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The built environment and travel behavior: making the connection

Jessica Y. Guo · Cynthia Chen

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We are thrilled to serve as guest editors of this third special issue of *Transportation* on a much debated topic: the inter-relationship between the built environment and travel behavior. Comprising five papers presented at the *2007 Annual Meeting of the Transportation Research Board* (TRB) and subsequently accepted for publication, this special issue displays a continued partnership between *Transportation* and TRB in their commitment to take on emerging and timely issues and disseminate the state-of-the-art knowledge to a worldwide audience.

The proposition that the built environment influences individuals' travels is not new. As early as in 1958, the now well-known *Chicago Area Transportation Study* revealed an inverse relationship between auto ownership and population density (Hamburg 1958). In the following year, the *Highway Research Board Bulletin 230* also showed population density as a major factor influencing transit and automobile use in urban areas (Adams 1959). What is new about this most recent surge of interest is the cross-discipline dialogue on the mix of concepts, methods, and evidence about the connection between the built environment and travel. Particularly noteworthy is that this recent dialogue has taken place amid an atmosphere that increasingly emphasizes sustainability at all levels. Policy makers are looking to modifying the built environment as a strategy to modify individual travel behavior and in turn mitigate the adverse congestion, environmental, and health impacts of auto dependency.

To date, the literature pertaining to the connection between the built environment and travel behavior strikes at several directions and presents very mixed findings about the true nature of this interrelationship. Foremost among them is the dialogue centered on the topic

J. Y. Guo (✉)
Civil and Environmental Engineering, University of Wisconsin – Madison, 1206 Engineering Hall, 1415 Engineering Drive, Madison, WI 53706, USA
e-mail: jyguo@wisc.edu

C. Chen (✉)
Civil Engineering, City College of New York, 140th Street and Convent Avenue, New York, NY 10031, USA
e-mail: c.chen@ccny.cuny.edu

of residential self-selection (also known as residential sorting) which refers to the phenomenon that households and individuals locate themselves to support their travel preferences. For example, people who enjoy walking may choose to live in high-density, mixed land use areas. This suggests that the increased pedestrian movements found in a neighborhood with new mixed land use development may be due to walk-inclined residents moving into the neighborhood, as opposed to existing residents becoming to walk more. In order to properly inform policies based on built environment designs, a priority in this research area is to assess the impact of the built environment on travel behavior while appropriately controlling for the residential self-selection effect.

This special issue includes three papers that focus on addressing the issue of residential self-selection, each taking a different analytical approach. In the first paper, Cao et al. report a quasi-longitudinal study of 547 individuals from Northern California who recently made a residential move. Their analysis focuses on identifying the directions of the causal relationships among the changes in car ownership, travel behavior, and built environment. This is achieved by applying the structural equations modeling (SEM) framework, in which the endogenous variable of one equation enters as an exogenous variable in another equation and multiple equations are estimated simultaneously. Among the several model specifications examined in the study, the final preferred specification consists of structural equations for changes in car ownership, changes in attractiveness, changes in outdoor spaciousness, changes in accessibility, changes in driving behavior, and changes in walking behavior. Exogenous variables considered include socio-demographic attributes, travel-related attitudes and preferences for environment qualities. Their empirical results suggest that environmental preferences and travel-related attitudes can influence travel behavior either directly, or indirectly through their influence on residential location choice. The study also shows a causal relationship between the built environment and driving/walking behavior. Specifically, increased accessibility is found to decrease driving; whereas improved neighborhood attractiveness, physical activity options, safety, and ease for socializing are found to increase walking. In other words, making desired destinations more accessible and providing a residential environment supportive of alternative modes of transportation are promising strategies for reducing driving and increasing walking.

The second paper in this collection also addresses the self-selection issue by simultaneously considering multiple endogenous variables in a single modeling framework. However, as opposed to using the SEM approach as in Cao et al., Pinjari et al. propose to jointly model two sets of random utility functions, one set corresponding to an individual's residential location choice and the other corresponding to the commute mode choice. Residential self-selection is captured by deterministic and stochastic components common to both sets of utility equations. Specifically, observed social-demographic characteristics that may influence both residential location and commute mode choices are simultaneously included in the utility equations for both choice dimensions. Unobserved attributes (such as individuals' attitudes) that may influence both choice dimensions are controlled for through the common stochastic component embedded in both utility equations. The modeling framework is applied to travel survey data collected for 1878 sampled residents in the Alameda County, California. The empirical results illustrate residential sorting due to observed attributes such as auto and bicycle availability, income, household size, and race. Moreover, there is evidence of unobserved factors related to commute time that simultaneously impact both residential location and mode choices. That is, unobserved factors that lead to an individual's preference for residential locations with shorter commutes would also lead to the individual's preference for the faster auto mode. This empirical evidence highlights the need to account for such endogeniety. After the effects of

residential sorting are controlled for, built environment attributes such as land use mix and population and employment density are found to have significant impacts on commute mode choice, suggesting the possibility of achieving modal shift through build environment changes.

The study by Hedel and Vance not only offers a different analytical approach to address the self-selection issue, but also offers insights into the urban form and travel connection in the European context. Their analysis is based on the German Mobility Panel data and considers variables describing the individual travelers, their associated households, and the ZIP code area of residence. They propose a two-stage modeling approach, referred to as the two-part model (2PM). The first stage involves estimating the so-called 'selector equation', in which an individual's decision to drive a car on a given travel day is regressed against socio-demographic and urban form factors. In the second stage, referred to as the outcome equation, the dependent variable is the total distance driven conditional on the individual's decision to drive. Two series of empirical models are developed. The first series of models assumes that urban form is exogenous to travel. The second series accounts for the possibility of endogeneity by introducing four measures of socio-demographic composition and architectural characteristics of the ZIP code areas as instrumental variables (IV). These IV are chosen because of their apparent correlation with urban form variables but little association with mobility decisions. The validity of the chosen IV is verified and generally supported by several statistical tests. An interesting observation drawn from the empirical results is the significant discrepancies between the urban form parameter estimates obtained for the non-instrumented and for the instrumented models, even though the socio-demographic parameter estimates are similar in magnitude between the two series of models. The statistically significant urban form variables include commercial density, roadway density, and walk access time to transit. Similar to the findings of Cao et al. and Pinjari et al., Hedel and Vance have provided statistical evidence to support the causal relationship between the built environment and individuals' travel decisions even after the residential sorting effects are controlled for.

While much of the existing literature focus on the short-term responses in travel behavior due to the influence of the built environment, Susilo and Maat put the evolving influence of the built environment at the center of their investigation. They argue that, while the built environment clearly influences travel behavior, the level of its impact will not remain stable over time. To understand this instability, they set out to examine the influence of the built environment on the long-term commuting pattern in the Netherlands. The 1995, 2000, and 2005 waves of the Dutch Travel Survey are used in the study. The built environment is described by data at the municipality level, which include a set of variables that distinguishes municipalities on the level of urbanization, job availability and accessibility, and transportation network density and accessibility in the home municipality. Their investigation lies upon four parameters of the commuting pattern: work place location, commute distance, commute mode, and commute time. For each parameter, three models are estimated, corresponding to each of the three selected waves. To evaluate the evolving trend of impact of the built environment, the authors first estimate a model comprising only socio-economic and demographic variables, followed by a model with added built environment variables. By examining the change in the goodness of fit measure over time, they determine the long-term influence of the built environment on the commuting pattern in the Netherlands. The empirical results confirm their hypothesis that the built environment influence on commuting has changed over time. The exact nature of the change varies over time when a unique parameter of the commuting pattern is concerned. While the level of influence has declined in some cases such as work location, the trend

appears to diverge in other cases. Overall, the influence of the built environment does not overcome that of socio-economic characteristics, suggesting that policies relying entirely on urban form reforms will not likely be successful.

The uniqueness of Krizek et al.'s study is its focus on the mode of bicycling. Their study aims at answering two important and related questions. First, how far cyclists are willing to travel to use a trail? And second, what are the contributing factors explaining cyclists' willingness to travel to access a trail? To answer these two questions, the authors employ data collected from users of an urban trail system in Minnesota. A distance decay function that relates the distance cyclists are willing to travel to use a trail and the percentage of trips surveyed suggests that over one-half of the users cycle less than 2500 m to use the trail and more than three-quarters of the users cycle less than 5000 m. As expected, the distance decay curve for recreational trips are flatter than those for shopping curves, suggesting a less elastic response to the distance. While the distance decay curve provides an estimate on the threshold of the access distance, the question remains as to what factors can explain the varying access distances observed in the survey. The authors approach this question by estimating two linear regression models on the distanced traveled (model 1) and the additional distance cyclists traveled over the calculated shortest path routes (model 2). Model 1 uncovers three significant variables in explaining the distance traveled: the age of the respondent, the location of the trail, and the number of intersections along the trail. The results of the model 2 suggest that the difference between the observed traveling distance and the calculated shortest path distance can be traced back to two significant variables: the difference in the number of intersections and the length of the trip traveled along a trail. The positive coefficient on the latter variable exhibits an expected and collaborative relationship between the distance traveled on a trail and the willingness to access. The results of this study have practical implications in locating off-road bicycle facilities.

The papers assembled in this special issue have lent us valuable insights into several important aspects, namely, residential self-selection, interaction between long-, medium- and short-term choices, the long-term perspective on the influence of the built environment, and a focus on a physically active mode: bicycling. These papers—together with the many related papers presented at the TRB annual meetings and subsequently published in the *Transportation Research Record: Journal of the Transportation Research Board* series—have greatly advanced our knowledge regarding the interrelationship between the built environment and travel behavior. Nevertheless, much remains to be explored in this field. New built environment variables need to be conceptualized and measured to expand the range of environmental aspects that are currently under examination. Longitudinal data need to be collected and analyzed to help separate the causes from the effects. Improved modeling methods need to be developed to assess and filter out the effects of residential self-selection. New theories need to be cultivated to better understand the underlying process that the built environment has on travel behavior. It is our hope that the findings and discussions presented in the current issue will stimulate ideas in our continued inquiry in this area.

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Author Biographies

Dr. Jessica Y. Guo is an Assistant Professor in the Department of Civil and Environmental Engineering at the University of Wisconsin—Madison, where she has been teaching and conducting research in transportation modeling and planning since 2006. Her research focuses on the application of econometric methods and advanced computing techniques in studying travel behavior, built environment, and urban systems in general. She is the current Chair of the Research Agenda Subcommittee under the TRB Committee on Transportation Demand Forecasting.

Dr. Cynthia Chen is an Assistant Professor in the Department of Civil Engineering at City College of New York. Her research interests spans several areas, including short-term activity and travel behavior, long-term residential selection, pedestrian and bicyclists safety, and transit riderships. She currently co-chairs the Time Use and Activity Patterns Subcommittee under the TRB Committee on Traveler Behavior and Values.