Travel Behaviour and Society 3 (2016) 51–58

Contents lists available at ScienceDirect

Travel Behaviour and Society

journal homepage: www.elsevier.com/locate/tbs

A joint model for trip purpose and escorting patterns of the disabled

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ARTICLE INFO

Article history:
Received 29 November 2014
Received in revised form 10 June 2015
Accepted 18 August 2015
Available online 5 September 2015

Keywords:
Persons with disabilities
Escort pattern
Activity purpose
Joint decisions

ABSTRACT

The activity and travel patterns of people with disabilities are generally distinct, as their activities are more dependent on others due to their special physical condition. This paper elaborates on the patterns of regular out-of-home activities (i.e. for different trip purposes) of disabled persons along with the way that they are accompanied to perform the activities. Household Travel Tracker Survey data collected by the Chicago Metropolitan Agency for Planning is used to develop new travel models. Two multinomial logit models are estimated to explore the influential variables and elaborate the consequences of ignoring their inter-dependency. From the influential parameters perspective, the modeling results indicate that people with limited mobility generate more healthcare trips than other disabled individuals. Elasticity results show that the chance of making a healthcare trip without any escort decreases around 0.8 percent as the age of people with disability increases by one percent. We also find that a one percent increase in trip duration increases escorted healthcare, non-escorted work, and non-escorted school trips by 0.16, 0.23, and 0.32 percent, respectively. From the modeling perspective, pursuant to the independent model, the probability of recreational trips reduces around 9 percent, if household car ownership increases from one to two. However, the joint model predicts a 2 percent increase in this situation for people with physical limitations. Therefore, neglecting the importance of the interaction of these decisions for persons with disabilities can manifest model specification error, leading to unrealistic policy assessments.

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1. Introduction

Disabled people are a subpopulation that has particular needs, and therefore, city officials and planners are expected to be aware of their situation to appropriately fulfill their needs. According to the World Health Organization report on disability (World Health Organization, 2011), around 15 percent of the world's population was disabled in 2010. Studies (Rogers, 1997; Jolly et al., 2006) have shown that a decrease in the level of persons with disabilities' participation in social activities based on their inadequate access to different modes of transportation leads to their disassociation and development of mental and emotional disorders such as depression. A recent study, for instance, argued that half of the people with disabilities might not visit their family and friends as often as they would like because of inadequate access to transportation systems (Jolly et al., 2006). Indeed, equity principles indicate that disabled individuals must enjoy an equal share of transportation, educational, healthcare, and cultural resources to that of anyone else in the society (Bynoe et al., 1991). As a result, the United Nations published a Convention on the Rights of Persons with Disabilities (CRPD) that had 159 signatories by March 2015 from the several countries including United States, Canada, and Australia. CRPD reads:

> *To enable persons with disabilities to live independently and participate fully in all aspects of life, States Parties shall take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation, to information and communication* ... (United Nations, 2008).

Following the signing of the Americans with Disabilities Act (ADA) in 1990, a significant number of persons with disability have established rightful access to employment, transportation, and public facilities. Eighteen years after the ADA, CRPD was adopted, but broader in scope and in application. Canada is another active participant of CRPD which declared that persons with disabilities are presumed to have legal capacity on an equal basis with others

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http://dx.doi.org/10.1016/j.tbs.2015.08.002
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in all aspects of their lives. Canadian government authorized Transport Canada to enter into a 5 year program to financially assist the more accessible transportation system. This program has proven to be very successful. Australia as a participant of CRPD declared the rights of persons with disability to both liberty of movement and a nationality on an equal basis with others. The Australian government, also, implemented a number of policies such as multi-purpose taxi which eases transportation for people who travel in wheelchairs to provide an equal liberty of movement for both persons with and without disabilities.

The first and foremost step for the city officials to provide suitable infrastructure and legislation for persons with disabilities is to understand their activity patterns. This study is an effort to explore significant factors that contribute to the out-of-home activity generation for persons with disabilities. In this study, the choice of activity type is modeled along with the accompaniment decisions, since understanding the reciprocal impact of these decisions can reveal information on how these decisions, especially activity generation, is made (Kapur and Bhat, 2007; Ferdous et al., 2010). Whilst understanding disabled people's travel demand would seem to be an important requirement, few modeling exercises have been conducted to inform this. Further, this paper argues how model misspecification may lead to distorted policy assessments.

The rest of this study is structured as follows. First, a critical review of the literature is provided. Then, the applied methodology is reviewed, followed by a description of the data. The estimation results of a joint model are proposed and compared with the independent model to underscore the significance of model misspecification. Finally, the paper concludes with an analysis of results and recommendations for future development.

2. Background

Since the middle of 1970s, the travel behavior and transportation needs of the disabled have been studied to better fulfill their needs (Brail et al., 1976). These studies have addressed: travel demand (Stern, 1993; Schmöcker et al., 2005), mode choice (Schmöcker et al., 2008), safety (Mitchell and Suen, 1998), accessibility (Venter et al., 2002; Barrett et al., 2003; Casas, 2007), and special transit services (Fitzgerald et al., 2000; Bearse et al., 2004). Past studies on the activity generation models are discussed in the following, and then a few studies are reviewed that elaborate on the accompaniment decision for persons with disabilities.

The effects of a diverse range of influential variables, including disability type, education, income, age, and gender on out-of-home activities have been investigated (Stern, 1993; Schmöcker et al., 2005; Páez and Farber, 2012). Table 1 shows past studies that analyzed activity types and escorting patterns.

To figure out how disability affects activity patterns, disabled individuals and people with no physical limitation are compared in some papers (Ferdous et al., 2010). Taylor and Józefowicz (2012) explored activities of persons with disabilities to explain how built environmental and demographic variables influence their choice of activity. Stern (1993) studied 245 persons with disabilities in rural Virginia and, using a Poisson regression model, found a negative correlation between age and work/recreational trips. Further, he observed that walking problems decrease the propensity to perform out-of-home activities, except for medical purposes. He also noted that females with disabilities generally have fewer tendencies to travel. In return, being African-American, married, and having higher levels of education increased the odds of making trips. In another study, Schmöcker et al. (2005) analyzed the effect of factors on trip generation of persons with disabilities in London, found all out-of-home activities are less likely as age increases. Owning a vehicle has no effect on work trips because most of the work trips in London are done through public transportation. Further, an increase in income leads to an increase in recreational trips.

Few studies (Sweeney, 2004; Brault, 2012) have analyzed the way that persons with disabilities are accompanied to perform an activity. Taylor and Józefowicz (2012) considered 238 leisure and recreational trips by persons with disabilities and showed that they are more likely to use an auto as a passenger rather than a driver. They argued that persons with disabilities rarely attend in cultural events because they usually need a companion. In the U.S., however, Sweeney (2004) analyzed the travel pattern of persons with disabilities and argued that as people with disabilities become older, they need more escorting for their trips. Sweeney found that 32 percent of disabled individuals over 65 years old, 22 percent aged 25–64, and 9 percent aged less than 25 years need escorting. Another study (Var et al., 2011) in Turkey found 56 percent of persons with disabilities required an escort when traveling out of town, and 69 percent of them preferred family members as escorts.

The literature has certain gaps that are addressed to a possible extent in this study. These include, first, no study has mathematically modeled the escorting decision for persons with disabilities. Second, it appears that activity generations and escorting decisions are inter-dependent decisions by persons with disabilities. This dichotomy has not been yet studied.

3. Data

Data collected in the Household Travel Tracker Survey by the Chicago Metropolitan Agency for Planning is used in this study. 1-day or 2-day activity and travel information was collected from 10,552 households (23,808 individuals) in the greater Chicago area during January 2007 to February 2008 (Inbakaran and Kroen, 2011). Travel information including trip purpose, mode, origin and destination, arrival and departure time, along with demographics such as age, gender, and education of the household members are brought together.

An analysis of the data revealed that around 7 percent of the population was identified as disabled, with the following share of disability types: limited mobility: 57 percent, visual: 8 percent, hearing: 2 percent, mental: 8 percent, or other types of disability: 23 percent. A final set of 2219 persons with disabilities was analyzed in this study, after data cleaning and leaving out those who did not take a trip on the survey day, or had incomplete records. Each person has trip chains for one or two certain days. The main activity in each chain was determined by finding the longest stop in a destination. In the original data set, trip purposes are classified into 21 different types, including work, education, shopping, health care, recreation, indoor activity, and drop off/pick up passengers. Five of these goals accounted for 86 percent of the trips taken by persons with disabilities, namely: work, education, shopping, recreation, and health care. Fig. 1.a shows the distribution of different activities among the persons with disabilities. Hence, people whose purpose of travel was one of these five were studied.

The survey reports the total number of attendants and family members; however, this study considers companionship as in an aggregate form with a 0/1variable. As shown in Fig. 1b, the highest number of escorts occurs in recreation, health care, and shopping activities. In fact, persons with disabilities are accompanied in 51 percent of their recreation trips, 48 percent of health care trips, and 46 percent of shopping trips. The lowest rate of accompaniment occurs for work trips. Having five choices (work, education, shopping, recreation, and health care) for the type of primary out-of-home activity and two choices (yes or no) for

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