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Project Title

Learning from the Travel Experiences of Persons with Disabilities: Investigating Navigation Challenges Posed by Infrastructure

University

University of Colorado Denver

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Research Needs

Vision Zero is built around the idea that we can improve the transportation network in ways that will eliminate fatalities and severe injuries (Johansson 2009; McAndrews 2013). Researchers (e.g., Thomas et al. 2019) widely accept that pedestrians and bicyclists are vulnerable groups with higher rates of fatalities than those traveling using other modes. Based on the abundant scholarship on bicycling and pedestrian travel, we see that infrastructure is starting to be supplied for these modes in ways that may, in time, bring society closer to the Vision Zero ideal. Researchers, however, have paid relatively little attention to what could be considered an even more vulnerable subset of our population, i.e., persons with disabilities (PWDs). This group travels mostly on infrastructure that is designed for those *without* disabilities (F Bromley et al 2007; Inada et al 2014; Jiang et al. 2012; Velho 2019). This remains true even through there is a robust discussion of Universal Design in the scholarly literature (Aarhaug and Elvebakk 2015; Sze and Christensen 2017). Imrie (2012) asserts that Universal Design has achieved "orthodoxy of what is presented as the very best in design practice." Yet it has not filtered down to practice. In the United States, access for PWDs is federally mandated under the Americans with Disabilities Act (ADA 1990). In this research, we argue that if we could make daily travel of this most vulnerable group convenient and safe, we would naturally expand safety to most of the rest of society and in effect move society closer to the Vison Zero and Universal Design ideals. Hence, as an exemplar and case, we focus this research project on understanding the micro-

mobility of PWDs—an area that has received sparse attention in terms of research on transportation infrastructure and travel behavior. Our proposal is a call to action based on findings that ADA is not static (Karger and Rose 2010; also see F Bromley et al. 2007 and Lucas 2012 for findings from the UK), but needs to evolve to achieve its ideal given the nature of changes in mobility options (e.g., micro-mobility tools such as e-scooters).

Two further practical motivations drive our decision to study PWDs for this research. First, PWDs do not represent an insignificant number of the US population based on the American Community Survey (ACS) estimates (Erickson et al. 2019). Second, as baby boomers age, the US is projected to have a higher percentage of the population with age-related disabilities including independent living disability, self-care disability, and ambulatory disability (Erickson et al. 2019; Li and Tilahun 2017). ACS defines ambulatory disability as serious difficulty in walking or climbing stairs. Today, 25.1% (or 7.4 million) of US persons 65 to 74 and 48.7% (or 9.8 million) over 74 have one or more disabilities. In terms of the overall population, both genders in the US have about 12.7% persons with one or more disability, which represents a total of 40.7 million individuals. A greater percentage of African Americans (13.6%) and Native Americans (18.1%), relative to White Americans (10.6%), have a disability. The employment rate among PWDs is 37.3% for those aged 21 to 64, and 25.4% of these working individuals have an ambulatory disability. Median annual household income for PWDs is $45,500, with those having ambulatory, self-care, or independent living disability having a median annual household income around $38,900. The poverty rate among working-age PWDs is 26.1%. PWDs have higher than average high school completion rates but far lower college completion rates than the non-disabled population (Erickson et al. 2019). About a fifth of the PWDs (18.9%) receive Supplemental Security Income (SSI) payments. PWDs are often veterans, with about a fourth (26.3%) having a service-related disability. These statistics point to a transportation issue because 6.9% (20.9 million) US persons have an ambulatory disability. Research indicates that lower educational attainment and earnings are likely a reflection of a lack of access (Bjerkan and Øvstedal 2018) to opportunities such as jobs (Grisé et al. 2018). Social exclusion (Lucas 2012) remains high in PWDs. More specifically, researchers show that PWDs face high levels of isolation and low life satisfaction (Bascom and Christensen 2017; Li and Tilahun 2017) due to their reliance on public transit (Velho 2019), which remains challenging for them to use effectively in most of the US (Schmöcker et al. 2008).

Research Objectives

Given the need for research on PWDs, we focus our project at the intersection of three large conceptual domains (Figure 1). First, we have the built environment with a pointed focus on infrastructure such as sidewalks and street crossings (Velho 2019). We contend that this research will provide new information for the placement and design of features in the right-of-way. Our findings will not only benefit PWDs but also other non-motorized travel modes through a focus on functional areas for inclusive transportation (Bjerkan and Øvstedal 2018). Second, we leverage the field of telematics and use this growing method of data collection using on-board (Inada et al. 2014) and/or smartphone applications to study mobility patterns. Our innovation in this research project is to study PWDs' micro-mobility through an app that will ping the device location at short time intervals to enable capturing finer grain information about mobility patterns. Third, we look at the larger notions of travel behavior and accessibility that remain largely unstudied for PWDs' mobility. We aim to collect data in warm and cold months as a

natural experiment to understand how the build environment/infrastructure influences micro-mobility and leads to choices (or lack thereof) for travel.

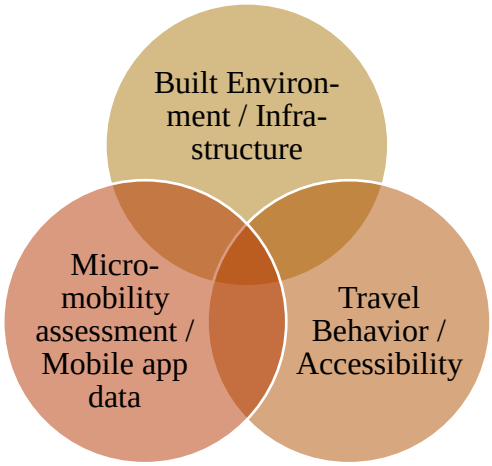

Figure 1: Conceptual areas guiding this project

This study will utilize smartphone tracking capabilities to collect locations of PWDs during two weeks each in warm and cold months. The specific objectives of this study are:

1. Collect data on the mobility of PWDs;
2. Investigate the micro-trajectory of travel undertaken by PWDs in the urban environment;
3. Study the limitations imposed by weather on the mobility of PWDs;
4. Analyze variations in temporal and spatial clusters (Hine and Grieco 2003) to identify hot-spots for policy and design interventions;
5. Advance knowledge for seasonal polices for the mobility of PWDs (and consequently for individual using travel modes on sidewalks);
6. Identify policy interventions for transit services at bus stops with respect to placement/design, and spatial-temporal variation in supply;
7. Establish accessibility indices (Grisé et al. 2018) for PWDs' travel using land use data integrated with start/end trip locations from tracking data;
8. Advance policy and practice for safer and equitable streets using the Vision Zero framework;
9. Create opportunities for student training; and
10. Build a basis for practical implementation through publications and presentations.

Research Methods

Our method will involve designing a smartphone app that will passively capture information about the individual's travel during two weeks each in the warm and cold seasons. We will use the change in weather as a natural experiment to develop a deeper understanding of changes in PWDs' travel patterns. The app will have one active component where we will seek information on standard socio-economic and demographic variables such as age, gender, income, highest education attainment, race/ethnicity, and employment status. During this active data gathering phase, we will also collect information on the nature of disability as well as opinions on how the disability limits transportation mobility through Likert scale questions. Each installed app will be

given a randomly generated unique id. No further personal identifying information will be collected.

During actual days of data collection, the only nudge will be to remind the participant to charge the phone every morning. We will rely on two local organizations to recruit volunteers who can provide informed consent: (1) Denver Regional Mobility & Access Council, and (2) AmputeeConcierge.org. Preliminary discussions with these organizations indicate a high level of interest in collaborating on such a research endeavor. Similarly, our preliminary discussion with campus IRB suggests that this project will go through an expedited review process which will enable us to get into the field as per schedule. Our sample selection criteria will include any individual who has physical or sensory long-term or recurring disabilities or illnesses and is at least 18 years old. Standard security measures for the data include removing the unique ids and socio-demographic information from the full dataset and storing these data separately. We will allow access to the dataset only to research personnel involved in the project. Additionally, the data with the unique ids and socio-demographic information will be encrypted and kept in a locked cabinet at the PI's offices on the University campus.

Our analytical methods will include tracing travel paths for movements outside single origins and destinations. We will rely on pings recording latitude and longitude of the tracker to trace paths. Any movements within 50 feet of a location where the individual stays for more than an hour will not be part of the dataset to protect privacy of activities at home or work sites. The analysis will primarily focus on passively collected variables, namely, trip distance, likely modes (estimated using speed and path), travel time, gradient changes, variations in speed, etc. We will join data about environmental conditions from publicly available data sources such as weather stations for information on environmental temperature, precipitation, snow days, etc. We will also collect built environment data such as planimetric sidewalk data from the Denver Regional Council of Governments, which has systematically mapped sidewalk infrastructure data for the last few years. Finally, we will rely on the actively collected data to segment and study populations to extract cohort differences by age, gender, income level, kinds of disabilities, etc. since the evidence (Erickson et al. 2019) suggests that these factors play an important role in life outcomes.

Expected Outcomes

Our project is designed to develop a user-based understanding of the urban environment for the most vulnerable group in society. Our analysis will have the following likely outcomes: (1) From the infrastructure design perspective, we hope to demonstrate the daily travel challenges faced by PWDs. These lessons should become part of infrastructure design for sidewalks and transit boarding areas. (2) From the perspective of transit policy, we hope that we can demonstrate particular access and egress challenges that PWDs face in the urban environment. This should provide a basis to re-think locations and conditions for bus stops, for example. More broadly, we see our work as adding a deeper set of actionable items to current ADA standards. The practical impacts of our research should be useful for planners and engineers working on streets/right-of-ways including sidewalks (e.g., complete streets and road diets) as well as those focused on transit supply.

Relevance to Strategic Goals

This proposal falls under the following strategic goals of the FAST ACT: Livable Communities, and Safety. Our project is aimed at making communities livable through better walking infrastructure by understanding the needs of an impacted minority. Safety in the public right-of-way, especially as it relates to interactions of pedestrians and vehicles, has been highlighted for its importance by many researchers. Our project will address this critical topic through the lens of PWDs and their travel needs.

Educational Benefits

This study will become part of two courses that Dr. Shirgaokar teaches in Urban and Regional Planning, namely, "Transportation, Land Use, and the Environment" and "Urban Policy Analysis". Specifically, the cold weather data generated from the project will be used in term projects in both courses. Note that these courses also attract students from the Department of Civil Engineering and from the School of Public Affairs. There is, hence, strong potential for interdisciplinary learning and training in the classroom environment for students from different fields at CU Denver.

Technology Transfer

The research products, namely, the smartphone app as well as the written documents will be aimed at academic, practitioner, and advocacy audiences. The reports and papers (in pre-print manuscript form) generated through this study will be shared publicly on the College of Architecture and Planning website. The hope is that this will enable our research partners, Denver Regional Mobility & Access Council and AmputeeConcierge.org, to more vocally advocate for the needs of PWDs. More academic versions of this work will be published in Q1 transportation journals. Additionally, the smartphone app designed through this project will be made available for use through open license agreements, so both the practitioner and research community can use it for future work.

Work Plan

The proposed scope of work is designed to be completed in one year. A feature of this study is to leverage the warm and winter months as a natural experiment for studying micro-mobility challenges for PWDs. After conducting a review of the literature, we will identify key constructs related to our objectives such as existing ADA requirements. We will build and test a smartphone app to collect tracking data from PWDs. The first phase of data collection will be in a cold month. Data cleaning and preliminary analysis will lead to creating data products that Dr. Shirgaokar will integrate in his Spring course/s. This will enable students to engage actively with the research process, and use this data for term projects. After the Spring term, we will collect warm weather data (in May or June). During Summer, we will integrate the second set of records into the data frame. We will use the complete dataset to run advanced analyses for conference/academic publications.

Task	Timeline
Literature review	Months 1-2
Build, test, deploy the smartphone app (cold weather data collection)	Months 2-4
Data cleaning and preliminary analyses	Months 4-6
Integration into course/s	Months 6-10
Warm weather data collection	Months 10-11
Data cleaning and integration into first-stage dataset	Months 10-11
Regression-based modeling	Months 10-11
Draft papers and presentation materials	Months 11-12

Project Cost

Total Project Cost:	$120,002.40
MPC Funds Requested:	$ 60,000.00
Matching Funds:	$ 60,002.40
Source of Matching Funds:	University of Colorado Denver

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