

# Technical Appendix 1

## Literature Review and Project Bibliography

This Literature Search and the Project Bibliography follow the outline originally proposed in the Amplified Work Plan (AWP) for TCRP H-51 with seven chapters. The first draft of the Project Bibliography was distributed to the panel in January of 2016, and has been updated for publication at this time. The Literature Search and the Project Bibliography are organized into seven sections, as described below.

### Seven Sections of the Project Bibliography

1. Generational Change in Transit and Travel Behavior
2. Demographics, Migration and Ethnicity
3. Attitudes, Values and Preferences in Travel Behavior
4. Environmental Motivations and Strategies
5. Land Patterns and Transit Markets
6. Intelligent Communications Technology and Transit Markets
7. Methods to Interpret Transit Markets

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## Part One: The Literature Search

### ***1. Generational Change in Transit and Travel Behavior***

#### *Has There Been a Change in the Travel Patterns of Youth?*

As is reported in Chapter 2 of TCRP Research Report 201, there is no debate that the travel patterns of American youth have changed over the past twenty years. And, while the number of vehicle-miles traveled by American youth has tumbled, the same thing also occurred simultaneously in other countries.

Kuhnimhof, et al. (2011) in "*A New Generation: Travel Trends among Young Germans and Britons*" find:

...decreasing car availability, a significant reduction of automobile mileage, increases in the use of other modes, and growing multimodal behavior of the young, with men reducing their automobile travel more than women. Even though the development is more pronounced in Germany [as compared to Britain], the similarity of the changes in young people's mobility patterns in the two countries is striking. This similarity suggests that the observed changes in travel behavior are not an idiosyncratic development in one country. Instead, the similarity may

indicate a structural change in travel behavior that may be found in other Western countries.

At the same time, Frändberg and Vilhelmson (2011) in *"More or Less Travel: Personal Mobility Trends in the Swedish Population Focusing Gender and Cohort,"* note that young people in Sweden were traveling less, while their elders were traveling more, reporting, "... substantial reductions in daily mobility and long-distance domestic travel are observed among the young."

A closer analysis of the travel behavior of youth internationally finds that this downward trend in car use has been seen especially in men. Kuhnimhof, et al. (2012) write, in *"Men Shape a Downward Trend in Car Use among Young Adults—Evidence from Six Industrialized Countries:"*

The findings indicate that since the turn of the millennium, access to cars, measured in terms of drivers' licences and household car ownership, has decreased in most study countries, especially for men. Moreover, average daily car travel distance has decreased in most study countries, again especially for men. In France, Japan, and most significantly in the USA, the decrease in car travel has led to a reduction in total everyday travel by young travellers. In Great Britain, the decline in car travel was partly, and in Germany fully, compensated by an increased use of alternative modes of transport.

(*The literature contained in*) the Project Bibliography documents that this multinational trend did in fact occur. Just how to interpret it brings a variety of approaches. Dutzik and Baxandall (2013), in *"A New Direction: Our Changing Relationship with Driving and the Implications for America's Future,"* conclude that, "... a new generation—the Millennials— is demanding a new American Dream less dependent on driving. Transportation policy in the United States, however, remains stuck in the past."

To some scholars, the change in travel behavior in the first decade of this century is immediately explainable and straightforward. In *"It's the Economy, Stupid: Increasing Fuel Price is Enough to Explain Peak Car in Sweden,"* Bastian and Börjesson write, "...in this paper we show that economic variables alone can explain the observed car use trends in Sweden from 2002-2012."

In the United States, Taylor et al. (2013) in *"Who Knows About Kids These Days? Analyzing the Determinants of Youth and Adult Mobility Between 1990 and 2009,"* find that, being employed, licensed, having access to cars, and residential area population density all significantly affect PMT (person miles traveled) regardless of age. By contrast, some socioeconomic factors long found to influence adult travel – such as race/ethnicity and household income – are not significant for today's teens. Finally, with the exception of employment, the effects of societal trends (ICTs [Information and Communication Technology], GDLs [graduated driver licensing], and young adults "boomeranging" to live at home with parents) on youth travel are surprisingly muted. When it comes to recent changes in teen, youth, (and adult) travel behavior, the adage, "it's the economy, stupid," appears to hold.

Blumenberg et al. (2012) in *"What's Youth Got to Do with It? Exploring the Travel Behavior of Teens and Young Adults"* emphasize that, "...unemployment rates during the current recession are highest for youth, thereby reducing journey-to-work and work-related travel and limiting the resources teens and young adults have to pay for non-work activities (and associated travel) of all types."

A highly balanced approach to the question of the role of economic factors is offered by Garceau et al. (2014) in *"Peak Travel and the Decoupling of Vehicle Travel from the Economy: A Synthesis of the Literature."* Garceau et al. argue,

The complex relationship between the economy (as measured by gross domestic product) and personal vehicle travel appears to be changing, and this change suggests a weakening connection between the two. Although causes such as saturation of demand, aging, decline of young drivers, preference shifts, and time budget constraints all contribute to reduced automobile travel at one time or another, or in one place or another, *none of these factors can explain why peak travel is occurring on multiple scales in a diversity of places.* The authors conclude that although the existing literature explains the recent trend reversal in specific cities or partially explains the global phenomenon, *the fundamental reasons for peak travel are still not understood.*

Several key factors are emphasized by Ralph (2015) in her PhD Thesis, *"Stalled On The Road To Adulthood? Analyzing the Nature of Recent Travel Changes for Young Adults in America, 1995 to 2009."* Ralph finds,

...economic constraints, role deferment, and racial/ethnic compositional changes in the population primarily explain the travel trends [among young adults] during this period [1995 to 2009]. The evidence in support of preferences and residential location explanations was substantially more limited. The concluding chapter contextualizes these findings, arguing that a large and growing share of young adults suffer from transportation disadvantage. The most important take-away from this work is that the decline in driving by young people in the 2000s deserves our attention—not as an unmitigated success story, but as an early indication of a problem.

In a study directly relevant to the key questions posed in TCRP H-51, Brown et al. (2016) in *"A Taste for Transit? Analyzing Public Transit Use Trends Among Youth,"* conclude that:

Findings indicate that although young adults are more likely to ride transit than older adults, transit use among youth can be explained largely by (1) life cycle factors common among young people but unlikely to persist as they age, (2) higher levels of transit use among nonwhites, who are disproportionately young, and (3) locational factors such as living in densely-developed neighborhoods that may or may not continue as young people age. Therefore, whereas transit habits established early in life may persist as young adults age, the data examined here suggest that such an outcome is far from assured.

In an innovative contribution to the literature particularly relevant to our study, McDonald (2015) in *"Are Millennials Really the 'Go-Nowhere' Generation?"* undertakes an analysis to estimate the extent to which various theories/factors contribute to the pattern of lowered vehicle use by the young. McDonald finds,

Among young adults, lifestyle-related demographic shifts, including decreased employment, explain 10% to 25% of the decrease in driving; Millennial-specific factors such as changing attitudes and use of virtual mobility (online shopping, social media) explain 35% to 50% of the drop in driving; and the general dampening

of travel demand that occurred across all age groups accounts for the remaining drop in travel.

Based on this analysis, McDonald challenges the planning profession to develop, "...improved planning processes that deal robustly with the uncertain future presented by Millennials who may continue to make very different travel choices than comparable people did in the past." In a recommendation very relevant to the TCRP H-51 work program, McDonald concludes that uncertainty over the future trajectory of the travel of Millennials needs to be recognized in the long-range transportation planning process. Practitioners can use scenario planning, as we will in this study, to understand how transport needs shift if Millennials continue to use automobiles less than previous generations or, if like other generations, they rapidly increase their auto usage as they become middle age.

The conclusions of McDonald (2015) were re-affirmed by Coogan, et al (2017) in the NCHRP study *Understanding Changes in Youth Mobility (2017)*, which concluded that even the traumatic economic environment experienced by young males at the time of the 2009 NHTS could not fully explain the drop in vehicle miles of travel occurring at that time. The study notes a rebound of VMT per capita did commence in 2013, which still results in lower travel per capita than its peak near 2005.

## Understanding the Unique Characteristics of Millennials

The Project Bibliography includes the abstracts of a cross section of literature concerning the characteristics of Millennials. The social patterns of the generation have been examined by the Pew Research Center in wide variety of research reports. One such report, *"Millennials in Adulthood: Detached from Institutions—Networked with Friends,"* by Taylor et al. (2014) finds,

Just 26% of this generation [Millennials] is married. When they were the age that Millennials are now, 36% of Generation X, 48% of Baby Boomers and 65% of the members of the Silent Generation were married. Most unmarried Millennials (69%) say they would like to marry, but many, especially those with lower levels of income and education, lack what they deem to be a necessary prerequisite—a solid economic foundation.

In an important TCRP project, Sakaria and Stehfest (2013) in *"Millennials and Mobility: Understanding the Millennial Mindset and New Opportunities for Transit Providers,"* report,

Reasons and motivations for transportation choices are pragmatic, with 46% stating that a need to save money drives their choices; 46% also note convenience, 44% want exercise, and 35% say they live in a community where it just makes more sense to use transit. Millennials would like to see the following in the next ten years: 1) more reliable systems (61%), 2) real-time updates (55%), 3) Wi-Fi or 3G/4G wherever they go (55%), 4) a more user-friendly and intuitive travel experience (44%).

## 2. Demographics, Migration and Ethnicity

### The Baby Boomers

In the transportation literature, there are relatively fewer studies that examine the demographics of transportation users compared to studies that examine changes in travel. McGuckin and Lynott (2012) in *"Impact of Baby Boomers on US Travel, 1969 to 2009,"* provide a historical analysis of the impact the Baby Boomers generation has had on American travel patterns. McGuckin and Lynott write,

Baby-boomer women entered the workforce and were licensed to drive at unprecedented rates, and as a result the dual-worker/two-car family became the average American household. The historic growth in-vehicle travel that followed the baby-boom cohort generated economic, spatial, and cultural changes that are still being felt today. As Baby Boomers move through the life stages of family-building to empty-nest and retirement, the consistent growth in-vehicle travel has slowed. The historical pattern of year-over-year increases in-vehicle miles of travel has even reversed to show declines for the first time since the second World War. Understandably, policy makers are wondering whether the recent declines in-vehicle travel reflect more than a temporary economic bump. Whether the slowing in growth is related to the aging of the Baby Boomers is unknown, and how much and by what means the Baby Boomers will travel in their golden years remains an open question."

A wide variety of demographic categories were utilized by Iseki and Smart (2012) in *"How Do People Perceive Service Attributes at Transit Facilities? Examination of Perceptions of Transit Service by Transit User Demographics and Trip Characteristics."* The article,

...examines how different sets of attributes that determine overall satisfaction vary by transit users' trip characteristics and demographics, such as age, sex, income level, race and ethnicity, auto availability, mode of travel, and frequency of transit use....

The analysis indicates that while safety is certainly the number-one priority for all transit users, travelers with different backgrounds on different modes of transit have different priorities for services and attributes to improve their transit experience.

### Travel Behavior of Immigrant Populations

In *"Explaining the 'Immigrant Effect' on Auto Use: The Influences of Neighborhoods and Preferences,"* Chatman (2013) reports that immigrants,

... travel very differently than the US-born, with a greater reliance on alternative modes such as carpooling, public transit, bicycling and walking, even when controlling for demographics and regional built environment characteristics—Preference measures play a much smaller role in explaining the immigrant effect than do neighborhood measures, although those who migrated to the US to join family are somewhat more likely to use automobiles.

Chatman and Klein (2013) in *"Why Do Immigrants Drive Less? Confirmations, Complications, and New Hypotheses from a Qualitative Study in New Jersey, USA,"* observe that,

More difficult driving conditions in the US and remittances back home may initially contribute to lower levels of auto ownership and use among immigrants. The rapid transition to auto use may be a function of household changes having more dramatic effects among immigrants given their initially high-density residential locations. The growth of non-English speaking transit riders, an increase in private transit services, and different residential location priorities may all contribute to the persistently lower auto use by immigrants even after many years in the US.

In *"Journey to Work Mode Choice Among the Foreign Born in New Jersey: Country of Origin Specific Differences,"* Klein (2010) concludes

... the foreign born in the United States make use of carpools, transit, biking and walking at much higher rates than US-born persons during their first years in the country. Some immigrant populations in New Jersey appear to follow the expected path: high rates of carpool, transit and walking/biking during their first years in the US giving way to drive alone rates that are comparable to the US-born in later years.

Blumenberg and Song (2008) in *"Travel Behavior of Immigrants in California: Trends and Policy Implications,"* find that

...immigrants rely more extensively on alternative commute modes (carpooling and transit) than native born commuters. But with time in the U.S., immigrants quickly assimilate away from these alternative modes and increasingly rely on solo driving. ... Cars may provide immigrants with increased access to employment and, consequently, contribute to their economic assimilation. However, declining transit use among recent immigrants and slowing immigration suggest that, unless transit planners intervene, transit ridership in California will decline.

Focusing more specifically on carpooling, in *"Immigrants and Resource Sharing: The Case of Carpooling,"* Blumenberg and Shiki (2008) explore

...the effect of nativity, length of residency, and race and ethnicity on mode choice. The findings show that with time in the U.S., immigrants tend to assimilate away from alternative modes of transportation (carpool, public transit, and walking) toward solo driving. Despite this trend, the odds of carpooling for Asian and Hispanic immigrants remain high even after many years in the U.S.

## Race and Transit

In *"Mobility and Mode Choice of People of Color for Non-Work Travel,"* Polzin and Rey (2001) find,

Mobility for minority travelers has increased and mode choice behavior, while still different, more closely resembles that of the aggregate population. Variations in aggregate group behavior can almost always be explained by socioeconomic and geographic conditions. The most significant race- or ethnicity-based difference appears to be a greater use of public transit by the African American population, even when the socioeconomic characteristics of travelers are taken into account.

## Gender and Transit

In "*Role of Gender and Attitudes on Public Transportation Use*," Namgung and Akar (2014) seek to "...help transportation planners understand the ways attitudes affect transit use and the differences across genders." Namgung and Akar find that,

"...including attitudes significantly increased the explanatory power of the model, and the results revealed the significant connections between attitudes related to public transportation and public transit use."

The theme of including attitudes in the study of transit use is further developed below.

### **3. Attitudes, Values and Preferences in Travel Behavior**

In support of the kinds of analyses presented in Chapter 5 of the Final Report, the Project Bibliography contains a wide variety of literature concerning the growing realization that attitudes and preferences about travel must be better incorporated into the planning and analysis process. Mokhtarian et al. (2015) in "*What Moves Us? An Interdisciplinary Exploration of Reasons for Traveling*," emphasize the importance of emotion-based motivations.

We suggest that travel is a behavior to which intrinsic motivations apply, and that focusing exclusively on the extrinsic motivations to travel runs the risk of substantially underestimating the demand for travel, and the resistance to policies attempting to reduce it or to technologies (notably, information and communication technologies) expected to (partly) replace it.

These observations by Mokhtarian et al. echo earlier conclusions about the importance of integrating both emotion-based factors and traditional economics-based factors. Steg (2005) in "*Car Use: Lust and Must. Instrumental, Symbolic and Affective Motives for Car Use*," concludes,

... that car use not only fulfills instrumental functions, but also important symbolic and affective functions [and that] commuter car use was most strongly related to symbolic and affective motives, and not to instrumental motives. ... most group differences were found in the evaluation of the symbolic and affective motives (and not the instrumental ones).

## The Importance of Incorporating Attitudes and Preferences

Popuri et al. (2011) in "*Importance of Traveler Attitudes in the Choice of Public Transportation to Work: Findings from the Regional Transportation Authority (RTA) Attitudinal Survey*," find that the inclusion of the attitudinal factors improved the quality of their model, noting, "...from a statistical standpoint, the attitude factors improved the intuitiveness and goodness-of-fit of the model."

Similarly, Outwater et al. (2014) in "*TCRP H-37 Characteristics of Premium Transit Services that Affect Mode Choice: Key Findings and Results*," conclude that, "...inclusion of non-traditional transit attributes and attitudes can maintain or improve the ability of mode choice models to predict the

usage of premium transit modes while reducing the weight on modal constants that vary between transit sub-modes.”

In *"Gauging Interventions for Sustainable Travel: A Comparative Study of Travel Attitudes in Berlin and London,"* Kandt et al. (2015) conclude that, "...comparative assessment of attitudinal, alongside geographical, characteristics of metropolitan travellers can provide better strategic input for realistic scenario-building and ex-ante assessment of sustainable transport policy." By comparing the results of a model with and without subjective influences, Van Acker et al. (2011) in *"Going Soft: On How Subjective Variables Explain Modal Choices for Leisure Travel,"* found that, "...subjective characteristics at various model levels are important decisive factors of modal choices for leisure travel."

In *"Travel Mode Choice: Affected by Objective or Subjective Determinants?"* Holz-Rau and Scheiner (2010) find that an individual's position in the life cycle may be more important than shorter-term lifestyle issues. Holz-Rau and Scheiner find,

...lifestyles influence mode choice, although just slightly, even when life situation is controlled for. The influence of life situation on mode choice exceeds the influence of lifestyle. The influence which lifestyle, and in part also life situation, have on mode choice is primarily mediated by specific location attitudes and location decisions that influence mode choice.

Vredin-Johansson et al. (2006) in *"The Effects of Attitudes and Personality Traits on Mode Choice,"* find that,

... both attitudes towards flexibility and comfort, as well as being pro-environmentally inclined, influence the individual's choice of mode. Although modal time and cost still are important, it follows that there are other ways, apart from economic incentives, to attract individuals to society's desirable public modes of transport.

In *"The Role of Attitudes, Transport Priorities, and Car Use Habit for Travel Mode Use and Intentions to Use Public Transportation in an Urban Norwegian Public,"* Şimşekoğlu et al. (2015) conclude,

... older age, strength of the car use habit, and priorities of flexibility (e.g. being able to choose the exact time of travel) increased the odds of car use. Structural equation modeling showed that priority of convenience, priority of safety and security, and favorable attitudes towards public transport use were positive predictors of intentions to use public transportation, while car use habit was a negative predictor of both intentions to use public transportation and reported public transportation use.



## The Role of Hedonic Factors

A key theme in much of the recent research in travel behavior is the influence of the “hedonic” category of emotions, i.e. one’s basic desire to have fun and to be happy. Ory and Mokhtarian (2009) in *“Modeling the Structural Relationships Among Short-Distance Travel Amounts, Perceptions, Affections and Desires,”* hypothesize that, “... the degree to which travel is enjoyed is a key determinant of shaping desires to reduce travel: the more travel is enjoyed, the less the desire to reduce it.” Steg et al. (2014) in *“The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions,”* find consistent support for their hypothesis that hedonic, egoistic, altruistic, and biospheric values can be distinguished empirically, [and that] hedonic values appeared to be significantly and negatively related to a range of environmentally relevant attitudes, preferences, and behaviors, even when the other values were controlled for. This suggests that it is indeed important to include hedonic values in environmental studies.

## Examination of the Factors Included in the Theory of Planned Behavior

Bamberg, Ajzen and Schmidt (2003) in *“Choice of Travel Mode in the Theory of Planned Behavior: The Roles of Past Behavior, Habit, and Reasoned Action,”* conclude, “...that choice of travel mode is largely a reasoned decision; that this decision can be affected by interventions that produce change in attitudes, subjective norms, and perceptions of behavioral control; and that past travel choice contributes to the prediction of later behavior only if circumstances remain relatively stable.”

Donald et al. (2014) in *“An Extended Theory of Planned Behaviour Model of the Psychological Factors Affecting Commuters’ Transport Mode Use,”*

... showed that car use was determined by intention and habit but not perceived behavioural control (PBC), whereas public transport use was influenced solely by intention. The analysis also revealed that TPB (Theory of Planned Behaviour) variables (attitude, subjective norm and PBC) influenced use of both transport modes indirectly through their effects on intention and habit. In contrast, the incremental validity of variables not contained in the model (moral norm, descriptive norm and environmental concern) was mixed and varied according to transport mode.

Abrahamse et al. (2009) in *“Factors Influencing Car Use for Commuting and the Intention to Reduce It: A question of Self-Interest or Morality?”* find that, “... car use for commuting was mostly explained by variables related to individual outcomes (perceived behavioral control and attitudes) whereas the intention to reduce car use was mostly explained by variables related to morality (personal norms).”

## 4. Environmental Motivations and Strategies

### Environmental Concern and Actual Travel Behavior

The weakness of the link between environmental concern and transportation behavior has been well documented in the available literature. As early as 1995, Grob in *"A Structural Model of Environmental Attitudes and Behaviour,"* reports,

The strongest effect on environmental behaviour stemmed from personal-philosophical values and emotions. *No effects on environmental behaviour stemming from factual knowledge were found.* Thirty-nine percent of the variance in environmental behaviour was explained by the attitudinal components.

The theory that awareness of environmental implications influences travel behavior has been explored in several articles. In one of these, Le Vine and Polak (2014) looked at the theory that environmental concerns were motivating youth to postpone the date of obtaining their driver's license. In their 2014 article noted above, *"Factors Associated With Young Adults Delaying and Foregoing Driving Licenses: Results from Britain,"* Le Vine and Polak find evidence that contradicts the hypothesis that, "... growing environmental sensitivity is responsible for falling rates of licensing amongst young adults, at least in Britain and the United States."

Line, et al. (2010) find that the environmentally friendly travel behavior of young people, such as walking or cycling to school, is not influenced by the issue of climate change. Similarly, DelBosc and Curie (2013) reported that none of the Australian youth sampled, "...spontaneously mentioned that environmental concerns shaped their travel choices; even when prompted, these concerns were far removed from travel decisions." In alignment with Line et al., DelBosc and Currie, Vredin-Johansson, from their article noted above, states, "Previous research has... shown little support for environmental criteria being of importance in travel mode choices...."

### Environmental Strategies and Normative Pressures

There is a considerable amount of literature addressing the question of how best to improve the environment and what strategies to use to do so. Steg et al. (2014) introduce the concept and the role of normative goals, which will be addressed in this TCRP project in *"An Integrated Framework for Encouraging Pro-environmental Behaviour: The Role of Values, Situational Factors and Goals..."* Steg et al. argue,

First, the conflict between goals can be reduced by decreasing the (hedonic and gain) costs of pro-environmental choices. Although this route is important when pro-environmental choices are very costly, it may not result in sustained pro-environmental actions. Second, normative goals can be strengthened. This strategy may encourage pro-environmental actions, even when it is somewhat costly. We propose that the strength of normative goals depends on values and situational factors that influence the accessibility of these values.

Cialdini (2003) in *"Crafting Normative Messages to Protect the Environment,"* addresses the importance of normative pressures, and the important difference between descriptive norms and injunctive norms—concepts which will be addressed in the formation of scenarios later in this TCRP project. He warns,

Within the statement, “Many people are doing this undesirable thing,” lurks the powerful and undercutting normative message, “Many people are doing this.” Only by aligning descriptive norms (what people typically do) with injunctive norms (what people typically approve or disapprove) can one optimize the power of normative appeals. Communicators who fail to recognize the distinction between these two types of norms imperil their persuasive efforts.

## **5. Land Patterns and Transit Markets**

### **Geographic and Attitudinal Factors Together**

In support of the development of Chapters Three and Four, the Project Bibliography includes several academic articles which deal with the intersection between geographic and attitudinal factors. The study *"Land Use, Attitudes, and Travel Behavior Relationships: A CrossSectional Structural Equations Model for Northern California"* by Circella et al. (2008), “...highlights the relevance of personal attitudes, in particular with reference to accessibility, as important explanatory variables for the choice of residential location.”

Van Acker et al. (2014) in *"Car Availability Explained by the Structural Relationships Between Lifestyles, Residential Location, and Underlying Residential and Travel Attitudes,"* find,

“...[a] significant direct effect of the residential neighbourhood on car availability. However, effects are small compared to the influence of other variables such as stage of life and travel (mode) attitude.”

Daisy and Habib (2015) in *"Investigating the Role of Built Environment and Lifestyle Choices in Active Travel for Home Based Weekly Non-Work Trips"* find,

“...individuals with pro-walk/bike and pro-transit attitudes are likely to use Active Travel (AT) more frequently for non-work related trips in comparison to their counterparts. Though the impact of individuals’ attitudes on AT trips is evident, this model also demonstrates that the built environment significantly influences the frequency of AT trips.”

### **Does Transit Oriented Development Change Travel Behavior?**

A fundamental question concerning the themes explored in Chapter 3 of the Final Report is the extent to which transit use is affected by land use strategies such as transit oriented development (TOD). McIntosh et al. (2014) in *"The Role of Urban Form and Transit in City Car Dependence: Analysis of 26 Global Cities from 1960 to 2000,"* argue that the data suggests that, “...while location effects are important, transit service levels and urban density play a significant part in determining urban car use per capita, and causality does flow from these factors towards a city’s levels of private vehicle travel.”

Nasri and Zhang (2014) in *"The Analysis of Transit Oriented Development (TOD) in Washington, D.C. and Baltimore Metropolitan Areas,"* find, “...that people living in TOD areas tend to drive less,

reducing their VMT [vehicle miles traveled] by around 38% in Washington, D.C. and 21% in Baltimore, compared to the residents of the non-TOD areas even with similar land use patterns.”

Holmgren and Ivehammar (2015) in *"Public Transport Quality as a Tool for Reducing Car Dependency,"* conclude that, “...in addition to income, level of education and age, the design of the public transport system and the time it takes to reach your destination by bicycle do have an effect on car ownership.”

In *"Transit Oriented Development and the Frequency of Modal Use,"* Noland and DiPetrillo (2015) find that, “...those living in TODs and closer to the train station use public transit and walk more frequently than those living farther out; they also drive less frequently than those living farther out.” Langlois et al. (2015) in *"Chasing Sustainability: Do New TOD Residents Adopt More Sustainable Modes of Transportation?"* find that, “TOD newcomers adopt more sustainable travel modes for amenities and leisure trips, whereas they are less likely to do so for work and shopping trips.” In *"Reconsidering the Impact of Access to Transit on Local Land Markets"* Redfearn (2015) finds that while, “...the effects of new stations are significant and positive, there is marked heterogeneity across stations, suggesting that more research is needed to understand the link between new stations and subsequent changes in land use.”

Concas and DeSalvo (2014) in *"The Effect of Density and Trip-Chaining on the Interaction Between Urban Form and Transit Demand"* find that,

... (1) population density has a small impact on transit demand, which decreases when residential location is endogenous; (2) households living farther from work use less transit, a result of trip-chaining; and (3) reducing the spatial allocation of non-work activities, improving transit accessibility at and around sub-centers, and increasing the presence of retail locations in proximity to transit oriented households would increase transit demand.

Wang (2013) in *"Causality Between Built Environment and Travel Behavior: Structural Equations Model Applied to Southern California"* finds that,

...high population and employment density, land use mix, high four-way intersection density, and road density as well as good transit service can either significantly encourage transit use, bicycling, and walking or reduce vehicle-miles traveled. However, the relatively small effect of the size of the built environment on travel behavior implies that achieving the above planning goals may cause considerable residential relocation, which contributes to the major part of observed travel behavior changes.

In *"The Role of Density in Supporting Sustainable Modes: A New Perspective on the Interaction Between Urban Form and Transit Travel,"* Concas (2012) finds that,

...population density does not have a large impact on transit demand and that the effect decreases when residential location is endogenous. ...households living farther from work use less transit and that trip-chaining behavior explains this finding. Households living far from work engage in complex trip chains and have, on average, a more dispersed activity space, which requires reliance on more flexible modes of transportation. Therefore, reducing the spatial allocation of non-work activities and improving transit accessibility at and around sub-centers would increase transit demand.

## 6. Intelligent Communications Technology and Transit Market

In Chapter 7, ICT (Information and Communications Technology) is examined in terms of several kinds of possible relationships with transit use. Among the more difficult questions concerns whether ICT is simply replacing travel.

### Has ICT Replaced Travel?

Imfo, a German research organization, collaborated with the Imperial College in London to publish a major study of the relationship between the use of Information and Communications Technology (ICT) and travel. As discussed in Chapter 7 of the Final Report, in "*ICT and Physical Mobility*" Pawlak et al. (2015) conclude,

"... that the naïve expectation that ICT is serving to replace physical mobility is unsupported by either theory or the empirical evidence in the public domain. Leading scholars demonstrate that, depending on one's interpretation, the results are either indeterminate in their conclusions or tend to, on balance, refute this 'replacement hypothesis.' The exact nature of the relationship typically depends on the specific instance of ICT and the prevailing travel conditions of the physical mobility, contextual factors such as institutional flexibility in employing ICT-based forms of interaction, individual preferences and skills, and the available infrastructure..." Further, the authors ask, "Does increasing use of ICT lead to changes in mode choice and car ownership decisions? The role of ICT in people's mode choices (e.g. bus, car, walking) and in car ownership appears to be, at most, secondary. Classical considerations such as prices, travel time, reliability, convenience, and prestige appear to persist as dominant factors in these decisions."

In "*Is the Rise of the E-society Responsible for the Decline in Car Use Among Young Adults? Results from the Netherlands*," Kroesen and Handy (2015) conclude that, "...among the Dutch, the latest trend in the digitalization of society *does not play a major role* in the currently observed downward trend in auto-mobility."

Le Vine et al. (2014) in "*Establishing the Links Between Online Activity and Car Use: Evidence from a Combined Travel Diary and Online Activity Pseudo-Diary Data Set*," find that, net of other effects, "Internet usage is *positively* associated with car use. The marginal effect of time spent online was, however, found to be negative." In a related study, Le Vine (2014) finds that, "...young adults who use the internet are, net of confounding effects, *more* likely to hold a driving licence than otherwise identical young adults who do not use the internet."

In "*Explore the Relationship Between Online Shopping and Shopping Trips: An Analysis with the 2009 NHTS Data*," Zhou and Wang (2014) find that, "...online shopping encourages shopping trips while shopping trips tend to suppress the online shopping propensity."

## ICT and the Productive Use of Time in Travel

Schwieterman and Fischer (2011) in *"Variations in the Rates of Passenger Usage of Portable Technology on Intercity Buses, Trains and Planes: Implications for Transportation Planning"* suggest

"...that the ability to use portable electronics may be a factor offsetting the longer travel times associated with certain bus and train trips, and provides a new incentive for travelers to use transportation services that operate to and from the downtown areas of major cities." The value placed on such use in the vehicle is explored by Dong et al. (2013) and Etna et al. (2012). The question of the role of ICT in preparing the traveler for the trip is explored by Dzielan (2008), Farag and Lyons (2012), Kenyon and Lyons (2003), and Schmitt et al. (2013).

## The Impact of Shared-Ride Services

### Present

In *"Shared Mobility and the Transformation of Public Transit TCRP J-11/TASK 21"* the Shared Use Mobility Center (2016) finds,

The more people use shared modes, the more likely they are to use public transit, own fewer cars, and spend less on transportation overall. ...Shared modes complement public transit, enhancing urban mobility. Ridesourcing services are most frequently used for social trips between 10pm and 4am, times when public transit runs infrequently or is not available. Shared modes substitute more for automobile trips than public transit trips.

Rayle et al. (2015) in *"App-Based, On-Demand Ride Services: Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco,"* observe that, "...ridesourcing, like taxis, appears to both substitute for and complement public transit; the majority of ridesourcing trips would have taken substantially longer if made by public transit." Martin et al. (2010) in *"Car-sharing's Impact on Household Vehicle Holdings,"* find that, "...carsharing members reduce their vehicle holdings to a degree that is statistically significant. The average vehicles per household of the sample drops from 0.47 to 0.24. Most of this shift constitutes one-car households becoming carless."

The question of the extent to which services from the Transportation Network Companies are already competitive with transit was further explored by Clewlow and Mishra (2017), in *"Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States."* They report that,

As compared with previous studies that have suggested shared mobility services complement transit services, we find that the substitutive versus complementary nature of ride-hailing varies greatly based on the type of transit service in question. Ride-hailing attracts Americans away from bus services (a 6% reduction) and light rail services (a 3% reduction). Ride-hailing serves as a complementary mode for commuter rail services (a 3% net increase in use).

### *Future Services*

While the professional literature does not currently focus on new service that could compete directly with transit (that we could locate), the emergence of new kinds of shared services was discussed in *"Between Public and Private Mobility Examining the Rise of Technology Enabled Transportation Services."* The TRB Committee for Review of Innovative Urban

Mobility Services (2016) notes,

To date, the most rapidly growing forms of shared mobility entail sequential sharing of vehicles, with each user in turn having exclusive use of a motor vehicle or bicycle. Potentially more consequential, but still in its infancy, is concurrent sharing of vehicles among strangers. By increasing vehicle occupancy, this form of shared services may collectively have greater effects—in terms of affordable personal mobility, vehicle use, energy consumption, traffic congestion, and environmental benefits—relative to today's most popular new sequential mobility options.

## **7. Methods to Interpret Transit Markets**

Chapter 6 of the Final Report presents the results of the program to analyze new data to support the development of future scenarios that envision the impact of a variety of external factors on transit markets. This section of the Literature Review reviews key articles about (i) progress in modeling “hard” and “soft” factors together and (ii) the growing use of advanced market segmentation techniques in support of such analytical processes.

### **Incorporating Attitudes into Travel Demand Models**

The TCRP H-51 work program was developed as part of larger effort to better incorporate values, attitudes and preferences into the analysis process traditionally based primarily on times and costs of transportation options. An innovative model was developed for NCRRP (National Cooperative Rail Research Program) Report 4 and was presented at the TRB Annual

Meeting in 2016. Hess and Spitz (2016) in *"How Much Do Attitudes and Values Matter in Mode Choice?"* describe a process that,

allows the joining of models that can analyze both “hard” concepts like travel times, costs, comfort, frequency, etc. with “softer” concepts like how attitudes and values influence choice making. ... the authors demonstrate how attitudes and values can influence demand and mode choice for two major US intercity corridors: The Northeast Corridor (NEC) and the Cascade Corridor. ...the authors obtained over 6,000 respondents—a very large dataset for such an effort—to use hybrid choice models to better understand the demand for these two major US intercity rail corridors. As far as is know from the literature, this is the largest scale study of its kind using hybrid choice techniques. ...the hybrid choice specification used here disentangles random heterogeneity from heterogeneity that is linked to attitudes. Also unlike many other studies, this study was very successful in linking attitudes to respondent characteristics (sociodemographics), thus improving the ability to deterministically predict the latent variables.



The Hess and Spitz model evolved from the development of a new set of hybrid models. A good example of these models is provided by Paulssen et al. (2013) in "*Values, Attitudes and Travel Behavior: A Hierarchical Latent Variable Mixed Logit Model of Travel Mode Choice*." Paulssen et al. write,

Values lie at the heart of an individual's belief system, serving as prototypes from which attitudes and behaviors are subsequently manufactured. Attitudes and behaviors may evolve over time, but values represent a set of more enduring beliefs. This study examines the influence of values on travel mode choice behavior. It is argued that personal values influence individual attitudes towards different alternative attributes, which in turn impact modal choices. ...the study estimates an integrated choice and latent variable model of travel mode choice that allows for hierarchical relationships between the latent variables and flexible substitution patterns across the modal alternatives. Results from the empirical application support the value-attitude-behavior hierarchical model of cognition, and provide insights to planners and policy makers on how better to sell public transit as a means of travel.

## The Use of Market Segmentation in Model Development

Chapter 4 of the Final Report presents the results of advanced market segmentation of potential transit riders. This strategy for application of market segmentation has evolved considerably over the past two decades. An early advocate for the use of market segmentation for transit, Elmore-Yalch (1998) in "*TCRP 36: A Handbook: Using Market Segmentation to Increase Transit Ridership*," writes,

Market segmentation is the identification of groups of people--or market segments--that have similarities in characteristics or needs who are likely to exhibit similar purchase behavior and/or responses to changes in the marketing mix. This handbook provides an overview of market segmentation--what it is and why it is relevant to public transit agencies.

A major contribution to the integration of attitudes and preferences into the analysis of travel behavior was provided by Anable (2005) in her PhD thesis, "'Complacent Car Addicts' or 'Aspiring Environmentalists?' Identifying Travel Behaviour Segments Using Attitude Theory." Anable writes,

Using an expanded version of a psychological theory of attitude-behaviour relations, namely the theory of planned behaviour, scores on factor analysed multi-dimensional attitude statements were used to segment a population of day trip travellers into potential 'mode switchers' using cluster analysis. Six distinct psychographic groups were extracted, each with varying degrees of mode switching potential. Each group represents a unique combination of preferences, worldviews and attitudes, indicating that different groups need to be serviced in different ways to optimise the chance of influencing mode choice behaviour. Sociodemographic factors had little bearing on the travel profiles of the segments, suggesting that attitudes largely cut across personal characteristics. The evidence clearly shows that the same behaviour can take place for different reasons and that the same attitudes can lead to different behaviours.



Similar to Annable, who uses the theory of planned behavior as the over-arching theoretical base in her early application of market segmentation, Hunecke et al. (2010) use constructs derived from an expanded version of the theory of planned behavior to identify distinct attitude-based target groups. In *"Attitude-Based Target Groups to Reduce the Ecological Impact of Daily Mobility Behavior,"* Hunecke et al. write,

Five groups were identified, each representing a unique combination of attitudes, norms, and values. The groups differed significantly from each other with regard to travel mode choice, distances traveled, and ecological impact. In comparison with segmentations based on sociodemographic and geographic factors, the predictive power of the attitudebased approach was higher, especially with regard to the use of private motorized modes of transportation.

The integration of market segmentation into advanced model development has been reported in several professional articles over the past few years. Fu and Juan (2015) in *"Transit Commuting Market Investigation Using the Latent Segmentation Approach,"*

...employ a latent segmentation approach to investigate the commuting market, with focus on the usage of public transit. The factor-cluster analysis technique is used to systematically deal with multi-dimensional psychological statements, and then segment the whole sample into homogenous groups. A six-cluster solution is arrived, each with distinct combinations of latent factors, including attitude, perception, habit, and intention to use public transit. On account of the unique psychological profile of each segment, related measures and strategies are proposed to promote the choice of public transit for each sub-segment. The results demonstrate that individuals within different segments must be treated in different ways since their behavior are motivated by different factors.

Molin et al. (2015) in *"Multimodal Travel Groups and Attitude: Latent Class Cluster Analysis"* apply latent class cluster analysis to identify multimodal travel groups.

Latent class cluster analysis is applied to identify multimodal travel groups based on the frequency of use of car, bicycle, train and BTM (bus, tram, metro.) ... The results indicate that the group who uses the car most often indeed has more negative perceptions and attitudes towards public transport, while frequent car users who also use public transport have less negative public transport perceptions and attitudes.

Furthermore, Molin et al. found that the *group who uses public transport most often is not the most positive about public transport*. The most positive group in this case is the group who bicycles most often and also uses public transport. The results further indicate relatively favorable car attitudes among the public transport group, suggesting that at least part of this group will use the car more often once they can afford it.

Liao et al. (2014) in *"Compact Development and Preference Heterogeneity in Residential Location Choice Behavior: A Latent Class Analysis,"* use,

...a market segmentation approach to identify preference heterogeneity in residents' location choices toward compact, walkable, and transit-friendly neighborhoods. Results derived from a latent class analysis suggest that strong preferences for compact development are more likely to occur among families with less school-age

children, lowincome and renter-occupied households, as well as those with greater focus on healthy lifestyle. ...The results imply that taking into account preference heterogeneity and a better understanding of people's transportation-land use preferences can help transport planners fulfill the potential of compact development and contribute to a sustainable future.

## Part Two: The Project Bibliography

### ***Generational Change in Transit and Travel Behavior***

Coogan, M., G. Spitz, M. Bradley, C. Rohr and R. Weinberger (2017). "***Understanding Changes in Youth Mobility***" Transportation Research Board, NCHRP, Project 08 - Task 132

This two-year project was undertaken within the National Cooperative Highway Research Program to help transportation planners and managers understand the implications of profound changes in the nature of travel demand patterns in the United States, and in other western countries. A seemingly unchangeable pattern of auto travel growth was broken in the first decade of the new century. All over the western world, separate researchers reported similar results in the first decade of this century, in which *the amount of auto travel taken by the younger generation decreased at a rate faster than for other groups*. At one level, this discovery unleashed an exceptional body of literature from many countries that helps the transportation practitioner understand a global phenomenon. At a different level, many elements of the popular press engaged in speculation about the attitudes and behaviors of the Millennial Generation, based on little or no actual fact. For the transportation planner, this may seem like a small, and perhaps irrelevant issue - or not! When the public believes that Millennials no longer drive in cars, no longer buy cars, and only wish to share cars, this implies that auto travel might suddenly grow out of favor. When the public believes that Millennials do not want to live in the suburbs, and would not drive further to get a larger house, this implies that travel forecasts used in the planning and environmental analyses of new transportation investments are all wrong, and thus invalid. The research project presents a neutral review of what exactly did happen in these two decades of change in travel behavior, and analyzes how much of this change is attributable to knowable, traditionally documented factors. This, then, builds the case for exploring how attitudinal and cultural changes might explain the rest of the change in travel behavior.

Brown, A. E. et. al (2016). "***A Taste for Transit? Analyzing Public Transit Use Trends among Youth.***" <http://dx.doi.org/10.5038/2375-0901.19.1.4>  
<http://scholarcommons.usf.edu/jpt/vol19/iss1/4>

In the past decade, there has been much talk about a decline in driving among youth. This study examined whether this decline is associated with an increased reliance on public transit. To address this issue, 2001 and 2009 National Household Travel Survey (NHTS) data were used to analyze the relationship between age and transit use. Findings indicate that although young adults are more likely to ride transit than older adults, transit use among youth can be explained largely by (1) life cycle factors common among young people but unlikely to persist as they age, (2) higher levels of transit use among non-whites, who are disproportionately young, and (3) locational factors such as living in densely-developed neighborhoods...

Bastian, A. and M. Börjesson (2014). "***It's the Economy, Stupid: Increasing Fuel Price is Enough to Explain Peak Car in Sweden.***" CTS-Centre for Transport Studies Stockholm (KTH and VTI)

It has long been well-known that economic variables such as GDP and fuel price as well as sociodemographic characteristics and spatial distribution are key factors explaining car use trends. However, due to the recently observed plateau of total car travel in many high

income countries, it has been argued that other factors, such as changes in preferences, attitudes and life-styles, have become more important drivers of car use. This would imply that traditional variables are no longer enough for explaining car travel trends. However, in this paper we show that economic variables alone can explain the observed car use trends in Sweden 2002-2012. We also find that urban populations, in particular those with low incomes, respond stronger to fuel price increases and economic downturn, i.e. are reducing car travel more. Among high income urban populations, however, we find signs of saturation in car ownership and distances driven. This underscores the importance of accounting for differences in accessibility with other travel modes and income distribution when explaining the Peak Car phenomenon.

Taylor, P., C. Doherty, K. Parker and V. Krishnamurthy (2014). ***"Millennials in Adulthood: Detached from Institutions–Networked with Friends."*** Pew Research Center, Washington, DC.

The Millennial generation is forging a distinctive path into adulthood. Now ranging in age from 18 to 31, they are relatively unattached to organized politics and religion, linked by social media, burdened by debt, distrustful of people, in no rush to marry— and optimistic about the future. They are also America's most racially diverse generation. In all of these dimensions, they are different from today's older generations. And in many, they are also different from older adults back when they were the age Millennials are now. Pew Research Center surveys show that half of Millennials (50%) now describe themselves as political independents and about three-in-ten (29%) say they are not affiliated with any religion. These are at or near the highest levels of political and religious disaffiliation recorded for any generation in the quarter-century that the Pew Research Center has been polling on these topics. At the same time, however, Millennials stand out for voting heavily Democratic and for liberal views on many political and social issues, ranging from a belief in an activist government to support for same-sex marriage and marijuana legalization. These findings are based on a new Pew Research Center survey conducted Feb. 14-23, 2014 among 1,821 adults nationwide, including 617 Millennial adults, and analysis of other Pew Research Center surveys conducted between 1990 and 2014. Millennials have also been keeping their distance from another core institution of society—marriage. Just 26% of this generation is married. When they were the age that Millennials are now, 36% of Generation X, 48% of Baby Boomers and 65% of the members of the Silent Generation were married. Most unmarried Millennials (69%) say they would like to marry, but many, especially those with lower levels of income and education, lack what they deem to be a necessary prerequisite—a solid economic foundation.

McDonald, N. C. (2015). ***"Are Millennials Really the "Go-Nowhere" Generation?"*** Journal of the American Planning Association. 10.1080/01944363.2015.1057196  
<http://dx.doi.org/10.1080/01944363.2015.1057196>

Problem, research strategy, and findings: News reports and academic articles contend that Millennials (those born in the last two decades of the 20th century) are different from earlier generations in their consumption and travel patterns. This article investigates the travel behavior of young American adults and compares the behavior of Millennials with those of previous generations using data from the 1995, 2001, and 2009 National Household Travel Surveys. The analysis uses descriptive statistics to profile trends and regression models to identify the factors associated with decreased travel by Millennials. In

fact, automobility declines for all Americans between 1995 and 2009, but the drops are largest for Millennials and younger members of Generation X starting in the late 1990s. Decreases in driving are not compensated by increases in the use of other modes for travel, nor do decreased trip distances explain the downturn in automobility. Among young adults, lifestyle-related demographic shifts, including decreased employment, explain 10% to 25% of the decrease in driving; Millennial-specific factors such as changing attitudes and use of virtual mobility (online shopping, social media) explain 35% to 50% of the drop in driving; and the general dampening of travel demand that occurred across all age groups accounts for the remaining 40%. Takeaway for practice: These changes highlight two challenges to planners and policymakers: managing increases in automobility as Millennials age and their economic fortunes improve, and developing improved planning processes that deal robustly with the uncertain future presented by Millennials who may continue to make very different travel choices than comparable people did in the past.

Ralph, K. M. (2015). *"Stalled On the Road To Adulthood? Analyzing the Nature of Recent Travel Changes for Young Adults in America, 1995 to 2009."* PhD thesis.

Young people in the 2000s traveled fewer miles, owned fewer vehicles, and were less likely to hold a driver's license than young people in the 1990s. Scholars, policymakers, and journalists proffered a host of possible explanations for this trend: attitudes and preferences about travel fundamentally changed due in part to the increased availability of communication technologies; economic conditions limited activities (including employment) and constrained travel options; young adults became less likely to attain adult roles like marriage and child-birth; young people lead a back-to-the-city movement where the utility of non-automobiles modes improved; and/or racial and ethnic minorities are less likely to drive and the population became more diverse. Whichever of these explanations is the principal cause, perhaps the American love affair with the car was over. I assess the evidence for these hypotheses using data from the 1995, 2001, and 2009 national travel surveys in the United States. I identify four distinct traveler types using latent profile analysis of travel patterns over a single day and an extended period. These types—Drivers, Long-distance Trekkers, Multimodals, and Car-less—serve as the dependent variable in the subsequent analysis, where I evaluate changes in the prevalence of each type over time for specific subgroups and use multinomial logistic regression to identify the independent relationship between traveler type and economic resources, adult roles, residential location, and race/ethnicity. I find that economic constraints, role deferment, and racial/ethnic compositional changes in the population primarily explain the travel trends during this period. The evidence in support of preferences and residential location explanations was substantially more limited. The concluding chapter contextualizes these findings, arguing that a large and growing share of young adults suffer from transportation disadvantage. The most important take-away from this work is that the decline in driving by young people in the 2000's deserves our attention—not as an unmitigated success story, but as an early indication of a problem.

Sneider, J. (2015). *"Millennials on the Move: How transit agencies are reaching out to the under-35 crowd."* *Progressive Railroading* 58(5): pp 14-18, 20-21.

[http://www.progressiverailroading.com/passenger\\_rail/article/Howtransit-agencies-are-trying-to-attract-millennial-riders--44402](http://www.progressiverailroading.com/passenger_rail/article/Howtransit-agencies-are-trying-to-attract-millennial-riders--44402) <http://trid.trb.org/view/1367452>

Millennials, the term for adults between the ages of 18 and 34, are more likely to live in urban areas and use public transit than other age groups. Transit is convenient and cost-effective for millennials, though they have high expectations for the quality of service. The transit industry is looking at ways to market to them, including using smartphone applications and social media, along with traditional television and billboard advertisement. It is necessary for the transit industry to keep millennials engaged in order to increase ridership and plan for the future.

Dutzik, T., J. Inglis and P. Baxandall (2014). ***"Millennials in Motion: Changing Travel Habits of Young Americans and the Implications for Public Policy"***

<http://uspirg.org/sites/pirg/files/reports/Millennials%20in%20Motion%20USPIRG.pdf>

<http://trid.trb.org/view/1328287>

Over the last decade—after 60-plus years of steady increases—the number of miles driven by the average American has been falling. Young Americans have experienced the greatest changes: driving less; taking transit, biking and walking more; and seeking out places to live in cities and walkable communities where driving is an option, not a necessity. Millennials (those born between 1983 and 2000) are the nation's largest generation, making their transportation needs particularly important. They have the most to gain or lose from the transportation investment decisions made today, as they will be affected by those investments for decades to come. If Millennials drive fewer miles than previous generations as they age—and if future generations of young people follow suit—America will have an opportunity to reap the benefits of slower growth in driving. These include reduced traffic congestion, fewer deaths and injuries on the roads, reduced expenditures for highway construction and repair, and less pollution of the air and climate. This paper—an update of the authors' 2012 report on changing driving trends among Millennials, Transportation and the New Generation—summarizes the growing body of knowledge about the changes that have occurred in young Americans' transportation attitudes and behaviors over the past decade. It is intended to help policymakers and the public make better informed and more responsive transportation decisions.

Garceau, T., C. Atkinson-Palombo and N. Garrick (2014). ***"Peak Travel and the Decoupling of Vehicle Travel from the Economy: A Synthesis of the Literature."*** Transportation Research Record: Journal of the Transportation Research Board.

Decades of growth in overall and per capita automobile use led many to believe that driving-rate increases would occur indefinitely. In the mid-2000s, driving levels in the United States and other developed countries peaked and then began to decline. Referred to as "peak travel," this international phenomenon is occurring in places with urban layouts, densities, and demographics that are quite different from one another and suggests a fundamental shift in travel behavior. Simultaneously, after 70 years of concurrent growth, the complex relationship between the economy (as measured by gross domestic product) and personal vehicle travel appears to be changing, and this change suggests a weakening connection between the two. This paper reviews the literature about the current understanding and potential causes of these revolutionary trend reversals. Although causes such as saturation of demand, aging, decline of young drivers, preference shifts, and time budget constraints all contribute to reduced automobile travel at one time or another, or in one place or another, none of these factors can explain why peak travel is occurring on

multiple scales in a diversity of places. The authors conclude that although the existing literature explains the recent trend reversal in specific cities or partially explains the global phenomenon, the fundamental reasons for peak travel are still not understood. Further, the authors challenge fellow researchers to explain these phenomena for more accurate and efficient planning of the transportation infrastructure.

Le Vine, S., Polak, J. (2014). "***Factors associated with young adults delaying and forgoing driving licences: Results from Britain.***" Traffic Injury Prevention.

OBJECTIVE: To identify the reasons that young adults (age 17 to 29) in Britain delay or forgo driving licence acquisition. METHODS: Using year 2010 British National Travel Survey microdata, we first analyse selfreported reasons (including their prioritisation) for not holding a full car driving licence and then estimate a logistic regression model for licence-holding to investigate additional factors, several of which extend from previous studies. This study also employs a novel segmentation approach to analyse the sets of reasons that individual young adults cite for not driving. RESULTS: These results show that, despite the lack of a graduated driving licence system at present, many young adults indicate that issues associated with the driving-licence-acquisition process are the main reason they do not hold a full driving licence. About three in ten young adults can be interpreted as not viewing driving as a priority, whilst half of those without a licence are either learning to drive or are deterred principally by the cost of learning. We calculate that after their 17th birthday (the age of eligibility for a full driving licence) young adults spend a mean of 1.7 years learning to drive. Young adults citing the costs of insurance or car purchase are likely to cite them as secondary rather than the main reason for not driving, whereas those citing physical/health difficulties are very likely to cite this as the main reason they do not drive. Two distinct groups of young people are identified that both indicate that costs deter them from driving – one group that is less well-off financially and that indicates that costs alone are the primary deterrent, and one that reports that other reasons also apply and is better-off. Status as an international migrant was found to be an important factor, net of confounding variables, for identifying that a young adult in Britain does not hold a driving licence. Further research is needed to understand the relative salience of plausible causal mechanisms for this finding. We also report that both personal income and household income are independently positively associated with licence-holding, but that [intuitively] the relationship of licence-holding with a young adult's own personal income is the much stronger of the two. CONCLUSIONS: On the basis of these findings, it can be concluded that a number of previously under-appreciated factors appear to be linked with young British adults not acquiring a driving licence.

Le Vine, S., Jones, P., Lee-Gosselin, M.E.H., Polak, J. (2014). "***Is heightened environmental-sensitivity responsible for the drop in young adults' driving-licence-acquisition rates?***" Transportation Research Record.

Across a range of developed societies, driving-licence acquisition rates amongst young adults have fallen from their historic peak levels (which in Britain were in the early 1990s). A widely-discussed hypothesis to explain this trend is that heightened environmental sensitivity amongst the current cohort of young adults could be responsible, either fully or, more plausibly, in part. The objective of this study was to establish whether empirical evidence provides support for this hypothesis. Public-opinion polling data from Britain and

the United States and British National Travel Survey microdata were statistically analysed. No evidence was found, either from the U.S. or Britain, of the populace becoming increasingly-inclined towards environmental protection. On the basis of longitudinal trends in public-opinion polling, the opposite seems to be true. Analysis of British National Travel Survey (n=2,820 unlicensed adults age 17-29) data shows that very few young British adults without driving licences report that sensitivity to the environment is either the main reason or a contributory reason that they have not acquired a driving licence. Approximately 1% of British adults aged 17 to 29 cite environmental sensitivity as a reason (either main or contributory) for not having a driving licence. By contrast, more than half (59%) of not-fully-licensed young British adults reported that they are either learning to drive (27%), or are put off mainly by the licence-acquisition testing requirements (2%) or by costs associated with motoring (30%). These findings are evidence contrary to the hypothesis that growing environmental sensitivity is responsible for falling rates of licencing amongst young adults, at least in Britain and the United States.

McCahill, C. (2014). "**Per capita VMT drops for ninth straight year; DOTs taking notice SSTI.**" State Smart Transportation Initiative

Estimates released by FHWA on Friday suggest that per capita vehicle miles of travel dropped again in 2013, making it the ninth consecutive year of decline (Figure 1). Total VMT in the United States increased by 0.6 percent from 2012, hovering just below 3 trillion, and per capita VMT dropped to 9,402 (the prior year's initial estimate was revised to 9,412). Unlike other past dips in driving, this recent downward shift has had no clear, lasting connection to economic trends or gas prices. Evidence suggests that the decline is likely due to changing demographics, saturated highways, and a rising preference for compact, mixed-use neighborhoods, which reduce the need for driving. Some key factors that pushed VMT upward for decades – including a growing workforce and rising automobile ownership – have also slowed considerably. SSTI released a report last September outlining the many contributing factors, with references to supporting literature. By now, some DOTs have acknowledged the downward trends in their states and begun to question what it means for their agencies—particularly when it translates into falling revenues, as in Oregon. It appears this has not affected investment priorities significantly in most states, but it has changed the way some DOTs now view future travel needs. Several recently updated long-range transportation plans reflect this shift.

Polzin, S. E., X. Chu and J. Godfrey (2014). "**The impact of Millennials' travel behavior on future personal vehicle travel.**" *Energy Strategy Reviews* 5: 59-65. doi:10.1016/j.esr.2014.10.003

The millennial generation, born between 1980 and 2000, is exhibiting different travel behavior trends than previous generations, which are shaped by several different yet correlated characteristics such as; place of residence, race/ethnicity, labor force participation, education level, income, living arrangements, lifecycle status, licensure status, vehicle ownership/availability, values, and propensity to substitute technology for travel. Many millennials are living with their parents longer, obtaining drivers licenses at older ages, postponing marriage and procreation, and substituting travel for work and socializing with telecommuting and social media. Millennials are currently shaping the nation's changing demographics, which in turn directly affect future travel behavior trends and their consequences on energy consumption and the environment.



Schoettle, B. and M. Sivak (2014). ***"The reasons for the recent decline in young driver licensing in the United States."*** *Traffic Injury Prevention* 15(1): 6-9.

Objective: This survey examined why a substantial percentage of young adults currently do not have a driver's license and the future plans of this group concerning obtaining a license. Method: A questionnaire was developed to examine several issues related to an individual's decision not to obtain a driver's license. An online survey was conducted, yielding useable responses from 618 persons aged 18 to 39 without a driver's license. Results: The top 8 reasons for not having a driver's license were as follows: (1) too busy or not enough time to get a driver's license (determined by personal priorities), (2) owning and maintaining a vehicle is too expensive, (3) able to get transportation from others, (4) prefer to bike or walk, (5) prefer to use public transportation, (6) concerned about how driving impacts the environment, (7) able to communicate and/or conduct business online instead, and (8) disability/medical/vision problems. Of the respondents, 22% indicated that they plan to never obtain a driver's license. On the other hand, 69% expect to get a driver's license within the next 5 years. Young adults without a driver's license—in comparison with the general population of the same age—tend to have less education and higher unemployment. However, the present study was not designed to investigate whether there is a causal relationship or the direction of the effect if there were such a relationship.

Sakaria, N. and N. Stehfest (2013). ***"Millennials and Mobility: Understanding the Millennial Mindset and New Opportunities for Transit Providers."*** from [http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp\\_w61.pdf](http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_w61.pdf).

TRB's Transit Cooperative Research Program (TCRP) Web-Only Document 61: Millennials and Mobility: Understanding the Millennial Mindset and New Opportunities for Transit Providers is designed to help public transit providers increase ridership by better understanding Millennials lifestyle and mobility decision-making processes. A quantitative survey was used in the development of TCRP Web-Only Document 61. The survey focused on quantifying Millennials' mobility motivations and behaviors.

Understand Millennials' lifestyle and decision-making processes with an emphasis on mobility (daily travel). Identify specific factors affecting Millennials' lifestyle decisions, including post-recession attitudes about the economy, heightened environmental awareness, a renewed interest in local communities, shifting social values amongst peers, new information technologies, urban attraction, and so on.

- Identify how Millennials make their mobility decisions in a holistic way (e.g., considering all means of transportation: driving personal vehicles, public transit, other mobility options such as biking, walking, car-sharing, etc.), taking into account the effect of major life decisions on mobility choices (e.g., where to live, where to work). Additionally, understand how these considerations may change as Millennials progress through life stages.
- Identify key hurdles and benefits of various mobility options, including accessibility, convenience, time, community/belongingness, fluidity with other mobility options (e.g., multi-modal transit), etc.
- Uncover potential opportunities for public transit providers to increase ridership—by improving messaging, information access, service offerings/accessibility, etc.

APTA (2013). ***"Millennials and Mobility: Understanding the Millennial Mindset."***

<http://www.apta.com/resources/reportsandpublications/Documents/APTA-Millennials-and-Mobility.pdf>

The Millennial Generation, those born between 1982 and 2003, is the largest and most diverse generation in American history. According to Millennial Makeover, a seminal volume on generational change, 40% of Millennials are African American, Latino, Asian or racially-mixed compared to only 25% of the next two older generations. Millennials are also living through times of economic dislocation and technological change. History shows that the combination of technological change, such as the advent of smartphone technology, television, or radio; combined with macro forces that shape behaviors, such as the Great Recession, the Great Depression, or World War II can lead to societal change that can last generations. It is in this context that Millennials, with their relative propensity for urban lifestyle components (whether they live in cities or in suburbs), dexterity with technology, while starting careers during economically constrained times can leave a lasting impact on society. In fact, they are already driving trends. As has been noted in a number of reports, including US PIRG's report, "A New Direction: Our Changing Relationship With Driving and the Implications for America's Future", rates of driving is down in the US, and Millennials are leading the trend. This APTA/TCRP report seeks to further understand the mindsets behind the trends and understand their implications for public transportation in the United States. This study utilizes a mixture of in-depth interviews in five cities and a survey of 1,000 people in six cities that are representative of the types of cities Millennials find attractive. Millennials are multimodal, they choose the best transportation mode (driving, transit, bike, or walk) based on the trip they are planning to take. Communities that attract Millennials have a multitude of transportation choices, as proven by Millennial hotspots, popular zip codes where residents have self-selected into a multimodal lifestyle. Public transportation options are considered the best for digital socializing and among the most likely to connect the user with their communities. Transit also allows Millennials to work as they travel, a trend noted by 40% of those polled. These benefits of public transit need to be fully leveraged by the industry, as they provide a clear competitive advantage. Reasons and motivations for transportation choices are pragmatic, with 46% stating that a need to save money drives their choices; 46% also note convenience, 44% want exercise, and 35% say they live in a community where it just makes more sense to use transit. Millennials would like to see in the next ten years: 1) 61% more reliable systems, 2) 55% real-time updates, 3) 55% Wi-Fi or 3G/4G wherever they go, 4) 44% a more userfriendly and intuitive travel experience. Fully leveraging technology, through real-time transit applications that connect users with community amenities, through smartphone fare payment, and the provision of WiFi and 3G/4G, will allow transit users to be more spontaneous, thus addressing the key competitive advantage of the car.

Blumenberg, E., M. Wander, B. Taylor and M. Smart (2013). ***"The Times Are They A-Changin'?" Youth, Travel Mode, and the Journey to Work"***. Transportation Research Board 92nd Annual Meeting

Today's youth live in a far different world than the youth of previous generations. They are struggling to transition into the most unwelcoming job market since the Great Depression, they are the first generation to have never known a world without the Internet, and they must surmount greater hurdles to driver's licensing than teens of any previous generation.

In this paper, the authors examine the effect of these momentous societal changes on the travel behavior of youth. In particular, the authors use data from the 1990, 2001, and 2009 National Personal/Household Travel Surveys (NP/HTS) to model the commute mode choices of young workers over time. The analysis suggests that both the economy and changes in licensing regulations have influenced youth commute mode choice. While youth in 2009 commute by solo driving at slightly higher rates than in 2001, the authors' analysis suggests that these rates would have been even higher in the absence of both the deep recession and changes in driver's licensing regulations. Whether the observed effects on youth travel will be short-lived (a period effect) or more enduring (a cohort effect) remains to be seen.

Delbosc, A. and G. Currie (2013). ***"Causes of youth licensing decline: a synthesis of evidence."*** *Transport Reviews* 33(3): 271-290.

In recent decades, young adults in many developed nations have become increasingly less likely to acquire a driving license. If this trend continues it could have significant impacts on transport futures. Licensing reductions have only recently been identified and causes are only just being explored. This paper presents a first synthesis of available evidence including an assessment of more influential causal factors. It begins by documenting the declining trend evident in 9 of 14 documented countries; the average rate of decline is 0.6% per annum, with highest declines documented in Australia. A range of causal factors are documented from cross-sectional and longitudinal studies. Changes in life stage and living arrangements, changes in motoring affordability, location and transport, graduated driver licensing schemes, attitudinal influences and the role of e-communication are all explored. Evidence is in general weak and preliminary but suggests multiple causes rather than any single influence. However, of the evidence available life stage factors and affordability influences have stronger links to license decline but are only likely to have a low affect size.

Dutzik, T. and P. Baxandall (2013). ***"A New direction: Our Changing Relationship with Driving and the Implications for America's Future"*** US PIRG, The Phoenix Institute

The Driving Boom—a six decade long period of steady increases in per-capita driving in the United States— is over. Americans drive fewer total miles today than we did eight years ago, and fewer per person than we did at the end of Bill Clinton's first term. The unique combination of conditions that fueled the Driving Boom—from cheap gas prices to the rapid expansion of the workforce during the Baby Boom generation— no longer exists. Meanwhile, a new generation—the Millennials— is demanding a new American Dream less dependent on driving. Transportation policy in the United States, however, remains stuck in the past. Official forecasts of future vehicle travel continue to assume steady increases in driving, despite the experience of the past decade. Those forecasts are used to justify spending vast sums on new and expanded highways, even as existing roads and bridges are neglected. Elements of a more balanced transportation system—from transit systems to bike lanes—lack crucial investment as powerful interests battle to maintain their piece of a shrinking transportation funding pie.

Hollenhorst, J. 2013 ***Keep an Eye on Gen Y: Mass Transit Magazine Editorial*** *Mass Transit* <http://www.masstransitmag.com/article/10944051/keep-an-eye-on-gen-y>

Generation Y: The millennials. Born between 1979 and 1995, these 18 to 34-year-olds who, like every generation before them, see things a little differently than their predecessors.

Baby boomers drove out to the suburbs in the 1960s and '70s and kept on driving to nearly all of their daily activities. Now Gen Y is moving back to cities for the urban lifestyle of convenient shopping, dining and offices. This is a generation that will shape the future by depending far less on the automobile for mobility, turning instead to walking, biking and transit. Over the past decade, transit use among Gen Y has risen 40 percent. According to a new report from the Urban Land Institute (ULI), "America in 2013: A ULI Survey on Views on Housing, Transportation, and Community," 63 percent of Gen Y respondents indicated they plan to move in the next five years. Numbering about 100 million in the United States, this is a massive wave heading toward cities and the transit systems that serve them. What are the policy implications of this trend? Of all respondents to the survey, 75 percent — which included Gen X, Gen Y and baby boomers with access to public transportation — rated the quality of public transportation as satisfactory and 52 percent said convenient public transportation is important to them. Customers will expect technologies in transit to keep pace with developments they experience elsewhere: mobile everything, fast data access, clear signage, eco-friendly propulsion, comfort and dependability. To keep riders satisfied will require dedicated funding not dependent on fuel taxes to continually maintain and improve our systems. This means politicians crafting policies that address new transportation realities while continuing to provide for their road builder supporters. That's a tough challenge, but the new reality is that vehicle miles traveled per year after six decades of increases is now declining. The car is far from becoming obsolete. Most people use them and will continue to do so. But when given a choice — because of smart urban planning and a commitment to a strong transit system — younger people, those most mobile, prefer to leave the driving to the professionals. This is a cohort that watches television everywhere but on a television, why would we expect them to choose the same car and housing options of the last generation.

Le Vine, S., C. Latinopoulos and J. Polak (2013). ***"A tenuous result: re-analysis of the link between internet usage and young adults' driving-licence holding. Comments on 'Recent changes in the age composition of drivers in 15 countries' "*** Traffic Injury Prevention. DOI: 10.1080/15389588.2013.793583

In their influential 2012 paper, Sivak and Schoettle of the University of Michigan Transportation Research Institute report that the main implication of their cross-national study into falling rates of licence-holding amongst young adults is that: Of particular note was the finding that a higher proportion of Internet users was associated with a lower licensure rate. Implications: The results of the analysis are consistent with the hypothesis that access to virtual contact reduces the need for actual contact among young people. This specific finding has been widely-cited, and referenced by the authors in multiple public interviews such as those reported in USA Today and the New York Times: The reasons behind the decline vary, officials say...Michael Sivak, a professor at the University of Michigan's Transportation Research Institute who provided the 2010 teen driving percentages, also pointed to teens' access to the Internet. (Yamiche Alcindor, USA Today, 3 March 2012) In a study of 15 countries, Michael Sivak, a professor at the University of Michigan's Transportation Research Institute (who also contributed to the D.M.V. research), found that when young people spent more time on the Internet, they delayed getting their driver's licenses. "More time on Facebook probably means less time on the road," he said. (Todd G. Buccholz and Victoria Buccholz, NY Times, 10 March 2012) Policymakers could

easily be left with the impression that this result is robust enough to form the basis for public-policy choices. The fact is that it is not known, on the basis of the available evidence, whether young people's online activity is causing them to acquire licences at a lower rate than in years past. In this short comment paper we show that the research-design of the aforementioned study cannot provide the evidence required to support the authors' assertion that such an effect has been identified. We present six distinct classes of methodological problems with the study. Sivak and Schoettle then replied to our analysis in a letter published concurrently in *Traffic Injury Prevention*. Readers can judge which set of arguments they find more persuasive.

Patterson, Z. and S. Saddier (2013). "***Are Baby Boomers Likely to Retire to the City in Canada?***" <http://trid.trb.org/view/1243011>

Due to the size of the baby-boomer generation, the question of where they will retire has important transportation planning implications. If they are to remain in the suburbs in retirement, this will have very different consequences than if they move to urban, transit-rich neighbourhoods – a possibility that has been raised frequently in recent years. This paper addresses the issue by looking at movers from Canadian microcensus data over 20 years and 4 censuses for Canada's six largest cities. While concentrating on Canadian cities, the paper develops a robust approach to evaluate the evolution of where retirees (or any age-group) have been moving, and how these trends might continue into the future. It does so by introducing a continuous Urban Core Index to classify census tracts as being part of the "Urban Core" or not. Then, disaggregate data on movers for the censuses of 1991, 1996, 2001 and 2006 are analysed in three phases. First they are analysed graphically, then with a trend analysis and finally through the use of logistic regression. Logistic regression models are used to compare the evolution of the effect that being over 65 has on the odds of choosing to live in the "Urban Core." Clear trends of 65+ movers increasingly moving to the suburbs are observed for three of the cities (Montreal, Calgary and Edmonton). For the other three cities such an increasing trend of choosing to move to the suburbs is not so clearly observed. At the same time and based on the observed trends, it does not appear that future retirees (and namely the baby boomers) are about to change previous patterns and move increasingly to the city.

Sakaria, N. and N. Stehfest (2013). "***Millennials and Mobility: Understanding the Millennial Mindset and New Opportunities for Transit Providers***", Transportation Research Board: 70p.

This document is designed to help public transit providers better understand Millennials (age 18-34) lifestyle and mobility decision-making processes. A quantitative survey was used in the development of this document. The survey focused on identifying how Millennials make their mobility decisions, identifying key hurdles and benefits of various mobility options, and uncovering potential opportunities for public transit providers to increase ridership. The findings from the survey indicate that transportation choices for Millennials are becoming increasingly multimodal. Cost, convenience, and exercise are the top motivations for Millennials' transportation choices and routines overall.

Sivak, M., Schoettle, B. (2013). "***Recent changes in the age composition of drivers in 15 countries.***" *Traffic Injury Prevention*. **13:125-132.** . DOI: 10.1080/15389588.2011.638016

Objective: This study examined the recent changes in the percentage of persons with a driver's license in 15 countries as a function of age. Method: The countries included were

Canada, Finland, Germany, Great Britain, Israel, Japan, Latvia, The Netherlands, Norway, Poland, South Korea, Spain, Sweden, Switzerland, and the United States. Results: The results indicate 2 patterns of change over time. In one pattern (observed for 8 countries), there was a decrease in the percentage of young people with a driver's license, and an increase in the percentage of older people with a driver's license. In the other pattern (observed for the other 7 countries), there was an increase in the percentage of people with a driver's license in all age categories. A regression analysis was performed on the data for young drivers in the 15 countries to explore the relationship between licensing and a variety of societal parameters. Of particular note was the finding that a higher proportion of Internet users was associated with a lower licensure rate. Implications: The results of the analysis are consistent with the hypothesis that access to virtual contact reduces the need for actual contact among young people.

Taylor, B., K. Ralph, E. Blumenberg and M. Smart (2013). ***"Who knows about kids these days? Analyzing the determinants of youth and adult mobility between 1990 and 2009."*** TRB

We know a great deal about the travel behavior of adults, and more recently about travel by children and the elderly, but what about teens and young adults? This question is particularly pressing because youth in the late 2000s and early 2010s (a) face the harshest economic climate in decades, which has caused much higher unemployment rates than among middle-aged adults and forced many young adults to return ("boomerang") home, (b) use information and communication technologies (ICTs) extensively, and considerably more than their elders, and (c) subject to increasingly stringent graduated driver's licensing (GDL) regulations. All are dramatic societal changes to be sure, but are they affecting youth travel behavior? And if so, how? To answer these questions we examine (1) how the travel behavior of youth compares to that of older adults, (2) whether the basic determinants of youth travel have changed over time, and (3) whether the societal changes described above affect youth travel behavior. To do this we analyzed nationwide personal mobility trends (measured as person-miles of travel (PMT)) between 1990 and 2009 and find that many key determinants of travel are similar for teens, young adults, and adults: being employed, licensed, having access to cars, and residential area population density all significantly affect PMT regardless of age. By contrast, some socio-economic factors long found to influence adult travel – such as race/ethnicity and household income – are not significant for today's teens. Finally, with the exception of employment, the effects of societal trends (ICTs, GDLs, and young adults "boomeranging" to live at home with parents) on youth travel are surprisingly muted. When it comes to recent changes in teen, youth, (and adult) travel behavior, the adage "it's the economy, stupid" appears to hold.

Zipcar-KRC-Research (2013). ***"Millennials & Technology A Survey Commissioned by Zipcar February 2013"*** [http://www.slideshare.net/Zipcar\\_Inc/millennial-slide-share-final-16812323](http://www.slideshare.net/Zipcar_Inc/millennial-slide-share-final-16812323)

The Millennials Survey Online survey of 1,015 adults £ Ages 18 and over, including 980 licensed drivers £ Conducted between December 6 and 9, 2012.... 2012 Key Findings The increasing availability of on-demand mobility services (such as car sharing, ride sharing and vehicle sharing) helps many Millennials drive less and makes it easier for them to live without owning a car. On-demand transportation options (transportation "apps") have a greater impact on Millennials' driving decisions than on the decisions of older generations. Technology, especially mobile devices, is more important to Millennials than a car.



Traditional influences, like the high cost of car ownership and environmental concerns of driving, are compelling many Millennials to drive less. 4. Millennials are Choosing to Drive Less In the past year, I have consciously made an effort to reduce how much I drive, and instead take public transportation, bike/walk or carpool when possible. 5. Thinking Green I want to protect the environment, so I drive less. 6. Cost Of Car Ownership A Key Barrier In today's economy, it can be difficult to own a car because of the high cost of gas, parking and maintenance. 7. More Options If there were more options in my area, such as public transportation, car sharing or convenient carpooling, I would drive less than I do now. 8. A New Way of Socializing With access to social networking sites such as Facebook and Twitter, text messaging and online gaming, I sometimes choose to spend time with friends online instead of driving to see them. 9. Teched Out How much more likely are you to purchase something online than to drive or take public transportation to a store? 10. Technology Wins In your daily routine, losing which piece of technology would have the greatest negative impact on you? TV Mobile phone Computer Car 11. In your daily routine, losing which piece of Mobile Transportation technology would have the greatest negative impact you? To what extent have transportation apps (i.e. taxi apps, car rental reservations, public transportation info, car sharing, ride sharing, etc.) reduced your driving frequency? 12. In your daily routine, losing which piece of Mobile Transportation technology would have the greatest negative impact on you? To what extent does the availability of transportation apps (i.e. taxi apps, car rental reservations, public transportation info, car sharing, ride sharing, etc.) make it easier to live without owning a car?

Blumenberg, E., B. Taylor, M. Smart, K. Ralph, M. Wander and S. Brumbagh (2012). "What's Youth Got to Do with It? Exploring the Travel Behavior of Teens and Young Adults

Today's teens are members of the first generation to have never known a world without instantaneous and nearly ubiquitous mobile phone access. They also must surmount greater hurdles to driver's licensing than any previous generation faced. And they are struggling to transition into the most unwelcoming job market since the Great Depression. These tectonic happenings surely augur equally dramatic changes in the travel choices and patterns of young adults in the years ahead. Or will they? This report examines this question. While scholars have studied the travel choices and patterns of adults extensively over the years, our knowledge of youth travel behavior is surprisingly limited and uneven. There is a growing body of research on how children travel to school and a second body of research on youth and travel safety, in particular, the high rates of crashes and driving fatalities among teenagers. Beyond these two rather focused lines of inquiry, however, studies of travel by children, teens, and young adults are rare. Researchers have posited several factors to explain differences in the travel behavior of youth and adults, and to support the argument that such differences may persist as today's youth move into adulthood. First, the rapid profusion and adoption of new communication technologies influences how people use their time and may affect how much they travel (Kwan, 2002), and young people tend to be early and frequent adopters of these technologies (Mans et al., forthcoming; Lenhart et al., 2005; Pew Research Center, 2010b). Second, all 50 states have now adopted graduated driver's licensing programs, making teen licensing more difficult and restrictive (with respect to time, trip purpose, and passengers) than in previous eras (Insurance Institute for Highway Safety, 2012). Third, unemployment rates during the current recession are highest for youth, thereby reducing journey-to-work and work-

related travel and limiting the resources teens and young adults have to pay for non-work activities (and associated travel) of all types. This prolonged economic downturn may also influence youth travel patterns indirectly; fragmentary evidence suggests that young adults struggling to find work increasingly “boomerang” back home to live with parents (Kaplan, 2009; Pew Research Center, 2010b; Wiemers, 2011), drawn by a free or steeply discounted bedroom, groceries, and, perhaps, access to parents’ cars.

Kuhnimhof, T., J. Armoogum, R. Buehler, J. Dargay, J. M. Denstadli and T. Yamamoto (2012). ***Men Shape a Downward Trend in Car Use among Young Adults—Evidence from Six Industrialized Countries.*** *Transport Reviews* 32(6): 761-779.

<http://dx.doi.org/10.1080/01441647.2012.736426>

This paper investigates trends in the travel behaviour of young adults in Germany, France, Great Britain, Japan, Norway, and the USA over the past few decades with a focus on car availability and car travel. The trend analysis relies on micro-data from over 20 National Travel Surveys from the study countries dating back to the mid-1970s. The analysis of the survey data is supplemented by official statistics on licence holding. On this basis, this paper compiles a body of evidence for changes in mobility patterns among young adults in industrialized countries over the past few decades. The findings indicate that since the turn of the millennium, access to cars, measured in terms of drivers’ licences and household car ownership, has decreased in most study countries, especially for men. Moreover, average daily car travel distance has decreased in most study countries, again especially for men. In France, Japan, and most significantly in the USA, the decrease in car travel has led to a reduction in total everyday travel by young travellers. In Great Britain, the decline in car travel was partly, and in Germany fully, compensated by an increased use of alternative modes of transport.

Mans, J., E. Interrante, L. Lem, J. Mueller and M. Lawrence (2012). ***Next Generation of Travel Behavior.*** *Transportation Research Record: Journal of the Transportation Research Board* 2323(1): 90-98.

Transportation behavior appears to have shifted in recent years. Between the 2001 and 2009 National Household Travel Surveys, the average annual vehicle miles traveled for all age brackets fell. This reduction in driving is likely to be related to a number of factors, one of which may be the rapid introduction and adoption of information and communication technologies (ICTs) over this period. This paper builds a framework that analyzes the extent to which recent studies and reports have been able to establish a link between the use of new technologies and changes in transportation behavior. The paper also attempts to establish whether there is a difference in the intensity and manner of technology use between age cohorts and in the manner in which technology use affects transportation behavior. Finally, the paper assesses major gaps in the current understanding of how ICTs may affect travel behavior.

Belden-Russonello-Stewart (2011). ***The 2011 Community Preference Survey What Americans are looking for when deciding where to live. Analysis of a survey of 2,071 American adults nationally*** Conducted for the National Association of Realtors®

The National Association of Realtors® asked Belden Russonello & Stewart LLC to update research done in 2004 on Americans’ preferences regarding the communities in which they live. There have been major changes in the economy and the housing market since the 2004



Community Preference Survey was conducted. Property values have dropped significantly in many areas, foreclosures are at record highs, and fluctuating gas prices have made long commutes more costly. This research explores how Americans' preferences regarding communities and housing have changed over the last seven years. The research covers characteristics consumers are looking for in a community, the reality of their current communities, and what policies they would support to improve their communities in the future. The 2011 BRS/NAR Community Preference Survey is a web-enabled survey of adults nationwide using the Knowledge Networks panel. Knowledge Networks uses probability methods to recruit its panel, allowing results to be generalized to the population of adults in the U.S. A total of 2,071 questionnaires were completed from February 15 to 24, 2011. The data have been weighted by gender, age, race, region, metropolitan status, and Internet access. The margin of sampling error for the sample of 2,071 is plus or minus 2.2 percentage points at the 95% level of confidence. A detailed methodology can be found in Appendix A.

Fischer, L. and J. Schwieterman (2011). ***"Who Rides Curbside Buses? A passenger survey of discount curbside bus services in six Eastern and Midwestern cities"***

This study summarizes the results of a survey of passengers using "curbside" bus lines such as BoltBus and [Megabus.com](http://Megabus.com) ("Megabus") in order to foster a greater understanding of the composition and preferences of the travelers these companies serve. This survey, to our knowledge, marks the first systematic attempt to evaluate the ridership of these discount operators and explore the changes in travel behavior engendered by their services. In addition to identifying some of the characteristics of the passengers served on these intercity carriers, this report compares these characteristics with passengers using conventional bus lines such as Greyhound. The timing for this report is notable due to the rapid expansion by BoltBus and Megabus as well as a rising visibility of smaller operators such as DC2NY Bus in recent years. These carriers are making curbside service an increasingly significant force in cities in the East and Midwest and providing a new travel option to millions of consumers. Since Megabus launched its Chicago hub in 2006, followed by a major expansion along with that of rival BoltBus in the New York region during 2008, the sector has grown to more than 400 daily bus operations serving 60 cities in 17 states. Curbside bus companies have attracted publicity for their steeply discounted fares, free wireless internet, and express services on routes that had seen little new service in decades. Although some routes had already seen the entry of so-called "Chinatown Operators"—bus lines, typically operated by Asian owned businesses, between the Chinatown districts of major cities—other routes filled a void that had left travelers with few options besides private automobile. Unlike conventional operators such as Greyhound and Trailways, curbside operators generally arrive and depart from designated curb locations along city streets, typically near the center of town. Another key difference between the curbside carriers and traditional bus lines is the absence of ticket counters (curbside operators rely almost entirely on online ticket sales) and waiting rooms at departure locations. The sector's robust growth comes in the wake of more than forty years of retrenchment in the intercity bus sector. Starting in the late 1950s and continuing until the early 2000s, the sagging image of bus travel, the rising availability of private automobiles and low-fare air services, and the deterioration of downtown districts took their toll. By the 1990s, many middle- and upper-income consumers considered the intercity bus a mode of last resort. Even after the terrorist acts of 9/11, which made air travel less convenient, the intercity bus

continued its slump. Only recently, on account of the emergence and expansion of curbside operators and a general recovery at Greyhound and other conventional lines, has a genuine turnaround occurred.

Frändberg, L. and B. Vilhelmson (2011). ***"More or less travel: personal mobility trends in the Swedish population focusing gender and cohort."*** *Journal of Transport Geography* 19(6): 1235-1244. <http://dx.doi.org/10.1016/j.jtrangeo.2011.06.004>  
<http://www.sciencedirect.com/science/article/pii/S0966692311000974>

This study explores mainstream trends and countertrends in the development of spatial mobility in the Swedish population. Tracing incipient change in travel behaviour is important for understanding the preconditions for social and environmental sustainability. We use data from the Swedish national travel surveys, conducted intermittently over almost 30 years (1978–2006), covering both daily and longdistance mobility. International travel is included for the last decade. With respect to mainstream trends, the results primarily concern the continuation of the spatial extension of overall mobility and of the motorization and individualization of travel modes, as well as an upward convergence between women's and men's mobility. When it comes to countertrends, substantial reductions in daily mobility and longdistance domestic travel are observed among the young.

Kuhnimhof, T., R. Buehler and J. Dargay (2011). ***"A New Generation: Travel Trends among Young Germans and Britons."*** 90th Annual Meeting of the Transportation Research Board

Like other industrialized countries, Germany and Great Britain have experienced increasing motorization over the past five decades. However, results from national travel surveys, vehicle registration statistics, and driver's licensing databases suggest that young Germans and Britons today are less automobile oriented than their parents' generation. The paper sheds light on this trend, with a focus on the group of 20- to 29-year-olds. The analysis finds decreasing car availability, a significant reduction of automobile mileage, increases in the use of other modes, and growing multimodal behavior of the young, with men reducing their automobile travel more than women. Even though the development is more pronounced in Germany, the similarity of the changes in young people's mobility patterns in the two countries is striking. This similarity suggests that the observed changes in travel behavior are not an idiosyncratic development in one country. Instead, the similarity may indicate a structural change in travel behavior that may be found in other Western countries. The paper substantiates findings of changes in trends in mobility patterns of young adults and identifies important storylines of this development on the basis of a harmonized international comparison. Finally, the paper intends to stimulate a discussion and research about reasons for these changes in mobility trend.

Zipcar-KRC-Research (2011). ***"Millennials & Driving: A Survey Commissioned by Zipcar November 2011 [Final]"*** [http://www.slideshare.net/Zipcar\\_Inc/millennial-slide-share-final](http://www.slideshare.net/Zipcar_Inc/millennial-slide-share-final)

No abstract provided.

Zipcar-KRC-Research (2010). ***"Millenials and Driving: A Survey Commissioned by Zipcar (Nov.2010)"*** <http://www.slideshare.net/colleenmccormick/millennials-survey-5861342>

No abstract provided.

Taylor, J. M. Barnard, C. White and J. Lewis (2007). ***"Understanding the travel aspirations, needs and behaviour of young adults.*** E. Department for Transport. London

This report presents findings from a qualitative study conducted for the Department for Transport by NatCen. The objectives were to explore young people as transport decision-making, the factors influencing their views and attitudes towards transport, the role of transport in key transitions in their lives, the significance of transport to their aspirations and future plans, and suggestions for how to meet their needs better. The study involved 12 focus groups and 36 in-depth interviews among people aged 16-25. Qualitative research was used to explore young people as perspectives in depth, to understand how transport fits into their changing lives, and to generate suggestions for improvements. Participants in the focus groups were selected through a household screening process; those who took part in interviews were selected from participants in the National Travel Survey. Full details of the recruitment process are available in the appendix, page 74. The samples were managed to ensure diversity in age, sex, geographic area, social grade, economic activity, living circumstances, educational attainment, expenditure on travel, use of public transport, and access to cars. Data from the National Travel Survey shows that young people aged 16- 25 make fewer trips overall than older age groups. Young people make fewer trips than people aged 26- 54 for all purposes apart from trips to education, trips to see friends at private homes or elsewhere, and for sports or entertainment. The majority of their journeys are made by driving a car, followed by walking and then being a car passenger. The qualitative data highlights five groups: those who mainly use cars, with limited use of other modes; those who mainly use cars but with more use of other modes; those who mainly use a limited range of public transport; those who use more diverse public transport; and those who mainly walk. There are important differences among young people in how much autonomy they have regarding when, where and how they travel. Some enjoy a great deal of autonomy, either as drivers or as active users of good public transport. Others are reliant on lifts from family and friends, including for regular and essential journeys, or on limited public transport. Some young people have other people who are dependent on them, particularly other family members if they are the only driver in the household. Young people did not generally have a clear sense of how much they spent on transport, but some were particularly financially constrained in their travel. There were also differences between young people in the distance and range of journeys they did, or aspired to do. This was shaped by personal circumstances and responsibilities, social and family relationships, daily activities and confidence. However, the relationship between the degree of mobility and satisfaction with mobility is not linear. More mobile people could be both more and less satisfied with their travel, and similarly among less mobile people there were both more and less satisfied groups.

Noble, B. (2005). ***"Why are some young people choosing not to drive?"***

After steady growth for many years, the proportion of young people in Great Britain with full licences started falling in the early 1990s. Over the last decade, the proportion of people aged 17-20 with a licence has fallen from 48% to 30%, and the effect is also clear for people in their 20s, and recently, in their early 30s. There is evidence of similar decreases in Scandinavia and the USA, but in some other European countries, the proportion of licensed young drivers continues to grow. Until these trends are investigated fully, there is concern that there may be an increase in young people driving without a licence. Fewer young

drivers could have important policy and planning implications, especially if there is a new cohort of younger people who choose never to learn to drive, rather than just delaying the acquisition of a licence. In particular, it could mean that current models need to be revised. Traffic may not grow as quickly in the future. Young people may get used to using alternatives to the car, including cycling, walking and taking a bus, and either never choose to drive, or delay driving until the demands of a young family make other alternatives less practical. This paper will consider a number of explanatory factors using detailed cross sectional and trend data from the Great Britain National Travel Survey and other data sources. It will discuss some of the likely reasons for the fall in licence holding, and include analysis of new attitudinal questions asked on the Office for National Statistics' Omnibus Survey in spring 2005, asking non-drivers for the reasons why they choose not to drive. For the covering abstract please see ITRD E135207.

Ruud, A. and S. Nordbakke (2005). ***"Decreasing driving licence rates among young people - consequences for local public transport."*** PROCEEDINGS OF ETC 2005, STRASBOURG, FRANCE 18-20 SEPTEMBER 2005 - TRANSPORT POLICY AND OPERATIONS - EUROPEAN POLICY AND RESEARCH - ACCESS TO TRANSPORT AND FUTURE ISSUES

Driving licence and access to a car traditionally have been among the most significant determinants for mode choice. In the 1980s, driving licence rates among young people increased in Norway and Sweden. In the 1990s, trend changed. The driving licence rates among young people between 18 and 24 years decreased both in Norway and in Sweden. The same trend has appeared in the big cities in Finland and also in the UK. At the same time, there has been a decline in young people's access to a car (defined as access to a car whenever you need one) in Norway and Sweden. A review of existing literature and analyses of transport use and attitudes to transport modes among young people was undertaken. The objective is to identify the most important barriers and determinants connected to transport mode choice today and identify the main challenges for future travel behaviour among young people. In what way will the trends among youth affect the use of local public transport, and how can the public transport sector meet these challenges? The findings indicate that the car does not have the same symbolic value as before among young people in the city areas. The development in the population's travel patterns show that people travel more, and the pattern of travel is becoming ever more differentiated. When young people choose transport mode, they look for a convenient way to organize their everyday life. The everyday life of many young people as structured consists of a set of different travel destinations; University, part time job, training, meeting friends at a café etc. Public transport users are not a homogenous group. Public transport users belong to groups in all categories, in all layers of society, with different needs and requirements with regard to travel and with different levels of willingness and capability to pay. Thus, public transport presents a major challenge with regard to developing a service which will meet the demands of these different groups. Developing a standard service designed to satisfy the needs of all groups may result in a poor service for the majority. If young people experience an inflexible and uncomfortable public transport supply not adjusted to their needs they will acquire a driving licence and buy a car as soon as they feel that their everyday trips are too complicated with public transport. For the covering abstract please see ITRD E135207.

### ***Demographics, Migration and Ethnicity***

Kawgan-Kagan, I. (2015). ***"Early adopters of carsharing with and without BEVs with respect to gender preferences."*** *European Transport Research Review* 7(4): 11p.

<http://dx.doi.org/10.1007/s12544-015-0183-3> <http://trid.trb.org/view/1371210>

The majority of current e-carsharing users are middle-aged men with a high education and high income; they are most likely to have a full-time employment. Women are consistently underrepresented in previous studies and therefore this paper focusses on characterization of female early adopters. It builds a basis to identify current female early adopters and understand their preferences in e-carsharing in order to address women as target groups for e-carsharing. A sample of 492 carsharing subscribers from Berlin is analysed according to socio-demographic backgrounds, mode choice, use and evaluation of (e-) carsharing services. Additionally, attitudinal indices and clusters based on mobility related attitudes are analysed to reveal significant differences between male and female users. Generally, the results confirm socio-demographic findings from previous literature about early adopters. Comparing females and males revealed differences in income, employment status and age. Female early adopters used battery electric vehicles (BEVs) more often than vehicles with an internal combustion engine and evaluate handling BEVs more positive. They show a higher bike affinity and lower affinities towards technology and innovation than male respondents. They combine public transportation and bicycling with the use of (e-) carsharing services as an additional part of urban mobility. Children do not seem to have an impact of the respective topics, although the findings suggest that services are not used with children. The analysis of carsharing schemes needs to focus on specific requirements of each trip (e.g. transporting or accompanying children) in order to make sustainable mobility an option for others than one 'typical early adopter'.

Namkung, M. and G. Akar (2014). ***"Role of gender and attitudes on public transportation use."*** *Transportation Research Record*, National Research Council. **2415**: 136-144.

This study aimed to evaluate gender differences in public transportation-related attitudes and their effects on transit use. How did attitudes affect people's transit use? Did public transit-related attitudes differ by gender in general and by status group (faculty, staff, and students)? This research aimed to address these questions. The analysis was based on data collected from the 2012 campus transportation survey at Ohio State University. The survey questionnaire covered individuals' sociodemographic characteristics, commute mode choices, and attitudes toward driving and taking public transit, including reliability, safety, flexibility, convenience, accessibility, and comfort. After the descriptive analysis of perceptions that were segmented on the basis of gender and status (faculty, staff, undergraduates, and graduate students), binary logit models were estimated to assess the influences of individuals' attitudes on transit use while controlling for other factors. First a binary logit model measuring the effects of respondents' status (student, staff, or faculty), car ownership, ethnicity, proximity to bus stops, and distance to campus was estimated. Then respondents' attitudes were added to the existing model. Results indicated that including attitudes significantly increased the explanatory power of the model, and the results revealed the significant connections between attitudes related to public transportation and public transit use. The findings of this study can help transportation planners understand the ways attitudes affect transit use and the differences across

genders. Although the study used data from Ohio State University, the findings can help in developing plans for increasing alternative transportation use on other campuses, as well as in surrounding areas.

Bhat, G. and R. B. Naumann (2013). ***"Travel-Related Behaviors, Opinions, and Concerns of U.S. Adult Drivers by Race/Ethnicity, 2010: A Special Report from the CDC."*** *Journal of safety research* 47: pp 93-97. <http://dx.doi.org/10.1016/j.jsr.2013.09.001>  
<http://www.sciencedirect.com/science/article/pii/S0022437513001497>  
<http://trid.trb.org/view/1285675>

The U.S. population is shifting to become both older and more racially and ethnically diverse. The current understanding of U.S. drivers' travel-related needs and concerns by race/ethnicity is limited. Data from the 2010 HealthStyles survey, an annual, cross-sectional, national mail-panel survey of persons ages 18 years or older living in the United States, were used to calculate weighted percentages of travel-related behaviors, opinions, and concerns by race/ethnicity. Logistic regression was used to explore associations between race/ethnicity and specific travel-related concerns, while adjusting for other demographic characteristics. Adequate transportation alternatives to driving were reported by a greater percentage of persons in certain minority groups compared to whites (Hispanic: 34.7%; white: 23.4%). Concern for the availability of alternatives to driving in the future was greater among minority groups (black: 57.7%; Hispanic: 47.3%; other: 50.9%) compared to whites (37.5%). Additionally, among persons with a household income of \$25,000 +, minorities were generally more likely than whites to report concern about having alternative transportation options to driving, whereas concern was consistently high among all racial/ethnic groups for those earning less than \$25,000 annually. In each racial/ethnic group, more than 10% of persons reported not knowing how they would get around if they could no longer drive. Important variations by race/ethnicity in both travel behaviors and concerns for adequate alternatives to driving were found, revealing the need for further research to better understand reasons for these differences and to identify ways to meet the transportation needs of the changing U.S. population demographics.

Chatman, D. G. (2013). ***"Explaining the "Immigrant Effect" on Auto Use: The Influences of Neighborhoods and Preferences"***. <http://trid.trb.org/view/1242925>

Immigrants make up a growing share of urban employment and population growth, a trend expected for the foreseeable future. They travel very differently than the US-born, with a greater reliance on alternative modes such as carpooling, public transit, bicycling and walking, even when controlling for demographics and regional built environment characteristics—a phenomenon I call the “immigrant effect.” Reasons for these differences are much discussed but little investigated, largely because data are not available. This study uses a unique and rich dataset to permit a deeper investigation of some hypotheses than earlier research on immigrant work and non-work travel. It looks at two distinct groups of immigrants—US residents born in South Asia and Latin America—using an original survey carried out in New Jersey, along with geographic data on homes and workplaces. Statistical analysis of current work and non-work auto use focuses on small-scale spatial characteristics as well as measures of preferences: residential location criteria, and migration motives. These pathways partly explain the lower reliance on autos by Latin American immigrants, particularly home neighborhood population density, rail and bus



availability, and access to grocery stores and restaurants, though controlling for neighborhoods increases the effect for South Asians. Enclave measures are less significant than built environment measures. Preference measures play a much smaller role in explaining the immigrant effect than do neighborhood measures, although those who migrated to the US to join family are somewhat more likely to use autos.

Chatman, D. G. and N. J. Klein (2013). ***"Why do immigrants drive less? Confirmations, complications, and new hypotheses from a qualitative study in New Jersey, USA."*** Transport Policy **30**: 336-344.

Recent immigrants to the United States drive autos less than the US-born, with rapid increases in their ownership and use of autos over time, and a persistently lower level of auto use even when controlling for socioeconomic characteristics and time in the US. Quantitative studies have not yet explained these phenomena. Given that population growth in the US is largely dependent on immigration, understanding auto ownership and use among immigrants is important for transportation sustainability. We conducted six focus groups with US residents born in India, the Philippines, and Latin America. Our findings confirm, complicate and contradict the existing literature explaining differences in auto use among immigrants and the US-born, and we identify some new hypotheses with implications for policy-relevant research. More difficult driving conditions in the US and remittances back home may contribute to the initially lower auto ownership and use among immigrants. The rapid transition to auto use may be a function of household changes having more dramatic effects among immigrants given their initially high-density residential locations. The growth of non-English speaking transit riders, an increase in private transit services, and different residential location priorities may all contribute to the persistently lower auto use by immigrants even after many years in the US.

Toop, E., A. Harmon and E. J. Miller (2013). ***"Aging Demographics in Medium-Sized Cities: Case Study of Travel Behavior in Kamloops, Canada"***. <http://trid.trb.org/view/1241326>

In western countries, the imminent aging of the baby boomer generation will have significant impacts on the function and sustainability of transportation systems. While the demographic shift of larger cities will be mitigated by the in-migration of younger residents, smaller cities will experience a sharper increase in median age due to the out-migration of younger residents. This outlook, coupled with the existing autooriented culture in medium-sized cities, presents a unique set of transportation sustainability challenges for smaller communities. In the Canadian context, the effects of the aging demographic on transportation demand have received surprisingly little attention, and, though the demographic change will be most pronounced in smaller cities, the existing literature is focused on large cities. Given this, this paper serves to research the effects of age on travel behavior in the medium sized city of Kamloops, British Columbia. From the city's household travel survey data, it is found that significant travel behavior differences exist between different age cohorts. The empirical behavior analysis is supplemented with the city's population projections for each age cohort to demonstrate the future transportation impacts of the aging demographics. Though transit ridership in the city is lacking and an increase in older residents is shown to perpetuate this problem, the analysis indicates that the city is well positioned to push for increasing active mode shares into the future.

Chu, X. (2012). **"An Assessment of Public Transportation Markets Using NHTS Data"**  
[http://www.dot.state.fl.us/research-center/Completed\\_Proj/Summary\\_PTO/FDOT\\_BDK85\\_977-17\\_rpt.pdf](http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PTO/FDOT_BDK85_977-17_rpt.pdf) <http://trid.trb.org/view/1138650>

This study assesses a range of public transit markets for Florida and the U.S. as a whole. Data from the 2009 National Household Travel Survey are used. The public transit markets are defined with trip purpose and seven personal, household and travel characteristics of persons in these transit markets, including driver status, immigration status, existence of medical conditions that make it difficult to travel out of the house, household income, vehicle availability, race and ethnicity, and monthly frequency of transit use. Based on an approach of cross tabulations, this study assesses these transit markets from five perspectives: 1. Market Size - how the overall transit market is distributed across these transit sub-markets. 2. Modal Share - how people within each transit market travel using various modes, including transit. 3. Attitudes - how people within each transit market feel about a set of transportation issues 4. Socio-Demographics - personal, household, location, and travel characteristics of transit markets 5. Trip Characteristics - transit-specific and general trip characteristics of transit markets. The assessment of Florida is limited to the first three perspectives due to sample size issues. The results presented are useful to operating agencies for strategic planning and to other government bodies for developing policies and funding programs for improving mobility of those who are transportation and economically disadvantaged and for improving the transportation system in general.

Iseki, H. and M. J. Smart (2012). **"How Do People Perceive Service Attributes at Transit Facilities? Examination of Perceptions of Transit Service by Transit User Demographics and Trip Characteristics."** Transportation Research Record: Journal of the Transportation Research Board (2274): pp 164–174.

Given the well-known fact that transit users perceive out-of-vehicle travel (walking, waiting, and transferring) as more onerous than in-vehicle travel, understanding what makes travelers' perceptions of the out-of-vehicle travel experience better is important for transit planners who seek to make public transit more attractive. Original survey data collected from 2,122 transit users regarding their perceptions of various attributes of service at 36 transit stops and stations in California were used to examine which attributes are important to transit users, as well as their satisfaction levels with each attribute, and to ascertain the relative needs for improvement of these attributes. The paper also examines how different sets of attributes that determine overall satisfaction vary by transit users' trip characteristics and demographics, such as age, sex, income level, race and ethnicity, auto availability, mode of travel, and frequency of transit use. In a series of ordered logit regression analyses, satisfaction levels for safety- and access-related variables were found to be more aligned with overall user satisfaction than were information- and reliability-related attributes and amenities. A similar result was found for various subpopulations—men, those making less than \$15,000 per year, frequent riders, commuters, and those with an alternative mode of travel—but not for others. The analysis indicates that while safety is certainly the number-one priority for all transit users, travelers with different backgrounds on different modes of transit have different priorities for services and attributes to improve their transit experience.



McGuckin, N. and J. Lynott (2012). *"Impact of baby boomers on US travel, 1969 to 2009."* Insight on the Issues 70.

The baby-boom generation has been the demographic engine fueling much of the growth in travel over the last forty years—both in the total number of travelers and in the amount of travel per person. Babyboomer women entered the workforce and were licensed to drive at unprecedented rates, and as a result the dual-worker/two-car family became the average American household. The historic growth in vehicle travel that followed the baby-boom cohort generated economic, spatial, and cultural changes that are still being felt today. As baby boomers move through the life stages of family-building to empty-nest and retirement, the consistent growth in vehicle travel has slowed. The historical pattern of year-over-year increases in vehicle miles of travel has even reversed to show declines for the first time since the Second World War. Understandably, policy makers are wondering whether the recent declines in vehicle travel reflect more than a temporary economic bump. Whether the slowing in growth is related to the aging of the baby boomers is unknown, and how much and by what means the baby-boomers will travel in their golden years remains an open question: city planners are trying to make urban centers attractive to older citizens while policy makers wonder how to offer mobility options for dispersed suburbanites and safety advocates prepare for the challenge of increased vehicle travel by an aging cohort of drivers. This paper offers one perspective on the role of the population bubble known as the baby boomers on vehicle travel in the U.S. as described through four decades of travel data.

Cottrill, C. D. and P. Thakuriah (2011). *"Privacy and Gender: Reviewing Women's Attitudes Toward Privacy in the Context of Intelligent Transportation Systems and Location-Based Services"*, Transportation Research Board. <http://www.trb.org/Publications/Blurbs/165294.aspx>  
<http://trid.trb.org/view/1101843>

Limited previous research has shown that women value online privacy more than men, potentially influencing their online behavior or willingness to reveal personal data online. New generations of intelligent transportation systems (ITS) and location-based services (LBS) technologies depend on the input of personalized and localized information to give, potentially, information that may uniquely address women's complex travel patterns, but which may raise locational privacy concerns for women and cause them to hesitate to share the needed information. This paper examines gender differences in the propensity to reveal the potentially sensitive information necessary to make ITS and LBS highly personalized to individual travelers. The authors develop privacy indicators based on refusals to answer sociodemographic and location questions in a household travel survey to evaluate whether women have a significantly different attitude toward willingness to share data related to position and personal identifiers compared with men. The results show that gender differences regarding privacy preferences are not statistically significant. However, this result is inconclusive because the survey overall achieved low response rates and participating households may already be self-selected into being open about divulging sensitive travel and locational information.

Tsang, F. and C. Rohr (2011). "***The Impact of Migration on Transport and Congestion***"  
[http://www.rand.org/content/dam/rand/pubs/technical\\_reports/2011/RAND\\_TR1187.pdf](http://www.rand.org/content/dam/rand/pubs/technical_reports/2011/RAND_TR1187.pdf)  
<http://trid.trb.org/view/1136455>

Economic migrants are individuals who have one country or area of origin, who come to another country or area - in this case the United Kingdom - with the main goal of working. The purpose of this study was to comprehend the most probable impact of economic migrants from outside of the European Economic Area (EEA) on traffic congestion and transportation networks. The authors reviewed 22 major studies on this subject matter. Very little literature existed on migrants' travel in the United Kingdom, though relevant papers from Sweden, Canada, Australia and Norway were found. The second part of the study involved an empirical analysis of data from the United Kingdom. The National Travel Survey, the Certificate of Sponsorship, and the Annual Population Survey were examined for relevant data. Here are some of the findings: 1. Migrants concentrate in metropolitan areas that provide extensive public transit. 2. Migrants generally use non-automobile modes of travel, such as walking, car sharing, bicycling and public transit. 3. The longer migrants stay in the United Kingdom, the more like the native population they become in their travel patterns.

Klein, N. J. (2010). "***Journey to Work Mode Choice Among the Foreign-Born in New Jersey: Country of Origin Specific Differences***". <http://trid.trb.org/view/910863>

According to recent research, the foreign-born in the United States make use of carpools, transit, biking and walking at much higher rates than US-born persons during their first years in the country. This paper takes a new look at the travel behavior of immigrants by using data from New Jersey and examining the differences among the foreign-born from the populous immigrant sending countries: India, the Philippines, Mexico, the Dominican Republic and Korea. Previous research has tended to categorize immigrants by large geographic sending regions and/or race/ethnicity but these groupings gloss over the important differences that exist across sending countries. The results of this study find support and contradictions of the previous research. Some immigrant populations in New Jersey appear to follow the expected path: high rates of carpool, transit and walking/biking during their first years in the US giving way to drive alone rates that are comparable to the US-born in later years. However, not all immigrant populations follow this trajectory. This analysis finds that travel behavior of Korean-born residents in New Jersey changes little during their years in the US, their rate of drive alone is comparable to US-born and they use transit at lower rates than the US-born.

Tal, G. and S. Handy (2010). "***Travel behavior of immigrants: An analysis of the 2001 National Household Transportation Survey***." *Transport Policy* 17(2): 85-93.

The purpose of this paper is to examine the relationships between travel behavior and immigrant status. The National Household Travel Survey (NHTS) allows us to explore the relationships between travel behavior and characteristics that are usually hard to discern in surveys with smaller samples. The correlation between travel behavior and immigrant characteristics such as place of birth and year of immigration in the US was tested while controlling for spatial and socio-demographic variables. The effects of place of birth and year of arriving to the US were found to be significant for some places of birth and for immigrants who entered the US in recent years. Understanding the differences in travel

behavior and the possible explanations for these differences can help in modeling travel demand, finding policies best suited to meeting the travel needs of foreign-born communities, and addressing environmental justice concerns.

Chatman, D. G. and N. Klein (2009). ***"Immigrants and Travel Demand in the United States: Implications for Transportation Policy and Future Research."*** Public Works Management & Policy 13(4): 312-327. 10.1177/1087724x09334633  
<http://pwm.sagepub.com/content/13/4/312.abstract>

Immigrants account for a majority of recent urban population growth in the United States, and for much economic growth as well. This is expected to continue for the next several decades. The foreign-born are much more likely to use transit, carpool, walk, and bicycle, particularly in their first few years of living in the United States. These trends represent challenges and opportunities for transportation and land use planners to increase the environmental sustainability of population growth, use existing transportation systems to their maximum efficiency, and support economic development. But doing so depends on anticipating the travel demands of varying immigrant groups, and those demands in turn depend on their employment and residential location choices. The authors present the most current data available on these trends, summarize research literature, and identify the major research questions needing answers to understand how to accommodate the travel demands of immigration-driven population growth.

Contrino, H. and N. McGuckin (2009). ***"Demographics Matter: Travel Demand, Options, and Characteristics Among Minority Populations."*** Public Works Management & Policy 13(4): pp 361-368. <http://dx.doi.org/10.1177/1087724X09336223> <http://trid.trb.org/view/901821>

Race and ethnicity are important in terms of travel choices, needs, and options. Many factors contribute to the differences in patterns of travel within population segments. This paper uses data from the US Census Bureau and the National Household Travel Survey Program to examine the demographic characteristics of minority populations and the resulting differences in their travel behavior. As the U.S. society becomes more diverse over the next few decades, a significant portion of growth in travel demand will come from minority populations. Minorities on average are more transit dependent, have higher automobile occupancies, and have lower levels of vehicle ownership. Factors such as these should be considered when forecasting travel demand and developing policy and planning initiatives.

Blumenberg, E. and K. Shiki (2008). ***"Immigrants and Resource Sharing: The Case of Carpooling"***. <http://trid.trb.org/view/848862>

Immigration has altered the demographic composition of California where the foreign-born population now comprises more than one-quarter of the population. Despite this staggering figure, surprisingly little academic scholarship has focused on the travel patterns and behavior of immigrants. Existing studies on this population group have largely centered on their use of public transit, yet most immigrants travel by automobile. In this study, we use data from the 2000 Public Use Microdata Sample (PUMS) of the U.S. Census and multinomial logistic models to examine the carpooling behavior of foreign-born workers in California relative to solo driving, public transit, and walking. The models focus on the effect of nativity, length of residency, and race and ethnicity on mode choice. The findings show that with time in the U.S. immigrants tend to assimilate away from alternative modes of

transportation (carpool, public transit, and walking) toward solo driving. Despite this trend, the odds of carpooling for Asian and Hispanic immigrants remain high even after many years in the U.S. These findings help us to better understand the prevalence and role of resource sharing among immigrant households. Further, they will aid transportation planners in planning for the transportation needs of this growing population group.

Blumenberg, E. and L. Song (2008). "***Travel Behavior of Immigrants in California: Trends and Policy Implications***". <http://trid.trb.org/view/848790>

This article examines the travel behavior of immigrants in California. Drawing on data from the 1980, 1990, and 2000 Public Use Microdata Sample of the U.S. Census, we describe immigrants' travel patterns in California, focusing on commute mode. We find that immigrants rely more extensively on alternative commute modes (carpooling and transit) than native-born commuters. But with time in the U.S., immigrants quickly assimilate away from these alternative modes and increasingly rely on solo driving. We then explore the effects of this transportation assimilation process for immigrant families and on public transit usage. Cars may provide immigrants with increased access to employment and, consequently, contribute to their economic assimilation. However, declining transit use among recent immigrants and slowing immigration suggest that, unless transit planners intervene, transit ridership in California will decline. We conclude by discussing the implications of these findings for transportation policy.

Blumenberg, E. and K. Shiki (2007). "***Transportation Assimilation: Immigrants, Race and Ethnicity, and Mode Choice***". <http://trid.trb.org/view/802238>

Immigration has altered the demographic composition of California where the foreign-born population now comprises more than one-quarter of the population. Despite this staggering figure, surprisingly little academic scholarship has focused on the travel patterns and behavior of immigrants. In this study, we use data from the 2000 Public Use Microdata Sample (PUMS) of the U.S. Census to examine the commute mode choice of California's foreign-born population and, more specifically, the relationship between length of residency in the U.S. and transit usage rates, controlling for other factors likely to influence mode choice. We find that recent immigrants—regardless of race or ethnicity—are significantly more likely to commute by transit than native-born adults. After the first five years in the U.S., assimilation to automobile use occurs across all immigrant groups; however, the rate of assimilation varies significantly by racial and ethnic group even controlling for income. Asian immigrants rapidly move to automobile use while Hispanic immigrants remain more likely to use transit than native-born commuters even after 20 years in the U.S. The findings from this study suggest that factors in addition to income and residential location—such as cultural differences—affect commute mode choice. Further, since assimilation to automobile use occurs across all immigrant groups, without a steady stream of new immigrants as well as policy changes to either slow the assimilation process or attract new riders, transit ridership in California likely will decline.

McGuckin, N., J. Zmud and Y. Nakamoto (2005). "***Trip-chaining trends in the United States: understanding travel behavior for policy making***." Transportation Research Record: Journal of the Transportation Research Board 1917(1): 199-204.

This paper uses data from the 1995 Nationwide Personal Transportation Survey and the 2001 National Household Travel Survey to examine trip-chaining trends in the United

States. The research focuses on trip chaining related to the work trip and contrasts travel characteristics of workers who trip chain with those who do not, including their distance from work, current levels of trip making, and the purposes of stops made within chains. Trends examined include changes in the purpose of stops and in trip-chaining behavior by gender and life cycle. A robust growth in trip chaining occurred between 1995 and 2001, nearly all in the direction of home to work. Men increased their trip chaining more than women, and a large part of the increase was to stop for coffee (the Starbucks effect). It was found that workers who trip chain live farther from their workplaces than workers who do not. It was also found that, in two-parent, two-worker households that drop off children at school, women are far more likely than men to incorporate that trip into their commute and that those trips are highly constrained between 8:00 a.m. and 9:00 a.m. An analysis was done of workers who stopped to shop and those who did not but made a separate shopping trip from home; a large potential to increase tripchaining behavior in shopping trips was found. Results of these analyses have important policy implications as well as implications for travel demand forecast model development. Finally, this paper uses these analyses to develop conclusions about the utility of transportation policies and programs that use the promotion of trip chaining as a primary travel demand management strategy.

Tal, G. and S. L. Handy (2005). "***The Travel Behavior of Immigrants and Race/Ethnicity Groups: An Analysis of the 2001 National Household Transportation Survey***, University of California, Davis: 37p.

The purpose of this paper is to examine the relationships between travel behavior and immigrant status. The National Household Travel Survey (NHTS) allows exploration of the relationships between travel behavior and characteristics that are usually hard to discern in surveys with smaller samples. The place of birth and year of immigration to the US on travel behavior was tested for commute mode and for general travel variables such as yearly miles driven, number of weekly walk trips, and number of daily trips by all modes. Full models that include spatial and socio-demographic variables were estimated for each of the dependent variables. The effects of place of birth and year of arriving to the US were found to be significant in the full models that control for commute mode and yearly miles driven but not for weekly walk trips or number of daily trips. Understanding the differences in travel behavior and the possible explanations for these differences can help in modeling travel demand, finding policies best suited to meeting the travel needs of foreign-born communities, and addressing environmental justice concerns.

Heisz, A. and G. Schellenberg (2004). "***Public transit use among immigrants.***" *Canadian Journal of Urban Research* 13(1): 170-191.

Using data from the 1996 and 2001 Censuses of Canada, we examine the propensity of immigrants and the Canadian-born to use public transit. We find that recent immigrants are much more likely to use public transit to commute to work than Canadian-born persons even after for controlling for demographic characteristics, income, commute distance and residential distance from the city centre. This higher propensity falls with time spent in Canada. We also find that recent cohorts of immigrants are more likely to take public transit than past cohorts of immigrants. Implications for public transit services are discussed.

Pucher, J. and J. L. Renne (2003). **"SOCIOECONOMICS OF URBAN TRAVEL: EVIDENCE FROM THE 2001 NHTS."** *Transportation Quarterly* 57(3): p. 49-77. <http://trid.trb.org/view/662423>

The 2001 National Household Travel Survey (NHTS) confirms most of the same travel trends and variation among socioeconomic groups documented by its predecessors, the Nationwide Personal Transportation Surveys of 1969, 1977, 1983, 1990 and 1995. The private car continues to dominate urban travel among every segment of the American population, including the poor, minorities and the elderly. By comparison, public transportation accounts for less than 2 percent of all urban travel. Even the lowest-income households make only 5 percent of their trips by transit. The most important difference in the 2001 NHTS is the doubling in modal share of walking trips in cities, due to a much improved survey technique that captured previously unreported walks. While the private car dominates travel, there are important variations in automobile ownership and travel behavior by income, race, ethnicity, sex and age. Overall, the poor, racial and ethnic minorities, and the elderly have much lower mobility rates than the general population. Moreover, the poor, blacks and Hispanics are far more likely to use transit than other groups. Indeed, minorities and low-income households account for 63 percent of the nation's transit riders. Different socioeconomic groups also have different rates of carpooling, taxi use, bicycling and walking. In addition, they travel different distances and at different times of the day. Many of these socioeconomic variations in travel behavior have important consequences for public policy.

Polzin, S. E., X. Chu and J. R. Rey (2001). **"Mobility and Mode Choice of People of Color for Non-Work Travel"**, Transportation Research Board.

<http://onlinepubs.trb.org/onlinepubs/circulars/ec026/ec026.pdf> <http://trid.trb.org/view/686716>

This paper takes a comprehensive look at mobility and mode choice behavior of people of color for their non-work travel. Travel by people of color is of strong policy interest because it is a growing and changing share of the total travel market and is expected to continue to grow much faster than overall travel well into the next century. The Nationwide Personal Transportation Survey (NPTS) provides a valuable data source for exploring travel behavior. Understanding non-work travel is becoming increasingly important due to its growing influence in people's lives and on the transportation system. Non-work travel includes travel for personal and family business, school activities, and religious activities, health care, and social and recreational activities. Work trip travel has declined to about 20% of all local travel. Even during traditional commuting rush periods, non-work travel comprises more than 70% of all trips. The resultant changes in temporal and spatial distributions of travel in metropolitan areas influence the types of transportation investments, services, and policies that can be used to address travel needs. This paper compares mobility trends by group using information from the 1983, 1990, and 1995 NPTS databases. Mode choice differences across groups are analyzed by examining how patterns of difference in mode choice vary with personal, household, geographic, and trip characteristics as reported in the 1995 NPTS. The exhaustive analysis examined a variety of distributions and tabulations and uses logistic regression to further explore mode choice differences between racial/ethnic groups. The analysis indicates that the differences in nonwork travel behavior for the various racial/ethnic groups has changed dramatically over time with minority travel behavior more closely matching majority behaviors. Mobility for minority travelers has increased and mode choice behavior, while still different, more



closely resembles that of the aggregate population. Variations in aggregate group behavior can almost always be explained by socioeconomic and geographic conditions. The most significant race- or ethnicity-based difference appears to be a greater use of public transit by the African-American population, even when the socioeconomic characteristics of travelers are taken into account.

Sandefur, G. D., M. Martin, J. Eggerling-Boeck, S. E. Mannon and A. M. Meier (2001). ***"An overview of racial and ethnic demographic trends."*** *America becoming: Racial trends and their consequences* 1: 40-102.

Provided here is an overview of major demographic trends for racial and ethnic groups in the United States over the past 50 or so years— a daunting undertaking for one paper, given the variety of groups and topics addressed. Consequently, this overview is selective, covering what we feel are the most important trends— population composition and growth, fertility, family, mortality, and migration. Racial and ethnic categories are the ones used by the federal government. To enumerate racial and ethnic groups, demographers rely on the U.S. decennial census and annual Current Population Surveys (CPS). To estimate marriage, fertility, and mortality rates, demographers use the national vital statistics records of births, marriages, and deaths. Estimates of internal migration come from the U.S. Bureau of the Census (USBC), and estimates of international migration come from the Immigration and Naturalization Services and USBC.

Doyle, D. G. and B. D. Taylor (2000). ***"Variation in Metropolitan Travel Behavior by Sex and Ethnicity."*** pp 181244. <http://www.fhwa.dot.gov/ohim/trvpatns.pdf>  
<http://trid.trb.org/view/899770>

Researchers have long observed that travel behavior varies systematically by sex and by ethnicity. However, the underlying causes of these differences and their policy implications have been subject to ongoing debate. In particular, there is an extensive literature comparing and contrasting the travel patterns of men and women, though relatively few studies have explicitly examined the combined influence of sex and ethnicity on travel behavior—the focus of this study. This research uses recently published data from the Nationwide Personal Transportation Survey (NPTS) to examine patterns of metropolitan travel by sex and ethnicity along three dimensions: (1) the choice of travel mode, (2) commuting to and from work, and (3) the purpose of travel. The authors use both cross-tabulations of data and multi-variate analyses (using both weighted and unweighted data) to explore ethnic and sex variations in travel behavior for metropolitan trips under 75 miles in length and 180 minutes in duration. In a nutshell, they find that race/ethnicity appears to be a more important influence than sex on mode choice and commuting behavior, although sex differences persist, especially by household type. Their analysis of non-work travel, however, reveals sharp distinctions between men and women across ethnic groups. Despite significant increases in paid labor force participation by women over the last third of the twentieth century, these data suggest that women continue to shoulder far more responsibility than men for maintaining households (and for household-serving travel). As a consequence, the authors find that women, regardless of race/ethnicity, are more likely than men to chain trips together into tours. This has important implications for urban transportation planning and policy. For example, the relative inflexibility of fixed-route transit service is often poorly suited to chaining



multiple trips together across a metropolitan area. Public transit systems may need to develop new, more flexible forms to better adapt to the needs of trip-chaining travelers.

FHWA (2000). "**TRAVEL PATTERNS OF PEOPLE OF COLOR**"

<http://www.fhwa.dot.gov/ohim/trvpatns.pdf>

<http://ntl.bts.gov/lib/10000/10800/10815/trvpatns.pdf> <http://trid.trb.org/view/679739>

This report develops a body of literature on travel by people of color, to better understand how Americans of all ethnic backgrounds are using our transportation systems today and to generate ideas to improve transportation mobility. The majority of the data used in these papers is from the Nationwide Personal Transportation Survey (NPTS) and the U.S. decennial Census. The report is a compilation of seven separate papers, each with its own specific focus and point of view. The topics include race, inequality, and travel patterns; demographics; commuting; residential location; mode choice; and gender differences. The papers, and their authors, contained in this work are: Race, Inequality and Travel Patterns, by A. Valenzuela, Jr.; Demographics of People of Color, by S.E. Polzin, X. Chu, and J.R. Rey; Work-Related Travel Patterns of People of Color, by R. Krovi and C. Barnes; Work, Automobility, and Commuting, by N. McGuckin; Residential Location Differences in People of Color, by G. Giuliano; Mode Choice by People of Color for Non-Work Travel, by X. Chu, S.E. Polzin, J.R. Rey, and E.T. Hill; and Variations in Metropolitan Travel Behavior by Sex and Ethnicity, by D.G. Doyle and B.D. Taylor.

Alba, R. D., J. R. Logan, B. J. Stults, G. Marzan and W. Zhang (1999). "**Immigrant Groups in the Suburbs: A Reexamination of Suburbanization and Spatial Assimilation.**" *American Sociological Review* 64(3): 446-460. <http://www.jstor.org/stable/2657495>

For a number of contemporary immigrant groups, suburbanization is occurring at high levels, and either increased or remained stable during the 1980s, a decade of high immigration. We investigate whether these settlement patterns are consistent with spatial-assimilation theory. Using Public Use Microdata from the 1980 and 1990 U.S. censuses, we examine the link between suburban residence and life-cycle, socioeconomic, and assimilation characteristics for 11 racial/ethnic groups, including those growing most from contemporary immigration as well as non-Hispanic whites. We find support for some aspects of the theory. The determinants of suburban residence are consistent between the 1980 and 1990 models, with some important exceptions: Among several groups, especially Asian groups, the effects of very recent immigration and linguistic assimilation have weakened. Our findings indicate that barriers to the entry of new immigrants to suburbia are now lower than before. The growing numbers of recent immigrants there suggest the emergence of new ethnic concentrations and infrastructure.

McGuckin, N. and E. Murakami (1999). "**Examining Trip-Chaining Behavior: Comparison of Travel by Men And Women.**" *Transportation Research Record* (1693): p. 79-85.

<http://dx.doi.org/10.3141/1693-12>

Gender and household life cycle together affect daily travel behavior. Although this makes intuitive sense, transportation planners and policy makers have done little to understand what effect and impact these factors have on daily transportation choices. The 1995 Nationwide Personal Transportation Survey was used to examine trip-chaining behavior of adult men and women traveling Monday through Friday. The data show that women continue to make more trips to perform household-sustaining activities such as shopping

and family errands to a greater extent than men. Women, especially with children in the household, are more likely to chain these household-sustaining trips to the trip to and from work. Women's participation in the labor force is at an all-time high, but women's patterns in travel to work are different from men's patterns, and they vary with family and life-cycle status. The type and location of jobs that women take are likely affected by their greater household and family responsibilities. The biggest question for the future is whether and how the changes in women's status in the workplace, and perhaps the concomitant change in the household dynamics and responsibilities, will affect travel behavior of both men and women. These changes will deeply affect the development of programs related to transit, land-use planning, work schedules, telecommuting, and other programs related to automobile use.

Preston, V., S. McLafferty and X. F. Liu (1998). ***"Geographical barriers to employment for American-born and immigrant workers."*** *Urban Studies* 35(3): 529-545.

Residential segregation interacts with the changing geography of transport and employment in urban areas to restrict access to workplaces. A growing literature suggests that spatial barriers limit the job opportunities of minority women and men in American cities. This study examines the nature and extent of geographical barriers for minority immigrants by analysing their commuting behaviour. Information from the 1990 Public Use Microdata Sample is used to compare the commuting times of immigrant and native-born minority women in central parts of the New York Consolidated Metropolitan Statistical Area. The effects of occupation, wages, family responsibilities, transport mode, year of arrival in the US and English fluency on commuting time are assessed separately for immigrant men and women. The results suggest that race/ethnic group has a larger influence on commuting times than place of birth. However, white immigrant women's employment is less restricted by geographical barriers than that of minority immigrants. The findings confirm the diversity of immigrant women's experiences, reinforcing the need to consider the interrelations among gender, race and class when examining urban labour markets.

Myers, D. (1997). ***"Changes Over Time In Transportation Mode For Journey To Work: Effects Of Aging And Immigration"***, Transportation Research Board.

<http://onlinepubs.trb.org/onlinepubs/conf/1997/cp13/cp13v2008.pdf>

<http://trid.trb.org/view/574900>

The changing commuting behavior of immigrants in Southern California is studied. Using 1980 and 1990 census data, trends in transportation mode are analyzed for cohorts of immigrants defined by age and recency of arrival in the United States. Cohorts are further identified by sex and race-ethnicity. The study finds that recent immigrants are far more reliant on public transit, but after they gain an additional 10 years of residence in the United States, their transit use falls markedly. The change is especially sharp in the case of women, who increase their rate of solo car driving noticeably. The implication is that sustained high immigration bolsters the ridership base of public transit and reduces traffic congestion.

Spielberg, F. and S. Andrlé (1982). ***"The implications of demographic changes on transportation policy."*** *Journal of the American Planning Association* 48(3): 301-308.

This article discusses the relationship between demographics, energy, and transportation, recognizing that demographic changes and energy constraints will place pressures on the

transportation system that must be addressed by policy. The major demographic trends include declining household size and moderate population growth. Also, the labor force will increase more rapidly than the population. Both jobs and households will increasingly be located in the suburbs, where the dominant transportation problem in the next two decades will be. Occasional energy shortages and steadily increasing gasoline prices will exacerbate the suburban travel problem, but chronic gasoline shortages should not be a problem in this century. Transportation policy themes will focus on better use and management of existing resources.

Spielberg, F., E. Weiner and U. Ernst (1981). ***"The Shape of the 1980s: Demographic, Economic, and Travel Characteristics."*** Transportation Research Record (807).

Forecasts of economic and demographic conditions are the base for all forecasts of travel demand. During the 1970s many changes were observed in the demographics of the nation. This paper reviews the trends in pertinent demographic measures and projects the directions of these measures through the 1980s. The objective is to determine how transportation demand is likely to change.

### ***Attitudes, Values and Preferences in Travel Behavior***

Kandt, J., P. Rode, C. Hoffmann, A. Graff and D. Smith (2015). ***"Gauging interventions for sustainable travel: A comparative study of travel attitudes in Berlin and London."***

Transportation Research Part A: Policy and Practice 80: pp 35-48.

<http://dx.doi.org/10.1016/j.tra.2015.07.008>

So-called 'soft' policy instruments that respond to the psychological aspects of travel are regularly acknowledged as necessary complements to 'hard' infrastructure investments to effectively promote sustainable travel in cities. While studies investigating subjective orientations among travellers have proliferated, open questions remain including the role of recent technological advances, the expansion of alternative mobility services, locally specific mobility cultures and residential selection. This paper presents the methods, results and policy implications of a comparative study aiming to understand mobility attitudes and behaviours in the wider metropolitan regions of Berlin and London. The authors specifically considered information and communication technology (ICT), new types of mobility services such as car sharing, electric cars and residential preferences. In each region, the authors identified six comparable segments with distinct attitudinal profiles, socio-demographic properties and behavioural patterns. Geocoding of the home address of respondents further revealed varying contextual opportunities and constraints that are likely to influence travel attitudes. The authors find that there is significant potential for uptake of sustainable travel practices in both metropolitan regions, if policy interventions are designed and targeted in accordance with groupspecific needs and preferences and respond to local conditions of mobility culture. The authors identify such interventions for each segment and region and conclude that comparative assessment of attitudinal, alongside geographical, characteristics of metropolitan travellers can provide better strategic input for realistic scenario-building and ex-ante assessment of sustainable transport policy.

Kaplan, S., F. Manca, T. A. S. Nielsen and C. G. Prato (2015). "***Applying the Theory of Planned Behavior to Understand the Intentions to Use Bike-Sharing for Holiday Cycling***"

<sup>^</sup><http://docs.trb.org/prp/15-0936.pdf> <http://trid.trb.org/view/1336855>

This study explored the behavioral factors underlying tourist intentions to use urban bike-sharing for recreational cycling while on holiday. The analytical framework relied on the Theory of Planned Behavior relating tourist intentions to pro-cycling attitudes, interest in bicycle technology, pro-cycling subjective norms and perceived cycling ease. The case-study focused on the new bike-sharing system in Copenhagen (Denmark) and questioned 655 potential tourists about a hypothetical holiday scenario. Structural equation models revealed: (i) the great interest in using bike-sharing, frequently and for multiple purposes; (ii) the relation between holiday cycling and living in a cycling-friendly country, past cycling experience and habitual mode choice; (iii) the appeal of electric bicycles to tourists with high interest in bicycle technology, low perceived cycling ease and weak pro-cycling norms; (iv) the relation between frequent and multipurpose cycling intentions and stronger pro-cycling attitudes and norms, and greater perceived likelihood that the holiday partners would cycle.

Li, L., J. Xiong, A. Chen, S. Zhao and Z. Dong (2015). "***Key Strategies for Improving Public Transportation Based on Planned Behavior Theory: Case Study in Shanghai, China.***" *Journal of Urban Planning and Development* **141**(2): Content ID 04014019.

[http://dx.doi.org/10.1061/\(ASCE\)UP.1943-5444.0000203](http://dx.doi.org/10.1061/(ASCE)UP.1943-5444.0000203)

To advance public transportation development, it should be explored from the perspective of behavioral analysis. This paper adopts the theory of planned behavior (TPB) to study public transportation choice behaviors. The first aim is to explore the necessity of dividing subjective norms into an injunctive norm and a descriptive norm and to explore their roles in predicting behaviors. The second aim is to investigate the mechanism related to several key variables and their role in forming the intention to take transit. The third aim is to develop appropriate improvement strategies through the analysis of behavior, subjective norms, or perceived control beliefs. Empirical data were collected by distributing online and hard-copy questionnaires in Shanghai, China. A sample of 393 valid questionnaires was collected. An ordinal regression model was constructed based on the empirical data. The results reveal that TPB can be applied to explain choice behaviors with respect to public transport. Among the factors affecting travelers' intentions, attitude toward public transport is most decisive. Descriptive norms seem to have more direct effects on public transport use behaviors on the basis of the correlation coefficients. Injunctive norms, at least in this case, have a more obvious influence on travelers' intention to take public transport than do descriptive norms. Furthermore, on the basis of belief analysis, some critical approaches to improving the competitiveness of Shanghai public transportation are proposed that can be used to develop people-oriented public transportation policies and strategies in other similar cities.

Mokhtarian, P. L., I. Salomon and M. E. Singer (2015). "***What Moves Us? An Interdisciplinary Exploration of Reasons for Traveling.***" *Transport Reviews* **35**(3): 250-274.

10.1080/01441647.2015.1013076

We review a number of theories of motivation, and typologies of motivations, in psychological theory and in application to a variety of specific contexts, including shopping,

eating, leisure, tourism, and travel. A recurring theme is the distinction between extrinsic (instrumental, utilitarian, functional) and intrinsic (autotelic, hedonic, experiential) motivations. We suggest that travel is a behavior to which intrinsic motivations apply, and that focusing exclusively on the extrinsic motivations to travel runs the risk of substantially underestimating the demand for travel, and the resistance to policies attempting to reduce it or to technologies (notably, information and communication technologies) expected to (partly) replace it. We offer a number of suggestions for improving standard travel surveys to help obtain the data needed to explore intrinsic motivations more fully. As better data become available, travel behavior models can be refined to partly account for such motivations. We believe that the resulting insights will be extremely valuable to policy-makers, planners, and behavioral scholars. © 2015, © 2015 Taylor & Francis.

Osman Idris, A., K. M. N. Habib, A. Tudela and A. Shalaby (2015). ***"Investigating the effects of psychological factors on commuting mode choice behaviour."*** Transportation Planning and Technology **38**(3): 265-276.

This paper utilizes socio-psychometric survey data to investigate the influence of attitudes, affective appraisal and habit formation on commuting mode choice. The data-set was collected in 2009–2010 in Edmonton, Alberta. In addition to conventional socio-economic, demographic and modal attributes, the survey gathered psychological information regarding habitual behaviour, affective appraisal and personal attitudes. Different psychometric tools were used to capture psychological factors affecting mode choice. Habitual behaviour was measured using Verplanken's response-frequency questionnaire. Affective appraisal was indirectly estimated using the Osgood's semantic differential. Five-point Likert scales were used to measure attitude. The structural equation modelling (SEM) approach was used to investigate the effects of psychological factors on mode choice behaviour. SEM captures the latent nature of psychological factors and uses path diagrams to identify the directionality as well as intensity of the relationships. The investigation reveals that passengers have positive emotions towards their chosen mode. Further, evidence of the superiority of the car as a travel alternative was established in terms of strong habit towards it, such that passengers would use the car for almost every single trip. © 2015, © 2015 Taylor & Francis.

Şimşekoğlu, T., T. Nordfjærn and T. Rundmo (2015). ***"The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public."*** Transport Policy **42**: 113-120. 10.1016/j.tranpol.2015.05.019 <http://www.scopus.com/inward/record.url?eid=2-s2.0->

The present study aims to identify clusters of transport users and to examine the role of transport priorities, travel mode use attitudes, and car use habit on travel mode use. An additional aim is to test whether such factors predict intentions to use public transport and reported use of public transport. Data were collected via a self-completion questionnaire survey conducted in June and August 2013. Participants included a total of 1039 people who were randomly selected from the urban regions of Norway using the Norwegian population registry. Due to missing data on travel mode use variables the analyses were conducted with 546 observed cases. Two clusters of transport users were identified; individuals who primarily use public and health-promoting transport (e.g. public transportation users, bicyclists) and car users. Logistic regression analysis showed that



older age, strength of the car use habit, and priorities of flexibility (e.g. prioritize being able to choose the exact time of travel) increased the odds of car use. Structural Equation Modeling showed that priority of convenience, priority of safety and security, and favorable attitudes towards public transport use were positive predictors of intentions to use public transportation, while car use habit was a negative predictor of both intentions to use public transportation and reported public transportation use. Traffic safety campaigns aiming to increase public transportation use in the urban Norwegian public could focus on increasing the attractiveness of public transport, particularly by improving flexibility of such transport. © 2015 Elsevier Ltd.

Donald, I. J., S. R. Cooper and S. M. Conchie (2014). ***"An extended theory of planned behaviour model of the psychological factors affecting commuters' transport mode use."*** *Journal of Environmental Psychology* **40**: 39-48. 10.1016/j.jenvp.2014.03.003  
<http://www.scopus.com/inward/record.url?eid=2-s2.0->

The present study tested an extended theory of planned behaviour (TPB) model within the domain of transport mode choice and identified the most important factors impacting on whether participants drove or used public transport to commute to work. Structural equation modelling of data from 827 participants showed that car use was determined by intention and habit but not perceived behavioural control (PBC), whereas public transport use was influenced solely by intention. The analysis also revealed that TPB variables (attitude, subjective norm and PBC) influenced use of both transport modes indirectly through their effects on intention and habit. In contrast, the incremental validity of variables not contained in the model (moral norm, descriptive norm and environmental concern) was mixed and varied according to transport mode. Theoretical and applied implications of the findings are discussed. © 2014 Elsevier Ltd.

Outwater, M. L., B. Sana, N. Ferdous, W. Woodford, C. Bhat, R. Sidharthan, R. Pendyala and S. Hess (2014). ***"TCRP H-37 Characteristics of Premium Transit Services That Affect Mode Choice: Key Findings and Results"***. Transportation Research Board 93rd Annual Meeting

This research seeks to improve the understanding of the full range of determinants for mode choice behavior and to offer practical solutions to practitioners on representing and distinguishing these characteristics in travel demand forecasting models. The principal findings are that awareness and consideration of transit services is significantly different than the perfect awareness and consideration of all modes which is an underlying assumption of mode choice and forecasting models. Furthermore, inclusion of non-traditional transit attributes and attitudes can maintain or improve the ability of mode choice models to predict the usage of premium transit modes while reducing the weight on modal constants that vary between transit sub-modes. Additional methods and analyses are necessary to bring these results into practice. This paper focuses on the key findings and results of the research of the value of non-traditional transit service attributes on modal choice, the influence of awareness and consideration of transit service on modal alternatives, and the importance of traveler attitudes on both awareness and consideration of transit and on the choice of transit or auto in mode choice. The models estimated to support these findings are described, but not in detail, due to the space limitations, but are available in the Transit Cooperative Research Program H-37A Final Report. The paper also documents the findings of the implementation testing, which concludes that including path

choices and non-traditional transit service attributes in mode choice models can reduce the weight of the modal constants.

Steg, L., G. Perlaviciute, E. van der Werff and J. Lurvink (2014). ***"The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions."*** Environment and Behavior 46(2): 163-192.

This article aimed to demonstrate that hedonic values are important for understanding environmentally relevant beliefs, preferences, and actions, next to egoistic, altruistic, and biospheric values. In four studies, the authors found consistent support for their hypothesis that hedonic, egoistic, altruistic, and biospheric values can be distinguished empirically, suggesting that the distinction between the four types of values is not only theoretically meaningful but also recognized by individuals. Importantly, in line with the authors' expectations, hedonic values appeared to be significantly and negatively related to a range of environmentally relevant attitudes, preferences, and behaviors, even when the other values were controlled for. This suggests that it is indeed important to include hedonic values in environmental studies and that interventions aimed to promote proenvironmental actions should consider hedonic consequences of actions, as these may be important barriers for behavior change. © 2012 SAGE Publications.

TransitCenter and RSG-Inc. (2014). ***"Who's On Board, Mobility Attitudes Survey 2014"***

The goal of this study is a definitive understanding of the differences in attitudes and behaviors among the US population with respect to public transportation and neighborhood choice. We aim to understand which characteristics and beliefs are behind those differences. To that end, we conducted a large online survey (11,842 respondents) across 46 Metropolitan Statistical Areas (MSAs) in the United States. The selected MSAs span the full geography of the U.S. and include some cities with well-developed transit systems and others with less developed transit system. The sample also ensured minimum quotas for all age groups, allowing the study to compare different generations, geographies, and neighborhood types. The results reveal that the most important factors in determining whether someone is at least an occasional transit user are: • High population density of home neighborhood (POSITIVE EFFECT) • Being employed or a student (POSITIVE EFFECT) • Being an ethnic minority (POSITIVE EFFECT) • High-quality local transit (POSITIVE EFFECT) • High income (NEGATIVE EFFECT) Surprisingly, education level and the presence of children in the home do not appear to have a strong association with transit use either way when the other variables are controlled for. This suggests that despite high rates of transit use in college, most former students do not continue to ride transit after that experience. People with kids, meanwhile, may be just as willing as others to take transit when it is available in their neighborhoods. We are able to explore what factors generally draw people to public transportation. Travel time, reliability, and cost appear to be more important than "flashy" features like Wi-Fi. Additionally, people who are offered pretax transit commuter benefits by their employers are over five times as likely to take transit regularly as employed persons who are not receiving benefits. The large sample size allows for comparisons across geography, age group, quality of local transit, levels of transit use, levels of population density, and other characteristics. We see the most variation across age groups. Behavior changes considerably along the age spectrum, even when controlling for other factors such as employment, household income, and neighborhood type. A central



topic of this report is the behavior and attitudes of the Millennial generation as compared to older Americans. Whether the apparent change in travel preferences among Millennials is the result of a true generational change in attitudes- rather than a product of economic or social circumstances-is a topic of fierce debate. We see behavioral evidence to suggest that such a shift is indeed taking place: Parents of school-age children who are under 30 are, it appears, more likely than parents of school-age children over 30 to use public transit, even when controlling for income. In addition to the links between demographics and behavior, the study also explores how attitudes and upbringing affect one's propensity to use public transportation. Our analysis establishes a connection between deeply held values and travel behavior, contributing to the broad conversation on what motivates an individual's travel preferences. While the type of neighborhood you live in emerges as the biggest single predictor of mode-choice, personal values and attitudes have a considerable effect on travel preferences. Values influence travel choices directly as well as indirectly, through an effect on neighborhood choice. In an effort to identify distinct "types" of travelers, we use a statistical technique to group the sample into seven distinct groups based on their values and attitudes with respect to transit and housing. In particular, we identify a group of environmentally conscious, outgoing people, largely in their 30s and 40s, who are open to taking transit but find the service inconvenient or inadequate. We conclude that policymakers and transit providers could most easily increase transit ridership by focusing on this group. We also look at the role of upbringing in mode choice. Investigating the childhood circumstances and travel patterns of Millennials (defined in the report as people under 30) and Baby Boomers (over 60) leads us to a paradox: The Millennial generation seems to be defying its sheltered, suburban upbringing by delaying the acquisition of a driver's license and choosing transit. Meanwhile, Baby Boomers, who grew up using transit and were encouraged to do so, are defying their upbringing by avoiding transit now. Finally, we explore data surrounding each respondent's neighborhood type. The questionnaire asked a series of questions about the respondent's current, childhood, and ideal home locations. From this data, we are able to infer that many respondents wish they lived in mixed-use neighborhoods, towns, and suburbs, rather than the residential areas they currently occupy. We draw the conclusion that land-use and housing policy would better serve Americans if it were to favor mixed-use development.

Redman, L., M. Friman, T. Gärling and T. Hartig (2013). ***"Quality attributes of public transport that attract car users: A research review."*** *Transport Policy* 25(0): 119-127.

<http://dx.doi.org/10.1016/j.tranpol.2012.11.005>

<http://www.sciencedirect.com/science/article/pii/S0967070X12001692>

The transport sector presents contentious issues with respect to sustainable development, particularly regarding the use of private motorised vehicles in urban areas. Public transport (PT) together with cycling and walking are generally agreed to be sustainable alternatives to private car use. This paper aims to contribute to a better understanding of those aspects of PT quality most likely to attract car users. Toward achieving this aim, relevant research was sought to answer the following two questions: What quality attributes of PT services are attractive to users? And what changes in quality attributes of PT services would encourage modal shift from private motor vehicles to PT? Using a qualitative systematic review, it is concluded that while service reliability and frequency are important PT attributes in general, those attributes most effective in attracting car users are largely

affective and connected to individual perceptions, motivations and contexts. Reduced fare promotions and other habit-interrupting transport policy measures can succeed in encouraging car users to try PT services initially. Attributes over and above basic accessibility, reliability and mobility provision, perceived by the target market as important service attributes, must then be provided in sustaining the switch from car use after promotional tactics have expired.

Spears, S., D. Houston and M. G. Boarnet (2013). ***"Illuminating the unseen in transit use: A framework for examining the effect of attitudes and perceptions on travel behavior."*** Transportation Research Part A: Policy and Practice **58**: 40-53.

This study develops the Perception–Intention–Adaptation (PIA) framework to examine the role of attitudes, perceptions, and norms in public transportation ridership. The PIA framework is then applied to understand the relative importance of socio-demographic, built environment, transit service, and socio-psychological factors on public transit use for 279 residents of south Los Angeles, California, a predominately low-income, non-white neighborhood. Confirmatory factor analysis based on 21 survey items resulted in six transit-relevant socio-psychological factors which were used in regression models of two measures of transit use: the probability of using transit at least once in the 7-day observation period, and the mean number of daily transit trips. Our analysis indicates that two PIA constructs, attitudes toward public transportation and concerns about personal safety, significantly improved the model fit and were robust predictors of transit use, independent of built environment factors such as near-residence street network connectivity and transit service level. Results indicate the need for combined policy approaches to increasing transit use that not only enhance transit access, but also target attitudes about transit service and perceptions of crime on transit.

Zou, F., B. Wu, J. Xiong and L. Li (2013). ***"Analyzing Public Transportation Competitiveness Based on the Theory of Planned Behavior"***. <http://dx.doi.org/10.1061/9780784413159.455>

This paper aims to improve the competitiveness of public transportation by exploring the psychological factors influencing public transport use behavior based on the theory of planned behavior (TPB). TPB direct variables like intention, attitude, subjective norm, descriptive norm, perceived behavioral control, and indirect variables like behavioral beliefs are included in the questionnaires. First, the authors constructed an ordered logit model with dependent variable intention and other independent variables for the 282 questionnaires of which people who don't have private cars, finding that factors like attitude and subjective norm are significant, but descriptive norm and perceived behavioral control have not entered the model. It is indicated that changing people's attitude toward bus and guiding the residents to choose public transit through family guidance or policy of the country, public transportation competitiveness can be highly improved. Second, 111 questionnaires of people who have private cars were analyzed. The results reveal that only attitude is significant in the model, indicating that these people who own private cars are more influenced by subjective attitude instead of objective condition when using buses. Therefore, transferring these potential passengers to public transport by providing them better services is possible. According to the further analysis of behavior beliefs, the authors find that increasing public transport's punctuality, convenience, and speed instead of reducing costs are the key strategies to enhance public transportation competitiveness.

Wang, T. and C. Chen (2012). ***"Attitudes, mode switching behavior, and the built environment: A longitudinal study in the Puget Sound Region."*** *Transportation Research Part A: Policy and Practice* **46**(10): pp 1594-1607. <http://dx.doi.org/10.1016/j.tra.2012.08.001>

Carpooling in the US has a storied history. After experiencing a peak 20% mode share in 1980, the current share of carpooling for work trips is about 10% and the majority of these carpooling trips are made by intrahousehold members. Casting the choice between single occupant vehicles (SOV) and carpool as a social dilemma in which SOV is a noncooperative choice and carpool is a cooperative one, the authors propose to test two hypotheses. First, the switch from SOV to carpool and the reverse choice are attributed to different factors' structural factors, or those factors altering the objective features of a decision scenario such as travel time and travel cost, play a dominant role in the switch from carpool to SOV while psychosocial factors (attitudes and beliefs) play a critical role in the switch from SOV to carpool. Second, the two choices are underlay by different behavioral mechanisms. In particular, the authors expect self-justification by carpool-to-SOV switchers - after they switch from carpool to SOV, they adjusted their attitudes toward carpool accordingly to match their behavior. The analysis of the first three waves of the Puget Sound Transportation Panel supports these two hypotheses. The study results recommend developing programs and policies that aim at influencing people's subjective assessments of carpooling, in addition to the existing ones that mostly focus on incentivizing carpooling, and differentiating between programs seeking to encourage SOV users to switch to carpool and those aiming to maintain existing carpoolers.

Dong, Z., L. Li, B. Wu and S. Zhao (2011). ***"Analyzing Public Transportation Use Behavior Based on the Theory of Planned Behavior: To What Extent Does Attitude Explain the Behavior?"*** ICCTP 2011, 11th International Conference of Chinese Transportation Professionals (ICCTP) Nanjing, China August 14-17, 2011.

Based on the theory of planned behavior (TPB) and its approach of investigation, this paper explores the psychological factors influencing public transport use behavior. Questionnaires containing TPB variables such as intention, attitude, subjective norm and perceived behavioral control are designed and SPSS is used to analyze the relationships among the variables. Correlation analysis and regression models show TPB can well explain public transport use. The behavior is positively correlated with intention and attitude and high coefficients are obtained by regression. People with more positive attitudes will have higher intention and be more inclined to use public transport. Attitude is then actively affected by speed, freedom, convenience and other qualities of a travel mode. The conclusions can help transport planning and management to better understand travelers' behaviors and psychological demands and then formulate corresponding policies so as to enhance the competitiveness of public transport.

Popuri, Y., K. Proussaloglou, C. Ayvalik, F. S. Koppelman and A. Lee (2011). ***"Importance of Traveler Attitudes in the Choice of Public Transportation to Work: Findings from the Regional Transportation Authority (RTA) Attitudinal Survey"***. <http://trid.trb.org/view/1091696>

The commute mode choice decision is one of the most fundamental aspects of daily travel. Although initial research in this area was limited to explaining mode choice behavior as a function of traveler socioeconomics, travel times, and costs, subsequent studies have included the effect of traveler attitudes and perceptions. This paper extends the existing

body of literature by examining public transit choice in the Chicago area. Data from a recent Attitudinal Survey conducted by the Regional Transportation Authority (RTA) in Northeastern Illinois were used to pursue three major steps. First, a factor analysis methodology was used to condense scores on 23 attitude statements related to daily travel into six factors. Second, the factor scores on these six dimensions were used in conjunction with traveler socio-economics, travel times, and costs to estimate a binary logistic regression of public transit choice. Third, elasticities of transit choice to the six factors were computed, and the factors were ranked in decreasing order of these elasticities. The analysis provided two major findings. First, from a statistical standpoint, the attitude factors improved the intuitiveness and goodness-of-fit of the model. Second, from a policy standpoint, the analysis indicated the importance of word-of-mouth publicity in attracting new riders, as well as the need for a marketing message that emphasizes the lower stress-level and better commute time productivity due to transit use.

Van Acker, V., P. Mokhtarian and F. Witlox (2011). ***"Going soft: on how subjective variables explain modal choices for leisure travel."*** European Journal of Transport and Infrastructure Research 11(2): 115-146.

<http://hdl.handle.net/1854/LU-1849426>

Most studies on the link between the built environment and modal choice characterize and model this relationship by objectively measurable characteristics such as density and diversity. Recently, within the debate on residential self-selection, attention has also been paid to the importance of subjective influences such as the individual's perception of the built environment and his/her residential attitudes and preferences, resulting in models that take account of both the objective and subjective characteristics of the built environment. However, self-selection might occur on other points than residential location as well. Expanding the analysis to also include both objective and subjective characteristics at other model levels (i.e., not only stage of life characteristics but also personal lifestyles; not only car availability but also travel attitudes, not only modal choice but also mode specific attitudes) is the purpose of this paper. To this end, a modal choice model for leisure trips is developed using data on personal lifestyles and attitudes, collected via an Internet survey, and estimated using a path model consisting of a set of simultaneous estimated equations between observed variables. While controlling for subjective lifestyles and attitudes, the effects of the built environment and car availability on modal choice can correctly be determined and thus insights into selfselection mechanisms can be gained. Moreover, we compared the results of a model with and without these subjective influences. The results show that subjective characteristics at various model levels are important decisive factors of modal choices for leisure travel.

Zhao, S., L. Li, Z. Dong and B. Wu (2011). ***"Analyzing Public Transportation Use Behavior Based on the Theory of Planned Behavior: To What Extent Does Attitude Explain the Behavior?"***

Based on the theory of planned behavior (TPB) and its approach of investigation, this paper explores the psychological factors influencing public transport use behavior. Questionnaires containing TPB variables such as intention, attitude, subjective norm and perceived behavioral control are designed and SPSS is used to analyze the relationships among the variables. Correlation analysis and regression models show TPB can well explain public transport use. The behavior is positively correlated with intention and attitude and high

coefficients are obtained by regression. People with more positive attitudes will have higher intention and be more inclined to use public transport. Attitude is then actively affected by speed, freedom, convenience and other qualities of a travel mode. The conclusions can help transport planning and management to better understand travelers' behaviors and psychological demands and then formulate corresponding policies so as to enhance the competitiveness of public transport.

Farag, S. and G. Lyons (2010). ***"Explaining Public Transport Information Use When a Car is Available: Attitude Theory Empirically Investigated."*** *Transportation* 37(6): pp 897-913.

Regions are investing significant resources in public transportation information services. However, many members of the traveling public are not using the available information services. This paper uses attitude theory to investigate the use or nonuse of public transport information. A mail survey was sent to a random sample of 10,000 households in Bristol and Manchester, UK, with a response rate of 13%. Respondents were asked about an uncertain journey they were going to make. Data collected mainly pertained to rail travel for an inter-urban trip. Structural equation modeling was used to investigate interdependencies among the factors studied. The results show that the desire to consult public transport information for an uncertain journey is affected by attitudes, subjective norms, and past behavior. These social-psychological factors are in turn affected by constraints such as travel behavior and trip context. Preferred mode of transport prior to consulting information was found to be a very important determinant of looking up public transportation information when planning an uncertain journey. These findings indicate that the stimulation of public transportation use and information use should go together rather than seeing the increased use of information as a means to stimulate greater public transportation use.

Fishbein, M. and I. Ajzen (2010). ***Predicting and Changing Behavior: The Reasoned Action Approach.*** Psychology Press

This book describes the reasoned action approach, an integrative framework for the prediction and change of human social behavior. It provides an up-to-date review of relevant research, discusses critical issues related to the reasoned action framework, and provides methodological and conceptual tools for the prediction and explanation of social behavior and for designing behavior change interventions. Categories: Applied Social Psychology, Health Psychology, Consumer Psychology. Chapters: 1. Introduction. 2. Defining and Predicting Behavior. 3. Attitudes and Their Determinants. 4. Perceived Norms and their Determinants. 5. Perceived Behavioral Control and its Determinants. 6. Attitudes, Norms and Control as Predictors of Intentions and Behavior. 7. General Attitudes and the Prediction of Behavior. 8. Challenges to the Reasoned Action Approach. 9. Changing Behavior: Theoretical Considerations. 10. Changing Behavior: Sample Interventions. 11. Conclusion

Holz-Rau, C. and J. Scheiner (2010). ***"Travel mode choice: affected by objective or subjective determinants?"*** *Transportation* 34(4): 487-511.

The contribution presents theoretical considerations concerning the connections between life situation, lifestyle, choice of residential location and travel behaviour, as well as empirical results of structural equation models. The analyses are based on data resulting from a survey in seven study areas in the region of Cologne. The results indicate that

lifestyles influence mode choice, although just slightly, even when life situation is controlled for. The influence of life situation on mode choice exceeds the influence of lifestyle. The influence which lifestyle and in parts also life situation have on mode choice is primarily mediated by specific location attitudes and location decisions that influence mode choice, likewise. Here objective spatial conditions as well as subjective location attitudes are important.

Van Acker, V., B. Van Wee and F. Witlox (2010). ***"When transport geography meets social psychology: Toward a conceptual model of travel behaviour."*** Transport Reviews 30(2): 219-240.

Many studies model the effects of the built environment on travel behaviour. Usually, results are controlled for socio-economic differences and sometimes socio-psychological differences among respondents. However, these studies do not mention why after all a relationship should exist between travel behaviour and spatial, socio-economic and personality characteristics. Answering this query involves combining and linking theories stemming from transport geography (e.g. time geography, activity-based approach) and social psychology (e.g. Theory of Planned Behaviour, Theory of Repeated Behaviour). Using key-variables from these theories, this paper aims to develop a conceptual model for travel behaviour. Comparable to customary theories in transport geography, this conceptual model considers travel behaviour as derived from locational behaviour and activity behaviour. But the conceptual model adds concepts such as 'lifestyle', 'perceptions', 'attitudes' and 'preferences' which indirectly influence travel behaviour.

Ory, D. and P. Mokhtarian (2009). ***"Modeling the structural relationships among short-distance travel amounts, perceptions, affections, and desires."*** Transportation Research Part A: Policy and Practice 43(1): 26-43.

Using structural equation modeling, the relationships among travel amounts, perceptions, affections, and desires across five short-distance (one-way trips of less than 100 miles) travel categories (overall, commute, work/school-related, entertainment/social/recreation, and personal vehicle) are examined. The models are estimated using data collected in 1998 from more than 1300 working commuters in the San Francisco Bay Area. A cross-model analysis reveals three robust relationships, namely: (1) myriad measures of travel amounts work together to affect perceptions; (2) perceptions are consistently important in shaping desires; and (3) affections have a positive relationship with desires. The second finding suggests that two individuals who travel the same objective amount may not have the same desire to reduce their travel: how much individuals perceive their travel to be is important. The third point argues that the degree to which travel is enjoyed is a key determinant of shaping desires to reduce travel: the more travel is enjoyed, the less the desire to reduce it.

Fielding, K. S., R. McDonald and W. R. Louis (2008). ***"Theory of planned behaviour, identity and intentions to engage in environmental activism."*** Journal of Environmental Psychology 28(4): 318-326.

This study incorporated identity constructs into the theory of planned behaviour (TPB) to investigate intentions to engage in environmental activism. First year students and participants of a students of sustainability conference (n=169) were administered a questionnaire survey that measured standard TPB constructs as well as environmental group membership and self-identity as an environmental activist. Consistent with

predictions, environmental group membership and self-identity were positive predictors of intentions. Thus, greater involvement in environmental groups and a stronger sense of the self as an environmental activist were associated with stronger intentions to engage in environmental activism. There was also evidence that self-identity was a stronger predictor of intentions for participants with low rather than high environmental group membership. In accordance with the standard TPB model, participants with more positive attitudes toward and a greater sense of normative support for environmental activism also had greater intentions to engage in the behaviour. The implications for groups seeking to harness support for activities to protect the environment are discussed.

Gardner, B. and C. Abraham (2008). ***"Psychological correlates of car use: A meta-analysis."*** *Transportation Research Part F: Traffic Psychology and Behaviour* 11(4): 300-311.

This meta-analysis synthesised quantitative research into potentially modifiable psychological correlates of car use and intentions to drive. Online psychology and transportation databases were searched, and inclusion criteria applied to potentially relevant records. An ancestry approach was also employed to search selected publications. Meta-analyses of effect size were performed on 23 unique study datasets. Results generally supported the predictive utility of variables derived from the Theory of Planned Behaviour, though cognitions towards not driving displayed uniformly larger effects than were observed for car use cognitions. There was also a strong effect of habit on behaviour. Support for effects of pro-environment cognitions on driving was weak. However, a dearth of available evidence limited our findings and precludes development of clear evidence-based recommendations for intervention design. Directions for future research are discussed.

Karash, K. H., M. A. Coogan, T. J. Adler, C. Cluett, S. A. Shaheen, I. Aizen, and M. Simon. (2008). ***TCRP Report 123: Understanding how individuals make travel and location decisions: Implications for public transportation.*** Washington, D.C.: Transportation Research Board of the National Academies. <http://www.trb.org/Publications/Blurbs/159638.aspx>.

This report explores a broader social context for individual decision making related to residential location and travel behavior and consequently will be of interest to planners, researchers, transit managers, and decision makers. The findings from this research contribute to efforts to predict mode choice and how to influence it through better policies and design, education, and communication.

Rhindress, M., F. Lynch, S. Bregman, R. E. Reichman, N. J. Coopersmith and J. A. Dunning (2008). ***"TCRP Report 122: Understanding How to Motivate Communities to Support and Ride Public Transportation"*** The National Academies Press

TCRP Report 122: Understanding How to Motivate Communities to Support and Ride Public Transportation provides a comprehensive discussion on the methods and strategies used by public transportation agencies in the United States and Canada to enhance their public images and motivate the support and use of public transportation. Additionally, the report identifies and describes methods and strategies used by other industries (comparable to public transportation) to enhance their public image and to motivate the support and use of their products and services. Also, this report examines the perceptions, misperceptions, and use of public transit, and the extent to which these affect support. Finally, the report identifies effective communication strategies, campaigns, and platforms for motivating



individuals to action in support of public transportation, and it recommends ways to execute those communication strategies, campaigns, and platforms. This report will be helpful to transit agencies; elected officials; community leaders; business leaders; and federal, state, and local funding agencies in both the United States and Canada.

Haustein, S. and M. Hunecke (2007). ***"Reduced Use of Environmentally Friendly Modes of Transportation Caused by Perceived Mobility Necessities: An Extension of the Theory of Planned Behavior."*** Journal of Applied Social Psychology 37(8): 1856-1883.

An extended version of the theory of planned behavior (TPB; Ajzen, 1991) was used to explain travel mode choice. As a new predictor, perceived mobility necessities (PMNs) were introduced, which are defined as people's perceptions of mobility-related consequences of their personal living circumstances. The database consisted of a survey of 1,545 car users in 3 large German cities. Using structural equation modeling, PMNs were integrated into TPB and showed the expected significant negative effect on use of environmentally friendly modes. In-depth interviews with 82 selected participants indicated that PMN moderates the relationship between public transportation attitude and intention. This moderator effect was confirmed by a regression analysis. The extension of TPB by PMN allows deduction of more differentiated intervention strategies.

Hunecke, M., S. Haustein, S. Grischkat and S. Böhler (2007). ***"Psychological, sociodemographic, and infrastructural factors as determinants of ecological impact caused by mobility behavior."*** Journal of Environmental Psychology 27(4): 277-292. 10.1016/j.jenvp.2007.08.001

In this study, the relevance of psychological variables as predictors of the ecological impact of mobility behavior was investigated in relation to infrastructural and sociodemographic variables. The database consisted of a survey of 1991 inhabitants of three large German cities. In standardized interviews attitudinal factors based on the theory of planned behavior, further mobility-related attitude dimensions, sociodemographic and infrastructural characteristics as well as mobility behavior were measured. Based on the behavior measurement the ecological impact of mobility behavior was individually assessed for all participants of the study. In a regression analysis with ecological impact as dependent variable, sociodemographic and psychological variables were the strongest predictors, whereas infrastructural variables were of minor relevance. This result puts findings of other environmental studies into question which indicate that psychological variables only influence intent-oriented behavior, whereas impact-oriented behavior is mainly determined by sociodemographic and household variables. The design of effective intervention programs to reduce the ecological impact of mobility behavior requires knowledge about the determinants of mobility-related ecological impact, which are primarily the use of private motorized modes and the traveled distances. Separate regression analyses for these two variables provided detailed information about starting points to reduce the ecological impact of mobility behavior. © 2007 Elsevier Ltd. All rights reserved.

Rhodes, R. E., S. G. Brown and C. A. McIntyre (2006). ***"Integrating the perceived neighborhood environment and the theory of planned behavior when predicting walking in a Canadian adult sample."*** Am J Health Promot 21(2): 110-118.

PURPOSE: To integrate the characteristics of the perceived environment with the theory of planned behavior (TPB) to determine (1) whether the TPB mediates relations among

environmental characteristics and walking, and (2) whether the environment moderates TPB-walking relations. DESIGN: Cross-sectional. SETTING: South Vancouver Island, British Columbia, Canada. SUBJECTS: Random sample of 351 adults (36% response rate). MEASURES: Participants completed measures of the perceived neighborhood environment, the TPB, and walking behavior that was assessed using an adapted Godin leisure time questionnaire. RESULTS: Results using structural equation modeling indicated that the TPB mediated the environment-walking relationship. Specifically, retail land-mix use and neighborhood aesthetics were associated with walking through affective and instrumental attitudes. Results using moderated regression analyses showed that recreation land-mix use moderated the intention-behavior relationship, with those individuals who perceived closer access to recreation facilities having a larger intention-behavior relationship. A significant moderating effect for crime on the instrumental attitude-intention relationship was also identified, but the effect size was small to trivial. CONCLUSIONS: These results suggest that the perceived neighborhood may influence walking through attitudes and may also influence the intention-behavior gap. Prospective studies using objective walking and environment data are required to improve the veracity of the findings and to identify possible causal relationships.

Vredin Johansson, M., T. Heldt and P. Johansson (2006). ***"The effects of attitudes and personality traits on mode choice."*** Transp Res Part A.

We hypothesise that differences in people's attitudes and personality traits lead them to attribute varying importance to environmental considerations, safety, comfort, convenience and flexibility. Differences in personality traits can be revealed not only in the individuals choice of transport, but also in other actions of their everyday lives—such as how much they recycle, whether they take precautions or avoid dangerous pursuits. Conditioning on a set of exogenous individual characteristics, we use indicators of attitudes and personality traits to form latent variables for inclusion in an, otherwise standard, discrete mode choice model. With a sample of Swedish commuters, we find that both attitudes towards flexibility and comfort, as well as being pro-environmentally inclined, influence the individual's choice of mode. Although modal time and cost still are important, it follows that there are other ways, apart from economic incentives, to attract individuals to the, from society's perspective, desirable public modes of transport. Our results should provide useful information to policy-makers and transportation planners developing sustainable transportation systems. \_ 2005 Elsevier Ltd. All rights reserved.

Anable, J. and B. Gatersleben (2005). ***"All work and no play? The role of instrumental and affective factors in work and leisure journeys by different travel modes."*** Transportation Research Part A: Policy and Practice 39(2–3): 163-181

This paper examines the relative importance that people attach to various instrumental and affective journey attributes when travelling either for work or for a leisure day trip and presents how journeys by various travel modes score on these attributes. Although not a comparative paper, data are presented for two studies which used some identical measurements: one on commuter journeys and one on leisure journeys. The results show that for work journeys, respondents tend to attach more importance to instrumental aspects, and especially to convenience than to affective factors. For leisure journeys, however, respondents appear to attach almost equal importance to instrumental and

affective aspects, particularly flexibility, convenience, relaxation, a sense of freedom and 'no stress'. Each study also examines (i) how regular users' evaluate their own mode and (ii) how car users perceive the performance of alternative modes compared to their importance ratings. This 'gap' analysis reveals on which modes and for which attributes the greatest deficiencies in performance lie. The data for both the work and leisure studies shows that for car users, alternative transport modes are inferior on the salient attributes such as convenience and flexibility even though car users rate modes such as walking and cycling as performing well, if not better, on less important attributes such as the environment, health and even excitement. Nevertheless, for those who cycle and walk regularly, satisfaction with their own travel mode as measured by the gap between importance and performance on salient attributes is better than for those who mostly use the car. Conclusions are made as to how greater attention to affective factors may improve our understanding of mode choice.

Collins, C. M. and S. M. Chambers (2005). ***"Psychological and situational influences on commuter-transport-mode choice."*** *Environment and Behavior* 37(5): 640-661.

The relative importance and relationship between psychological and situational factors in predicting commuter-transport-mode choice was tested by four hypotheses. First, the influence of individuals' values on commuter behavior is mediated by their corresponding beliefs about the environmental threat of cars (mediation hypothesis). Second, the influence of these beliefs on behavior is moderated by individual consideration of future consequences and control beliefs (moderation hypothesis). Third, cost, time, and access factors contribute to individuals' commuter choice (situational hypothesis). Fourth, situational and psychological factors jointly influence proenvironmental behavior (interaction hypothesis). A sample of 205 Australian university students completed a survey to measure these relationships. Regression analyses indicated support for the mediation, situational, and interaction hypotheses. It was concluded that to achieve a transport-mode shift to public transport, public policy strategies should focus on individuals' transport-related environmental beliefs (personal control and environmental effect of cars) and situations (access to public transport at reduced cost).

Hilliam, A. and J. Farrington (2005). ***"Using behavioural psychology to plan, market and manage transport."***

Prior to mass car ownership, viable public transport services could be provided in most rural areas. With car ownership and use increasingly being the first choice of even elderly people, those households which depend on public transport are finding themselves unable to access essential services and facilities. Traditional methods of transport delivery are decreasingly successful, with unsustainable rural bus subsidies failing to meet the needs of the population. New approaches are emerging with systems that are more demand responsive. The CO-OPERATE project was funded under the UK Future Integrated Transport Research programme managed by the Department for Transport, to identify techniques to foster joint working between users and providers. This paper describes the CO-OPERATE approach and in particular how personal construct psychology techniques were adapted for use in the transport sector to help stimulate attitude change and manage behaviour change. To test the emerging techniques a pilot area was used in North East Scotland to analyse user perceptions within a situation of change in rural transport management. From this basis, the research developed a toolkit which has the potential to be

applied across Europe for involving more stakeholders in improving rural accessibility. The research also identified areas where organisational culture change, developments in administration and funding, enhancements in marketing, routes to increase understanding of local perceptions of public transport, and stimulation of local and community based initiatives can all be used to build bridges to co-operation between stakeholders to enhance service delivery. For the covering abstract please see ITRD E135207.

Bamberg, S., I. Ajzen and P. Schmidt (2003). ***"Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action."*** Basic and applied social psychology 25(3): 175-187.

Relying on the theory of planned behavior (Ajzen, 1991), a longitudinal study investigated the effects of an intervention-introduction of a prepaid bus ticket-on increased bus use among college students. In this context, the logic of the proposition that past behavior is the best predictor of later behavior was also examined. The intervention was found to influence attitudes toward bus use, subjective norms, and perceptions of behavioral control and, consistent with the theory, to affect intentions and behavior in the desired direction. Furthermore, the theory afforded accurate prediction of intention and behavior both before and after the intervention. In contrast, a measure of past behavior improved prediction of travel mode prior to the intervention, but lost its predictive utility for behavior following the intervention. In a test of the proposition that the effect of past on later behavior is due to habit formation, an independent measure of habit failed to mediate the effects of past on later behavior. It is concluded that choice of travel mode is largely a reasoned decision; that this decision can be affected by interventions that produce change in attitudes, subjective norms, and perceptions of behavioral control; and that past travel choice contributes to the prediction of later behavior only if circumstances remain relatively stable.

Heath, Y. and R. Gifford (2002 ). ***"Extending the Theory of Planned Behavior: Predicting the Use of Public Transportation."*** Journal of Applied Social Psychology, 32, 10,: 2154-2189.

An expanded version of the theory of planned behavior (TPB) was used to predict and explain public transportation use. A pre-post design was used to examine changes in university students' bus ridership after the implementation of a universal bus pass (U-pass) program. Bus ridership significantly increased after the U-pass was implemented and associated changes in attitudes and beliefs about transportation modes were found. In both phases, students' public transportation use was well predicted by the original TPB. However, two additional constructs-a descriptive norm. and the interaction between intention and perceived behavioral control~~~significantly improved prediction in both phases of the study. These constructs might be useful additions to the original TPB, at least in this behavioral domain.

Hunecke, M., A. Blöbaum, E. Matthies and R. Höger (2001). ***"Responsibility and Environment: Ecological Norm Orientation and External Factors in the Domain of Travel Mode Choice Behavior."*** Environment and Behavior 33(6): 830-852.

In the domain of travel mode choice behavior, the interaction between ecological norm orientation and the external aspects "fare" and "subway station range" was investigated in an experimental field study. The ecological norm orientation is conceptualized based on the Schwartz theory on altruistic behavior, which is then applied to the environmental context. In a random sample of 160 persons, fare was experimentally manipulated by distributing

free public transport tickets, whereas the station range was varied by selecting test participants at different distances from a station. Within the norm activation model, the mobility-specific personal ecological norm proves to be the strongest predictor of travel mode choice as recorded in standardized questionnaires. Reducing the fare by distributing free tickets has a quantitatively similar effect. The results suggest that the “economy-plus-moral” formula best describes the fact that the integrative mechanism (external factor fare plus normative ecological orientation) is the determinant of travel mode choice.

Wirthlin-Worldwide and FJCANDN (2000). ***TRCRP 63: Enhancing the Visibility and Image of Transit in the United States and Canada*** TCRP

As population increases, streets and highways become more congested, and natural resources grow more precious, it will become increasingly important to realize the full economic and environmental efficiencies of transit (defined as publicly sponsored bus and rail transit services) in order to maintain a high level of mobility and livability in communities. To achieve full potential, public support for and use of transit are essential. Currently, transit has an image problem, and unless the general public's perception of transit is improved, the necessary public support for and use of transit is in question. In response to this concern, transit organizations at the national, regional, and local levels are contemplating the development of campaigns to enhance the visibility and image of transit. To date, significant research has been completed to define the general public's perceptions of transit, to better understand the reasons for these perceptions, and to identify major motivators and barriers to using transit. In order to develop potential visibility and image campaigns, additional research was needed to develop effective messages that build an emotional connection with key target markets, and to develop a series of strategic approaches and tactics that could be implemented nationally, regionally, or locally by transit systems of various sizes as part of such campaigns. Under TCRP Projects B-20 and B-20A, research was undertaken by Wirthlin Worldwide and FJCANDN to provide guidance to national, regional, and local organizations interested in initiating campaigns to enhance the visibility and image of transit through value shifts that will improve the perceptions of transit among the general public, and appropriate target audiences.

Aarts, H., B. Verplanken and A. Van Knippenberg (1997). ***"Habit and information use in travel mode choices."*** *Acta Psychologica* 96(1): 1-14.

This study focuses on the role of habit in the process of information use underlying daily travel mode choices. Based on the ‘policy capturing’ paradigm, eighty-two students performed a multiattribute travel mode judgment task, in which they could use information about travel circumstances in order to make a number of judgments. Measures of information use were obtained by performing multiple regression analyses for each subject. It was found that habit reduced the elaborateness of information use in judgments of travel mode use. This effect was independent of effects of manipulated accountability demands.

Ajzen, I. (1991). ***"The theory of planned behavior."*** *Organizational Behavior and Human Decision Processes* 50(2): 179-211.

Research dealing with various aspects of the theory of planned behavior (Ajzen, 1985, 1987) is reviewed, and some unresolved issues are discussed. In broad terms, the theory is found to be well supported by empirical evidence. Intentions to perform behaviors of different kinds can be predicted with high accuracy from attitudes toward the behavior,

subjective norms, and perceived behavioral control; and these intentions, together with perceptions of behavioral control, account for considerable variance in actual behavior. Attitudes, subjective norms, and perceived behavioral control are shown to be related to appropriate sets of salient behavioral, normative, and control beliefs about the behavior, but the exact nature of these relations is still uncertain. Expectancy-value formulations are found to be only partly successful in dealing with these relations. Optimal rescaling of expectancy and value measures is offered as a means of dealing with measurement limitations. Finally, inclusion of past behavior in the prediction equation is shown to provide a means of testing the theory's sufficiency, another issue that remains unresolved. The limited available evidence concerning this question shows that the theory is predicting behavior quite well in comparison to the ceiling imposed by behavioral reliability.

### ***Environmental Motivations and Strategies,***

Holmgren, J. and P. Ivehammar (2015). "***Public Transport Quality as a Tool for Reducing Car Dependency***" In order to

attain a transport system that promotes sustainability instead of being part of the problem, the dominance of the private car has to be reduced. Therefore, a greater proportion of future travel has to be made by bicycle, by foot or by public transport. The greatest potential for such development is found in built up areas with high density of both population and activities. Despite this, local public transport has been on the decline, in absolute terms, as well as in market shares in many countries. The loss of market share has primarily been to the private car. This negative trend has been going on since the 80s. Alongside increased levels of income and traffic volume, car ownership has also increased in most countries. In Sweden, car ownership has increased by 190% since the mid-60s and it is estimated to increase by another 55% until 2030. Since car owners are hard to influence into using more environmentally friendly modes of transport, breaking the link between income and car ownership is especially important for the development of the future environmental impact of the transport sector. In the short-run, the design of the public transport system in an urban area affects the decision of which mode of transport to use for a specific trip but it is also a potential tool for influencing long-run behavior. It is possible that if a city has a well-functioning public transport system, its citizens might, to a lesser degree, feel the need for owning a car. Another important effect might be a reduced need for owning two (or more) cars in a family. This would increase the positive environmental effects of public transport in the long run. The purpose of this paper is therefore to study the impact of public transport system design on car ownership in urban areas. The effects of accessibility, public transport price and travel time will be analyzed. The study will be based on data from a mid-size Swedish town obtained through a survey sent to 3000 randomly selected individuals. This data will be complemented with national statistics from Sweden. The reason for selecting a mid-size (small in international terms) is to study the decision to own a car in an environment where bicycling and walking as well as public transport and private car are viable options for people for most purposes. Hopefully, this study will contribute to increased knowledge of how the public transport system could be designed in order to promote long-term sustainability. It is concluded that in addition to income, level of education and age, the design of the public transport system and the time it takes to reach your destination by bicycle do have an effect on car ownership. The elasticities for car

ownership with respect to income, bus fare, bus time, and bicycle time was found to be 0.7, 0.1, 0.079 and 0.15 respectively.

Steg, L., J. W. Bolderdijk, K. Keizer and G. Perlaviciute (2014). ***"An Integrated Framework for Encouraging Proenvironmental Behaviour: The role of values, situational factors and goals."*** Journal of Environmental Psychology **38**: 104-115.

Many environmental behaviours involve a conflict between hedonic and gain goals versus normative goals; people often need to incur some costs to benefit the environment. Based on this assumption, we propose an integrated theoretical framework for understanding behaviour change that identifies two routes to encourage pro-environmental behaviour. First, the conflict between goals can be reduced by decreasing the (hedonic and gain) costs of pro-environmental choices. Although this route is important when proenvironmental choices are very costly, it may not result in sustained pro-environmental actions. Second, normative goals can be strengthened. This strategy may encourage pro-environmental actions, even when it is somewhat costly. We propose that the strength of normative goals depends on values and situational factors that influence the accessibility of these values. We discuss theoretical implications of our reasoning, and indicate how the integrated framework adopted in this paper may advance theory development and environmental policy making. © 2014 Elsevier Ltd.

Haustein, S. and M. Hunecke (2013). ***"Identifying target groups for environmentally sustainable transport: assessment of different segmentation approaches."*** Current Opinion in Environmental Sustainability **5**(2): 197-204.

Recently, the use of attitude-based market segmentation to promote environmentally sustainable transport has significantly increased. The segmentation of the population into meaningful groups sharing similar attitudes and preferences provides valuable information about how green measures should be designed and promoted in order to attract different user groups. This review highlights advances in the understanding of mode choice from a psychological perspective, taking into account behavioural theories of car use and car-use reduction. In this contribution, attitudinal, socio-demographic, geographical and behavioural segmentations are compared regarding marketing criteria. Although none of the different approaches can claim absolute superiority, attitudinal approaches show advantages in providing starting-points for interventions to reduce car use.

Schuitema, G., J. Anable, S. Skippon and N. Kinnear (2013). ***"The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles."*** Transportation Research Part A: Policy and Practice **48**: 3949.

The aim is to understand how private car drivers' perception of vehicle attributes may affect their intention to adopt electric vehicles (EVs). Data are obtained from a national online survey of potential EV adopters in the UK. The results indicate that instrumental attributes are important largely because they are associated with other attributes derived from owning and using EVs, including pleasure of driving (hedonic attributes) and identity derived from owning and using EVs (symbolic attributes). People who believe that a proenvironmental self-identity fits with their self-image are more likely to have positive perceptions of EV attributes. Perceptions of EV attributes are only very weakly associated with car-authority identity. © 2012 Elsevier Ltd.



van der Werff, E., L. Steg and K. Keizer (2013). ***"The value of environmental self-identity: The relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour."*** Journal of Environmental Psychology 34(0): 55-63.

Biospheric values and environmental self-identities are considered to be important antecedents of environmental preferences, intentions, and behaviour. Although various authors suggest a relationship between values and self-identity, this has rarely been studied empirically. This paper aimed to clarify the relationship between biospheric values and environmental self-identity and to study how both are related to environmental preferences, intentions, and behaviour. We hypothesized that biospheric values are related to environmental self-identity, and that self-identity is in turn related to preferences, intentions, and behaviour. Results of three studies including a wide range of environmental preferences, intentions, and behaviour support our reasoning and show that biospheric values are related to environmental self-identity, even when measured months before. Moreover, we found that the relationship between biospheric values and environmental preferences, intentions and behaviour was fully mediated by environmental self-identity, indicating that biospheric values are related to preferences, intentions, and behaviour via one's environmental self-identity. This suggests that values need to be linked to the self in order to be influential in choices made.

de Groot, J. and L. Steg (2010). ***"Relationships between value orientations, self-determined motivational types and pro-environmental behavioural intentions."*** Journal of Environmental Psychology 30(4): 368-378.

We examined the predictive power of egoistic, altruistic and biospheric value orientations and six types of self-determined motivations (i.e. intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation) toward acting pro-environmentally for explaining two types of pro-environmental intentions in two questionnaire studies among student samples (N = 304 and N = 520). The two pro-environmental intentional measures included choosing a car based on environmental performance and donating to an environmental organisation. Values were more predictive of proenvironmental intentions than were self-determined motivational types, although these differences were not always statistically significant. Furthermore, we explored how value orientations are related to selfdetermined motivational types. The more respondents were altruistically and biospherically oriented, the more they were self-determined to act pro-environmentally. When respondents endorsed egoistic values, they were less self-determined towards acting in a pro-environmental way. When altruistic and especially biospheric values were important predictors of pro-environmental intentions, stronger types of selfdetermined motivations were also important to explain intentions. And, when egoistic values contributed uniquely to the explanation of pro-environmental intentions, amotivation and external regulation (i.e. less self-determined motivational types) were most relevant for explaining intentions.

Line, T., K. Chatterjee and G. Lyons (2010). ***"The travel behaviour intentions of young people in the context of climate change."*** Journal of Transport Geography 18(2): 238-246.

This article examines the factors influencing the future travel behaviour intentions of young people (aged 11–18), with specific attention given to how climate change considerations affect these. Overall it is found that the participants' travel behaviour

intentions are dominated by a desire to drive and that their values relating to identity, self-image, and social recognition (at the expense of their environmental values), as well as their affective attitudes towards transport modes, are key influences on this. Although they are aware of climate change, the participants' understanding of the link between transport and climate change was weak. At the same time, they illustrated an apathy towards climate change – in part due to the timing and intangibility of its associated impacts and their lack of self-efficacy with respect to tackling this issue. However, despite claiming that their current environmentally friendly travel behaviours (such as walking or cycling to school) are not influenced by the issue of climate change, a number are accepting of the idea of enforced travel behaviour change – away from use of the car, towards more 'environmentally friendly' modes. This acceptance was in part due to their belief that such action would remove the influence of the 'social dilemma', where their own efforts to tackle climate change may be rendered worthless by the inaction of others.

Abrahamse, W., L. Steg, R. Gifford and C. Vlek (2009). ***"Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality?"*** Transportation Research Part F: Traffic Psychology and Behaviour 12(4): 317-324.

Car use for commuting contributes to various environmental and traffic problems, such as pollution and congestion. Policies aimed at reducing commuter car use will be more effective when they target important determinants of car use and willingness to reduce it. This study examined whether variables reflecting self-interest (from the theory of planned behavior [Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behavior* (pp. 11– 39). Berlin: Springer]) and variables reflecting moral considerations (from the normactivation model [Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10, pp. 221–279). New York: Academic Press]) were able to explain self-reported car use for commuting and intentions to reduce it in a sample of Canadian office workers. Car use for commuting was mostly explained by variables related to individual outcomes (perceived behavioral control and attitudes) whereas the intention to reduce car use was mostly explained by variables related to morality (personal norms). The study also found that perceived behavioral control moderated the relation between personal norms and behavioral intentions: stronger personal norms were associated with stronger behavioral intentions, but only when perceived behavioral control was low. Some issues evoked by these results are discussed.

Steg, L. and C. Vlek (2009). ***"Encouraging pro-environmental behaviour: An integrative review and research agenda."*** Journal of Environmental Psychology 29(3): 309-317.

Environmental quality strongly depends on human behaviour patterns. We review the contribution and the potential of environmental psychology for understanding and promoting pro-environmental behaviour. A general framework is proposed, comprising: (1) identification of the behaviour to be changed, (2) examination of the main factors underlying this behaviour, (3) design and application of interventions to change behaviour to reduce environmental impact, and (4) evaluation of the effects of interventions. We discuss how environmental psychologists empirically studied these four topics, identify apparent shortcomings so far, and indicate major issues for future research.

de Groot, J. and L. Steg (2007). ***"General beliefs and the theory of planned behavior: The role of environmental concerns in the TPB."*** Journal of Applied Social Psychology 37(8): 1817-1836.

This study tested whether the theory of planned behavior (TPB; Ajzen, 1985) could explain people's intention to use a park-and-ride facility (transferium) in Groningen, The Netherlands. We extended the TPB by including egoistic, altruistic, and biospheric concerns. A questionnaire study was conducted among 218 respondents who regularly visit the center of Groningen for work or shopping. Environmental concerns were directly related to attitudes toward using the transferium. However, the 3 types of concerns were not directly related to intention to use the transferium. Furthermore, positive attitudes, positive subjective norms, and high perceived behavioral control toward the use of the transferium were related to stronger intention to use the transferium. Limitations and practical implications of the study are discussed

Steg, L. (2005). ***"Car use: lust and must. Instrumental, symbolic and affective motives for car use."*** Transportation Research Part A: Policy and Practice 39(2-3): 147-162

This paper reports results of two questionnaire studies aimed at examining various motives for car use. In the first study, a random selection of 185 respondents who possess a driving licence were interviewed. Respondents were recruited from the cities of Groningen and Rotterdam, The Netherlands. The sample of the second study comprised a random selection of 113 commuters who regularly travelled during rush hours in and around Rotterdam, a region in the west of the Netherlands. First, it was examined which categories of car use motives may be distinguished. As proposed by Dittmar's (1992) [The social psychology of material possessions: to have is to be. Havester Wheatsheaf, Hemel Hempstead, UK; St. Martin's Press, New York] model on the meaning of material possessions, results from both studies revealed that car use not only fulfils instrumental functions, but also important symbolic and affective functions. Second, it was studied to what extent these different motives are related to the level of car use. From the results of study 2, it appeared that commuter car use was most strongly related to symbolic and affective motives, and not to instrumental motives. Third, individual differences in the relative importance of the three categories of motives were investigated. In both studies, most group differences were found in the evaluation of the symbolic and affective motives (and not the instrumental ones). Especially frequent drivers, respondents with a positive car attitude, male and younger respondents valued these non-instrumental motives for car use. These results suggest that policy makers should not exclusively focus on instrumental motives for car use, but they should consider the many social and affective motives as well.

Cialdini, R. B. (2003). ***"Crafting Normative Messages to Protect the Environment."*** Current Directions in Psychological Science 12(4): 105-109.

It is widely recognized that communications that activate social norms can be effective in producing societally beneficial conduct. Not so well recognized are the circumstances under which normative information can backfire to produce the opposite of what a communicator intends. There is an understandable, but misguided, tendency to try to mobilize action against a problem by depicting it as regrettably frequent. Information campaigns emphasize that alcohol and drug use is intolerably high, that adolescent suicide rates are alarming, and—most relevant to this article—that rampant polluters are spoiling the environment. Although these claims may be both true and well intentioned, the campaigns' creators have

missed something critically important: Within the statement “Many people are doing this undesirable thing” lurks the powerful and undercutting normative message “Many people are doing this.” Only by aligning descriptive norms (what people typically do) with injunctive norms (what people typically approve or disapprove) can one optimize the power of normative appeals. Communicators who fail to recognize the distinction between these two types of norms imperil their persuasive efforts.

Steg, L. (2003). ***"Can Public Transport Compete with the Private Car."*** IATSS RESEARCH 27(2).

Public transport is often perceived to be a poor alternative for car use. This paper describes who may be open to use public transport more often, and how people might be persuaded to use it. A computerised questionnaire study was conducted among 1,803 Dutch respondents in May 2001. Results revealed that especially fervent car users disliked public transport. For them, the car outperformed public transport not only because of its instrumental function, but also because the car represents cultural and psychological values, e.g. the car is a symbol of freedom and independence, a status symbol and driving is pleasurable. So, for fervent car users, car use is connected with various important values in modern society. Infrequent car users judged less positively about the car and less negatively about public transport. Consequently, they may be open to use public transport more regularly. In contrast, many efforts are needed to stimulate fervent car users to travel by public transport, because in their view, public transport cannot compete with their private car. In this case, policies should be aimed at reducing the functional, psychological and cultural values of private cars, as well as increasing the performance of public transport and other (more) environmentally sound modes of transport on these aspects.

Steg, L., C. Vlek and G. Slotegraaf (2001). ***"Instrumental-reasoned and symbolic-affective motives for using a motor car."*** Transportation Research Part F: Traffic Psychology and Behaviour 4(3): 151-169.

This study was aimed at clarifying the relative importance of symbolic-affective as opposed to instrumental-reasoned motives for car use. We examined which motivational dimensions are underlying the (un)attractiveness of car use, in order to distinguish a limited set of main motive categories. Three methods were developed, which differed in the extent to which the purpose of the task was apparent. The tasks were: (1) a similarity sorting of car-use episodes, (2) a Q-sorting following attractiveness of car-use episodes, and (3) a semantic-differential method for evaluating (un)attractive aspects of car use. The symbolic-affective motives for car use were better expressed when the aim of the research task was not too apparent. If the aim of the task was evident, respondents tended to evaluate car use in terms of instrumental-reasoned motives. Overall, the results indicate that both instrumental-reasoned and symbolic-affective functions of the motor car are significant dimensions underlying the attractiveness of car use.

Grob, A. (1995). ***"A structural model of environmental attitudes and behaviour."*** Journal of Environmental Psychology 15(3): 209-220

The multivariate relationship between environmental attitudes and pro-environmental behaviour was examined. In two studies a structural model linking environmental awareness, emotions, personal philosophical values, perceived control and behaviour was proposed and tested. The main questions investigated were (a) whether, to what extent, and in which constellation personal belief systems affect environmental behaviour, and (b)

the generalizability of the model from two known groups. New instruments were created to measure the model's constructs. Using LISREL VII, Study I confirmed the proposed model. The strongest effect on environmental behaviour stemmed from personal-philosophical values and emotions. No effects on environmental behaviour stemming from factual knowledge were found. Thirty-nine per cent of the variance in environmental behaviour was explained by the attitudinal components. Study II showed the extent to which persons differ in their environmental behaviour depending on their membership in a 'green' drivers' association, compared with traditional drivers.

Steg, L., C. Vlek and T. Rooijers (1995). "***Private car mobility. Problem awareness, willingness to change, and policy evaluation: A national interview study among Dutch car users.***" Studies in Environmental Science, Elsevier.

This paper reports on a field study, based on personal interviews with 539 car users. Problem awareness appears to be an important condition for any attempts to make people voluntarily reduce car use. Problem awareness also is an prerequisite for the acceptance of policy measures aimed at reducing car use. Problem awareness is higher the more people are confronted with the problems of car use.

### ***Land Patterns and Transit Markets***

America, S. G. (2016). "***Core Values: Why American Companies are Moving Downtown*** "

Hundreds of companies across the United States are moving to and investing in walkable downtown locations. As job migration shifts towards cities and as commercial real estate values climb in these places, a vanguard of American companies are building and expanding in walkable downtown neighborhoods. Why are companies choosing these places? What are the competitive advantages they see in these locations? And what features do they look for when choosing a new location? *Core Values: Why American Companies are Moving Downtown* examines the characteristics, motives, and preferences of companies that have either relocated, opened new offices, or expanded in walkable downtowns between 2010 and 2015. Smart Growth America partnered with global real estate advisors Cushman & Wakefield to identify nearly 500 companies that have made such a move in the past five years. Of those, we interviewed representatives from more than 40 companies to gain a better understanding of this emerging trend. The research reveals an enormous diversity of businesses choosing to locate downtown. The companies included in our study represent over 170 specific industries, including 15 software developers and 29 information technology companies, 45 manufacturers, 11 universities and colleges, 7 food production companies, 6 advertising agencies, and 6 oil and gas companies. The group includes 52 companies on the Fortune 500, and 12 of Fortune's "100 Best Companies to Work For" from 2015. And these companies are of all sizes, from just a few employees to thousands... This trend is visible across the country, in big cities and small ones, in the middle of the country and the coasts, as well as in secondary markets within larger metropolitan areas. An online interactive map includes more information about where in the country these moves are happening.... Common themes also emerged about what companies looked for when choosing a new location. Many interviewees said they chose vibrant, walkable neighborhoods where people want to both live and work. Companies also wanted their new location to be accessible by a range of transportation options, emphasizing in particular commuting choices for their employees as well as convenient access to the rest of the city

and the region. Great office space was another important factor for these companies, and many highlighted renovated warehouses or other unique and inspired architecture that dovetailed with a desire for similar neighborhood qualities.

Circella, G., P. L. Mokhtarian and S. L. Handy (2008). "***Land use, attitudes, and travel behavior relationships: A cross-sectional structural equations model for Northern California***".

Transportation Research Board 87th Annual Meeting

This paper focuses on the interactions between land use (LU) and travel behavior (TB), with the goal of increasing the understanding of the causal links among residential location, car ownership and travel behavior. These relationships are analyzed through the use of a structural equations model (SEM), based on survey data collected from residents of eight neighborhoods in Northern California. A cross-sectional analysis is carried out, in order to separately identify the influence of socio-demographics and attitudes on residential location and travel behavior, and distinguishing the impact of attitudes on TB from that of the built environment (BE) itself. In particular, the research aims at testing the hypothesis that residential self-selection (RSS) accounts for a significant portion of the impact of the BE on TB. The results confirm strong interactions among the built environment, car ownership and the travel behavior of residents. Moreover, the study highlights the relevance of personal attitudes, in particular with reference to accessibility, as important explanatory variables for the choice of residential location. A concurrent role of the BE and of RSS is found relevant in determining TB. The cross-sectional nature of the analysis allows exploring different directions of causality between car ownership and TB, and between land use attitudes and TB. Strong associations are found among these variables, although some degree of ambiguity persists on the definition of the dominant direction of causality.

Cao, X. (2015). "***Heterogeneous effects of neighborhood type on commute mode choice: An exploration of residential dissonance in the Twin Cities***." *Journal of Transport Geography* **48**: pp 188-196.

Many studies have measured residential and travel preferences to address residential self-selection and they often focused on the average or independent effect of the built environment on travel behavior. However, individuals' behavioral responses to built environment interventions may vary by their different tastes. Using the 2011 data from the Minneapolis–St. Paul metropolitan area, this study examines the influences of neighborhood type, travel attitudes, and their interaction terms on commute mode choice. The interactions between neighborhood type and travel attitudes have no significant impact on driving commute frequency whereas the effects of neighborhood type on the propensity for transit commute differ by transit preference. Specifically, urban consonants (including those in LRT neighborhoods) have the highest propensity for transit commute, followed by suburban dissonants, urban dissonants, and then suburban consonants. Therefore, individuals' heterogeneous responses to built environment elements should be taken into account in future research and in the design of land use and transportation policies aiming to shape urban travel.

Daisy, N. S. and M. A. Habib (2015). "***Investigating the Role of Built Environment and Lifestyle Choices in Active Travel for Home Based Weekly Non-Work Trips***".

<http://trid.trb.org/view/1339497>

This paper aims to examine the influence of the built environment and individual lifestyle choices on the weekly frequency of active transportation (AT) for home-based non-work trips in the Halifax Regional Municipality (HRM), Nova Scotia, Canada. The growing trend of auto-oriented lifestyle choices and dependency not only intensify environmental emissions and energy use, but also lead to the decreased usage of AT for daily activities. Studies show that the built environment plays a significant role in active mode choice for non-work trips; these trips are more flexible in time and location. However, limited research investigates the effect of life style and attitudes in combination with the built environment attributes for AT usage, particularly in the case of week-long non-work trips. Accordingly, this paper investigates weekly active travel using data from the Halifax Household Mobility and Travel Survey (HMTS), Canada. A factor analysis is performed to capture the effects of life style choices and attitudes, which is categorised in two groups: a) individuals' attitudes towards travel modes; and b) individuals' attitudes towards land use and the environment. Based on the loading of the factors of the lifestyle choice variables, nine attitudinal variables are obtained. The paper employs an ordered probit modelling framework to examine relative contributions of the relevant socio-economic characteristics, built environment attributes and attitudinal factors. Model results reveal that attitudes and life style choice factors play an important role in weekly AT frequency for non-work trips. For example, individuals with pro walk/bike and pro transit attitudes are likely to use AT more frequently for non-work related trips in comparison to their counterparts. Though the impact of individuals' attitudes on AT trips is evident, this model also demonstrates that the built environment significantly influences the frequency of AT trips.

Halat, H., M. Saberi and H. S. Mahmassani (2015). "***Land Use and Travel Behavior: Empirical Evidence of the Effects of Mixed-Use Development on Travel Mode Choice in Chicago***". <http://trid.trb.org/view/1338347>

This study empirically investigates the influence of land use on travel mode choice in the Chicago metropolitan area. First, the authors examine if an association between the selected measurements and mode choice exist. The land use variables considered in this study include variables such as mixed-use development, transit accessibility, population, and employment densities. To control for non-spuriousness, several commonly used attitudinal and socio-demographic variables including income and ratio of number of vehicles per number of workers in the household are included in the models. The effects are analyzed for home-based work (HBW) trips only, using a mixed logit framework. The objective is to examine and provide further empirical evidence on how land use, specifically mixed-use development, influences mode choice, and to identify the existing interactions.

Langlois, M., D. S. van Lierop, R. A. Wasfi and A. M. El-Geneidy (2015). "***Chasing sustainability: Do new TOD residents adopt more sustainable modes of transportation?***". <http://trid.trb.org/view/1337347>

It is suggested that one of the solutions for mitigating the detrimental effect of motor vehicles on society is to implement Transit-Oriented Development (TOD). This type of development is intended to reduce automobile use and urban sprawl as well as to provide communities with more socially, environmentally, and economically sustainable neighborhoods that offer a variety of mobility choices. This paper attempts to find out whether new TOD residents adopt more sustainable modes of transportation after their



relocation. The analysis determines which factors influence travel mode switching decisions by specifying a multilevel multinomial logistic regression model. Data for the analysis is drawn from a travel behavior survey conducted on residents in seven different North American TODs in 2013. The authors' results show that TOD newcomers adopt more sustainable travel modes for amenities and leisure trips, whereas they are less likely to do so for work and shopping trips. To encourage more sustainable travel modes, the authors' findings suggest that transit incentives coupled with workplace parking charges need to be considered. Awareness of the environmental impact of each travel mode, walkability of the neighborhood and availability of various destinations as well as proximity to transit stops are factors that increase the probability of switching to a more sustainable mode of transportation for new TOD residents. However, larger household size and becoming a homeowner, as well as the addition of a new car, have a negative impact. Findings from this research provide new insights into TOD planning and its link to travel behavior that can be of benefit to planners, engineers and policy makers adopting this approach of development with the goal of mitigating car usage.

Manaugh, K. and A. M. El-Geneidy (2015). ***"The importance of neighborhood type dissonance in understanding the effect of the built environment on travel behavior."*** Journal of Transport and Land Use 8(2): pp 45-57.

For many years, researchers have struggled to separate the effects of personal tastes—including residential choices—from built environment and transport-related factors when attempting to understand and model travel behavior. This paper will briefly describe how issues related to self-selection, if not controlled for in a travel behavior analysis, can lead to overestimation and underestimation of the effect of the built environment on travel behavior. A theoretical model is presented, which is followed by an empirical analysis based on survey data capturing residential choice factors to test the authors' theory. Their analysis shows that by separating people who have chosen their current home location based primarily on transport-related concerns from people who have located based primarily on housing and neighborhood characteristics, they are able to gain a nuanced understanding of how various "costs" associated with using public transit (access time, waiting time, and transfers) affect the likelihood of taking transit. The authors find a strong aversion to transfers as well as different responses to these factors based on reasons for living in a given location. They demonstrate how model predictions vary greatly especially when self-selection factors are included in the analysis. Findings from this research shed light on the importance of self-selection in travel-behavior research, giving transport planners and engineers clear examples of how ignoring these factors can lead to misleading findings.

Noland, R. B. and S. DiPetrillo (2015). ***"Transit-oriented development and the frequency of modal use."*** Journal of Transport and Land Use 8(2): pp 21-44.

Transit-oriented development (TOD) is assumed to be effective at changing the travel behavior of individuals, particularly in increasing the use of public transit, but also by increasing walking activity while decreasing driving. The analysis presented here examines the frequency of using these modes of travel for those living in TODs and proximate to a train station versus those living more distantly. Household survey data was collected for the area surrounding eight rail stations in the state of New Jersey in the United States. The

models developed include factors that control for attitudes about the neighborhood where respondents reside and how long they have lived at their current residence. Other control variables to represent the urban design of the neighborhood are also included. A factor analysis of the attitudinal variables produces five factors that are used as controls in an ordered structural equation model of frequency of using public transit, walking, and driving. Results suggest that those living in TODs and closer to the train station use public transit and walk more frequently than those living farther out; they also drive less frequently than those living farther out.

Redfearn, C. L. (2015). *"Reconsidering the Impact of Access to Transit on Local Land Markets"* <http://www.metrotrans.org/sites/default/files/research-project/Redfearn%20METTRANS%20Report-Final.pdf>

This research assesses the impact of new passenger rail stations on changes in land use intensity in Los Angeles County. In the county, employment outside downtown is concentrated in nodes with 3.2 million jobs (about half of all jobs in the metropolitan area). Making use of the employment centers as units of analysis reveals significant growth in both employment and population density around new stations. These results are useful for policy makers interested in assessing the indirect benefits of investment in new stations. The results are also informative for those using the Differences-in-differences approach in urban settings. While the effects of new stations are significant and positive, there is marked heterogeneity across stations, suggesting that more research is needed to understand the link between new stations and subsequent changes in land use.

Rosenberger, T., C. Nardi and K. Liwag (2015). *"What is Generating Transit Ridership Increase in US and Canadian Cities?"* <http://abstracts.aetransport.org/paper/index/id/4605/confid/20>

Transit ridership is rising in America. Ridership in the United States (US) has increased by more than 37% since 1995, outpacing population growth of 20%, and increased by 1.1% in between 2012 and 2013, in spite of falling fuel prices. Transit has always been an important form of transport in some large American cities, like New York, Boston and San Francisco. But in the past decade, transit has been increasing in most US cities. Smaller cities like Flagstaff, Arizona and Canton, Ohio, and auto-centric ones like Los Angeles and Indianapolis, are seeing large gains. Canadian cities have seen even greater increases, in larger cities like Vancouver and Toronto as well as smaller ones like Regina, Alberta and Oakville, Ontario. The authors, who have performed transit system restructuring projects in a number of smaller and mid-sized US and Canadian cities, document the long-term demographic and socio-economic trends that are the underlying cause of this ridership growth, and explain why it is likely to continue. These trends include the changing tastes and lifestyle preferences of the millennial generation, the retirement from work of the baby boom generation, concerns about environmental issues and global climate change, growing economic polarization, immigration, and changes in the population's ethnic composition. Many of these same trends will affect European cities, albeit in ways that are unique to each city and country, and subtly different from most American cities. In many cities and regions, the funding structures that have supported local transit systems are inadequate to meet the growing demand for transit service. Likewise, the systems that national governments use to support transit infrastructure development are generally inadequate to meet the demand for vehicles and infrastructure that these long term trends will generate. Policymakers both

in North America and Europe will soon be forced by public demand to allocate greater importance, and greater funding, to transit to meet this growing demand.

Concas, S. and J. S. DeSalvo (2014). ***"The effect of density and trip-chaining on the interaction between urban form and transit demand."*** Journal of Public Transportation 17(3): pp 16-38.

It is unclear whether policies designed to reduce auto and increase transit usage achieve their objective. Evidence is mixed because most empirical research on these policies use ad hoc specifications, whereas the authors' models are drawn from economic theory. Three models of increasing generality show how endogenizing relevant variables changes results obtained by others. The theoretical hypotheses are empirically tested using a dataset that integrates travel and land use. The main findings are (1) population density has a small impact on transit demand, which decreases when residential location is endogenous; (2) households living farther from work use less transit, a result of trip-chaining; and (3) reducing the spatial allocation of non-work activities, improving transit accessibility at and around subcenters, and increasing the presence of retail locations in proximity to transit-oriented households would increase transit demand.

De Vos, J., V. Van Acker and F. Witlox, (2014) ***"The influence of attitudes on Transit-Oriented Development: An explorative analysis."*** Transport Policy.

Transit-Oriented Development (TOD), where compact, mixed-use neighbourhoods are being realized around existing or new public transit stops, is a promising tool to restrict urban sprawl and stimulate sustainable travel modes. However, TODs are not always as easy to implement at every location. In high-density city centres a TOD is relatively easy to implement, since density and diversity are already high and most residents have a positive stance toward car alternatives due to self-selection processes. In more low-density suburbs, however, the situation is more difficult. There is not only the problem of adapting the built environment, but also the problem that most initial residents have a preference for car use, since they chose their neighbourhood based on the physical characteristics of the initial neighbourhood. In this viewpoint we will look at how travel-related attitudes and residential self-selection can affect the success rate of TODs in three different situations. It seems that taking into account attitudes is especially important for the realization of TODs in low-density neighbourhoods.

Knuiman, M. W., H. E. Christian, M. L. Divitini, S. A. Foster, F. C. Bull, H. M. Badland and B. Giles-Corti (2014). ***"A Longitudinal Analysis of the Influence of the Neighborhood Built Environment on Walking for Transportation: The RESIDE Study."*** American Journal of Epidemiology 180(5): pp 453-461.

This article reports on a longitudinal analysis of the influence of the built environment in a neighborhood on walking for transportation reasons. The authors used data collected over 7 years (from 4 surveys) in the Residential Environments (RESIDE) Study, Perth, Australia, 2003–2012. They studied the relationship between neighborhood walkability and destination accessibility, comparing effect estimates from 3 types of logistic regression models. Two of the models use all available data (a population marginal model and a subject-level mixed model); the third model is a subject-level conditional model that exclusively uses within-person longitudinal evidence. The study identified factors that supported walking for transportation, including neighborhood walkability (especially land-use mix and street connectivity), local access to public transit stops, and variety in the types

of local destinations. The authors describe how their analysis determined there was little or no bias from self-selection factors. However, uncontrolled time-varying factors, such as health status, may still have an undetermined impact. The authors conclude that their longitudinal study provides stronger evidence than cross-sectional studies of a possible supportive effect of the neighborhood built environment on local transport-related walking.

McIntosh, J., R. Trubka, J. Kenworthy and P. Newman (2014). ***"The role of urban form and transit in city car dependence: Analysis of 26 global cities from 1960 to 2000."*** Transportation Research Part D: Transport and Environment 33: pp 95-110.

Car dependence is in decline in most developed cities, but its cause is still unclear as cities struggle with priorities in urban form and transport infrastructure. This paper draws conclusions from analysis of data in 26 cities over the last 40 years of the 20th century. Statistical modelling techniques are applied to urban transport and urban form data, while examining the influence of region, city archetype and individual fixed effects. Structural equation modelling is employed to address causation and understand the direct and indirect effects of selected parameters on per capita vehicle kilometers traveled (VKT). Findings suggest that, while location effects are important, transit service levels and urban density play a significant part in determining urban car use per capita, and causality does flow from these factors towards a city's levels of private vehicle travel as well as the level of the provision of road capacity.

Nasri, A. and L. Zhang (2014). ***"The analysis of transit-oriented development (TOD) in Washington, D.C. and Baltimore metropolitan areas."*** Transport Policy 32: pp 172-179.

Transit-oriented development (TOD) is mainly focused on providing transit service along with high density and mixed-use development to encourage transit ridership. The Maryland Department of Transportation defines TOD as "a place of relatively higher density that includes a mixture of residential, employment, shopping and civic uses and types located within an easy walk of a bus or rail transit center" (Transit-Oriented Development Task Force, Maryland Department of Transportation, 2000). TOD is a fast-growing development strategy and is becoming more popular among city planners, land developers, and government officials for its potential to increase transit ridership and reduce VMT by shortening trips. However, there has not been enough research done on how successful TODs are in providing sustainable transportation modes, which will eventually result in less energy consumption, environmental pollution, and traffic congestion in urban areas. The present study tries to understand how travel behavior is different for TOD residents in the two metropolitan areas of Washington, D.C. and Baltimore. This is done specifically by examining the changes in vehicle miles traveled (VMT) in order to analyze the effectiveness of TODs on encouraging driving less and switching to transit, walking, biking, and other sustainable modes of transportation. The question of "can transit-oriented development (TOD) reduce vehicle miles of travel?" has been asked frequently, since TODs were first proposed and implemented in urban areas. This paper tries to find a viable answer to this question by analyzing the VMT of Washington, D.C. and Baltimore residents. Results indicate that people living in TOD areas tend to drive less, reducing their VMT by around 38% in Washington, D.C. and 21% in Baltimore, compared to the residents of the non-TOD areas even with similar land use patterns.

Ramsey, K. and A. Alexander Bell (2014). ***"Smart Location Database, Version 2.0 User Guide"*** U.S. EPA Office of Sustainable Communities

The Environmental Protection Agency's (EPA) Smart Location Database (SLD) was developed to address the growing demand for data products and tools that consistently compare the location efficiency of various places. The SLD summarizes several demographic, employment, and built environment variables for every Census block group (CBG) in the United States.<sup>1</sup> The attributes measured serve as indicators of the commonly cited "D" variables that have been shown in the transportation research literature to be related to travel behavior. The Ds include concepts such as residential and employment density, land use diversity, design of the built environment, access to destinations, and distance to transit. SLD variables can be used as inputs to travel demand models, baseline data for scenario planning studies, and combined into composite indicators characterizing the relative location efficiency of CBG within U.S. metropolitan regions. This report contains a detailed description of the data sources and methodologies used to calculate each of the variables contained in the SLD. It also discusses any known limitations associated with variables in the SLD. More information about the environmental significance of several individual variables contained in the SLD will be available in the form of fact sheets developed for EPA's EnviroAtlas<sup>3</sup>. Links to these fact sheets will be added to this document as they become available.

Van Acker, V., P. Mokhtarian and F. Witlox (2014). ***"Car availability explained by the structural relationships between lifestyles, residential location, and underlying residential and travel attitudes."*** *Transport Policy* 35(0): 88-99.

The majority of land use-travel behaviour studies only considers the direct influence of spatial characteristics on daily travel behaviour. However, this framework should be expanded. A first step is to explore the complex interdependencies of long-term lifestyle decisions, medium-term decisions about residential location and car ownership, and the underlying residential and travel attitudes. Travel behaviour should be considered within a hierarchy of decisions while considering the motivational background of these decisions. Using data from an Internet survey completed by +1800 respondents in Flanders, Belgium, this paper defines car ownership somewhat more broadly as car availability. Results of a structural equation model indicate a significant direct effect of the residential neighbourhood on car availability. However, effects are small compared to the influence of other variables such as stage of life and travel (mode) attitude, the latter referring to travel-related self-selection. Moreover, one should keep in mind that residential attitudes remain important in the initial selection of the residential neighbourhood and its spatial characteristics, indicating the need to control for residential self-selection.

Buehler, R. and J. Pucher (2013). ***"Demand for Public Transport in Germany and the USA: An Analysis of Rider Characteristics"***. <http://docs.trb.org/prp/13-0530.pdf>

This paper presents a detailed analysis of public transport demand in Germany and the USA, using uniquely comparable national travel surveys from 2001/2002 and 2008/2009 for both countries. Public transport has been far more successful in Germany than in the USA, with much greater growth in overall passenger volumes and trips per capita. Even controlling for differences between the countries in demographics, socioeconomics, and land-use, logistic regressions show that Germans are five times as likely as Americans to use

public transport. Moreover, public transport in Germany attracts a much broader cross-section of society and for a greater diversity of trip purposes. The success of German public transport is due to a coordinated package of mutually supportive policies that include: (1) more and better service, (2) attractive fares and convenient ticketing, (3) full multi-modal and regional integration, (4) high taxes and restrictions on car use, and (5) land-use policies that promote compact, mixed-use developments. It is the integrated package of complementary policies that explains why public transport in Germany can compete so well with the private car, even among affluent households. Conversely, it is the lack of complementary policies that explains the continuing struggle of public transport in the USA.

Wang, K. (2013). ***"Causality Between Built Environment and Travel Behavior: Structural Equations Model Applied to Southern California."*** Transportation Research Record: Journal of the Transportation Research Board (2397): pp 80–88.

The goal of this study was to explore the causality between the built environment and three transportation modes (private vehicles, mass transit, and nonmotorized modes such as bicycling and walking) while accounting for sociodemographic characteristics for an understanding of what factors may foster transit and nonmotor use. Data from the 2009 National Household Transportation Survey combined with Los Angeles County, California, land use data were used to estimate a recursive structural equations model for an examination of causality direction and for a quantification of the built environment effect and residential self-selection effect. Results suggest that urban planning strategies that promote high population and employment density, land use mix, high four-way intersection density, and road density as well as good transit service can either significantly encourage transit use, bicycling, and walking or reduce vehicle miles traveled. However, the relatively small effect of the size of the built environment on travel behavior implies that achieving the above planning goals may cause considerable residential relocation, which contributes to the major part of observed travel behavior changes.

Concas, S. (2012). ***"The Role of Density in Supporting Sustainable Modes: A New Perspective on the Interaction Between Urban Form and Transit Travel"***. <http://trid.trb.org/view/1130887>

In recent years, urban policies intended to reduce presumed negative externalities associated with suburbanization have focused on reducing auto travel by manipulating urban form to reduce trip frequencies and travel distances. In addition, it is assumed that shorter distances provide added opportunities to link more destinations in a single trip chain. The effectiveness of sustainable transport strategies, however, provides mixed evidence. This is so because the research is based on ad-hoc empirical specifications, lacking a formal behavioral framework that considers travel the result of activities planned and executed through space and time. To assess these shortcomings, the authors present an analytical model of the interaction between urban form and the demand for transit travel, in which residential location, transit demand, and the spatial dispersion of non-work activities are endogenously determined. Theoretically derived hypotheses are empirically tested using a dataset that integrates travel and land-use data. The authors find that population density does not have a large impact on transit demand and that the effect decreases when residential location is endogenous. When population density and residential location are jointly endogenous, the elasticity of transit demand with respect to walking distance to a transit station decreases by about 33 percent over the case in which these variables are

treated an exogenous. The authors find that households living farther from work use less transit and that trip-chaining behavior explains this finding. Households living far from work engage in complex trip chains and have, on average, a more dispersed activity space, which requires reliance on more flexible modes of transportation. Therefore, reducing the spatial allocation of non-work activities and improving transit accessibility at and around subcenters would increase transit demand. Similar effects can be obtained by increasing the presence of retail locations in proximity to transit-oriented households. Although focused on transit demand, the framework can be easily generalized to study other forms of travel.

Cervero, R. and E. Guerra (2011). "Urban Densities and Transit: A Multi-dimensional Perspective: 15p.

This paper investigates the relationship between transit and urban densities in the United States. An analysis of light rail systems finds that a residential density of about 30 people per gross acre near stations is needed to in order to make them among the top 25 percent of rail transit investments in terms of cost effectiveness; for heavy rail systems, the density is 45 people per gross acre. Increasing density around stations would greatly increase ridership, particularly when jobs are located within one-quarter mile of the stations and housing is located within one-half mile. Stakeholders in the small city of Stockton found high levels of density unacceptable, and supported transit improvements, such as bus rapid transit, only when there would be no impact on private vehicle traffic.

Evans, I., R. H. Pratt, A. Stryker and J. R. Kuzmyak (2007). ***"Transit-Oriented Development--Traveler Response to Transportation System Changes."***

TRB's Transit Cooperative Research Program (TCRP) Report 95: Traveler Response to Transportation System Changes, Chapter 17--Transit-Oriented Development explores the transit-oriented development (TOD) land use strategy and its transportation impacts in terms of regional context, land use mix, and primary transit mode. TOD generally refers to higher-density development, with pedestrian priority, located within easy walking distance of a major public transit station or stop. This report is part of TCRP's Traveler Response to Transportation System Changes Handbook series. The overarching objective of the Traveler Response to Transportation System Changes Handbook is to equip members of the transportation profession with a comprehensive, readily accessible, interpretive documentation of results and experience obtained across the United States and elsewhere from (1) different types of transportation system changes and policy actions and (2) alternative land use and site development design approaches.

Van Wee, B., H. Holwerda and R. Van Baren (2002). ***"Preferences for modes, residential location and travel behaviour: the relevance for land-use impacts on mobility."*** European Journal of Transport and Infrastructure Research 2(3/4): 305-316.

Nowadays almost all researchers focusing on the impact of land use on travel behaviour examine personal and household variables such as income, age and household type. Still, within 'homogeneous' groups there may be preferences for travel modes (especially car or public transport), and these may have an impact on the influence of land use on travel behaviour □ a subject for which available literature is scarce. This paper represents then an endeavour to relay results of empirical research on this matter and also attempts to answer the following questions: 1. Are there preferences for modes? 2. Is there a relationship between preferences and neighbourhood characteristics? 3. Have preferences for modes



played a role in residential choices of households? 4. Do preferences for modes add explanatory power to models for travel behaviour that include personal and household characteristics, and land-use variables? Results obtained reveal positive answers to all four questions; but this then confronts us with the following question: Do land-use policies then make no sense? Yes, in our opinion, these policies do make sense, in the least because they allow people who prefer certain modes to live in an area that meets their preferences. However, this does not mean that land use alternatives leading to the lowest car use levels should always be recommended. Rather, what is needed is a broad evaluation of all the pros and cons of these alternatives.

### ***Intelligent Communications Technology and Transit Markets***

Clewlow, R. R. and G. S. Mishra (2017). "***Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States***" Research Report–UCD-ITS-RR-17-07, Davis: University of California

Ride-hailing services have experienced significant growth in adoption since the introduction of Uber, in 2009. Although business models to support the sharing of vehicles (e.g., carsharing) have been present in the United States for more than 15 years, their adoption has been somewhat limited to niche markets in dense, urban cities or college campuses. To date, carsharing has attracted over 2 million members in North America and close to 5 million globally. Conversely, this new model of "shared mobility" is estimated to have grown to more than 250 million users within its first five years. The rapid adoption of ride-hailing poses significant challenges for transportation researchers, policymakers, and planners, as there is limited information and data about how these services affect transportation decisions and travel patterns. Given the long-range business, policy, and planning decisions that are required to support transportation infrastructure (including public transit, roads, bike lanes, and sidewalks), there is an urgent need to collect data on the adoption of these new services, and in particular their potential impacts on travel choices. This paper presents findings from a comprehensive travel and residential survey deployed in seven major U.S. cities, in two phases from 2014 to 2016, with a targeted, representative sample of their urban and suburban populations. The purpose of this report is to provide early insight on the adoption of, use, and travel behavior impacts of ride-hailing.

Shared Use Mobility Center, (2016). "***SHARED MOBILITY AND THE TRANSFORMATION OF PUBLIC TRANSIT TCRP J-11/TASK 21***" Washington, DC APTA [www.sharedusemobilitycenter.org](http://www.sharedusemobilitycenter.org)

Technology is transforming transportation. The ability to conveniently request, track, and pay for trips via mobile devices is changing the way people get around and interact with cities. This report examines the relationship of public transportation to shared modes, including bikesharing, carsharing, and ridesourcing services provided by companies such as Uber and Lyft. The research included participation by seven cities: Austin, Boston, Chicago, Los Angeles, San Francisco, Seattle and Washington, DC. Some have predicted that, by creating a robust network of mobility options, these new modes will help reduce car ownership and increase use of public transit, which will continue to function as the backbone of an integrated, multimodal transportation system. The objective of this research analysis, which is distilled from a larger forthcoming study on the same topic, is to examine these issues and explore opportunities and challenges for public transportation as they

relate to technology-enabled mobility services, including suggesting ways that public transit can learn from, build upon, and interface with these new modes. To accomplish this task, the study draws from several sources, including in-depth interviews with transportation officials, a survey of shared mobility users, and analysis of transit and ridesourcing capacity and demand. Together, these elements provide a snapshot of a rapidly widening mobility ecosystem at an early moment in its evolution. KEY FINDINGS 1. The more people use shared modes, the more likely they are to use public transit, own fewer cars, and spend less on transportation overall. “Supersharers”—people who routinely use several shared modes, such as bikesharing, carsharing (e.g. car2go or Zipcar), and ridesourcing (e.g. Lyft or Uber)—save the most money and own half as many household cars as people who use public transit alone. 2. Shared modes complement public transit, enhancing urban mobility. Ridesourcing services are most frequently used for social trips between 10pm and 4am, times when public transit runs infrequently or is not available. Shared modes substitute more for automobile trips than public transit trips. 3. Shared modes will continue to grow in significance, and public entities should identify opportunities to engage with them to ensure that benefits are widely and equitably shared. Public transit agencies should seize opportunities to improve urban mobility for all users through collaboration and public-private partnerships, including greater integration of service, information and payment methods. 4. The public sector and private operators are eager to collaborate to improve paratransit service using emerging approaches and technology. While a number of regulatory and institutional hurdles complicate partnerships in this area, technology and business models from the shared mobility industry can help drive down costs, increase service availability and improve rider experience.

Rayle, L., D. Dai, N. Chan, R. Cervero and S. Shaheen (2016). *“Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco.”* *Transport Policy* 45: 168-178. <http://dx.doi.org/10.1016/j.tranpol.2015.10.004>  
<http://www.sciencedirect.com/science/article/pii/S0967070X15300627>

In this study, we present exploratory evidence of how “ridesourcing” services (app-based, on-demand ride services like Uber and Lyft) are used in San Francisco. We explore who uses ridesourcing and for what reasons, how the ridesourcing market compares to that of traditional taxis, and how ridesourcing impacts the use of public transit and overall vehicle travel. In spring 2014, 380 completed intercept surveys were collected from three ridesourcing “hot spots” in San Francisco. We compare survey results with matchedpair taxi trip data and results of a previous taxi user survey. We also compare travel times for ridesourcing and taxis with those for public transit. The findings indicate that, despite many similarities, taxis and ridesourcing differ in user characteristics, wait times, and trips served. While ridesourcing replaces taxi trips, at least half of ridesourcing trips replaced modes other than taxi, including public transit and driving. Impacts on overall vehicle travel are unclear. We conclude with suggestions for future research.

Pawlak, J., S. Le Vine, J. Polak, A. Sivakumar, and J. Kopp. 2015. **ICT and physical mobility: State of knowledge and future outlook.** Munich, Germany: Institute for Mobility Research.  
<https://www.bmwgroup.com/content/dam/bmw-group-websites/bmwgroup.com/company/downloads/en/2015/November%202015.pdf>

Information and communications technology (ICT) is rapidly evolving and is penetrating more and more aspects of people's everyday lives, including how they travel. This study establishes the current state of knowledge regarding the relationship between ICT and physical mobility, and gives specific guidance for avenues of future research. To address these objectives, we first conducted a detailed review of the academic literature, followed by a Call for evidence, an expert Workshop and two young Adult (teenage) Workshops. We identified five distinct yet interrelated themes around which the discussion in this report is organised. We recognise that the state of knowledge is advancing very quickly in this area of research, and at present the field is characterised by many theoretical, methodological and empirical challenges. Commercial decisions and policy measures relating to ICT and physical mobility must therefore be made with explicit recognition that the current state of knowledge is continuously evolving and sometimes fragmentary. ...Does increasing use of ICT lead to changes in mode choice and car ownership decisions? The role of ICT in people's mode choices (e.g. bus, car, walking) and in car ownership appears to be, at most, secondary. Classical considerations such as prices, travel time, reliability, convenience, and prestige appear to persist as dominant factors in these decisions.

Committee for Review of Innovative Urban Mobility Services (2016). ***"Between Public and Private Mobility Examining the Rise of Technology-Enabled Transportation Services"*** Transportation Research Board; National Academies of Sciences, Engineering, and Medicine Information

Information and communication technologies, combined with smartphone applications and location data from global positioning systems, are making feasible transportation services that have long been imagined but never realized on a large scale. These innovations include carsharing; bikesharing; microtransit services; and, most notably, transportation network companies (TNCs) such as Uber and Lyft. These services are being embraced by millions of travelers who are using their smartphones to arrange for trips by car, shuttle, and public transit, as well as for short-term rental of cars and bicycles. The rapid growth in these services follows and amplifies a rebound in travel by taxis and public transit that began more than a decade ago. The new services epitomize today's sharing economy and allow an increasing number of people to enjoy the mobility benefits of an automobile without owning one, and may encourage others to leave their personal vehicle at home for the day, reduce the number of vehicles in their household, or even forgo having one at all. Notably, most of these innovations are occurring and being deployed in the private sector without public financial support, with the exception of bikesharing, which is typically publicly subsidized. Whereas TNCs have received the lion's share of media attention to date, the other innovative mobility services are growing, evolving, and expanding mobility while also reducing personal vehicle travel, greenhouse gas emissions, and possibly automobile ownership. Although travel using innovative mobility services still represents a small share of total trips, a continued increase in customers and trips has substantial implications for the future. To date, the most rapidly growing forms of shared mobility entail sequential sharing of vehicles, with each user in turn having exclusive use of a motor vehicle or bicycle. Potentially more consequential, but still in its infancy, is concurrent sharing of vehicles among strangers. By increasing vehicle occupancy, this form of shared services may collectively have greater effects—in terms of affordable personal mobility, vehicle use, energy consumption, traffic congestion, and environmental benefits—relative to today's most popular new sequential mobility options. At the same time that innovative mobility

services are being enthusiastically embraced by tech-savvy travelers, they do raise public policy issues. For example, those without credit accounts and smartphones cannot access many of these new services, and helmet requirements may increase safety, but can discourage bikesharing.... The committee that conducted this study concludes that innovative mobility services can provide broad mobility benefits while serving other societal goals, but that reaping these benefits will require informed policy making. The committee favors a carefully calibrated regulatory approach for both innovative mobility services and the traditional services with which they frequently compete—an approach that accomplishes public policy goals and creates a level playing field while still allowing the full spectrum of mobility services ample opportunity to innovate and compete.

Balac, M., F. Ciari and K. W. Axhausen (2015). ***"Carsharing Demand Estimation: Zurich, Switzerland, Area Case Study."*** Transportation Research Record: Journal of the Transportation Research Board(2536): pp 10–18.

Worldwide carsharing has grown significantly in recent years. The traditional round-trip model is no longer the only carsharing model offered. It is now being accompanied by more flexible options such as one-way stationbased, free-floating and peer-to-peer carsharing. Moreover, it has become important to have tools that can estimate both the spatial and temporal demand for carsharing services, providing operators with a good instrument for planning their services. The work presented in this paper makes use of the multiagent simulation tool (MATSIM) to investigate the effects of supply on the demand of the existing round-trip service in the Zurich area of Switzerland. Additionally, the results provide guidance for the possible optimization of the carsharing service. Also presented is an implementation of a one-way station-based model as a part of the MATSIM framework as well as an investigation of the potentials of one-way carsharing service in the study area. Results show that there is still untapped potential of round-trip carsharing, but that service might need optimization. Furthermore, because of greater convenience, one-way carsharing would generate slightly less than three times more trips compared with the round-trip option.

Fishman, E., S. Washington and N. Haworth (2015). ***"Bikeshare's Impact on Active Travel: Evidence from the United States, Great Britain, and Australia."*** Journal of Transport & Health 2(2): pp 135-142.

Over 800 cities globally now offer bikeshare programs. One of their purported benefits is increased physical activity. Implicit in this claim is that bikeshare replaces sedentary modes of transport, particularly car use. This paper estimates the median changes in physical activity levels as a result of bikeshare in the cities of Melbourne, Brisbane, Washington, D.C., London, and Minneapolis/St. Paul. This study is the first known multicity evaluation of the active travel impacts of bikeshare programs. To perform the analysis, data on mode substitution (i.e. the modes that bikeshare replaces) were used to determine the extent of shift from sedentary to active transport modes (e.g. when a car trip is replaced by bikeshare). Potentially offsetting these gains, reductions in physical activity when walking trips are replaced by bikeshare was also estimated. Finally a Markov Chain Monte Carlo analysis was conducted to estimate confidence bounds on estimated impacts on active travel given uncertainties in data sources. The results indicate that on average 60% of bikeshare trips replace sedentary modes of transport (from 42% in Minneapolis/St. Paul to

67% in Brisbane). When bikeshare replaces a walking trip, there is a reduction in active travel time because walking a given distance takes longer than cycling. Considering the active travel balance sheet for the cities included in this analysis, bikeshare activity in 2012 has an overall positive impact on active travel time. This impact ranges from an additional 1.4 million minutes of active travel for the Minneapolis/St. Paul bikeshare program, to just over 74 million minutes of active travel for the London program. The analytical approach adopted to estimate bikeshare's impact on active travel may act as the basis for future bikeshare evaluations or feasibility studies.

Kopp, J., R. Gerike and K. W. Axhausen (2015). ***"Do Sharing People Behave Differently? An Empirical Evaluation of the Distinctive Mobility Patterns of Free-floating Car-sharing Members."*** *Transportation* 42(3): pp 449-469.

Characteristics of users and usage of station-based car-sharing services have been discussed in various studies. First analyses of the free-floating car-sharing model DriveNow have shown that member composition and patterns of use are not very different from those of station-based car-sharing schemes. Nevertheless, free-floating car-sharing members were drawn from a new pool of travellers, they were not attracted by existing station-based car-sharing schemes. This paper goes beyond these analyses and looks not only at the usage of car-sharing services but at the overall travel behaviour of free-floating car-sharing members (FFCS). To the best of our knowledge, this is the first time that the specifics of this travel behaviour have been analysed based on substantial data that was collected specifically for this purpose with an innovative survey design based on a global positioning system (GPS) tracking smartphone application. The goal of this study is to contrast the core group of members of the free-floating car-sharing model DriveNow (male, 25-45 years old) with people who do not use car-sharing. Key travel indicators are compared for FFCS and non-carsharers (NCS) with a special emphasis on type and extend of multimodal travel behaviour within those two groups. The results show higher trip frequency for FFCS and differences in mode choice pattern. FFCS are more intermodal and multimodal in their behaviour. Shares of cycling are significantly higher, shares of private car trips are significantly lower for FFCS compared to NCS. The insights gained in this study can help cities and car-sharing operators to develop framework conditions and services that optimally integrate freefloating car-sharing services into the overall urban transport systems.

Kroesen, M. and S. Handy (2015). ***"Is the Rise of the E-society Responsible for the Decline in Car Use Among Young Adults? Results from the Netherlands"***. <http://trid.trb.org/view/1337706>

Trends toward decreases in car use and car licensing rates have been observed in several industrialized countries in the last decade. This study assesses whether and to what extent this decline may (partially) be attributed to the latest trends in the digitalization of society, in particular the growing use of mobile internet devices (smartphones and tablets) and online services like social network sites, especially among young people. These technologies and services enable and encourage people to be connected anytime and anywhere, and may thereby reduce (car) travel by partly replacing face-to-face contacts with friends and relatives. Based on a representative sample of Dutch respondents, the results were found to be inconsistent with this expectation and indicated that the use of the new technologies and services was associated with more (instead of fewer) out-of-home social activities.

However, among young adults, the use of social network sites was found to be associated with a more favorable attitude towards public transport, suggesting that a lifestyle of being connected anytime and anywhere goes along with an increased orientation towards public transport. Overall, the results suggest that, among the Dutch, the latest trend in the digitalization of society does not play a major role in the currently observed downward trend in automobility.

Ma, T., C. Liu and S. Erdoğan (2015). "***Bicycle Sharing and Transit: Does Capital Bikeshare Affect Metrorail Ridership in Washington, D.C.?***" <http://docs.trb.org/prp/15-5660.pdf>

Bicycle sharing programs have emerged around the world as an affordable, convenient, and sustainable travel option with various benefits. One of the benefits of such programs is touted to be their positive impacts on transit ridership by increasing accessibility and providing much needed last-mile connection. Thus, locating bicycle sharing programs in transit station areas is believed to benefit the use of both modes. However, the question of how and to what extent bicycle sharing programs affect transit ridership remains to be answered despite the attempts of few empirical and quantitative studies. From the microeconomic perspective, bicycle sharing can be a substitute, complement or both to transit use. In this paper, the authors examine impacts of bicycle sharing program on rail transit ridership using Washington, D.C. as a case study. Specifically, they explore the Capital Bikeshare (CaBi) program's impact on Metrorail's ridership. Two sets of analysis are conducted (1) an Origin-Destination analysis to map quarterly CaBi trips, (2) a regression analysis to estimate the effects of CaBi trips on transit ridership controlling for other variables. The first analysis showed that Metrorail stations have been important origins/destinations of CaBi trips. Six out of seven CaBi stations with more than 500 trips are close to Metrorail stations. The result of regression analysis show that transit ridership is positively associated with CaBi ridership at the station level. Results suggest that 10 percent increase of CaBi ridership will contribute to a 2.8-percent increase in Metrorail ridership. Based on the results, policy implications and recommendations are discussed.

Newmark, G. L. and M. C. Schramm (2015). "***The Carsharing-Transit Card: Is It Good for Public Transportation?***" <http://trid.trb.org/view/1339562>

The proliferation of new shared-ride transportation services provides a unique opportunity for transit agencies to reach new markets. Unfortunately, many transit agencies are wary of partnering with private companies. To address these concerns, this research analyzes the usage data from a unique joint carsharing\transit smartcard in Chicago. This work explores the general revenue and ridership impacts of this smartcard before examining the impact of a promotional incentive of a \$50 transit credit. The research found that the joint smartcard steadily increased transit ridership and revenue. The research also found that the promotion attracted new cardholders who were more likely to reduce their public transportation use and spending than a non-incentivized group; however, the large numbers attracted by the promotion meant that on aggregate, a year later, the incentivized group still spent more than three times as much on transit as the non-incentivized control group. These findings suggest that strategic partnerships and financial incentives are successful ways to market transit. Furthermore, joint carsharing\transit smartcards represent a specific partnership with a high probability of success.



Pawlak, J., S. Le Vine, J. Polak, A. Sivakumar, and J. Kopp. 2015. **ICT and physical mobility: State of knowledge and future outlook**. Munich, Germany: Institute for Mobility Research.

[https://www.bmwgroup.com/content/dam/bmw-group-websites/bmwgroup\\_com/company/downloads/en/2015/November%202015.pdf](https://www.bmwgroup.com/content/dam/bmw-group-websites/bmwgroup_com/company/downloads/en/2015/November%202015.pdf).

Information and communications technology (ICT) is rapidly evolving and is penetrating more and more aspects of people's everyday lives, including how they travel. This study establishes the current state of knowledge regarding the relationship between ICT and physical mobility, and gives specific guidance for avenues of future research. To address these objectives, we first conducted a detailed review of the academic literature, followed by a Call for evidence, an expert Workshop and two young Adult (teenage) Workshops. We identified five distinct yet interrelated themes around which the discussion in this report is organised. We recognise that the state of knowledge is advancing very quickly in this area of research, and at present the field is characterised by many theoretical, methodological and empirical challenges. Commercial decisions and policy measures relating to ICT and physical mobility must therefore be made with explicit recognition that the current state of knowledge is continuously evolving and sometimes fragmentary. ... Does increasing use of ICT lead to changes in mode choice and car ownership decisions? The role of ICT in people's mode choices (e.g. bus, car, walking) and in car ownership appears to be, at most, secondary. Classical considerations such as prices, travel time, reliability, convenience, and prestige appear to persist as dominant factors in these decisions.

Rayle, L., S. Shaheen, N. Chan, D. Dai and R. Cervero (2015). *"App-Based, On-Demand Ride Services: Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco"* <http://trid.trb.org/view/1338744>

The rapid growth of on-demand ride services such as uberX and Lyft, or "ridesourcing," has prompted debate among policy makers and stakeholders. At present, ridesourcing's usage and impacts are not well understood. Key questions include: how ridesourcing and traditional taxis compare with respect to trip types, customers, and locations served; whether ridesourcing complements or competes with public transit; and potential impacts on vehicle kilometers traveled. The authors address these questions using an intercept survey. In spring 2014, 380 complete surveys were collected from three ridesourcing "hot spots" in San Francisco. Survey results are compared with matched-pair taxi trip data and results of a previous taxi user survey. The authors also compared travel times for ridesourcing and taxis with those for public transit. The findings indicate ridesourcing serves a previously unmet demand for convenient, point-to-point urban travel. Although taxis and ridesourcing share similarities, the findings show differences in users and the user experience. Ridesourcing wait times are markedly shorter and more consistent than those of taxis, while ridesourcing users tend to be younger, own fewer vehicles and more frequently travel with companions. Ridesourcing, like taxis, appears to both substitute for and complement public transit; the majority of ridesourcing trips would have taken substantially longer if made by public transit. Impacts on overall vehicle travel are unclear. Future research should build on this exploratory study to further understand impacts of ridesourcing on labor, social equity, the environment, and public policy.

Shaheen, S. A. and A. Bansal (2015). *"Perceptions of Peer-to-Peer Carsharing in the San Francisco Bay Area, CA, USA."* *ITE Journal* 85(5): pp 39-42. <http://trid.trb.org/view/1368026>



Peer-to-peer carsharing is an example of the growing “sharing economy,” in which owners of vehicles can use a third-party smartphone application (app) to rent out their idle cars to users for a fee. Major advancements in smartphone apps and location-based features have facilitated tremendous growth of “collaborative consumption”—the sharing of resources and services by a group of people. An innovative approach to collaborative consumption are peer-to-peer (P2P) sharing services, such as home sharing (e.g., Airbnb), equipment sharing (e.g., JustShareIt), ridesharing (e.g., Zimeride), and finally, carsharing (e.g., RelayRides). Carsharing differs from on-demand ride services, also known as transportation network companies (TNCs) or “ridesourcing,” which use apps to connect community drivers with passengers. With ridesourcing, a passenger is driven in a privately owned vehicle by the owner of that vehicle.

Sun, C. and P. Edara (2015). ***“Is Getting an Uber-Lyft from a Sidecar Different from Hailing a Taxi? Current Dynamic Ridesharing Controversy.”*** Transportation Research Record: Journal of the Transportation Research Board(2536): pp 60–66.

Ridesharing has a long, storied history, beginning as carsharing clubs during World War II and evolving into the current technologically savvy communities. Ridesharing has traditionally enjoyed the support of public agencies at all levels of government because of the potential gains in congestion relief and environmental sustainability. However, the most recent incarnation of ridesharing, dynamic ridesharing, has the taxi industry and the taxi regulatory agencies crying foul. They allege that dynamic ridesharing companies engage in unfair and deceptive practices, compete unfairly by skirting regulatory requirements, make false representations, and interfere with protected contractual relationships. This paper examines the central question in this controversy, Is dynamic ridesharing just a taxi in ridesharing’s clothing? The examination of ridesharing history and modal characteristics such as service provided, travel patterns and routes, financial compensation, and physical characteristics produces a negative answer. However, this new and exciting industry could benefit from regulations that ensure equality of access for the disabled and other classes of persons while protecting the consumer from credit fraud, personal data breach, and insurance gaps.

Delatte, A., S. Kettner, J. Schuppan and O. Schwedes (2014). ***“Urban Multimodal Travel Behaviour: Towards Mobility Without a Private Car”***.  
<http://abstracts.aetransport.org/paper/index/id/4356/confid/19>

Multimodal travel behavior has been growing for the last decades in densely populated urban areas. With its implications for a more sustainable travel behavior it has come to the fore in the area of transport and mobility research recently. While the quantitative aspects of multimodal travel behavior has been shown in some studies for Germany, material for a comprehensive analysis about peoples’ motives for multimodal travel is scarcely available. This paper provides empirical data gathered in the research project city2.e on the motivations and organization of multimodal transport use of urban car owners. Further it provides an example for their classification with respect to their willingness to reduce car use or (even) abolish the private car. The results from this study demonstrate the heterogeneity of ‘urban multimodals’ with a different openness towards alternatives to the car. In context of city2.e, multimodal travel behavior was analyzed based on a qualitative study with citizens of Prenzlauer Berg, a highly dense inner-city part of Berlin. The sample

comprises people with a private car and a contrast group of people in households without one. This allows for recommendations concerning a user-oriented approach to reorganize the use of the car in the inner city in favor of public transport modes, cycling and forms of car sharing. Different groups of multimodal car owners were identified. They need specifically targeted measures to support the use of alternative transport modes. For instance, one of the groups identified are 'multimodals with a particular preference for the car'. This group mainly uses the car for irregular transports, (family) trips and holidays. The research shows that their idea of an acceptable mobility is strongly dependent on the motive of flexibility and accessibility that they only attribute to their car. This holds true even if they have positive experiences with the use of transport alternatives in other contexts of their everyday life. Consequently, they would need information and incentives to test flexible car rental or sharing schemes which replace the private car in other contexts of use. Additionally, those schemes should be part of integrated concepts, e.g. including public transport tickets or rental car offers with extra kilometers allowing an easy organization of trips outside the city. To support a multimodal travel behavior with an emphasis on transport mode alternatives, the results suggest supplement specific restrictions that hamper the conditions of use of an own car.

Le Vine, S., Latinopoulos, C., Polak, J. (2014). "***Establishing the links between online activity and car use: Evidence from a combined travel diary and online-activity pseudo-diary data set.***" Transportation Research Record. The

linkages between online activity and physical mobility are of wide and growing interest to researchers, practitioners and policymakers. This paper presents results from analysis of Scottish Household Survey microdata, a unique large-scale, nationally-representative dataset that includes both a travel diary instrument and a pseudo-diary of online activity participation. Multivariate regression models were estimated to relate people's online-activity profiles with their car driving mileage. The models include demographic and spatial characteristics to control for potential confounding effects. It was found that, net of other effects, Internet usage is positively associated with car use. The marginal effect of time spent online was, however, found to be negative. The paper concludes with a discussion of further research needs to advance this line of enquiry.

Le Vine, S., C. Latinopoulos and J. Polak (2014). "***What is the relationship between online activity and driving-licence-holding amongst young adults?***" Transportation. DOI: 10.1007/s11116-014-9528-3

There is growing interest amongst both practitioners and researchers in the correlates of young adults' driving-licence-acquisition. One aspect of the ongoing scholarly debate is whether taking part in online (i.e. virtual) activities may be associated with young adults feeling less need to drive and hence to acquire a driving licence. This paper addresses this issue by drawing on analysis of two distinct datasets. Both contain rich pseudo-diary instruments in which people indicate detailed characteristics of their unique online-activity profile. This includes both indicators of the types of online activities in which respondents participate, and a separate metric of internet-use intensity. The latter is defined in one dataset as the amount of time per week spent online, and in the other dataset the frequency of their internet use. On the basis of a set of multivariate regression analyses, a positive (i.e. complementary) cross-sectional relationship between young adults' online activity and

licence-holding was found. We find that young adults who use the internet are, net of confounding effects, more likely to hold a driving licence than otherwise identical young adults who do not use the internet. Both datasets show this type of effect, and it is robust across a range of model specifications, including multi-stage estimations to address cross-correlation between indicators of internet usage. In addition to the positive net statistical association, we also report several other noteworthy effects.

Of the six effects associated with online-activity types that are directly comparable between the two datasets, we find that the correlation in the parameter estimates across the two datasets is 0.63. This suggests similar types of relationships across the two datasets. Also, in several (but not all) of our analyses we found an inverted 'U' shaped ceteris paribus relationship between intensity-of-internet-use and licenceholding. The positive net statistical association between internet use and licence-holding is a different relationship than previously reported in the literature, and therefore further research is needed to reconcile the differences (which are likely due at least in part to different methodological approaches and data resources). Further research is also needed to continue to resolve between the relative saliency of other hypothesised determinants of licence-holding (e.g. economic and socio-demographic explanators, as well as licence-acquisition regimes that vary by time and place).

Martin, E. W. and S. A. Shaheen (2014). ***"Evaluating public transit modal shift dynamics in response to bikesharing: a tale of two U.S. cities."*** *Journal of Transport Geography* 41: pp 315-324.

Public bikesharing—the shared use of a bicycle fleet—has recently emerged in major North American cities. Bikesharing has been found to decrease driving and increase bicycling. But shifts in public transit have been mixed. The authors evaluate survey data from two U.S. cities to explore who is shifting toward and away from public transit as a result of bikesharing. The authors explore this question by mapping geocoded home and work locations of respondents within Washington DC and Minneapolis. Respondents were mapped by their modal shift toward or away from bus and rail transit. The results show that in Washington DC, those shifting toward bus and rail transit live on the urban periphery, whereas those living in the urban core tend to use public transit less. In Minneapolis, the shift toward rail extends to the urban core, while the modal shift for bus transit is more dispersed. The authors analyze socio-demographics associated with modal shift through cross-tabulations and four ordinal regression models. Common attributes associated with shifting toward public transit include increased age, being male, living in lower density areas, and longer commute distances. The authors conclude with a discussion of the final results in the context of bikesharing's impacts on other cities throughout North America.

Schade, W., M. Krail and A. Kühn (2014). ***"New mobility concepts: myth or emerging reality?"*** [http://tra2014.traconference.eu/papers/pdfs/TRA2014\\_Fpaper\\_20038.pdf](http://tra2014.traconference.eu/papers/pdfs/TRA2014_Fpaper_20038.pdf)

Urban mobility seems to be at the edge of a transition towards a new mobility concept. Transport users will not buy and own a car anymore. Rather they will have a contract with a mobility service provider that will fulfil the whole variety of urban mobility needs, including offering the users shared cars. This concept is nowhere fully implemented, yet. However, the building blocks of such a concept seem to form in Europe, in Asia and even in some US cities. The paper describes such a new urban mobility concept based on sharing-instead-

of owning. It explains the status of the emerging building blocks that form such an urban mobility concept. New mobility options, ICT technologies both on front-end applications (smart-phones, key card systems for vehicles) and on back-end (reservation and payment systems) seem currently to become available. However, the market is still forming, but with some public transport operators, most car-manufacturers and large system operators setting-up mobility service schemes the competition is driving the development of a new mobility concept. It seems to us that transport research has largely neglected the emergence of such new mobility concepts. We are lacking behavioural studies e.g. on how a user would perform modal choice in such new concept, as well as modelling studies providing us with impacts on transport demand.

Vaidyanathan, S. (2014). "***How information and communication technologies can transform personal transportation***"

The transportation sector consumes approximately 28% of total energy used in the United States. Of that 28%, 60% is consumed by light-duty vehicles such as cars, light trucks, and motorcycles (Davis, Diegel, and Boundy 2014). In recent years, the federal government has made significant progress in limiting energy use in personal vehicles through updated mileage and emission standards. Nevertheless, there is still plenty of potential for efficiency improvements in passenger travel. A comprehensive approach to transportation efficiency requires addressing overall system efficiency in addition to vehicle efficiency. Enter intelligent efficiency, which can address the untapped efficiency potential and reduce overall energy consumption in the transportation sector. "Intelligent efficiency" is a term used to describe information and communications technologies (ICT) that can respond and adapt to external stimuli and predict future outcomes that can help reduce energy consumption (Rogers et al. 2013). This report aims to present the reader with detailed information on a sample of ICT-based strategies that are currently in use in the transportation sector and could yield energy savings. These include car and bike sharing, real-time transit information, in-vehicle ICT applications, vehicle-to-vehicle (V2V) communications, and work-based transportation demand management (TDM) programs. We also provide an estimate of energy savings for each strategy in the near term (2015) and the potential for longer term (2030) savings to give readers a sense of what the ICT and transportation landscape could look like by 2030 once a number of applications have been fully phased in. The strategies discussed in this report demonstrate that ICT can play a significant role in reducing energy consumption in the transportation sector.

Zhou, Y. and X. C. Wang (2014). "***Explore the relationship between online shopping and shopping trips: An analysis with the 2009 NHTS data.***" Transportation Research Part A: Policy and Practice 70: 1-9.

The rapid growth of ecommerce brings great changes to the transportation system. However, most existing studies focus on the impact of ecommerce on freight system. Its impact on personal trips is relatively less studied. It is reasonable to argue that online shopping reduces the need of shopping trips by making goods accessible via door-to-door deliveries. On the other hand, online shopping may also create more shopping trips as online shoppers travel to stores to experience, compare or pick up the goods. Understanding the connections between online shopping and shopping trips is critical for transportation planners to prepare for changes that information technology will continue to

bring to this nation in the future. Using the 2009 National Household Travel Survey (NHTS) data and a structural equation model (SEM), this paper disentangles the bidirectional connections between online shopping and shopping trips. Results show that online shopping encourages shopping trips while shopping trips tend to suppress the online shopping propensity. Besides, both online shopping and shopping trips are influenced by exogenous factors such as shoppers' demographic features, regional specific factors and household attributes. A closer examination at the state level further confirms model validity while disclosing spatial variation in their relationship

Alpert, L. (2013). "***Integrating Shared-Use Vehicles: Building the Next Generation of Transit***" <http://trid.trb.org/view/1240937>

This paper serves as an introduction to practitioners on shared use vehicles and several strategies to implement and integrate shared use vehicles into an existing transit or transportation network. The shared use vehicles identified are ride sharing, car sharing and bike sharing. The history and current market of each mode is reviewed. The paper includes a review of research on transit integration. The integration methods suggested are integration through street infrastructure, the fare card and information technology. Challenges of each integration method are reviewed and several case studies are explored. A policy implementation chart is included to guide practitioners in municipal government to implement an integrated transportation system that includes shared use vehicles. Policy suggestions include advocacy, coalition building, and infrastructure improvements. Short term and long term suggestions are included as well as challenges. This integrated approach being studied by researchers should begin to be implemented by policy makers and those in field. It is only through implementation and experimentation that researchers and practitioners know what will ultimately be successful. An integrated approach of shared use vehicles, transit, freight and land use is the process by which we fill the world's empty seats and create a more sustainable and long lasting transportation system.

Ball, C. (2013). "***Collaboration between public transport and car-sharing could end our love affair with the private car.***" *Public Transport International* 62(3): pp 34-35.

Car-sharing has evolved from an "alternative" option among many transportation choices to a commonsense approach to getting from point A to point B, which comfortably complements active travel and public transport. Understanding this shift in consumer behavior is crucial when working to meet the challenge of doubling the public transport market share worldwide by 2015. While Britain has yet to fully recognize this complementary relationship, there is increasing evidence of its success in strengthening intermodality, as well as opportunities for collaboration, particularly in the realm of rail and car-sharing. Examples of joint work between these two modes are given for the English Lake District, Scotland, and London, where carsharing will be included in the next version of the smart card - Oyster Card, operated by Transport for London. Including car sharing in the next generation of smart mobility will help towards the goal of tempting people out of their private cars.

Dong, Z., P. L. Mokhtarian and G. Circella (2013). "***Estimation of Changes in Rail Ridership Through Onboard Survey: Did Free Wi-Fi Make a Difference to Amtrak's Capitol Corridor Service?***"

Amtrak launched free Wi-Fi service on the California Capital Corridor (CC) on November 28, 2011. To study the impact of free Wi-Fi on ridership, an on-board survey was conducted in March, 2012. Through the descriptive analysis, several conventional factors (trip frequency in 2011, trip purpose, station to station distance and employment) as well as Wi-Fi are found to have some impact on the expected trip frequency in 2012. A linear regression model based on the specification of three market segments was built to better understand the impact of selected variables on the expected number of CC trips in 2012. According to the model results, past trip frequency is the most important predictor of future frequency. The impact of free Wi-Fi on 2012 trip frequency is statistically significant and positive for the two (lower-frequency and higher-frequency) continuing rider segments, albeit modest in magnitude. Using the estimated parameters from the model, the number of trips the sample expects to make in 2012 is 1.3% higher than would have been the case without free Wi-Fi. Furthermore, the effect clearly differs among the three segments: lower-frequency continuing riders (those using CC less than once a week in 2011) expect to make 8.5% more trips than if Wi-Fi were not available, whereas the corresponding number for higher-frequency continuing riders (using CC once a week or more in 2011) is 0.7%. Wi-Fi has no statistically significant impact on the expected 2012 trip frequency for new riders.

Dutzik, T., T. Madsen and P. Baxandall (2013). ***"A New Way to Go: The Transportation Apps and VehicleSharing Tools that Are Giving More Americans the Freedom to Drive Less"*** U.S. PIRG Education Fund Frontier Group

The rapid advance of the Internet, mobile communications technologies and social networking - and the technology-enabled transportation services they are spawning has the potential to expand the share of American households with the freedom to live without a car, or to live with fewer cars than they own today. These new tools give Americans a broader array of convenient, flexible transportation choices - enabling them to drive when and where they need to, share rides where they can, and take full advantage of the particular benefits of public transportation, bicycling and walking. Many of these new services are still in their infancy, while others are well on their way to becoming important fixtures of the nation's transportation system. Local, state and federal officials should take immediate steps to facilitate the growth of these services, while integrating emerging transportation technologies and tools into planning and decision-making for the future. This report looks at some of these emerging technologies and their impact on transportation choices. Topics covered include: social networking, carsharing, bikesharing, transit apps, ridesharing, multi-modal apps, taxi hailing and transportation network services. Policy recommendations are also included.

File, T. (2013). ***"Computer and internet use in the United States."*** Current Population Survey Reports, P20-568. US Census Bureau, Washington, DC.

In 2011, more Americans connected to the Internet than ever before, although differences continued to exist between those with use and those without. Just as with differences in use, variation in the ways that people were connecting online and the frequency of their use remained prevalent as well. This report provides household and individual level analysis of computer usage and Internet use. The findings are based on data collected in a July 2011 supplement to the Current Population Survey (CPS), which includes questions about computer ownership, Internet use both inside and outside the home, and the additional

devices that people use to go online. The U.S. Census Bureau has asked questions in the CPS about computer use since 1984 and Internet use since 1997.

Fuller, D., L. Gauvin, Y. Kestens, P. Morency and L. Drouin (2013). ***"The potential modal shift and health benefits of implementing a public bicycle share program in Montreal, Canada."*** International Journal of Behavioral Nutrition and Physical Activity 10(1): p 6.

Background: This study estimated the modal shift associated with the implementation of a public bicycle share program in Montreal, Canada. Methods: A population-based sample of adults participated in two cross sectional telephone surveys. Self-reported travel behaviors were collected at the end of the first (Fall 2009) and second (Fall 2010) season of implementation. The sample included 2502 (mean age=47.8 years, 61.8% female), and 2509 (mean age=48.9 years, 59.0% female) adult respondents in each survey. Results: The estimated modal shift associated with the implementation of the public bicycle share programs (PBSP) from motor vehicle use to walking, cycling, and public transportation was 6483 and 8023 trips in 2009 and 2010. This change represents 0.34% and 0.43% of all motor vehicle trips in Montreal. Conclusions: The implementation of a PBSP was associated with a shift toward active transportation. The modal shift was complex and not simply the result of a discrete shift from one mode to another. Promotion of active transportation should encourage integration of multiple active transportation modes to better reflect people's actual transportation behaviors.

Ettema, D., M. Friman, T. Gärling, L. E. Olsson and S. Fujii (2012). ***"How in-vehicle activities affect work commuters' satisfaction with public transport."*** Journal of Transport Geography 24(0): 215-222.

Research has recently questioned the commonly held opinion that travel time is valued as negative, arguing that engagement in activities during travel may make these trips more enjoyable or productive. Satisfaction with travel has to date been assessed using utility-based models or measures of productivity of the trip. The present study is the first to assess the influence of activities performed during travel on public transport users' subjective well-being. To this end, a survey was conducted in Sweden in 2010 in which activities during the work commute by public transport were recorded and subjective well-being during travel was measured retrospectively using the Satisfaction with Travel Scale (STS). Results show that talking to other passengers has the strongest positive effect on STS, whereas activities related to entertainment and relaxation lead to lower STS, possibly since engaging in these activities reflect unsuccessful attempts to abate boredom. In addition, it is found that activities during travel may have a more positive effect on the commute back home, suggesting that the mindset related to the destination influences travel satisfaction.

Schwieterman, J. and L. Fischer (2012). ***"Privacy Invades Public Space: The Growing Use of Portable Electronic Technology on Intercity Buses, Trains & Planes between 2009 and 2010."*** DePaul University

Travelers on intercity buses, trains, and planes increasingly are using portable electronic devices while en route. The use of these devices appears to serve two purposes at once: They enable the passenger to remain in touch with the world outside the vehicle while insulating the passenger from the noise, distractions or just plain boredom normally experienced in the interior. Whether for work or leisure, many travelers engage in



intensive digital activities that would have been almost inconceivable a decade ago. In doing so they are profoundly changing the way private individuals inhabit and experience public space. To clarify the implications of this phenomenon, this study evaluates data from 19,000 unique passenger observations on intercity trips, primarily in the United States but also on selected Canadian and Western European routes. Among the notable results are: 1. Usage of portable electronic devices rose markedly among travelers on all modes of intercity transportation in the United States between the 4th quarters of 2009 and 2010 (Table A). 2. Opportunities for using portable electronic technology continue to give passenger trains and “curbside” bus service an important competitive edge over personal automobiles and air travel. 3. Travelers on all modes are rapidly shifting toward more sophisticated devices, especially those with built-in LCD screens and Internet capability. 4. High-speed trains offer travelers particularly advantageous environments for technology usage, but even conventional trains are congenial to the practice because their generous interior dimensions offer the electronics user more personal space than the interior of a bus or airliner. 5. Use of portable electronic devices is making significant gains on commercial airlines but still lags the rate of the other modes surveyed. 6. As buses and airplanes become more crowded, consumers are less apt to use portable technology, perhaps due to concerns over privacy or lack of adequate personal space needed to manipulate devices

Cairns, S. (2011). *"Accessing cars: different ownership and use choices"*

This report examines a range of alternative ways to access cars other than by households simply owning and using their own vehicles - including renting vehicles, getting a lift and taking a taxi. Some or all of these alternative car options potentially offer a number of benefits for sustainable transport policy, such as: 1. moving people away from habitual car use, and increasing the incentive for people to consider car use in conjunction with other modes; 2. improving social inclusion by providing greater choice to those without access to a car; 3. increasing choice and flexibility by providing people with occasional access to cars (or to second cars) on a cheaper basis than personal ownership, which brings particular benefits in areas which have few other options or parking scarcity; 4. encouraging more efficient use of road space and/or parking land by reducing the space needed for cars, yielding benefits such as reduced congestion and improved streetscape in urban areas, and helping to improve quality of life; 5. both directly and indirectly facilitating the take-up of electric vehicles and other new vehicle technologies; 6. enabling people to become non-carowners, to remain as non-car-owners for longer, or to reduce the number of cars in their household; 7. encouraging or enabling people to own or use smaller or cleaner cars where larger, more fuel consumptive ones are not needed; 8. providing improved access to rail for longer journeys; 9. reducing the resources consumed, or the emissions created, by transport; 10. offering relatively popular and cost-efficient alternatives to mainstream car use.

Martin, E. and S. Shaheen (2011). *"The Impact of Carsharing on Household Vehicle Ownership."* Access 38: pp 2227. [http://www.uctc.net/access/38/access38\\_carsharing\\_ownership.pdf](http://www.uctc.net/access/38/access38_carsharing_ownership.pdf)

One of the perceived benefits of carsharing is reduced household vehicle ownership. An online survey of carsharing organizations' members gathered data about travel behavior, household vehicle ownership, and the make, model and year of each vehicle owned (to

determine fuel economy). Many carsharing households reduce their vehicle ownership, with a significant number owning no vehicles after joining a carsharing program. Carsharing also appears to keep carless households from purchasing a vehicle. Carsharing also leads to greater fuel economy since most carshare vehicles are more efficient than average.

Schwieterman, J. and L. Fischer (2011). ***"Variations in the Rates of Passenger Usage of Portable Technology on Intercity Buses, Trains and Planes: Implications for Transportation Planning."*** Journal of Transportation Law, Logistics and Policy 78(1).

In recent years, the use of portable electronic devices by passengers on intercity transportation services has risen markedly. Transportation providers support the use of such devices by installing Wi-Fi systems, power outlets, and cellular telephone signal boosters for passenger use. To fill a void in research about the effects of portable electronic technology on intercity travel behavior, this study evaluates newly collected data for 7,028 passengers on 96 bus, train, and air trips in 14 states. The paper explores how usage differs by mode and time of day as well as the implications that these differences have on various sectors of the U.S. transportation system. Interpreted broadly, the research findings suggest that the ability to use portable electronics may be a factor offsetting the longer travel times associated with certain bus and train trips, and provides a new incentive for travelers to use transportation services that operate to and from the downtown areas of major cities.

Martin, E., S. Shaheen and J. Lidicker (2010). ***"Carsharing's Impact on Household Vehicle Holdings"***, University of California, Davis: 17p.

As carsharing has expanded in North America, there has been a growing demand to understand its environmental impacts. This paper presents the results of a North American carsharing member survey. The authors establish a "before-and-after" analytical design with a focus on carsharing's impacts on household vehicle holdings and the aggregate vehicle population. The results show that carsharing members reduce their vehicle holdings to a degree that is statistically significant. The average vehicles per household of the sample drops from 0.47 to 0.24. Most of this shift constitutes one-car households becoming carless. The average fuel economy of carsharing vehicles used most often by respondents is 10 miles per gallon (mpg) more efficient than the average vehicle shed by respondents. The median age of vehicles shed by carsharing households is 11 years, but the distribution covers a considerable range. An aggregate analysis suggests that carsharing has taken between 90,000 to 130,000 vehicles off the road. This equates to 9 to 13 vehicles (including shed and postponed auto purchases) for each carsharing vehicle.

Ohta, H., S. Fujii, Y. Nishimura and M. Kozuka (2009). ***"Psychological Analysis of Acceptance of Pro-environmental Use of the Automobile: Cases for Carsharing and Eco-Car"***  
<http://trid.trb.org/view/882416>

This study conducted a web-based survey for the purpose of acquiring basic knowledge which could contribute to promotion of carsharing and eco-car that are expected to be pro-environmental use of car. Respondents were divided into 9 groups based on the number of household cars and inhabited area with modal share of cars. The survey provided different types of information on carsharing and eco-car to respondents that were randomly assigned. The data analyses shows eco-car has already prevailed, and behavioral intention to purchase it was rather high. In addition it was shown that information on the situation

that eco-car was now actually prevailing had a positive effect on the intention to purchase it. On the other hand, it was indicated that carsharing has not yet prevailed. However those who don't have automobiles or living in urban area had relatively high intention to join the organization, thus it would be effective to target them for promotion of carsharing.

Dziekan, K. (2004). ***"Customer perceptions and behavioural responses to IT-based public transport information."*** KTH Infrastructure, Stockholm, Sweden.

A considerable amount of money is spent on IT-based applications such as real-time, at-stop displays on public transport, but actual knowledge about the behavioural effects these have on customers or potential customers in real life is quite sparse. This paper presents a review of relevant literature, focussing specially on user response to public transport information via telephone, mobile devices, the Internet and at-stop displays. This paper also presents the findings of a questionnaire returned by a number of specially selected experts on how information delivered via IT applications influences the behaviour of people in reality. The experts commented on the "efficiency" of a journey, whether or not the IT systems matched customer needs, customer perceptions of reliability and trust in the system, and changes in the numbers of travellers. Both the literature review and the opinions of the experts show that more evaluation studies need to be done that include customer perspectives. The main conclusion that can be drawn from this paper is twofold—the effect of public transport information delivered via IT-based applications on modal split should not be overestimated, nor should its potential effect be underestimated.

### ***Methods to Interpret Transit Markets***

Hess, S. and G. Spitz (2016). ***"How much do attitudes and values matter in mode choice?"*** TRB Annual Meeting.

Academics have increasingly been using hybrid structures that integrate choice models with additional model components to measure the role of attitudes and perceptions. This allows the joining of models that can analyse both "hard" concepts like travel times, costs, comfort, frequency, etc. with "softer" concepts like how attitudes and values influence choice making. Most of the work to date has been academic with small samples and little effort on understanding important policy implications. In this study for NCRRP, we demonstrate how attitudes and values can influence demand and mode choice for two major US intercity corridors: the Northeast Corridor (NEC) and the Cascade Corridor. The NEC in particular is the biggest intercity corridor in the country and is in desperate need for infrastructure investment, which will cost many billions of dollars. In this study, we obtained over 6,000 respondents—a very large dataset for such an effort—to use hybrid choice models to better understand the demand for these two major US intercity rail corridors. As far as we know from the literature, this is the largest scale study of its kind using hybrid choice techniques. Additionally, and unlike most previous studies, the hybrid choice specification used here disentangles random heterogeneity from heterogeneity that is linked to attitudes. Also unlike many other studies, this study was very successful in linking attitudes to respondent characteristics (sociodemographics), thus improving the ability to deterministically predict the latent variables. *(Also documented in Final Report of NCRRP 03-02.)*

Chevalier, A. and F. Lantz (2015). ***"Personal car or shared car? Predicting potential modal shifts from multinomial logit models and bootstrap confidence intervals."*** International Journal of Automotive Technology and Management 15(2): pp 149-170.  
<http://dx.doi.org/10.1504/IJATM.2015.068549>

Daily household mobility in France is characterised by the supremacy of the automobile. The main objective of this paper is to explain the modal choice of French households for their daily trips and to predict potential shifts from personal car to shared car. A multinomial logit model is estimated and reveals the particular importance of motorisation on modal choices. A conditional logit model is also estimated and shows no particular importance of the costs in the shared car deployment. Moreover, the increase in distances between 2010 and 2020 makes motorised modes more necessary. Simulations show that personal car should remain the main mode of transportation by 2020 except if households have no car. In that case, public transport would become the main transport mode and the shift to shared car would be at a maximum. Thus, personal car and public transport should remain the main modes of transportation by 2020.

de Luca, S. and R. Di Pace (2015). ***"Modelling users' behaviour in inter-urban carsharing program: A stated preference approach."*** Transportation Research Part A: Policy and Practice 71: pp 59-76.

In this paper, the effects of an inter-urban carsharing program on users' mode choice behaviour were investigated and modelled through specification, calibration and validation of different modelling approaches founded on the behavioural paradigm of the random utility theory. To this end, switching models conditional on the usually chosen transport mode, unconditional switching models and holding models were investigated and compared. The aim was threefold: (i) to analyse the feasibility of an interurban carsharing program; (ii) to investigate the main determinants of the choice behaviour; (iii) to compare different approaches (switching vs. holding; conditional vs. unconditional); (iv) to investigate different modelling solutions within the random utility framework (homoscedastic, heteroscedastic and cross-correlated closed-form solutions). The set of models was calibrated on a stated preferences survey carried out on users commuting within the metropolitan area of Salerno, in particular with regard to the home-to-work trips from/to Salerno (the capital city of the Salerno province) to/from the three main municipalities belonging to the metropolitan area of Salerno. All of the involved municipalities significantly interact each other, the average trip length is about 30 km a day and all are served by public transport. The proposed carsharing program was a one-way service, working alongside public transport, with the possibility of sharing the same car among different users, with free parking slots and free access to the existent restricted traffic areas. Results indicated that the inter-urban carsharing service may be a substitute of the car transport mode, but also it could be a complementary alternative to the transit system in those time periods in which the service is not guaranteed or efficient. Estimation results highlighted that the conditional switching approach is the most effective one, whereas travel monetary cost, access time to carsharing parking slots, gender, age, trip

frequency, car availability and the type of trip (home-based) were the most significant attributes. Elasticity results showed that access time to the parking slots predominantly influences choice probability for bus and carpool users; change in carsharing travel costs mainly affects carpool users; change in travel costs of the usually chosen transport mode mainly affects car and carpool users.

Fu, X. and Z. Juan (2015). **"Transit commuting market investigation using the latent segmentation approach."** *Travel Behaviour and Society* 2(2): pp 102-108.  
<http://dx.doi.org/10.1016/j.tbs.2014.11.001>

This study employs a latent segmentation approach to investigate the commuting market, with focus on the usage of public transit. The factor-cluster analysis technique is used to systematically deal with multidimensional psychological statements, and then segment the whole sample into homogenous groups. A six-cluster solution is arrived, each with distinct combinations of latent factors, including attitude, perception, habit, and intention to use public transit. On account of the unique psychological profile of each segment, related measures and strategies are proposed to promote the choice of public transit for each sub-segment. The results demonstrate that individuals within different segments must be treated in different ways since their behavior are motivated by different factors.

Molin, E., P. Mokhtarian and M. Kroesen (2015). **"Multimodal Travel Groups and Attitude: Latent-Class Cluster Analysis"**. <http://trid.trb.org/view/1337752>

For developing sustainable travel policies, it may be helpful to identify travelers that make use of more than one mode in a given time period, hence multimodal travelers. Especially it is of interest to identify car drivers who also use public transport, as it is suggested in the literature that this group may have less biased public transport perceptions and may develop different attitudes towards public transport. As this has not received much research attention yet, this is the focus of this paper. Latent class cluster analysis is applied to identify multimodal travel groups based on the frequency of use of car, bicycle, train and BTM (bus, tram, metro). In addition, the authors explore the effects of a range of socio-demographic, work related and mode perception and attitude variables on the probability of belonging to each of the five identified multimodal travel groups. The results indicate that the group who uses the car most often indeed has more negative perceptions and attitudes towards public transport, while frequent car users who also use public transport have less negative public transport perceptions and attitudes. Furthermore, the authors found that the group who uses public transport most often is not the most positive about public transport. The latter is the case for the group who bicycles most often and also uses public transport. The results further indicate relatively favorable car attitudes among the public transport group, suggesting that at least part of this group will use the car more often once they can afford it.

Liao, H., S. Farber and R. Ewing (2014). **"Compact Development and Preference Heterogeneity in Residential Location Choice Behavior: A Latent Class Analysis"**.  
<http://trid.trb.org/view/1287402>

Despite the known benefits of compact development—such as reduced vehicle miles traveled, increased transit use, and healthy outcomes—successful transportation and land use planning efforts require accurately gauging the public demand for these alternative development forms. Drawing upon a discrete choice experiment in the Wasatch Front, the

largest metropolitan region in the state of Utah, this paper uses a market segmentation approach to identify preference heterogeneity in residents' location choices toward compact, walkable, and transit-friendly neighborhoods. Results derived from a latent class analysis suggest that strong preferences for compact development are more likely to occur among families with less schoolage children, low-income and renter-occupied households, as well as those with greater focus on healthy lifestyle. By comparing respondents' preferences to their actual residential locations and travel patterns in two contrasting sub-regions, the authors also address the complex relationships between environment, preferences, residential locations, and travel behavior. The results imply that taking into account preference heterogeneity and a better understanding of people's transportation-land use preferences can help transport planners fulfill the potential of compact development and contribute to a sustainable future.

Clifton, K., J. Liu and R. Chen (2013). ***"Understanding Market Segments for Current and Future Residential Location and Travel Choices"***

This project aims to examine the connections between residential location choices and travel at the household level with an emphasis on identifying current residents' preferences for their future housing, neighborhood and transportation choices (collectively referred to as lifestyle choices) that can be used in scenario planning exercises. The goal is to understand how future lifestyle aspirations relate to current choices. This work builds on a current project, funded by the Oregon Department of Transportation (ODOT), that employs data from the recent Oregon Household Activity Survey (OHAS) to define discrete market segments of lifestyle choices based upon the revealed preferences for housing, neighborhoods and travel. In this proposed second phase, a sample of people in each of these market segments will participate in this study, which relies upon experimental survey techniques and visualization tools to see how these lifestyle preferences may change over the life course and may differ from currently held assumptions about these preferences. Understanding the changes in preferences is key to improving the presentation of residential locations choices in integrated land use and travel demand models. As communities struggle to address challenges related to public infrastructure provision, climate change preparation, energy and natural resource consumption, and the creation of a livable future given present economic uncertainty and constraint, land use and transportation plans have become predicated on certain assumptions about the market for various housing types, residential environments and travel modes. If planners lack faith in the estimates from these models, the long range supply of housing, mix of uses, and other land use characteristics will be insufficient to meet future demands. This research will inform these assumptions and contribute to a more robust understanding of the public's desires and how they may be accommodated in future scenarios.

Hensher, D. A., J. M. Rose, W. Leong, A. Tirachini and Z. Li (2013). ***"Choosing Public Transport—Incorporating Richer Behavioural Elements in Modal Choice Models."*** *Transport Reviews* 33(1): pp 92-106.

The development of behaviourally richer representations of the role of well-established and increasingly important influences on modal choice, such as trip time reliability and accounting for risk attitude and process rules, has moved forward at a fast pace in the context of automobile travel. In the public transport setting, such contributions have, with

rare exception, not been considered. In this paper, the authors discuss and empirically illustrate the merits of advanced modelling developments aimed at improving the understanding of public transport choice, namely the inclusion of reliability in extended expected utility theoretic forms, to recognize risk attitude and perceptual conditioning, the consideration of passenger crowding and its inclusion in linear additive models, and the role of multiple heuristics in representing attribute processing as a way of conditioning modal choice. The authors illustrate the mechanics of introducing these behaviourally appealing extensions using a modal choice data set collected in Sydney.

Hunecke, M., S. Haustein, S. Böhler and S. Grischkat (2010). ***"Attitude-Based Target Groups to Reduce the Ecological Impact of Daily Mobility Behavior."*** *Environment and Behavior* 42(1): 3-43.

This study analyzes the usefulness of an attitude-based target group approach in predicting the ecological impact of mobility behavior. Based on a survey of 1,991 inhabitants of three large German cities, constructs derived from an expanded version of the Theory of Planned Behavior were used to identify distinct attitudebased target groups. Five groups were identified, each representing a unique combination of attitudes, norms, and values. The groups differed significantly from each other with regard to travel-mode choice, distances traveled, and ecological impact. In comparison with segmentations based on sociodemographic and geographic factors, the predictive power of the attitude-based approach was higher, especially with regard to the use of private motorized modes of transportation. The opportunities and limits of reducing the ecological impact of mobility behavior on the basis of an attitude-based target group approach are discussed.

Ayvalik, C., K. Prossaligou, R. Greene-Roesel and C. Wornum (2008). ***"TOD Choices Study - Market Segmentation Results."*** M. T. Commission. MTC Library

Most service providers understand that not all their customers are the same. The private sector has long used market research to investigate customer attitudes and preferences in order to develop and target products and service at specific market segments. This study extends private market research techniques to identify the market segments for all those looking for an apartment or house. This research starts with a survey of Bay Area households that have recently moved or are planning to move. By surveying the attitudes of these "movers", it is possible to divide them into market segments, each with distinct attitudes and preferences. The segmentation will ultimately give public agencies critical information regarding public amenities and policies that can make Transit Oriented Developments (TOD) a more attractive choice to specific market segments. Market segmentation is a multi-step process. This document describes each of the steps, which are: 1. Gathering of information on the attitudes of the target group (new movers). 2. Analysis of the attitudes to identify underlying attitudinal dimensions or "factors", which represent combinations of attitudinal statements. This step includes both exploratory and confirmatory factor analysis. 3. Structural Equations Modeling (SEM), which links each factor with a set of related socioeconomic characteristics. 4. Cluster analysis, which defines unique market segments based on respondents' socioeconomic characteristics and the importance they attach to each factor.



Shiftan, Y., M. Outwater and Y. Zhou (2008). ***"Transit market research using structural equation modeling and attitudinal market segmentation."*** Transport Policy 15(3): 186-195

This paper presents a comprehensive approach for identifying potential transit markets and for developing strategies to increase public transport ridership. The approach uses structural equation modeling (SEM) to identify simultaneously travelers' attitudes, travel behavior, and the causal relationships between a traveler's socioeconomic profile and his/her attitude toward travel. Travel attitudes are also used to identify distinct market segments and to develop plans that best serve the needs of each segment and increase transit ridership. The approach is demonstrated with a case study from the Utah Transit Authority.

Karash, K., M. Coogan and T. Adler (2007). ***"Exploring Market Support for New Products and Services for Transit and Walking: New Market Research Approach."*** Transportation Research Record: Journal of the Transportation Research Board (Issue Number: 2034 ISSN: 0361-1981).

This paper concerns the relationship between mobility products and services and the propensity to change travel behavior. In an online panel survey, 501 respondents answered questions about their attitudes toward increasing their use of transit and walking. The questions first established base conditions for variables specified by the theory of planned behavior. Respondents were then exposed to seven products and services. A follow-up set of questions revealed shifts in key attitudes. New products and services may influence the traveler's personal inclination to change modal behavior, belief that a change in modal behavior might be socially acceptable, and belief or self-confidence that he or she can change modal behavior. These three attitudinal categories were examined for four market segments, two more positive and two more negative. The positive segments included the transit loyalists, who were already heavy users of transit, and the environmental mode changers, who were not heavy transit users but who wanted to help the environment. Both positive segments significantly shifted their ratings of the social acceptability of transit with the improvements. However, the segments differed in terms of what factors were associated with the improved social acceptability. For the environmental mode changers, the strongest association was with concern about being lost or stranded on public transportation, whereas for the transit loyalists, the strongest association was with being able to depend on public transportation to be timely. However, it is unclear from this research which products and services contribute to improved social acceptability.

Anable, J. (2005). ***"'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using attitude theory."*** Transport Policy 12(1): 65-78.

Using an expanded version of a psychological theory of attitude-behaviour relations, namely the theory of planned behaviour (TPB), scores on factor analysed multi-dimensional attitude statements were used to segment a population of day trip travellers into potential 'mode switchers' using cluster analysis. Six distinct psychographic groups were extracted, each with varying degrees of mode switching potential. Each group represents a unique combination of preferences, worldviews and attitudes, indicating that different groups need to be serviced in different ways to optimise the chance of influencing mode choice behaviour. Sociodemographic factors had little bearing on the travel profiles of the segments, suggesting that attitudes largely cut across personal characteristics. The evidence clearly shows that the same behaviour can take place for different reasons and that the

same attitudes can lead to different behaviours. The paper asserts that commonly used a priori classifications used to segment populations based on demographic variables or simple behavioural measures may oversimplify the structure of the market. Cluster analysis is rarely used in studies of travel behaviour but this study demonstrates its utility in providing a way of extracting naturally occurring, relatively homogenous and meaningful groups to be used in designing targeted hard and 'soft' transport policies.

Vermunt, J. K. and J. Magidson (2005). ***"Factor analysis with categorical indicators: A comparison between traditional and latent class approaches."*** New developments in categorical data analysis for the social and behavioral sciences: 41-62.

The linear factor analysis (FA) model is a popular tool for exploratory data analysis or, more precisely, for assessing the dimensionality of sets of items. Although it is well known that it is meant for continuous observed indicators, it is often used with dichotomous, ordinal, and other types of discrete variables, yielding results that might be incorrect. Not only parameter estimates may be biased, but also goodness-of-fit indices cannot be trusted. Magidson and Vermunt (2001) presented a nonlinear factor-analytic model based on latent class (LC) analysis that is especially suited for dealing with categorical indicators, such as dichotomous, ordinal, and nominal variables, and counts. The approach is called latent class factor analysis (LCFA) because it combines elements from LC and traditional FA. This LCFA model is one of the LC models implemented in the Latent GOLD program (Vermunt & Magidson, 2000, 2003).

Zhou, Y., K. Viswanathan, Y. Popuri and K. E. Proussaloglou (2004). ***"Transit district customers in San Mateo County, California: who, why, where, and how."*** Transportation Research Record: Journal of the Transportation Research Board 1887(1): 183-192.

In the face of declining transit market share and an increase in population and jobs, transit agencies have to go beyond the traditional approach of trying to balance between maximizing ridership and meeting the needs of those who are most dependent on transit. Innovative approaches that account for customer perceptions and attitudes towards transit need to be undertaken in an effort to make transit a more attractive option for customers. This study reports the efforts of the San Mateo County Transit District (SamTrans) to understand customer attitudes and perceptions and create market segments that reflect and account for traveler attitudes. The study uses a Structural Equation Modeling (SEM) approach along with cluster analysis to identify market segments in the population that can be targeted for new services to be offered by SamTrans. In addition, the results of the market segmentation are applied spatially so that SamTrans can customize their response to address individual market areas. The results of the market segmentation were applied based on a mode choice model that determines the market share for competing auto, bus and enhanced transit modes. This study provides SamTrans with the means of identifying the spatial and modal distribution of their service market based on customer needs. This approach allows SamTrans to design transit services that compete more effectively in the target geographic markets addressing the needs of individual market segments.

Outwater, M. L., S. Castleberry, Y. Shiftan, M. Ben-Akiva, Y. S. Zhou and A. Kuppam (2003). "***Use of structural equation modeling for an attitudinal market segmentation approach to mode choice and ridership forecasting***". 10th International Conference on Travel Behaviour Research, Lucerne, Switzerland, Citeseer

The San Francisco Bay Area Water Transit Authority is evaluating expanded ferry service, as required by the California Legislature. As part of this process, Cambridge Systematics developed forecasts using a combination of market research strategies and the addition of non-traditional variables into the mode choice modeling process. The focus of this work was on expanding the mode choice model to recognize travelers' attitudes and different types of urban travelers making different modal choices. We used structural equation modeling to simultaneously identify the attitudes of travel behaviours and the causal relationships between traveler's socioeconomic profile and traveler attitudes. We extracted six attitudinal factors, three of which were used to partition the ferry riding market into eight segments. These market segments were used to estimate stated-preference mode choice models for 14 alternative modes, which separated the traveler's reaction to time savings by market segment and recognized that modal choices are different for market segments that are sensitive to travel stress or desire to help the environment. The new mode choice models were applied within the framework of the Metropolitan Transportation Commission's regional travel model and calibrated to match modal shares, modes of access to each ferry terminal, ridership by route and time period, and person trips by mode at screenline crossings. Additional validation tests of significant changes in ferry service in recent years were used to confirm the reasonableness of the SP model. The model has been applied for three future year alternatives and to test the sensitivity of pricing, service changes and alternative transit modes.

Elmore-Yalch, R. (1998). "***TCRP 36: A Handbook: Using Market Segmentation to Increase Transit Ridership***"

This handbook will be of interest to transit managers, marketing professionals, planners, and others interested in the potential implementation of market segmentation strategies to increase transit ridership. Market segmentation is the identification of groups of people--or market segments--that have similarities in characteristics or needs who are likely to exhibit similar purchase behavior and/or responses to changes in the marketing mix. This handbook provides an overview of market segmentation--what it is and why it is relevant to public transit agencies. It serves as an introduction for managers to the basic concepts and approaches of market segmentation and provides steps and procedures for marketers or market researchers who have the responsibility for implementing a market segmentation program. The handbook places special emphasis on issues that must be addressed when using market segmentation, procedures and terminology that one may encounter in connection with segmentation, problems likely to arise in implementing segmentation studies, ways to encourage the use of market segmentation at transit agencies, and methods to translate segmentation findings into strategy. Private and public sector examples of market segmentation analyses are used extensively throughout the handbook to illustrate concepts presented. In addition, the handbook provides the results of market segmentation

analyses performed as part of this project at three demonstration transit agencies: Boise Urban Stages, the Milwaukee County Transit System, and the Washington Metropolitan Area Transit Authority. As a result of these demonstrations, key market segments are identified and reported in the handbook.