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Potential of converting short car trips to active trips: The role of the built environment in tour-based travel

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ABSTRACT

Objective: To better understand trip-chaining patterns and mode choice of various urban forms, this study examines the effects of land use on travel mode choice and analyzes the concept of neighborhood design in the substitution of short car trips by other transportation modes.
Methods: A 'tour' is defined as a home-to-home loop of individual trips, including all the stops made along the way. This paper develops tour-based, mode-choice models and conducts integrative assessments to determine the relative influences of the various factors associated with tour-based travel and activity space environments for short round trips.
Results: The short round trips most likely to require a car tended to be either commuting trips, trips involving heavy goods, or trips that link two or more stops. Transit trips for short-distance travel were likely to involve trip chaining, while most shopping trips comprised a single outing with no trip chaining. A key to increasing travel by walking was a concentration of retail shops and service providers near people's homes whereas street networks and a good regional accessibility encouraged cycling and transit use respectively, although potential spurious effects cannot be fully determined.
Conclusions: Policymakers in LA who hope to increase walking should focus on the concentration of business activity in a compact commercial core in residential areas, while transit agencies in LA should consider trends like chained trip-making and restructure communities and central places with much greater transit accessibility. These strategies for local urban design and regional accessibility are likely to affect people's decisions concerning travel mode mostly in non-work travel without intervening stops; therefore, personal vehicle use can be reduced more easily by focusing on trips for leisure time activities and personal business activities near residential locations rather than on work commutes.

1. Introduction

New Urbanism and Transit-Oriented Development (TOD) strategies, which are a recent American reform approach to development, attempt to encourage physical activity and reduce personal vehicle use. Despite the growing interest in such strategies, the policies that must be implemented to encourage drivers to find alternatives to short automobile trips are often ignored (Gärling et al., 2000). The 2009 National Household Travel Survey for California Add-on (NHTS-CA) shows that about 40 percent of all trips taken in the Los Angeles County were under 5 miles in round-trip length, and that driving was the mode for about 60 percent of these short

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trips. Some argue that we should target short trips in cars to reduce vehicle use (Hillman, 1998; Loukopoulos and Gärling, 2005) because short trips in cars cause disproportionate environmental impacts. Short trips in cars often take place before the engine has had time to warm up, and such trips generate additional emissions, such as carbon monoxide (CO) and volatile organic compounds (VOCs) (de Nazelle et al., 2010).

In addition to the associated environmental effects, reducing short trips in cars may be a viable way to reduce traffic congestion on local roads. For example, about 40% of all short trips started during peak traffic times and a half of these trips were taken by private vehicles in Los Angeles area (NHTS-CA, 2009).

Furthermore, these trips in cars can be replaced with walking and cycling, thereby providing needed physical exercise in the course of daily life (Handy, 1996; Greenwald and Boarnet, 2001; Cervero and Duncan, 2003). However, few studies have assessed the determinants that lead people to use cars for short trips or the neighborhood-scale interventions that could be designed and implemented to encourage changing the mode of such trips (Rodríguez and Joo, 2004). Taken together, these are all compelling reasons to focus on short trips because benefits will accrue as short, emission-intensive trips are replaced by non-automobile trips.

People use their cars for short trips for several reasons. A British study (Mackett, 2003) investigated short trips through in-depth interviews with 377 travelers who had taken short trips in their cars. His results attributed the use of cars for short trips to the transport of heavy goods and of children to school, the shortage of time, and the need for the car in a subsequent trip. Another study (Forward, 1998) reported that convenience made cars the dominant mode of travel and that the main disadvantage of walking was time constraints. In their surveys, Walton and Sunseri (2010) found that weather was the most common factor influencing the decision to drive a short distance. The additional factors that affect the choice of travel mode for short trips include the traveler's socio-economic and demographic status and preferences, the availability of a car, activity patterns, the purpose of the trip, the availability and quality of alternative modes, and the quality of the built environment of the neighborhoods that they live in or travel to (Kim and Ulfarsson, 2008; Loukopoulos and Gärling, 2005).

Among these factors, the built environment has been identified as a key factor that affects non-motorized travel (Badoe and Miller, 2000; Brownstone, 2008; and Handy 2005). The phrase “built environment” encompasses many factors, including residential density, the mix of land uses, the connectivity and scale of the streets, aesthetic qualities, and the transportation system. These factors are related to the basic strategies of New Urbanism and TOD that attempt to foster more compact development near transit stations by providing retail and employment centers within walking distance of high-density housing. Many urban designers and planners believe that neighborhood-level urban characteristics are strongly related to transportation modes. In particular, it is believed that the right urban form will promote alternatives to personal car use. This belief has been supported by the empirical literature using a mode choice model that hypothesizes that environmental characteristics act as incentives for travel behavior (Cervero, 2002; Chen et al., 2008; He, 2011; Kockelman, 1997; Zhang, 2004). These studies have provided useful insights in analyzing travel demand based on the traveler's preferences and the benefits obtained from the travel, as well as the costs, by examining individual trips, which is a trip-based approach.

Research into the fundamental influences on travel behavior has addressed the weaknesses and limitations of the trip-based approach, as findings have seldom reflected the linked nature of most travel, even though the choice of mode may be affected by both the outbound and return portions of the trip, and have raised key concerns regarding 'trip chaining' (i.e., travel involving multiple purposes and multiple destinations). Furthermore, research has indicated that trip chaining has been a growing phenomenon over the past decade and is becoming a significant part of people's daily travel because people increasingly tend to economize their amount of travel, given their limited time budgets and the high value of travel time savings (Hensher and Reyes, 2000).

Given this increased interest in trip chaining behavior, recent efforts have examined travel behavior through observations of the sequence of trip segments, which is called the tour-based approach. A "tour" links individual trips, including all the stops made along the way. Tour-based modeling can offer a more insightful understanding of the impact of land-use strategies on various travel behavior decisions by analyzing the sequence and combinations of all trips and activity patterns (Rasouli and Timmermans, 2014). For example, it is possible that land use diversity influences a person's decision to drive or walk short distances for a grocery shopping trip from home as a single outing that does not involve trip chaining. In that case, trip-based models can be used to show that the potential for shopping near the residential area may contribute to shifts in mode. However, when commuting by car to work and doing grocery shopping on the way, the likelihood of changing modes is very low. This difference can be revealed by using tour-based modeling that analyzes whole activity patterns.

This paper builds on previous studies and draws together behavioral and practical aspects of modeling individual tour-based mode choice. With the relative paucity of research investigating the effects of activity patterns and tour formation on mode choice, especially for short travel, this study was conducted to obtain a better understanding of the effects of tours to test the hypothesis that compact urban forms reduce short car travel. In so doing, the built environment characteristics of the origin (home) and destination (work or other activities location) areas of the tours, measured on different spatial scales, were considered.

The next section provides an overview of the literature reviewing the context of the theory of activity and travel decisions, and the tour-based approach to investigate the relationship between travel behavior and land use. This is followed by a description of the research methodology used to conduct the study and the main results. The next section presents the results and discussion. The paper ends with the conclusion section, which includes the study limitations and directions for further research.

2. Literature review

The tour-based approach is drawn from the activity-based approach that views travel as a derived demand for activities (Jones et al., 1990, Axhausen and Gärling, 1992). The approach focuses on sequences of travel behavior as the unit of analysis. It emphasizes