reasonable reflection of the two modes, as a direct drive trip between the two cities take approximately 3 hours, and a flight takes 45 minutes from takeoff to landing. This analysis was expanded to all intercity trips between cities and urban areas in Alberta. Intercity trips between fourteen urban zones in Alberta (including urban service area Fort McMurray and oil sands camps Fort MacKay) were extracted using a similar methodology. Overall, the data shows that larger cities have more trips originate and destined there, and the distance between cities also affected the share of trips (i.e. smaller cities had fewer trips but the highest proportion of trips to and from cities nearby, sparsely located cities had very few trips anywhere). Two methods were utilized to infer the trip mode for trips between Edmonton Calgary, first by categorizing the travel times using upper and lower limits, second by hierarchical clustering of the travel times. Hierarchical clustering of trips less than 8 hours results in distinct clusters that represent air trips, ground trips, and longer ground trips (likely made with stops). The clusters showed a mode split that ranged from 12-25% air trips and 88-75% ground trips for the two days. Hierarchical clustering was then conducted for all intercity trip pairs that had direct air service between them, with a unitless, rescaled travel times based on the average ground travel time for each pair. Mode splits ranged widely between the two days of data, which could be due to seasonal variations in trip patterns (i.e. more people flying in winter than in the summer) or sampling issues in the data. The mode split results shows the trend that cities further apart will have a higher share of air trips then ground. This work contributes to the existing research on intercity travel and passive data applications in transportation. It builds on existing research that have identified origin-destination flows and shows how trip mode can be inferred from travel times, using clustering techniques.

This research is limited by the small sample size of two individual days of data, and the data contains only a sample of all records from the cellular service provider. Though the data here is limited, it demonstrates its ability to provide useful information about intercity travel behaviour. Traditional data sources and passive data both have their own limitations, but if used together, they can overcome current limitations in data.

**Subject Areas:** Transportation; Intercity travel; Passive data; Cell phone data

**Availability:** Hui, T.Y., 2017 *Investigating the Use of Anonymous Cellular Data for Intercity Travel Patterns in Alberta*. (Doctoral dissertation, University of Alberta).

<https://era.library.ualberta.ca/files/c2b88qc610#.WjlpybQ-fOQ>

**10.36. Title: A Comparison of Domestic Passenger Demand for Intercity Travel by Rail and Air in the United States: The Rail Station a Case Study**

**Author:** Moncrief, K.W.

**Abstract:** This study endeavored to develop an in-depth understanding of the motivations behind a prospective air travel passenger's substitution of rail. For reasons known only to them, intercity passengers are increasingly choosing travel by rail over travel by air. America's intercity air travel analysts did not forecast or plan for Amtrak's record-setting fiscal year (FY) 2013 passenger ridership. Industry researchers find that this increase in passenger demand for rail travel influences the demand for other travel modes downward, exceptionally affecting the profitability of air. The study explored this subject through the use of qualitative methodology applying a single-case study design. Conveniently sampled from almost 30,000 daily rail riders at the research site, study participants were interviewed in-person. To elicit otherwise unobservable individually-unique passenger perceptions and preferences, the researcher iteratively sorted, read, and coded narrative data from these interviews to extract major themes. The study then compared the qualitative analysis with more than 40,000 household travel survey responses to a work commute behavior question. Findings from the case study revealed that perceptions and attitudes influence a prospective passenger's travel mode choice. When choosing from among multiple travel alternatives (e.g., air, rail, auto, bus), for example, focus group and one-on-one interview participants confessed their warm regard for convenience and speed to destination. When the list of available travel options is restricted to travel by air and travel by rail - directly addressing the research question—interview participants intimated their higher reverence for rail's convenience and speed over the amenities and comfort accorded to air passengers.

**Subject Areas:** Air travel passenger; Intercity travel; Commute behavior

**Availability:** Moncrief, K.W., 2017. *IA Comparison of Domestic Passenger Demand for Intercity Travel by Rail and Air in the United States: The Rail Station a Case Study*. (Doctoral dissertation, Capella University).

<https://search.proquest.com/openview/db7c83a657a6057e99d065766f8d4421/1?pq-origsite=gscholar&cbl=18750&diss=y>

**10.37. Title: Transportation Sustainability in the Urban Context: A Comprehensive Review**

**Authors:** Sultana, S., Salon, D. and Kuby, M.

**Abstract:** Although the term “sustainability” did not gain traction until the 1980s, concerns about the consequences of transportation technology started long before. This paper reviews the literature on urban transportation sustainability using three frameworks. First, urban transportation can be unsustainable environmentally, economically, and socially (the three pillars of sustainability). Second, sustainable strategies tend to fall into two paradigms. Sustainable Transport Technology improves current patterns of modes and trips by consuming less resources and generating less waste. Sustainable Travel Behavior and Built Environment takes a more holistic approach that targets more sustainable travel choices, recognizing that changes in the built environment that currently constrains those choices are also essential. Third, the Planner’s Triangle helps explain commonly encountered situations where inherent tradeoffs can impede win-win-win strategies across environmental, economic, and social domains. The paper concludes with future research directions and concluding thoughts about urban transportation and sustainability.

**Subject Areas:** Cities; Sustainability; Urban transportation; Travel behavior; Built environment; Technology

**Availability:** Sultana, S., Salon, D. and Kuby, M., 2017. *Transportation Sustainability in the Urban Context: A Comprehensive Review*. Urban Geography, pp.1-30.

<http://www.tandfonline.com/doi/ref/10.1080/02723638.2017.1395635?scroll=top>

**10.38. Title: Structural Analysis on Activity-travel Patterns, Travel Demand, Socio-demographics, and Urban Form: Evidence from Cleveland Metropolitan Area**

**Author:** Chen, Y.J.

**Abstract:** Research on travel behavior continues to be one of the most prominent areas in the transportation area. Planners and policymakers try to understand and manage travel behavior. Making and implementation of travel demand management (TDM) policies greatly rely on the understanding of the determinants of activity-travel patterns and travel demand. Among the activity-travel patterns, trip chaining and joint travel have received much research interest. Trip chaining is typically viewed as a home-based tour that connects multiple out-of-home activities. Joint travel is commonly defined as traveling with others. Travel demand is generally measured by trip generation and travel distances. Investigating different aspects of travel behavior helps us better understand the links between activity participation and mobility, and improves the evaluation of the transportation infrastructure investments and policies such as high occupancy vehicle (HOV) lanes and vehicle miles traveled (VMT) reduction programs.

Several studies have regarded trip chaining, joint travel, trip generation, and travel distances as different dimensions of travel behavior to be examined in terms of various socio-demographics and urban form factors. However, limited work has been done to use activity-travel patterns as mediating variables and analyze how trip chaining and joint travel shape the resulting travel demand. Furthermore, relationships between travel behavior and urban form factors at out-of-home activity locations remain unclear. Based on the 2012 travel survey data from the Cleveland Metropolitan Area, this study first investigates the relationships among trip chaining, joint travel, home-based tour generation, and travel distances at three different levels: tour, individual, and household levels. Second, the influences of socio-demographics and urban form factors at tour origins and destinations on travel behavior are examined simultaneously. Lastly, while using trip chaining and joint travel as mediating variables, this study estimates the mediating effects of socio-demographics and urban form via activity-travel patterns on travel demand. The Structural Equation Modelling (SEM) approach is applied.

The study reveals the existence of significant relationships between activity-travel patterns and travel demand. Trip chaining is negatively associated with joint travel. While it increases travel distances, this effects gets weakened through its indirect effect via decreased tour generation. Joint travel appears to increase tour generation but decrease the travel distances. Most socio-demographics have significant effects with expected signs on travel behavior. The analysis suggests that urban form factors at tour origins and destinations play important roles on the resulting travel demand. Some urban form factors may not have direct effects on travel demand but have significant indirect effects on tour generation or travel distances through activity-travel patterns. This research presents how activity-travel patterns shape travel demand and concludes that trip chaining and joint travel should be taken into consideration while analyzing travel demand. The findings on socio-demographics and urban form factors can be used as inputs to improve the future evaluation of transportation projects and help planners integrate land-use strategies as tools to change people's travel behavior. This will further mitigate the negative externalities associated with our travel patterns.

**Subject Areas:** Trip Chaining; Joint Travel; Tour Generation; Travel Distances; Vehicle Miles Traveled; Travel Demand; Urban Form; Built Environment; Land Use; Transportation Planning;

## Structural Equation Model

**Availability:** Chen, Y.J., 2017. *Structural Analysis on Activity-travel Patterns, Travel Demand, Socio-demographics, and Urban Form: Evidence from Cleveland Metropolitan Area*. (Doctoral dissertation, The Ohio State University).

[https://etd.ohiolink.edu/pg\\_10?0::NO:10:P10\\_ACCESSION\\_NUM:osu1492719562434723](https://etd.ohiolink.edu/pg_10?0::NO:10:P10_ACCESSION_NUM:osu1492719562434723)

**10.39. Title: Impacts of Telecommuting on Nonmandatory Activity Participation: Role of Endogeneity**

**Author:** Asgari, H. and Jin, X.

**Abstract:** Telecommuting has been regarded as an alternative work arrangement that provides higher levels of resilience and flexibility for the workforce. To provide a robust estimation of telecommuting activity, it is important to understand the extent of telecommuting and the underlying factors that contribute to telecommuters' decisions. One line of discussion in behavioral decisions (including telecommuting) is the endogeneity issue, also referred to as simultaneity in cause and effect. The question is whether certain activity travel behaviors are the causes of telecommuting adoption or telecommuters are manifesting such behaviors because they telecommute. For instance, are people traveling more or farther because of the higher spatial-temporal freedom brought by telecommuting, or are they choosing to or having to telecommute because they already have those activity arrangements (e.g., take care of kids) in place. Exploring such interrelationships between the choice to telecommute, activity travel plans, and other personal and household decisions is the major motivation for this research. Structural equation models were developed. Results showed that adding feedback effects to the full model improved the goodness of fit of the model, and this improvement is statistically significant (P-value=0.032). Furthermore, it could be inferred that a decision to participate in nonmandatory activities has significant positive impact on propensity to telecommute, and it is more in favor of a full-day telecommuting arrangement (versus a part-day arrangement). This study used the 2010-2011 regional household travel survey data from the New York metropolitan region.

**Subject Areas:** Telecommuting; Endogeneity; Travel behaviors; Structural equation models

**Availability:** Asgari, H. and Jin, X., 2017. *Impacts of Telecommuting on Nonmandatory Activity Participation: Role of Endogeneity*. Transportation Research Record: Journal of the Transportation Research Board, (2666), pp.47-57.

<http://trjjournalonline.trb.org/doi/abs/10.3141/2666-06>



**10.40. Title: Land Use, Travel Behavior, and Disaggregate Travel Data**

**Author:** Boarnet, M.G.

**Abstract:** Book Chapter

**Subject Areas:** Neighborhood; Travel behaviors; Mixed-use; Transit oriented developments

**Availability:** Boarnet, M.G., 2017. *Land Use, Travel Behavior, and Disaggregate Travel Data*. The Geography of Urban Transportation, p.164.

<https://books.google.com/books?hl=en&lr=&id=WE3IDAAAQBAJ&oi=fnd&pg=PA164&dq=%22National++Household+Travel%22++Survey+,+NHTS&ots=yj3XGBdIY0&sig=CdURB70HrL7q1UsCV1dAWyrTpVs#v=onepage&q=%22National%20%20Household%20Travel%22%20%20Survey%20%2C%20NHTS&f=false>

**10.41. Title: Development of a Neighborhood Commute Mode Share Model using Nationally-Available Data**

**Authors:** Schneider, R.J., Hu, L. and Stefanich, J.

**Abstract:** Practitioners often use demand models to predict how neighborhood-level land use, infrastructure, demographic, and other changes may impact transportation systems. Few of the models available to predict automobile, transit, bicycle, and pedestrian travel are based on easily-accessible data, which creates barriers for transportation agencies with limited data or modeling resources. We help fill this gap by developing a fractional multinomial logit model that estimates United States neighborhood work commute mode shares using existing, nationally-available data from 5000 randomly-selected, non-adjacent census tracts. After controlling for socioeconomic characteristics, the model shows that public transit, walk, and bicycle commuting are associated with higher population and employment density, more housing constructed prior to 1940, and more rental housing. Public transit and walk commuting are associated with being in a North-eastern state, automobile commuting is associated with being in a Southern state, and bicycle commuting is associated with being in a West Coast state. Validation of the model using a separate set of 1000 census tracts and application of the model in the Milwaukee metropolitan region show promise but also highlight several limitations of this approach. This sketch-planning model is a building block for future practically-oriented neighborhood commute mode share models.

**Subject Areas:** Transit; Walk; Bicycle; Commute; Fractional multinomial logit model

**Availability:** Schneider, R.J., Hu, L. and Stefanich, J., 2017. *Development of a Neighborhood Commute Mode Share Model using Nationally-Available Data*. Transportation, pp.1-21.  
<https://link.springer.com/article/10.1007/s11116-017-9813-z>

**10.42. Title: Intertemporal Substitution and the Value of Leisure Time**

**Authors:** Lloyd-Smith, Patrick., Abbott, J. K., Adamowicz, Wiktor., and Willard, Daniel.

**Abstract:** Understanding the extent to which people substitute activities across time is important for evaluating behavior and welfare impacts in many contexts including assessing the damages caused by oil spills and climate change impacts. We develop a structural demand model that explicitly focuses on intertemporal substitution and incorporates time constraints on behavior. We also implement a flexible, individualized approach to measuring how people value their leisure time and how substitutable time is between periods. The model is estimated in an empirical application using data on recreation demand. The results demonstrate how getting the value of time 'right' is important for assessing welfare impacts of policies with large intertemporal substitution effects. We find people value their leisure time heterogeneously and substantially differently from their implied wage rate and this value differs by time of year. These findings raise concerns with the common practice of only using labor market information to value people's leisure time.

**Subject Areas:** Intertemporal substitution; Value of time; Demand system; Mode Choice; Travel cost model

**Availability:** Lloyd-Smith, Patrick., Abbott, J. K., Adamowicz, Wiktor., and Willard, Daniel., 2017. *Intertemporal Substitution and the Value of Leisure Time*.  
[http://www.joshuakabbott.com/uploads/9/5/6/1/95618488/intertemporalsubvot\\_april20.pdf](http://www.joshuakabbott.com/uploads/9/5/6/1/95618488/intertemporalsubvot_april20.pdf)

### **10.43. Title: Latent Class Analysis of Residential and Work Location Choices**

**Authors:** Paleti, R., Sarker, A.A. and Haque, K.

**Abstract:** Residential and work location choices are medium-to-long term decisions that have a significant impact on day-to-day activity-travel decisions of people. Typically, these choices are modeled using discrete choice models, but, several important aspects including attitudes and preferences (e.g., greener lifestyle and tech-savvy attitude), the consideration choice set, and the decision making mechanism are typically not observed in the revealed preference dataset. These unobserved factors can lead to heterogeneity in travel sensitivities across different population segments or lead to variation in the consideration choice set across decision makers. Thus, standard choice models (e.g., MNL) cannot control for these factors. In such scenarios, latent class models that can probabilistically classify households into latent classes (e.g., neo and conventional) are particularly useful.

Since, location choices are usually undertaken at the zonal level (e.g., TAZ), the size of choice set is typically large, comprising thousands of alternatives. While sampling techniques can be used to resolve the computational problem associated with large choice sets, the sampling mechanism itself might introduce some bias and make it more difficult to identify latent segments. To avert this problem, this study proposes a two-stage decision framework for location choices. In the first stage, a household (or a worker) is assumed to select a neighborhood type (such as central business district, urban, suburban) to live (or work). In the second stage, the household (or worker) is assumed to choose a specific zone based on the selected neighborhood type. The latent class analysis is undertaken at the first stage which has a much smaller choice set than the conditional zonal choice model in the second stage. However, these two components are not completely independent. Both the model components are estimated sequentially but the expected utility or logsum from the zonal destination choice is used as an explanatory variable in the neighborhood type choice alternatives to link the two model components.

For case study purposes, data from a 2012 household travel survey, conducted in Nashville, Tennessee, is used. The model results indicate significant heterogeneity in the consideration probability of different neighborhood type alternatives both in the residential and work location choices. Also, the model applicability is tested by calculating elasticity effects and identifying demographic groups with different residential and work location preferences. Compared with standard MNL models, that assume all decision makers consider the complete universal choice set, the latent class neighborhood models were found to perform more strongly

**Subject Areas:** Travel decisions; Latent Class Models; Location choices

**Availability:** Paleti, R., Sarker, A.A. and Haque, K., 2017. *Latent Class Analysis of Residential and Work Location Choices*. The Intermodal Freight Transportation Institute, The University of Memphis (No. 17-06430).

[http://www.ce.memphis.edu/smishra/Research\\_Reports/Latent\\_Class\\_Final\\_Report\\_v8.pdf](http://www.ce.memphis.edu/smishra/Research_Reports/Latent_Class_Final_Report_v8.pdf)

#### **10.44. Title: Development and Application of Advanced Econometric Models for Exploring Activity-Travel Behavior**

**Author:** Enam, Annesha.

**Abstract:** Historically, transportation planning relied on aggregate, trip-based procedures, namely, four-step modeling, for modeling travel demand. The aggregate approaches served well when the capacity oriented policies were of primary interest. However, in the last few decades, with the growing demand for travel and the increasing externalities (e.g. congestion, energy implications, pollution), there is a widespread acknowledgement that capacity oriented approach to transportation planning is unsustainable. Instead, the focus of the transportation planners has shifted towards sustainable demand management strategies wherein the idea is to alter existing behaviors and promote new behaviors such that demand for travel can be met while also reducing the externalities of travel choices. This swing in policy necessitated a shift to disaggregate, activity-based approaches for analyzing travel behavior. One of the fundamental differences between the trip- and activity-based travel behavior analyses lies in the treatment of time. In the trip-based approach, time is merely treated as a cost of accessing activity opportunities separated in space. On the other hand, activity-based approach, dwells on the understanding of time expenditure behavior of individual including how, where, and with whom individuals spend their time. Subsequently, trips are organically derived from activity engagement behavior.

As can be seen, a robust understanding of time engagement decision of individuals forms the backbone of current day transportation planning process. Individuals' allocation of time has intrigued researchers not only from the field of transportation, but also from various other disciplines such as economics, philosophy, psychology, and sociology.

The overarching objective of this dissertation is to advance the time engagement research with the goal of enriching the state-of-the-art activity-based travel analysis techniques. To this end, the contributions of the research are twofold. First, on the substantive side, the dissertation utilizes a multidisciplinary approach by incorporating theories from various disciplines such as economics, and psychology to further our understanding of the time engagement decisions of individuals. Second, on the methodological side, the dissertation develops, and applies advanced econometric methodologies to characterize the time engagement behavior of the individuals. The substantive and methodological findings allowed for an enriched formulation of time engagement in activity-based travel behavior models.

**Subject Areas:** Travel demand; Travel choices; Policy; Trip-based approach; Travel behavior models

**Availability:** Enam, Annesha., 2017. *Development and Application of Advanced Econometric Models for Exploring Activity-Travel Behavior*. Doctoral Dissertations. 1595.

<http://opencommons.uconn.edu/dissertations/1595/>

**10.45. Title: The Interactions Between Online Shopping and Personal Activity Travel Behavior: An Analysis with a GPS-Based Activity Travel Diary.**

**Authors:** Ding, Y. and Lu, H.

**Abstract:** Accompanying the widespread use of the Internet, the popularity of e-commerce is growing in developing countries such as China. Online shopping has significant effects on in-store shopping and on other personal activity travel behavior such as leisure activities and trip chaining behavior. Using data collected from a GPS-based activity travel diary in the Shangdi area of Beijing, this paper investigates the relationships between online shopping, in-store shopping and other dimensions of activity travel behavior using a structural equation modelling framework. Our results show that online buying frequency has positive effects on the frequencies of both in-store shopping and online searching, and in-store shopping frequency positively affects the frequency of online searching. Frequent online purchasers tend to shop in stores on weekends rather than weekdays. We also found a negative effect of online buying on the frequency of leisure activities, indicating that online shopping may reduce out-of-home leisure trips.

**Subject Areas:** Online shopping; In-store shopping; Leisure activity; Travel behavior; Structural equation model

**Availability:** Ding, Y. and Lu, H., 2017. *The Interactions Between Online Shopping and Personal Activity Travel Behavior: An Analysis with a GPS-Based Activity Travel Diary*. Transportation, 44(2), pp.311-324.

<https://link.springer.com/article/10.1007/s11116-015-9639-5>

## 11. Trend Analysis and Market Segmentation

**11.1.** Title: SmartTrips Ithaca: Encouraging Sustainable Transportation Options Through a Personalized Educational Campaign

**Author:** Dotson J., Gutierrez N., Chang H., and Bosco S.

**Abstract:** SmartTrips Ithaca is a neighborhood-based personalized educational campaign that encouraged residents of downtown Ithaca to try out sustainable modes of transportation such as walking, biking, transit, and carsharing through incentives and communication customized to each program participant as a stepping stone towards living a car-free or car-lite lifestyle. The report offers a case study in how the SmartTrips model was adjusted to the unique context of a small college town, and summarizes the positive results in trip reduction and mode shift that occurred in a before-and-after survey of program participants. Information contained in this document, such as web page addresses, are current at the time of publication.

**Subject Areas:** Community-Based Social Marketing; Transportation Demand Management; Smart-Trips; Individualized Marketing.

**Availability:** Dotson J., Gutierrez N., Chang H., and Bosco S., 2017. *SmartTrips Ithaca: Encouraging Sustainable Transportation Options Through a Personalized Educational Campaign*. NYSERDA Report 16-34, Ithaca Carshare, Inc.

<http://search.proquest.com/openview/fdc10ab9ef18432a9872f455c8c21803/1?pq-origsite=gscholar&cbl=18750&diss=y>

## **11.2. Title: A Time-Dependent Stated Preference Approach to Measuring Vehicle Type Preferences and Market Elasticity of Conventional and Green Vehicles**

**Authors:** Cirillo, C., Liu, Y. and Maness, M.

**Abstract:** The diversity of new vehicle technology and fuel markets, the governments' sustainable call to reduce energy consumption and air pollution lead to a change in the personal vehicle market. Considering the impact of these factors, a stated preference survey approach is adopted to analyze household future preferences for gasoline, hybrid electric, and battery electric vehicles in a dynamic marketplace. The stated choice experiment places respondents in a nine-year hypothetical time window with dynamically changing attributes including vehicle purchasing price, fuel economy, recharging range, and fuel price. A web-based survey was performed during 2014 in the state of Maryland. The collected data include household social-demographics, primary vehicle characteristics, and vehicle purchasing preferences of 456 respondents during the year of 2014-2022. Mixed Multinomial logit (MMNL) models are employed to predict vehicle preferences based on households' socio-demographics and vehicle characteristics. The estimation results show that young people are more likely to buy vehicles with new technology, especially battery electric vehicles (BEV). Women with a high education level (bachelor degree or higher) prefer to choose hybrid electric vehicle (HEV) while men with a high education level are more likely to buy BEV. The estimated vehicle market elasticities with respect to vehicle price are from -1.1 to -1.8 for HEV and BEV, higher than those for gasoline vehicles from -0.6 to -1.0. The vehicle market cross-elasticities estimated by MMNL models range from 0.2 to 0.6. In addition, willingness to pay (WTP) of vehicle characteristics estimated by MMNL models provide a good understanding of household future vehicle preferences.

**Subject Areas:** Green Vehicle; Sustainable Transport; Mixed Multinomial logit

**Availability:** Cirillo, C., Liu, Y. and Maness, M., 2017. *A Time-Dependent Stated Preference Approach to Measuring Vehicle Type Preferences and Market Elasticity of Conventional and Green Vehicles*. Transportation Research Part A: Policy and Practice, 100, pp.294-310.  
<http://www.sciencedirect.com/science/article/pii/S0965856416301483>



### **11.3. Title: Stochastic Programming Approach for Electric Vehicle Charging Network Design**

**Authors:** Faridimehr, S., Venkatachalam, S. and Chinnam, R.B.

**Abstract:** Advantages of electric vehicles (EV) include reduction of greenhouse gas and other emissions, energy security, and fuel economy. The societal benefits of large-scale adoption of EVs cannot be realized without adequate deployment of publicly accessible charging stations. We propose a two-stage stochastic programming model to determine the optimal network of charging stations for a community considering uncertainties in arrival and dwell time of vehicles, battery state of charge of arriving vehicles, walkable range and charging preferences of drivers, demand during weekdays and weekends, and rate of adoption of EVs within a community. We conducted studies using sample average approximation (SAA) method which asymptotically converges to an optimal solution for a two-stage stochastic problem, however it is computationally expensive for large-scale instances. Therefore, we developed a heuristic to produce near to optimal solutions quickly for our data instances. We conducted computational experiments using various publicly available data sources, and benefits of the solutions are evaluated both quantitatively and qualitatively for a given community.

**Subject Areas:** Electric Vehicles; Fuel Economy; Sustainable Transport

**Availability:** Faridimehr, S., Venkatachalam, S. and Chinnam, R.B., 2017. *Stochastic Programming Approach for Electric Vehicle Charging Network Design*. IarXiv preprint arXiv:1701.06723. <https://arxiv.org/abs/1701.06723>

#### **11.4. Title: Electricity Costs for a Level 3 Electric Vehicle Fueling Station Integrated with a Building**

**Authors:** Flores, R.J., Shaffer, B.P. and Brouwer, J.

**Abstract:** Despite the potential environmental benefits, plugin electric vehicles (PEVs) face challenges associated with driving range and long refueling times. Level 3 electric vehicle service equipment (EVSE) is capable of refueling PEVs quickly, but may face economic challenges, such as high utility demand charges. The current study extends prior work to determine if lower utility costs can be achieved by integrating Level 3 EVSE with a commercial or industrial building. Models are developed to simulate travel patterns using real travel data, building demand based upon real building data, and subsequent refueling of Level 3 compatible PEVs to evaluate cost implications of integrating public fast charging into real buildings operating under current electric utility rate structures. Two types of Level 3 refueling station operations are considered (conventional and valet parking). By integrating EVSE with a building, savings can be produced if lower cost energy is accessed, and by the sharing of demand charges between the PEV drivers and the building. These savings were determined to be much more significant to the refueled PEVs than any examined building. The dynamics of building electricity consumption have a large effect on overall demand charge cost reductions, with high load factor buildings providing the smallest savings. Lower load factor buildings may experience a larger benefit, but only if the maximum building demand does not coincide with the refueling of PEVs. In general, savings tend to disappear or turn into losses when valet parking is active and PEV traffic is moderate to high. Increasing building size reduces the risk of peak building and PEV refueling demand coinciding, maintaining savings for PEVs. However, the relative value of the savings due to integration disappears for larger buildings. Installing multiple EVSE can provide a cost benefit under conventional parking, but nearly always increases costs under valet parking. Increasing EVSE power always reduces savings, or increases losses. Finally, if multiple utility rates exist, EVSE integration can result in a rate switch for small buildings, significantly increasing utility costs for the building. (EHVs).

**Subject Areas:** Plug-in electric vehicles; Fast charging; Demand charges; Utility costs

**Availability:** Flores, R.J., Shaffer, B.P. and Brouwer, J., 2017. *Electricity Costs for a Level 3 Electric Vehicle Fueling Station Integrated with a Building*. *Applied Energy*, 191, pp.367-384.  
<http://www.sciencedirect.com/science/article/pii/S030626191730017X>

### **11.5. Title: Essays on Regulation and its Impact on Industry and Taxation: Studies on Cafe Standards**

**Author:** Wang, Y.

**Abstract:** Adopted in 1975, Corporate Average Fuel Economy (CAFE) standards had profound influences on the automobile industry as well as fleet fuel economy in the United States. In my dissertation, I first looked into the historical impacts of CAFE standards in the automobile industry using vehicle attribute data. I found evidence that the increase in the stringency of CAFE standards can induce the innovation of fuel economy related technologies in the automobile industry. I further estimated the response rate of the induced innovation with respect to stringency increases in CAFE standards. Using these estimates, I predicted that automobile companies would be able to meet the high 2025 fuel economy target by making medium downsizing in cars and minor downsizing in light duty trucks. Such methods can also be applied in other industries that have performance based regulations. CAFE standards increased fleet fuel economy in the United States as it was designed to. However, a more fuel efficient fleet resulted in less gasoline tax revenue, which is the major source of road maintenance. This trend affected governments at both federal and state levels. With more stringent CAFE standards enforced by the Obama Administration, which seek to almost double vehicle fuel economy by 2025, the gasoline tax revenue would be further eroded. As major increases in the gasoline tax rate are not politically feasible in the United States, policy makers seek other methods, such as a vehicle mile traveled (VMT) tax, to maintain a more stable revenue flow. I estimated households' driving demand in response to driving cost changes using household survey data and estimated tax revenue under different tax scenarios. I showed that although a VMT tax can be more regressive than a gasoline tax, it provides more stable tax revenue without having to make major adjustments in tax rates when fleet fuel economy keeps increasing.

**Subject Areas:** Fuel economy; VMT

**Availability:** Wang, Y., 2017. *Essays on Regulation and its Impact on Industry and Taxation: Studies on Cafe Standards*. (Doctoral dissertation, Cornell University).

<http://search.proquest.com/openview/27540781abcb80b48c47d585573ba53b/1?pq-origsite=gscholar&cbl=18750&diss=y>

### **11.6. Title: CVaR-Constrained Optimal Bidding of Electric Vehicle Aggregators in Day-ahead and Real-time Markets**

**Authors:** Yang, H., Zhang, S., Qiu, J., Qiu, D., Lai, M. and Dong, Z.

**Abstract:** An electric vehicle aggregator (EVA) that manages geographically dispersed electric vehicles offers an opportunity for the demand side to participate in electricity markets. This paper proposes an optimization model to determine the day-ahead inflexible bidding and real-time flexible bidding under market uncertainties. Based on the relationship between market price and bid price, the proposed optimal bidding model of EVA aims to minimize the conditional expectation of electricity purchase cost in two markets considering price volatility. Moreover, the penalty cost of the deviation between the bidding quantities is included to avoid large power variation and arbitrage. The conditional expectation optimization model is formulated as an expectation minimization problem with the conditional value-at-risk (CVaR) constraints. Based on the price data in the PJM market, simulation results verify that our model is a decision-making tool in electricity markets, which can help market players comprehend the variants of bid price, expected cost and probability of successful bidding.

**Subject Areas:** Electric vehicles Aggregators; Bidding Strategy; Conditional value at risk; Day-ahead and Real-time markets

**Availability:** Yang, H., Zhang, S., Qiu, J., Qiu, D., Lai, M. and Dong, Z., 2017. *CVaR-Constrained Optimal Bidding of Electric Vehicle Aggregators in Day-ahead and Real-time Markets*. IEEE Transactions on Industrial Informatics, PP(99).

<http://ieeexplore.ieee.org/abstract/document/7839209/>

### **11.7. Title: An Optimal Integrated Planning Method for Supporting Growing Penetration of Electric Vehicles in Distribution Systems**

**Authors:** Zeng, B., Feng, J., Zhang, J. and Liu, Z.

**Abstract:** This paper proposes a multi-year expansion planning method for enabling distribution systems to support growing penetrations of plug-in electric vehicles. As distinct from the existing studies, the temporal characteristics of charging loads and their reliability impacts are especially focused in our work. To achieve this, a novel dual-stage optimization framework is developed. The proposed method considers the capacity reinforcement of distribution systems in conjunction with their operation decisions and coordinates them under the same frame so as to minimize the total system costs for accommodating electric vehicles. The uncertainties associated with renewable energy generation, charging behaviors, and conventional load demand are represented by multiple probabilistic scenarios. To fully reveal the impacts of electric vehicle integration, both uncontrolled and coordinated charging schemes are considered in our analysis. Furthermore, as charging loads bring about extra demand to the grid, the reliability criteria is also taken into account in the proposed model. Using a heuristic algorithm combined with reliability analysis, the optimal solution for the concerned problem can be determined, which involves the best timing, locations, and capacities for installation of distributed generation units and network components. The effectiveness of the proposed framework is examined based on a 38-bus test system and the obtained results verify the performance of the approach.

**Subject Areas:** Distribution network; Plug-in electric vehicle; Dual-stage optimization; Supply adequacy; Uncertainty; Chronological information

**Availability:** Zeng, B., Feng, J., Zhang, J. and Liu, Z., 2017. *An Optimal Integrated Planning Method for Supporting Growing Penetration of Electric Vehicles in Distribution Systems*. Energy, 126, pp.273-284.

<http://www.sciencedirect.com/science/article/pii/S0360544217303729>

### **11.8. Title: Effectiveness Evaluation for a Commercialized PV-Assisted Charging Station**

**Authors:** Liu, N. and Cheng, M.

**Abstract:** The Photovoltaic-assisted Charging Station (PVCS) is regarded as one of the most promising charging facilities for future electric vehicle (EV) energy supplementation. In this paper, the operation mode and profitability of a commercialized PVCS are analyzed under the energy policy of China. In order to evaluate the long-term effectiveness of using the PVCS to provide guidance for the investors of the stations, a set of evaluation indexes is introduced, including the quality of service, the environmental and economic benefits, and the impacts on the grid. Furthermore, an easily-achieved charging strategy which considers the quality of service and the self-consumption of PV energy is proposed. Finally, an effectiveness evaluation for different operational scenarios of the PVCS is completed, based on the actual statistical data. The simulation and evaluation results indicate that the PVCS has the potential to produce satisfactory environmental/economic benefits and to reduce the impacts and dependence of an EV's charging load on the grid.

**Subject Areas:** Electric Vehicle; PV System; Effectiveness evaluation; Operation mode; Charging strategy

**Availability:** Liu, N. and Cheng, M., 2017. *Effectiveness Evaluation for a Commercialized PV-Assisted Charging Station*. Sustainability, 9(2), p.323.

<http://www.mdpi.com/2071-1050/9/2/323/htm>

### **11.9. Title: Deployment and Utilization of Plug-in Electric Vehicles in Round-trip Carsharing Systems**

**Authors:** Jacquillat, A. and Zoepf, S.

**Abstract:** Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEVs) can reduce gasoline consumption, but increase vehicle acquisition costs and introduce operational constraints. We develop a comprehensive approach to EV/PHEV deployment and utilization in round-trip carsharing systems. First, we formulate and solve the tactical problem of utilizing a mix of gasoline vehicles and EVs/PHEVs to serve trip demand, using Mixed Integer Programming optimization to estimate the minimal gasoline consumption in a computationally efficient manner, and simulation to assess the effect of reservation order on realized gasoline consumption. Second, we use these results to inform the strategic deployment of EVs/PHEVs in the carsharing fleet, using meta-optimization. We implement our approach using data from a large carsharing provider. From the perspective of a carsharing operator, our results suggest that replacing some portion of existing gasoline fleets by EVs/PHEVs would result in gasoline savings likely to outweigh upfront investments and the constraints on vehicle utilization that it creates. Moreover, we find that easily implementable heuristics can capture some of these benefits, and that the integration of vehicle utilization patterns into the design of EV/PHEV deployment strategies can result in added benefits.

**Subject Areas:** Reliability; Carsharing; Electric Vehicles; Mixed Integer Programming; Simulation

**Availability:** Jacquillat, A. and Zoepf, S., 2017. *Deployment and Utilization of Plug-in Electric Vehicles in Round-trip Carsharing Systems*. International Journal of Sustainable Transportation, (just-accepted).

<http://www.tandfonline.com/doi/abs/10.1080/15568318.2017.1328624>

**11.10. Title: Adequacy Assessment of Power Distribution Network with Large Fleets of PHEVs considering Condition-Dependent Transformer Faults**

**Authors:** Tan, J. and Wang, L.

**Abstract:** As a new form of distributed energy resources, massive plug-in hybrid electric vehicles (PHEVs) could affect the power distribution system adequacy considering their intermittent charging loads and the load recovery ability during system outages. This paper proposes a comprehensive framework for adequacy evaluation of power distribution networks with PHEVs penetration. A condition-dependent outage model is used in this paper to obtain the time sequential failure rate of the transformer. Also, a business model for the PHEVs is developed to encourage the PHEV owners to charge their vehicles in such a way that the distribution system adequacy is enhanced. Based on this model, a smart charging algorithm is proposed for the PHEVs to minimize their charging cost and enhance the adequacy of the distribution network at the same time. Various simulation studies are carried out to verify the effectiveness of the proposed smart charging approach. The simulation results show that the proposed approach is effective in enhancing both the adequacy of the distribution network and economic profits of PHEVs.

**Subject Areas:** Plug-in hybrid electric vehicle; Power system adequacy assessment; Hybrid transformer failure model; Monte Carlo simulation

**Availability:** Tan, J. and Wang, L., 2017. *Adequacy Assessment of Power Distribution Network with Large Fleets of PHEVs considering Condition-Dependent Transformer Faults*. IEEE Transactions on Smart Grid, 8(2), pp.598-608.

<http://ieeexplore.ieee.org/abstract/document/7491332/>



### **11.11. Title: Economic Analysis of Different Electric Vehicle Charging Scenarios**

**Authors:** Ying, L., Haiming, Z., Xiufan, M. and Hao, W.

**Abstract:** Influence of electric vehicles (EV) to grid cannot be ignored. Research on the economy analysis of different charging scenarios is helpful to guide the user to charge or discharge orderly. EV charging models are built such as disordered charging, valley charging, intelligent charging, and V2G (Vehicle to Grid), by which changes of charging load in different scenarios can be seen to analyze the influence to initial load curve, and comparison can be done about user's average cost. Monte Carlo method is used to simulate the electric vehicle charging behavior, cost in different charging scenarios are compared, social cost is introduced in V2G scene, and the relationship between user's average cost and social cost is analyzed. By test, it is proved that user's cost is the lowest in V2G scenario, and the larger the scale of vehicles is, the more the social cost can save.

**Subject Areas:** Electric vehicles; Vehicle to Grid; Monte Carlo method

**Availability:** Ying, L., Haiming, Z., Xiufan, M. and Hao, W., 2017. *Economic Analysis of Different Electric Vehicle Charging Scenarios*. In IOP Conference Series: Materials Science and Engineering, 199(1), p. 012041, IOP Publishing.

<http://iopscience.iop.org/article/10.1088/1757-899X/199/1/012041/meta>

**11.12. Title: Innovative Transit Financing: Is the New Markets Tax Credit a Viable Financing Mechanism for Transit Projects?**

**Author:** Vachris, M.S.

**Abstract:** Financing transit projects is expensive and as the federal government and local municipalities balance multiple spending priorities, the pool of funds for transit could be reduced. Transit agencies and supporters should continue looking for innovative ways to source funds for projects. The New Markets Tax Credit is an established program that encourages private sector investment in qualified projects, such as transit. A comparison of New Markets Tax Credit program criteria and available public transit data proves that there is enough crossover to leverage the New Markets Tax Credit as an innovative financing option for transit projects, particularly Demand Response systems.

**Subject Areas:** Tax credit; Demand response; Accessibility; Financing; Public Transportation; Policy; Society

**Availability:** Vachris, M.S., 2017. *Innovative Transit Financing: Is the New Markets Tax Credit a Viable Financing Mechanism for Transit Projects?* Transportation Research Board, (No. 17-03490).

<http://docs.trb.org/prp/17-00318.pdf>

**11.13. Title: Relationships between the Online and In-store Shopping Frequency of Davis, California Residents**

**Authors:** Lee, R.J., Sener, I.N., Mokhtarian, P.L. and Handy, S.L.

**Abstract:** The growth of online shopping will likely impact rates of in-store shopping, signaling potentially significant ramifications for shopping-related vehicle travel. To better understand this relationship, we studied shoppers in Davis, California using a comprehensive survey dataset to explore the effect of personal characteristics, attitudes, perceptions, and the built environment on the frequencies of shopping online and within three distinct shopping settings. Overall, results showed that attitudes and perceptions played an important role in the shopping decision. The ordered response models of shopping frequency also revealed that the shopping motivations for each setting differed. Most notably, many of the factors influencing the frequency of shopping outside Davis had the opposite effect on shopping within Davis. Joint copula models subsequently suggested that online shopping had a complementary relationship with in-store shopping frequency, even after controlling for demographic variables and attitudes. Rather than reducing shopping travel, it appears that online shopping is associated with higher in-store shopping rates.

**Subject Areas:** Online shopping; Shopping trips; Shopping setting; Complementarity; Ordered response; Copula models

**Availability:** Lee, R.J., Sener, I.N., Mokhtarian, P.L. and Handy, S.L., 2017. *Relationships between the Online and In-store Shopping Frequency of Davis, California Residents*. . Transportation Research Part A: Policy and Practice, 100, pp.40-52.

<http://www.sciencedirect.com/science/article/pii/S0965856416300416>

#### **11.14. Title: Customer Data Driven PHEV Refuel Distance Modeling and Estimation**

**Authors:** Gong, Q. and Kapadia, J.

**Abstract:** Plug-in hybrid electric vehicles (PHEV) have an EV mode driving range which can cover a portion of customer daily driving. This EV mode range affects the refuel frequency substantially compared with conventional vehicle. For a conventional vehicle, daily driving pattern, tank size and fuel economy are the factors affecting the refuel frequency. While for a PHEV, EV range is another factor would affect the results substantially. Traditional method of label range can't represent real world driving range between fill-ups for PHEV well. How to accurately predict the PHEV refuel distance taking into account real world customer driving patterns and PHEV parameters become critical for PHEV system design and optimization. This paper presents real world big customer data based PHEV refuel distance estimation modeling. The target is to estimate PHEV refuel distance given several specific parameters such as EV range, hybrid mode fuel economy, tank size etc. A big EuroFOT data set is used for the analysis and model development. Then a linear model is developed based on sensitivity analysis. The estimation results are compared with the NHTS data based estimation, and validated with the real world PHEV data. Finally an Neural Network based estimation model is proposed to further capture the non-linearity in the model and improve accuracy.

**Subject Areas:** Customer satisfaction; Electric vehicle charging; Electric vehicles; Hybrid vehicles; Neural networks; Range (Vehicles); Refueling; Simulation; Travel patterns

**Availability:** Gong, Q. and Kapadia, J., 2017. *Customer Data Driven PHEV Refuel Distance Modeling and Estimation*. SAE Technical Paper.(No. 2017-01-0235).  
<http://www.sciencedirect.com/science/article/pii/S0965856416300416>

**11.15. Title: Cash for Corollas: When Stimulus Reduces Spending.**

**Authors:** Hoekstra, M., Puller, S.L. and West, J.

**Abstract:** The 2009 Cash for Clunkers program aimed to stimulate consumer spending in the new automobile industry, which experienced disproportionate reductions in demand and employment during the Great Recession. Exploiting program eligibility criteria in a regression discontinuity design, we show more than half of the subsidies went to households who would have purchased during the two-month program anyway; the rest accelerated sales by no more than eight months. Moreover, the program's fuel efficiency restrictions shifted purchases toward vehicles that cost on average \$7,600 less. Thus, we estimate on net the \$3 billion program reduced total new vehicle spending by \$5 billion.

**Subject Areas:** Cash for Clunkers program; Automobile industry; Consumer spending

**Availability:** Hoekstra, M., Puller, S.L. and West, J., 2017. *Cash for Corollas: When Stimulus Reduces Spending*. American Economic Journal: Applied Economics, 9(3), pp.1-35.  
<http://pubs.aeaweb.org/doi/pdf/10.1257/app.20150172>

**11.16. Title: Nonparametric Estimation of a Nonseparable Demand Function under the Slutsky Inequality Restriction.**

**Authors:** Blundell, R., Horowitz, J. and Parey, M.

**Abstract:** We present a method for consistent nonparametric estimation of a demand function with nonseparable unobserved taste heterogeneity subject to the shape restriction implied by the Slutsky inequality. We use the method to estimate gasoline demand in the United States. The results reveal differences in behavior between heavy and moderate gasoline users. They also reveal variation in the responsiveness of demand to plausible changes in prices across the income distribution. We extend our estimation method to permit endogeneity of prices. The empirical results illustrate the improvements in finite-sample performance of a nonparametric estimator from imposing shape restrictions based on economic theory.

**Subject Areas:** Slutsky inequality; Gasoline demand; Gasoline users

**Availability:** Blundell, R., Horowitz, J. and Parey, M., 2017. *Nonparametric Estimation of a Nonseparable Demand Function under the Slutsky Inequality Restriction*. *Review of Economics and Statistics*, 9(2),pp.291-304.

[http://www.mitpressjournals.org/doi/abs/10.1162/REST\\_a.00636](http://www.mitpressjournals.org/doi/abs/10.1162/REST_a.00636)

**11.17. Title: Identifying Odometer Fraud In Used Car Market Data.**

**Author:** Montag, J.

**Abstract:** This paper investigates the presence of odometer fraud in the used car market using a large dataset of car sale advertisements from the Czech Republic. The strategic aspects of sale decisions and the practice of rounding odometer readings, however, render the standard statistical tests for fabricated data invalid. I therefore develop and employ a modification of the last-digit test, which has been used to detect fraud in election data. Simulations using the data from advertisements and travel survey data from the United States support the validity of this test under alternative distributional assumptions. The results suggest that suspicious patterns are more prevalent in the segment of cars imported from abroad. I also show that this test can be used at the seller level, which may be of interest to authorities and market participants.

**Subject Areas:** Used car market; Odometer fraud; Digit tests

**Availability:** Montag, J., 2017. *Identifying Odometer Fraud In Used Car Market Data*. Transport Policy, 60, pp.10-23.

<https://www.sciencedirect.com/science/article/pii/S0967070X16308083>

**11.18. Title: Consumer Inattention and Demand for Energy Cost Savings**

**Author:** Leard, B.

**Abstract:** Consumer undervaluation of energy cost savings is a common explanation for the energy efficiency gap, where markets fail to adopt fuel-saving technologies even though the value of energy savings exceeds the costs. This paper presents empirical evidence on the relationship between a potential source of undervaluation - consumer inattention - and demand for energy-efficient products. Using survey data on respondents' attention to automobile fuel costs, attribute preferences, and discrete choice experiments, I find heterogeneity in inattention toward and willingness to pay for fuel cost savings. Estimates from discrete choice models suggest that inattentive consumers undervalue fuel cost savings and attentive consumers fully value these savings. The results imply that designing energy efficiency policies requires careful consideration of consumer inattention.

**Subject Areas:** Inattention; Energy Efficiency; Discrete Choice

**Availability:** Leard, B., 2017. *Consumer Inattention and Demand for Energy Cost Savings*. Resource For the Future (RFF) Report.

<http://www.ourenergypolicy.org/wp-content/uploads/2017/08/RFF-Rpt-Consumer-Inattention.pdf>



**11.19. Title: Incorporating Online Shopping into Travel Demand Modelling: Challenges, Progress, and Opportunities**

**Author:** Suel, E. and Polak, J.W.

**Abstract:** There is a large body of literature, spanning multiple disciplines, concerned with the relationship between traditional (physical) shopping and associated travel behaviour. However, despite the recent rapid growth of digital retailing and online shopping, the impact on travel behaviour remain poorly understood. Although the issue of the substitution and complementarity between conventional and virtual retail channels has been extensively explored, few attempts have been made to extend this work so as to incorporate virtual retail channels into modelling frameworks that can link shopping and mobility decisions. Here, we review the existing literature base with a focus on most relevant dimensions for personal mobility. How online activity can be incorporated into operational transport demand models and benefits of such effort are discussed. Existing frameworks of shopping demand are flexible and can, in principle, be extended to incorporate virtual shopping and the associated additional complexities. However, there are significant challenges associated with lack of standard ontologies for crucial concepts and insufficiencies in traditional data collection methods. Also, supply-side questions facing businesses and policy-makers are changing as retailing goes through a digital transformation. Opportunities and priorities need to be defined for future research directions for an assessment of existing tools and frameworks.

**Subject Areas:** Transport planning; Demand models; Online shopping, e-commerce

**Availability:** Suel, E. and Polak, J.W., 2017. *Incorporating Online Shopping into Travel Demand Modelling: Challenges, Progress, and Opportunities*. Transport Reviews, pp.1-26.  
<http://www.tandfonline.com/doi/abs/10.1080/01441647.2017.1381864>

**11.20. Title: Reliability-Based Design Optimization (RBDO) for Electric Vehicle Market Systems**

**Authors:** Lee, U., Kang, N. and Lee, I.

**Abstract:** When designing a product, both engineering uncertainty and market heterogeneity should be considered to reduce the risk of failure in the market. Reliability-based design optimization (RBDO) approach allows decision makers to achieve target confidence in product performance under engineering uncertainty. Design for market systems (DMS) approach helps decision makers to find profit-maximized product design under market heterogeneity. This paper integrates RBDO and DMS approaches for an Electric vehicle (EV) design. Consumers' preferences on warranted battery lifetime are heterogeneous while battery life itself is affected by various uncertainties such as battery characteristics and driving patterns. We optimized and compared four scenarios depending on whether engineering systems are deterministic or probabilistic, and whether a market is homogeneous or heterogeneous. The results provide some insight on how the optimal EV design should be altered depending on engineering uncertainty and market heterogeneity.

**Subject Areas:** Electric Vehicle; Reliability-based optimization

**Availability:** Lee, U., Kang, N. and Lee, I., 2017. *Reliability-Based Design Optimization (RBDO) for Electric Vehicle Market Systems*. ASME 2017 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (pp. V02AT03A038-V02AT03A038). American Society of Mechanical Engineers.

<http://proceedings.asmedigitalcollection.asme.org/proceeding.aspx?articleid=2661960>

**11.21. Title: Long-term Trends in Domestic US Passenger Travel: The Past 110 Years and the Next 90**

**Author:** Schäfer, A.W.

**Abstract:** Based upon a long-term historical data set of US passenger travel, a model is estimated to project aggregate transportation trends through 2100. One of the two model components projects total mobility (passenger-km traveled) per capita based on per person GDP and the expected utility of travel mode choices (logsum). The second model component has the functional form of a logit model, which assigns the projected travel demand to competing transportation modes. An iterative procedure ensures the average amount of travel time per person to remain at a pre-specified level through modifying the estimated value of time. The outputs from this model can be used as a first-order estimate of a future benchmark against which the effectiveness of various transportation policy measures or the impact of autonomous behavioral change can be assessed.

**Subject Areas:** Passenger travel; Time series model; Mode choice; Travel time budget; Peak car Scenario

**Availability:** Schäfer, A.W., 2017. *Long-term Trends in Domestic US Passenger Travel: The Past 110 Years and the Next 90*. Transportation, 44(2), pp.293-310.  
<https://link.springer.com/article/10.1007/s11116-015-9638-6>

**11.22. Title: Comparative Analysis of Cast-in-place Post-tensioned and Steel-concrete Composite Bridge Bent Caps**

**Authors:** Yazdani, N. and Ruiz, F.D.

**Abstract:** The complexity of the IH-635 Managed Lanes Project, located in Dallas County, Texas, posed several technical and constructive challenges, leading to the adoption of solutions different from the traditional. Two alternative solutions for the pier cap on one of the bridge crossings over IH-35E in the IH-635 project were analyzed in this case study, a cast-in-place post-tensioned concrete cap and an innovative prefabricated steel-concrete composite cap. The approach was to use an estimation of direct costs for material and labor and consideration of construction time schedules. A supplementary numerical modeling confirmed that both alternatives behave elastically under imposed loads. The direct cost of material and labor for the two alternatives were close. However, the composite alternative required 13 days less construction time, resulting in substantial cost savings from traffic closing in the very busy traffic corridor. Traffic closing costs were substantially higher than the direct costs, especially for the post-tensioned cap. The quantification of the benefits allows more confidence in the utilization of the composites caps, leading to faster completion of bridge projects and substantial economic savings.

**Subject Areas:** Bridge pier cap; Bridge bent; Post-tensioned structure; Steel-concrete cap; Cost estimation; Construction schedule; Traffic closing cost

**Availability:** Yazdani, N. and Ruiz, F.D., 2017. *Comparative Analysis of Cast-in-place Post-tensioned and Steel-concrete Composite Bridge Bent Caps*. Journal of Modern Transportation, 25(3), pp.194-204.

<https://link.springer.com/article/10.1007/s40534-017-0136-8>

### **11.23. Title: Implications of Consumer Lifestyle Changes and Behavioral Heterogeneity on U.S. Energy Consumption and Policy**

**Author:** Sekar, A.

**Abstract:** Understanding the relationship between consumer lifestyle and energy use is essential to solving many of the energy and sustainability challenges. By studying shifts in consumer lifestyle over time and behavior heterogeneity, this dissertation provides valuable insights into understanding energy consumption trends and improving energy efficiency programs. Technologies continue to change our daily lifestyles, influencing energy demand. In the first part of the dissertation, changes in how people spend their time (time-use) patterns are used as an indicator of lifestyle shifts. Using decomposition analysis changes in energy use due to these lifestyle shifts are measured. The results show that for an average American, time spent in residences increased at the rate of 3.1 minutes per day per year while time spent for travel and other non-residential activities decreased (-0.4 min/day/year and -2.7 min/day/year respectively). The time-use shifts induced a net energy change of -1,722 trillion BTU, 1.8% of national primary energy consumption in 2012. The lifestyle/energy shifts are interpreted as primarily driven by information and communication technology: people are spending more time at home with online entertainment and services. Information provided to consumers and energy efficiency rebate programs generally assume characteristics of an average consumer. There is, however, substantial heterogeneity in behavior, energy prices and impacts of electricity use. To understand the impact of heterogeneity on rebate programs, in the second part, the economic and carbon benefits of efficient choices of three household technologies (television, clothes washer and dryer) are assessed for different locations and usage patterns. For some households, an efficient energy washers and dryers do not save money, but brings substantial economic benefits to others. Viewing utility appliance rebate programs as tools for carbon abatement, abatement cost of carbon was assessed. At current rebate levels, for an average household, the abatement cost for carbon exceeds social cost of carbon (SCC). However, subpopulations with abatement cost less than SCC exists: 4%, 6%, and 41% for televisions, washers and dryers respectively. Therefore, abatement programs can benefit from targeted intervention. For targeted intervention, it would be useful to identify groups with high energy use and characterize their demographics. To achieve this, in the third analysis, time-use survey data is used to characterize patterns of TV watching. Using cluster analysis, the population was divided into three groups, the high-energy use cluster has 14% of the population and spends an average of 7.7 hours per day on TV. This relatively small group, due to high use, accounts for 34% of total television energy consumption. This group tends to be older, not in the work force and/or poorly educated. A high-use household purchasing an efficient television saves more than three times the energy of an average household.

**Subject Areas:** Consumer lifestyle; Energy use; Behavior heterogeneity; Decomposition analysis; Time-use patterns

**Availability:** Sekar, A., 2017. *Implications of Consumer Lifestyle Changes and Behavioral Heterogeneity on U.S. Energy Consumption and Policy*. (Doctoral dissertation, Rochester Institute of Technology).

<https://search.proquest.com/openview/916bf0f4000612c3ecd1169bac6ad067/1?pq-origsite=gscholar&cbl=18750&diss=y>

**11.24. Title: How Much Do Consumers Value Fuel Economy and Performance?**

**Authors:** Leard, B., Linn, J. and Zhou, Y.C.

**Abstract:** During historical periods in which US fuel economy standards were unchanging, automakers increased performance but not fuel economy, contrasting with recent periods of tightening standards and rising fuel economy. This paper evaluates the welfare consequences of automakers forgoing performance increases to raise fuel economy as standards have tightened since 2012. Using a unique data set and a novel approach to account for fuel economy and performance endogeneity, we find undervaluation of fuel cost savings and high valuation of performance. Welfare costs of forgone performance approximately equal expected fuel savings benefits, suggesting approximately zero net private consumer benefit from tightened standards.

**Subject Areas:** Passenger vehicles; Fuel economy standards; Technology adoption; Consumer welfare

**Availability:** Leard, B., Linn, J. and Zhou, Y.C., 2017. *How Much Do Consumers Value Fuel Economy and Performance?* Resources For The Future Report (RFF) Report.  
[http://www.rff.org/files/document/file/RFF-Rpt-WTP\\_FuelEconomy%26Performance.pdf](http://www.rff.org/files/document/file/RFF-Rpt-WTP_FuelEconomy%26Performance.pdf)

## **11.25. Title: Economical Staging Plan for Implementing Electric Vehicle Charging Stations**

**Authors:** Alhazmi, Y.A. and Salama, M.M.

**Abstract:** This paper proposes an economical staging planning method that optimally matches Plug-in Electric Vehicle (PEV) charging demand with the installation of Fast Charging Stations (FCSs) in the distribution system. The proposed plan consists of two stages. The first stage evaluates the capability of distribution systems to supply PEV charging demands with the existence infrastructure. To investigate the influence of using different types of charging (i.e. Level 2, Level 3), PEV demand is distributed between residential and public charging facilities with different shares considering the travel patterns when modeling PEV loads. Optimal Power Flow (OPF) analysis is utilized to obtain the maximum penetration level of PEVs that the existing distribution system can adapt without any technical violations. In the second stage, the growth of public PEV demand is optimally matched by the installed FCS capacity using the economical staging plan model. By including the waiting and the service times of charging service, the proposed planning model considers not only the economic assessment of the FCS plan but also the quality of FCS service. A comprehensive case study for coupled transportation and electrical networks is examined. The results show that no major distribution system upgrades are required to serve public PEV demand, up to a 30% penetration level, during the early stage of adoption. The influence of using FCS to allocate and manage the PEV demand is illustrated, and the current work provides to FCS investors a means to evaluate the profitability of such a business.

**Subject Areas:** Plug-in Electric Vehicles; Fast charging stations; Penetration level; Economical staging plan; Queuing system

**Availability:** Alhazmi, Y.A. and Salama, M.M., 2017. *Economical Staging Plan for Implementing Electric Vehicle Charging Stations*. *Sustainable Energy, Grids and Networks*, 10, pp.12-25. <http://www.sciencedirect.com/science/article/pii/S2352467717300413>

**11.26. Title: How does On-road Fuel Economy vary with Vehicle Cumulative Mileage and Daily Use?**

**Authors:** Greene, D.L., Liu, J., Khattak, A.J., Wali, B., Hopson, J.L. and Goeltz, R.

**Abstract:** Understanding the fuel economy of vehicles in actual use has important implications for fuel economy, greenhouse gas emission and consumer information policies. This study explores how fuel economy varies with intensity of daily vehicle use, cumulative mileage, and ambient temperature. Using a unique longitudinal database, we quantify variations in fuel economy (miles per gallon or MPG) over time for the same vehicle. The database consists of more than 600,000 odometer and fuel purchase records, obtained from the “My MPG” section of the <http://fueleconomy.gov> website. Over 10,000 drivers reported their fuel purchases and vehicle usage, with an average of 36 fill-ups per vehicle. Multilevel models are used to analyze and compare relationships for conventional gasoline and hybrid vehicles. For gasoline vehicles, within-vehicle variation accounts for 23% total variation of fuel economy and 77% is between-vehicle variation. For hybrids, the equivalent proportions are 19% and 81%. On-road fuel economy increases nonlinearly with cumulative mileage, with nearly all of the increase occurring within the first few thousand miles. The estimated trend for hybrid vehicles is very different from that of conventional gasoline vehicles. Hybrids were found to have higher daily miles of use than conventional gasoline vehicles. Cold temperatures appear to have a greater effect on the fuel economy of hybrids than conventional gasoline vehicles.

**Subject Areas:** On-road fuel economy; Cumulative mileage; Vehicle usage; Multi-level modeling; My MPG

**Availability:** Greene, D.L., Liu, J., Khattak, A.J., Wali, B., Hopson, J.L. and Goeltz, R., 2017. *How does On-road Fuel Economy vary with Vehicle Cumulative Mileage and Daily Use?* Transportation Research Part D: Transport and Environment, 55, pp.142-161. <https://www.sciencedirect.com/science/article/pii/S1361920916301742>



**11.27. Title: Optimal Temporal-Spatial PEV Charging Scheduling in Active Power Distribution Networks**

**Authors:** Sun, S., Yang, Q. and Yan, W.

**Abstract: Background:** The increasing penetration of a massive number of plug-in electric vehicles (PEVs) and distributed generators (DGs) into current power distribution networks imposes obvious challenges on power distribution network operation.

**Methods:** This paper presents an optimal temporal-spatial scheduling strategy of PEV charging demand in the presence of DGs. The solution is designed to ensure the reliable and secure operation of the active power distribution networks, the randomness introduced by PEVs and DGs can be managed through the appropriate scheduling of the PEV charging demand, as the PEVs can be considered as mobile energy storage units.

**Results:** As a result, the charging demands of PEVs are optimally scheduled temporally and spatially, which can improve the DG utilization efficiency as well as reduce the charging cost under real-time pricing (RTP).

**Conclusions:** The proposed scheduling strategy is evaluated through a series of simulations and the numerical results demonstrate the effectiveness and the benefits of the proposed solution.

**Subject Areas:** Plug-in hybrid ehicles (PEVs); temporal-spatial scheduling strategy; Distributed generators (DGs); Real-time pricing (RTP); Energy storage; Charging demand; Charging scheduling strategy; Active power distribution networks

**Availability:** Sun, S., Yang, Q. and Yan, W., 2017. *Optimal Temporal-Spatial PEV Charging Scheduling in Active Power Distribution Networks*. Protection and Control of Modern Power Systems, 2(1), p.34.

<https://link.springer.com/article/10.1186/s41601-017-0065-x>

**11.28. Title: Optimal Scheduling of Unbalanced Distribution Networks to Improve the Contribution of Renewables and Network Balancing Performance**

**Authors:** Hamidi, A., Nazarpour, D. and Golshannavaz, S.

**Abstract:** High penetration of photovoltaic (PV) units in distribution networks along with unbalanced nature of residential loads deteriorates the voltage quality metrics and ends in unbalanced operations. The ever increasing number of plug-in electric vehicles (PEVs) and their smart charging/discharging processes provides a potential opportunity for lessening the voltage unbalance factor (VUF), operated independently at each of the single-phase's components. On the other hands, in different types of operation modes, collaboration of voltage conditioning devices such as under-load tap-changing (ULTC) transformer with PEVs and PV units necessitates adoption of efficient distribution management systems (DMSs). Contributing to this context, this study develops a DMS concentrating on various types of control methods say as symmetric and asymmetric operation of devices. The main goal is to achieve the best operation characteristics in unbalanced conditions and boosting the hosting capacity of renewable energy resources. The proposed approach is modeled as a non-linear problem (NLP) and tested on an IEEE 33-bus test network. Results are discussed in depth.

**Subject Areas:** Plug-in hybrid electric vehicles (PHEVs); Unbalanced distribution network; High penetration of photovoltaics (PVs); Three-phase smart charging/discharging algorithm; Distribution management system (DMS)

**Availability:** Hamidi, A., Nazarpour, D. and Golshannavaz, S., 2017. *Optimal Scheduling of Unbalanced Distribution Networks to Improve the Contribution of Renewables and Network Balancing Performance*. Electrical Engineering (ICEE), 2017 Iranian Conference on (pp. 1236-1241). IEEE.

<http://ieeexplore.ieee.org/abstract/document/7985230/>

**11.29. Title: The Economic Impact of Electric Vehicle Routing and Charging Strategy on Traffic-Power Integrated Networks**

**Authors:** Shi, Y., Sun, T. and Feng, D.

**Abstract:** The penetration of electric vehicles (EVs) has attracted growing research interests in its impact on both power and traffic networks. With the expansion of EVs' range as well as the development of fast charging technology and related infrastructure, large-scale EVs are involved in intercity transportation systems and power transmission systems. We propose a traffic-power integrated network model and convert a EV routing and charging problem into a shortest path problem in this model. Considering the "congestion" in both traffic and power networks, we design a real-time scheduling strategy at the level of EV owners to minimize their synthetic trip costs. In our simulation, the economic impact of the proposed strategy on the integrated system is evaluated numerically, in comparison with the impacts of other strategies at both the custom level and the system level.

**Subject Areas:** Electric Vehicle; Traffic-Power Integrated Network; Fast Charging; Locational Marginal Price; Real-Time Scheduling

**Availability:** Shi, Y., Sun, T. and Feng, D., 2017. *The Economic Impact of Electric Vehicle Routing and Charging Strategy on Traffic-Power Integrated Networks*. Industrial Electronics Society, IECON 2017-43rd Annual Conference of the IEEE(pp. 453-458). IEEE.

<http://ieeexplore.ieee.org/abstract/document/8216080/>

### **11.30. Title: Enabling Fast Charging - Infrastructure and Economic Considerations**

**Authors:** Burnham, A., Dufek, E.J., Stephens, T., Francfort, J., Michelbacher, C., Carlson, R.B., Zhang, J., Vijayagopal, R., Dias, F., Mohanpurkar, M. and Scoffield, D.

**Abstract:** The ability to charge battery electric vehicles (BEVs) on a time scale that is on par with the time to fuel an internal combustion engine vehicle (ICEV) would remove a significant barrier to the adoption of BEVs. However, for viability, fast charging at this time scale needs to also occur at a price that is acceptable to consumers. Therefore, the cost drivers for both BEV owners and charging station providers are analyzed. In addition, key infrastructure considerations are examined, including grid stability and delivery of power, the design of fast charging stations and the design and use of electric vehicle service equipment. Each of these aspects have technical barriers that need to be addressed, and are directly linked to economic impacts to use and implementation. This discussion focuses on both the economic and infrastructure issues which exist and need to be addressed for the effective implementation of fast charging at 400 kW and above. In so doing, it has been found that there is a distinct need to effectively manage the intermittent, high power demand of fast charging, strategically plan infrastructure corridors, and to further understand the cost of operation of charging infrastructure and BEVs.

**Subject Areas:** Extreme fast charging (XFC); Electric vehicle infrastructure; Battery electric vehicles; Demand charges; Total cost of ownership; Economics

**Availability:** Burnham, A., Dufek, E.J., Stephens, T., Francfort, J., Michelbacher, C., Carlson, R.B., Zhang, J., Vijayagopal, R., Dias, F., Mohanpurkar, M. and Scoffield, D., 2017. *Enabling Fast Charging - Infrastructure and Economic Considerations*. Journal of Power Sources, 367, pp.237-249.

<https://www.sciencedirect.com/science/article/pii/S0378775317308625>

**11.31. Title: Adoption of Electric Vehicles in Commercial Fleets: Why do Car Pool Managers Campaign for BEV Procurement?**

**Authors:** Globisch, J., Dütschke, E. and Wietschel, M.

**Abstract:** We use regression analysis to study what motivates car pool managers to campaign for BEV procurement using primary data from 229 car pool managers including adopters and non-adopters of EVs. Key findings are that a personal interest in EVs due to technophilia increases the intention to start procurement initiatives for BEVs. These findings underpin the fact that the attitudes of single individuals can influence internal organizational decision processes and therefore play an important role in explaining BEV adoption in commercial fleets. Other factors that foster initiatives for BEV procurement are organizational innovativeness, and the expectation of environmental benefits and positive effects on employee motivation. The fear of mobility constraints and doubts about the reliability of BEVs counteract the intention to campaign for their procurement.

**Subject Areas:** Acceptance; Electric vehicles; Commercial fleets; Motivation; Organizational innovation adoption

**Availability:** Globisch, J., Dütschke, E. and Wietschel, M., 2017. *Adoption of Electric Vehicles in Commercial Fleets: Why do Car Pool Managers Campaign for BEV Procurement?* Transportation Research Part D: Transport and Environment.

<https://www.sciencedirect.com/science/article/pii/S136192091630774X>

**11.32. Title: Design of Optimal Incentives for Smart Charging Considering Utility-Customer Interactions and Distribution Systems Impact**

**Authors:** Humayd, A.S.B. and Bhattacharya, K.

**Abstract:** With increasing environmental concerns the penetration of plug-in electric vehicles (PEVs) is expected to increase in the future. Such electrification of the transportation sector will impact the distribution grid adversely; however, PEV smart charging strategies can help mitigate the impacts. In this paper, a PEV smart charging approach is proposed where the charging loads are controlled and incentivized by the local distribution company (LDC) for every unit of energy controlled. A novel framework is proposed to determine the optimal participation of PEVs in the smart charging program and optimal incentives paid by the LDC to PEV customers, such that both parties are economically benefited. The proposed framework models the relationship between customers' participation and incentives offered by the LDC. The relationship between the expected investment deferral and hence the economic benefits from smart charging participation are considered as well. Monte Carlo simulation is used to simulate the uncertainty of demand, electricity market price, drivers' behaviour, PEV market share, and charging level share. The proposed framework is tested on the 33-bus distribution system and the results show that the proposed approach is effective and can economically benefit both LDC and smart charging PEV participants, while also improving distribution system operation.

**Subject Areas:** Capacity deferral; Customer participation; Incentive mechanisms; Local distribution company; Plug-in electric vehicles; Smart charging; Uncontrolled charging

**Availability:** Humayd, A.S.B. and Bhattacharya, K., 2017. *Design of Optimal Incentives for Smart Charging Considering Utility-Customer Interactions and Distribution Systems Impact*. IEEE Transactions on Smart Grid.

<http://ieeexplore.ieee.org/abstract/document/8100987/>

### **11.33. Title: Optimal Electric Vehicle Scheduling: A Co-Optimized System and Customer Perspective**

**Author:** Ferdowsi, M.

**Abstract:** Electric vehicles provide a two pronged solution to the problems faced by the electricity and transportation sectors. They provide a green, highly efficient alternative to the internal combustion engine vehicles, thus reducing our dependence on fossil fuels. Secondly, they bear the potential of supporting the grid as energy storage devices while incentivising the customers through their participation in energy markets. Despite these advantages, widespread adoption of electric vehicles faces socio-technical and economic bottleneck. This dissertation seeks to provide solutions that balance system and customer objectives under present technological capabilities. The research uses electric vehicles as controllable loads and resources. The idea is to provide the customers with required tools to make an informed decision while considering the system conditions.

First, a genetic algorithm based optimal charging strategy to reduce the impact of aggregated electric vehicle load has been presented. A Monte Carlo based solution strategy studies change in the solution under different objective functions. This day-ahead scheduling is then extended to real-time coordination using a moving-horizon approach. Further, battery degradation costs have been explored with vehicle-to-grid implementations, thus accounting for customer net-revenue and vehicle utility for grid support. A Pareto front, thus obtained, provides the nexus between customer and system desired operating points. Finally, we propose a transactive business model for a smart airport parking facility. This model identifies various revenue streams and satisfaction indices that benefit the parking lot owner and the customer, thus adding value to the electric vehicle.

**Subject Areas:** Electric vehicles; Genetic algorithm; Fossil fuels

**Availability:** Ferdowsi, M., 2017. *Optimal Electric Vehicle Scheduling: A Co-Optimized System and Customer Perspective*. (Doctoral dissertation, Missouri University of Science and Technology).

<https://search.proquest.com/openview/61e16a2353422fb9d8e9925980a4691a/1?pq-origsite=gscholar&cbl=18750&diss=y>

### **11.34. Title: A Local Energy Market for Electricity and Hydrogen**

**Authors:** Xiao, Y., Wang, X., Pinson, P. and Wang, X.

**Abstract:** The proliferation of distributed energy resources entails efficient market mechanisms in distribution-level networks. This paper establishes a local energy market (LEM) framework in which electricity and hydrogen are traded. Players in the LEM consist of renewable distributed generators (DGs), loads, hydrogen vehicles (HVs), and a hydrogen storage system (HSS) operated by a HSS agent (HSSA). An iterative LEM clearing method is proposed based on the merit order principle. Players submit offers/bids with consideration of their own preferences and profiles according to the utility functions. The decentralized LEM clearing process not only avoids complex calculation induced by centralized decision process, but also preserves players' privacy. Case studies are conducted that demonstrate that the LEM promotes local integration of renewable energy, reduces peak demand, and improves players' utilities. Sensitivity analysis is then implemented to discuss the influences on the LEM clearing results of capacities of DGs, Loads, and the HSS, as well as price of hydrogen from the hydrogen station (HS).

**Subject Areas:** Distributed Energy Resources; Hydrogen Storage System; Iterative Market Clearing; Local Energy Market

**Availability:** Xiao, Y., Wang, X., Pinson, P. and Wang, X., 2017. *A Local Energy Market for Electricity and Hydrogen*. IEEE Transactions on Power Systems.

<http://ieeexplore.ieee.org/document/8128505/>



**11.35. Title: Coordination of PEV Charging Across Multiple Stations in Distribution Networks using Aggregate PEV Charging Load Model**

**Authors:** Chen, H., Guo, Z., Xin, Y., Zhao, Y. and Jia, Y.

**Abstract:** Plug-in electric vehicles (PEVs) are receiving global attention. However, the integration of large-scale PEVs brings challenge to the existing power system. Therefore, it is necessary to develop a coordinated charging strategy for PEVs. In this paper, based on aggregate PEV charging load model, we propose a coordinated charging strategy for multiple stations in the distribution network, which aims to minimize the total PEV charging costs. The mathematical model formulated for the charging strategy includes PEV charging constraints, i.e., charging demands constraints and charging power constraints, and distribution networks constraints, i.e., bus power balance constraints, power flow equality constraints, voltage constraints and branch thermal constraints. The model is further linearized to simplify computation. In the case studies, Monte Carlo simulation method is used to generate the PEVs' parking behaviors according to the National Household Travel Survey (NHTS) of U.S., and the comparison between the coordinated charging scenario and the uncoordinated charging scenario indicates that, after coordination, the PEV charging costs can be effectively reduced and more PEVs can be connected to the distribution networks.

**Subject Areas:** Plug-in electric vehicle; Aggregate; Load model; Coordinated charging; Smart grids

**Availability:** Chen, H., Guo, Z., Xin, Y., Zhao, Y. and Jia, Y., 2017. *Coordination of PEV Charging Across Multiple Stations in Distribution Networks using Aggregate PEV Charging Load Model*. In Smart Cities Conference (ISC2), 2017 International (pp. 1-5). IEEE, September.  
<http://ieeexplore.ieee.org/abstract/document/8090819/>