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A pathway linking smart growth neighborhoods to home-based pedestrian travel

Steven R. Gehrke *, Kelly J. Clifton

Department of Civil & Environmental Engineering, Portland State University, 1930 SW 4th Avenue, Suite 200, Portland, OR 97207, USA

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ABSTRACT

Land development patterns, urban design, and transportation system features are inextricably linked to pedestrian travel. Accordingly, planners and decision-makers have turned to integrated transportation-land use policies and investments to address the pressing need for improvements in physical activity levels via the creation of walkable communities. However, policy questions regarding the identification of smart growth indicators and their connection to walking remain unanswered, because most studies of the built environment determinants of pedestrian travel: (a) represent the built environment with isolated metrics instead of as a multidimensional construct and (b) model this transportation-land use relationship outside of a multidirectional analytic framework. Using structural equation modeling, this Portland, Oregon study identifies a second-order latent construct of the built environment indicated by land use mix, employment concentration, and pedestrian-oriented design features. Study findings suggest this construct has a strong positive effect on the household-level decision to walk for transportation and discretionary trip purposes.

1. Introduction

Urban planners and transportation experts have pointed to smart growth development as a response to a pressing need for improving transportation-related physical activity levels and environmental quality (Saelens et al., 2003). The prevailing rationale is that land development patterns and urban design, which are impacted by transportation policies and investments, are inextricably linked to travel behaviors and outcomes (Handy, 2005). This connection underscores a desirability for smart growth communities, which bring residents closer to out-of-home activity destinations and improve their feasibility of reaching those locations by walking (Handy et al., 2002). Accordingly, smart growth and other integrated transportation-land use investment strategies must continue to be pursued in order to develop activity friendly, walkable environments that support increased physical activity (Frank and Kavage, 2009).

Smart growth neighborhoods exhibit compact development patterns with higher densities, land use diversity, and a pedestrian-friendly design aimed at minimizing automobile use for short trips (Downs, 2005). The formation of these sustainable communities was a policy goal in the 2014–2018 strategic plan of the US Environmental Protection Agency and previously envisioned within a suite of livability principles guiding its 2009 Interagency Partnership for Sustainable Communities with the US Departments of Transportation and Housing and Urban Development. However, questions regarding the identification of a set of built environment indicators and creation of commonly accepted standards for what constitutes a walkable, smart growth neighborhood largely continue to be unanswered (Clifton et al., 2007). An unlikely circumstance that exists despite a popularity in transportation-land use research rising from the potential to moderate travel behaviors and patterns by altering the physical environment in accordance with smart growth policy (Ewing and Cervero, 2010).

This policy discussion remains because past active travel behavior studies have adopted imperfect measures to reflect the interrelated dimensions characterizing the built environment (Handy et al., 2002). Although recent studies have used more sophisticated statistical methods to estimate the effects of more environmental factors (Ewing and Cervero, 2010), these studies tend to depict the built environment as a series of isolated measures rather than a comprehensive collection of synergistic indicators reflecting its multidimensionality. Factor analysis has gained approval as one method to derive generalized dimensions of neighborhood character from isolated measures that may display conceptual or empirical redundancy (Song and Knaap, 2007). The use of this method to

* Corresponding author.
E-mail addresses: sgehrke@pdx.edu (S.R. Gehrke), kclifton@pdx.edu (K.J. Clifton).

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recognize the built environment as a multidimensional concept can offer insight into measurement selection and the cumulative impact of altering interrelated land development pattern, urban design, and transportation system factors comprising this higher-order construct on travel behavior.

The impact of residing in a smart growth neighborhood on walking may also not be fully realized because the indirect effects of the various explanatory factors influencing one another and travel behavior have been inadequately examined (Van Acker et al., 2007). A host of individual, societal, and contextual factors is hypothesized to predict walking for both transportation and recreational purposes (Pikora et al., 2003). However, by not accounting for the indirect effects of these characteristics, which may diminish or confound the total effect of the built environment on pedestrian travel, studies may offer an incomplete picture of this transportation-land use connection. In all, the precise nature of residing in a smart growth community on travel behavior cannot be entirely understood without a conceptual and methodological framework specifying the many pathways to and determinants of travel (Bagley and Mokhtarian, 2002).

The objectives of this study are twofold. First, this study introduces a multidimensional concept of the physical environment reflecting several heralded tenets of smart growth policy. Second, this paper proposes a framework linking this second-order environmental construct and sociodemographic aspects to pedestrian travel and tests these complex interactions using structural equation modeling (SEM). By doing so, this paper offers a novel and robust measure of what constitutes a smart growth neighborhood and extended understanding of how this multidimensional concept influences household-level pedestrian travel.

2. Literature review

Of the existing studies linking a built environment construct to travel behavior using SEM techniques, the measurement of identified indicators has been either objective, perceived, or some combination (Ma et al., 2014). Further, once a construct has been confirmed, a number of travel outcomes and behaviors have been explored by using pathways illustrated in a variety of proposed conceptual frameworks. The following subsections review the SEM evidence base linking built environment constructs to travel and recommend a conceptual framework to guide this study's analysis of household-level pedestrian travel.

2.1. Structural equation models of the transportation-land use connection

While most transportation-land use studies focus on objective built environment measurement, several SEM applications have identified built environment constructs based on individual perceptions. These studies have explored themes of neighborhood accessibility (Cao et al., 2007; Cao, 2016), arrangement and aesthetic (Aditjandra et al., 2012; Aditjandra and Mulley, 2016; Banerjee and Hine, 2016) and sense of place (Deutsch et al., 2013) to recognize their influence on automobile ownership and travel mode choice. Other studies have identified residential environments as single constructs containing both perceived and objective indicators (Bagley and Mokhtarian, 2002) or as distinct constructs reflecting an individual's objective and perceived residential environment (Ma et al., 2014).

In a San Francisco Bay Area study, Bagley and Mokhtarian (2002) identified separate constructs for traditional and suburban environments to estimate the impact of neighborhood types, lifestyles, and attitudes on miles traveled via automobile, public transit, and active transport. The objectively measured indicators of the traditional environment included population density, grid-like street design, and speed limit of the road (Bagley et al., 2002). In a Portland-based study examining the effect of objective and perceived environments on monthly cycling rates, Ma et al. (2014) described an objective environment with built environment indicators including the number of business establishments, percent of connected streets, and miles of bike infrastructure near an individual's home. Consequently, the construct better represented an objective bicycling environment rather than a residential environment; underscoring the importance in selecting measurement variables that reflect a residence's overall built environment (de Abreu e Silva et al., 2012a).

In the European context, several studies have examined the impact of land development patterns on travel behavior. Van Acker et al. (2007) examined this path with a land use factor reflecting the distance to public transit and two categorical indicators of the residential environment in Flanders. Their results indicated land use had a positive direct effect on a travel behavior construct reflecting the total distance, duration, and number of trips originating from the home location. A second study by Van Acker and Witlox (2010) examined the mediating effect of auto ownership on the path connecting the built environment to automobile use. While this latter study had additional variables related to land development and patterns, the SEM application does not describe the residential environment as a multidimensional construct. Eboli et al. (2012) explored the land use-travel behavior link with latent factors for each, in southern Italy. Land use was indicated by only two objective measures: housing unit surface area and residential environment.

Using a more comprehensive set of built environment indicators, a series of papers addressed the impact of land patterns on short- and long-term travel behavior decisions in Lisbon (de Abreu e Silva et al., 2006), Seattle (de Abreu e Silva and Goulias, 2009), Montreal (de Abreu e Silva et al., 2012a), and Los Angeles (de Abreu e Silva et al., 2012b). In the first paper, a traditional urban land use factor largely driven by population density and public transit supply at the residence predicted an increase in distance traveled and trip frequency for nonmotorized travel modes. The authors then identified a residential environment construct with Montreal data reflective of land use entropy and automobile accessibility as well as a pair of home- and job-based constructs described as a central, denser, and accessible area. In the American context, this multidimensional construct describing a dense and centrally-located residential environment indicated by population, building, and intersection density as well as distance to the central business district was identified in Seattle. Finally, the Los Angeles study examined the link to trip scheduling from a residential land use construct with indicators representing the activity participation opportunity.

Overall, only a handful of SEM studies have exclusively represented the built environment as a set of objectively measured indicators reflecting a multidimensional latent construct. In contrary to perceived environmental measures, a construct composed of objective measurements is not subjected to reporting bias that may inflate the effect of residing in a smart growth community on pedestrian travel (Aditjandra and Mulley, 2016). Further, those SEM studies detailing a construct with objective indicators have tended to examine its influence on auto-related outcomes rather than pedestrian travel patterns and behaviors. While smart growth communities provide an alternative to auto-oriented neighborhoods, policies related to improving community livability via increased transportation-related physical activity levels are provided limited insight by past studies focused solely on auto travel (Handy, 2005).