Analysis of Activity-travel Patterns and Tour Formation of Transit Users

Michael G. McNally, UCI   University of California, Irvine

Rezwana Rafiq, UCI   mmcnally@uci.edu

Problem Statement and Project Objective

The complexity of travel behavior has evolved as travelers respond to varying activity demands and the changing supply environment, measured by congestion, cost, and emerging technologies. Complexity in travel behavior is often manifested by an increasing tendency to chain several activities within a tour to minimize total travel time and the number of trips, leading travelers to seek more flexible travel modes to complete their complex travel demands. While personal vehicles arguably provide more flexibility managing travel needs, a more sustainable mode of transport is public transit. However, public transit often offers less flexibility and mobility services than a private car in chaining activities due to temporal and spatial constraints. Its widespread adoption is arguably dependent on improving its ability to offer effective chaining of trips and activities. Unfortunately, little is known in the context of American travel patterns regarding the complex travel behavior of transit users. Therefore, the goal of this study was to analyze the complex travel behavior of transit users by expanding conventional trip-based approaches by considering activity-travel *tours* and *patterns* as basic units of analysis. A tour was defined as a sequence of trips that begins and ends at home and a pattern was defined as an entire day's sequence of activities and the associated travel.

Data

The 2017 National Household Travel Survey (NHTS) provides information on travel by US residents in all 50 states and the District of Columbia, including data on trips made by all modes of travel and for all trip purposes. The NHTS dataset contained 129,696 households comprising 264,234 persons who took a total of 923,572 trips. For this study, we identified *public transit users* as those individuals who used public transit for at least one trip segment on a tour that starts and ends at home. A choice of travel mode is treated as public transit if it is any of the following NHTS categories: public or commute bus, city-to-city bus, subway/elevated/light rail/streetcar, and Amtrak/commuter rail. This yields a final sample of 4,994 individuals who made a total of 20,222 trips, where almost half of the trips are made by transit (10,011). We also identified *transit commuters* as those individuals who are at least 18 years old, perform at least one work activity, and used public transit on at least one trip segment within a home-based work tour. This resulted in a subsample of 2,448 individuals. Home-based work tours are formed by linking person trip sequences that start and end at home and contain at least one work activity. The result was a total of 2,454 home-based work tours.

Research Objectives, Methodology, and Findings

The three broad research objectives, methodology, and findings are discussed below.

Objective 1. Identify the Complex Travel Behavior of Transit Commuters

The first objective was to examine *how* and *when* public transit commuters incorporated non-work activities in their work tours using basic descriptive analyses. We identified dominant patterns of work tours made by transit commuters and analyzed these tours using a set of activity-travel analytics. The primary insights of this objective were:

Finding 1.1 About 80 percent of work tours consisted of seven dominant patterns whereas the other 20 percent of tours demonstrated a total of 106 diverse and more complicated patterns.
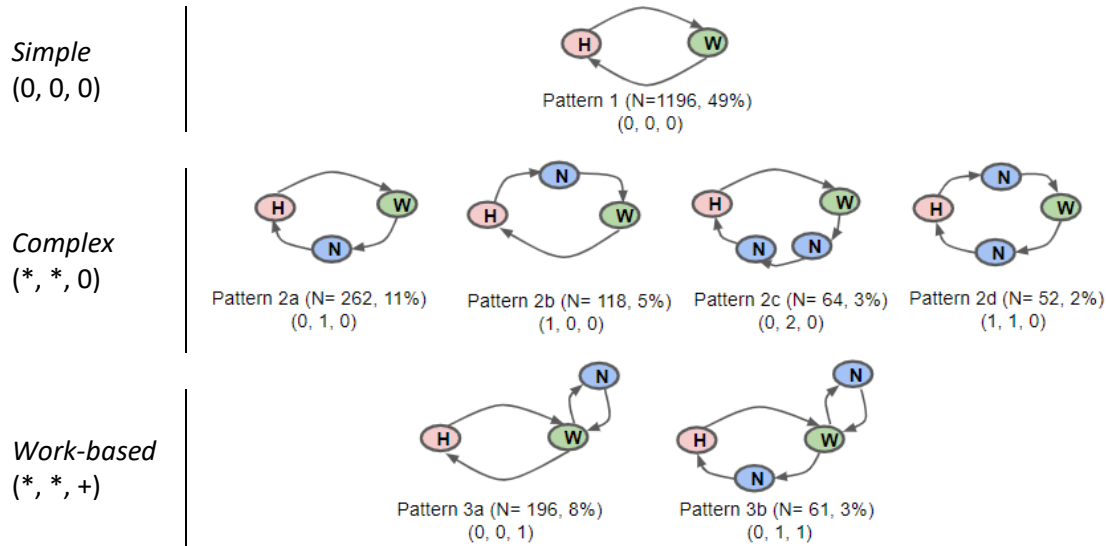
Figure 1. Seven dominant patterns of work tours: simple work tours, complex work tours, and complex work tours with work-based sub-tours (non-work before, after, or during work)

**Finding 1.2** In terms of complexity, half of the transit work tours are complex.

Finding 1.3 In terms of mode use, most simple work tours are transit-only tours whereas most complex tours are multimodal tours.

Finding 1.4 Transit use is more complex than the traditional home to work commute with a diverse set of choices at various stages of activity scheduling.

Objective 2. Identify Classes of Transit Users based on Complex Travel Behavior

The second objective was to apply a comprehensive classification approach, Latent Class Analysis (LCA), to study the activity-travel behavior of transit users. The goal was to identify latent classes of transit users based on the heterogeneity in activity-travel patterns and then associate those classes with particular socio-demographic characteristics of transit users.

Finding 2.1 Transit users can be classified into five distinct classes, each with a representative activity-travel pattern.
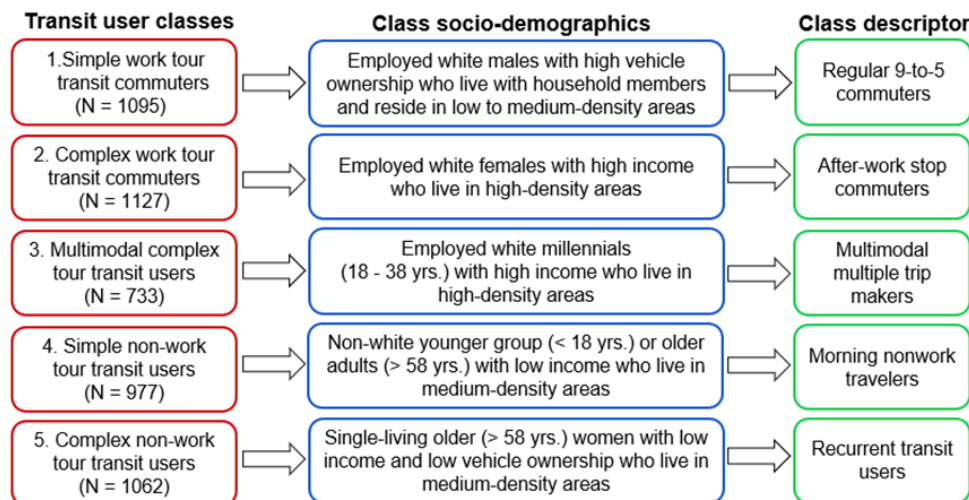
Figure 2. Five transit user classes and their socio-demographic properties

Finding 2.2 Transportation disadvantaged groups have different activity-travel patterns than those who do not belong to any of the specified disadvantaged groups. For example, a larger fraction of transit users who did not belong to a disadvantaged group used transit for work purposes, which was the reverse of the pattern for each defined transit disadvantaged group.

Objective 3. Develop a Tour Choice Model for Transit Commuters

The third and final objective was to develop a tour choice model to characterize public transit commuters based on the complexity of work tours and to assess the impacts of various demographic, location, and activity-travel factors on the likelihood that a transit commuter would choose a particular type of work tour by applying Structural Equation Modeling.

Finding 3.1 Structural models suggest that neighborhood density, flexibility of work schedules, household activity interactions, travel party composition, and availability of private vehicles in work tours were important determinants of work tour choice for transit commuters.

Finding 3.2 Structural model results provided the demographic characterization of three groups of work tour makers (simple, complex, and complex with work-based sub-tours).
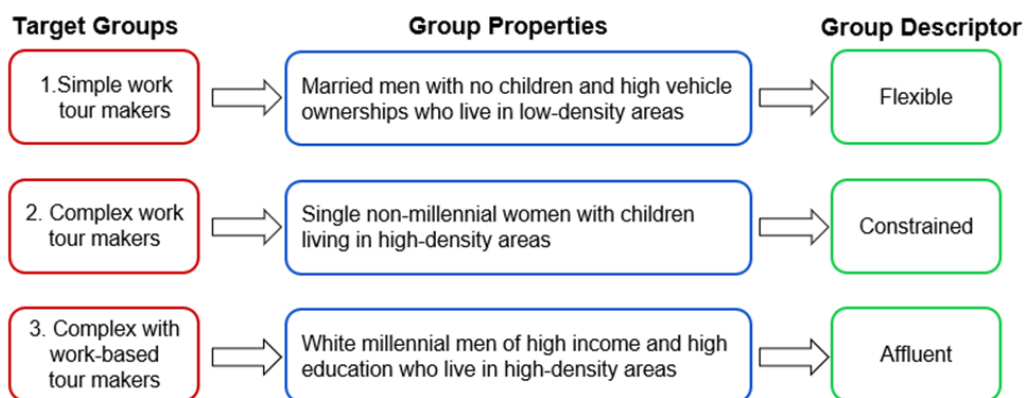
Figure 3. Three target groups of transit commuters and their properties

Policy Recommendations

These research findings can help transit agencies identify potential market groups of transit users with particular socio-demographic characteristics and activity-travel patterns, and to propose market strategies that address these different groups of users to meet their specific travel needs and thus to improve the quality of services provided. For example, frequent transit services and strict on-time schedules need to be ensured and monthly transit pass options can be offered particularly to those who regularly commute by transit. While performing after-work non-work activities, a substantial portion of users use private vehicles for non-work or return-home trips since transit use is not generally conducive to do so. To provide a convenient modal linkage for this class, transit stations should be designed to consider parking facilities and other activity services. Although transit services typically better accommodate peak commuters rather than off-peak travelers, study results suggested that transit authorities could consider improvements in off-peak hour service to address the travel needs of transit-dependent groups, particularly for those who have limited modal alternatives or who depend primarily on transit due to age, income, or disability. Improving transit facilities by addressing transit-dependent groups can increase their mobility and may indirectly encourage greater transit use in the general population. Identifying travel needs and barriers to personal mobility for transit disadvantaged groups is important in establishing effective policies to reduce travel inequities.