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LEARNING FROM THE TRAVEL EXPERIENCES OF PERSONS WITH DISABILITIES: INVESTIGATING NAVIGATION CHALLENGES POSED BY INFRASTRUCTURE



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

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ABSTRACT

The transportation experiences of people with disabilities have improved since the passing of the Americans with Disabilities Act (ADA) in 1990. Despite progress, many aspects of the current transportation system still limit people with disabilities from traveling safely and efficiently. Moreover, transportation planning and design efforts consistently lack representation of people with disabilities.

This research seeks to address this disconnect via semi-structured interviews with 37 stakeholders. Among those, 28 are people with disabilities or are caretakers/advocates and nine are government officials whose work intersects with the supply of infrastructure regulated under the ADA. One objective is to understand how attributes of transportation infrastructure impact the daily mobility of people with disabilities. A second is to understand how the implementation and management of transportation assets impact the accessibility of travel for people with disabilities.

Through a thematic and content analysis of interview data, we reveal hard infrastructure issues, such as intersection design and programming/management issues, such as communication of transit service changes that impact the daily travel experiences of people with disabilities. Further, government officials demonstrated how supply and implementation challenges, including funding and maintenance, affect the condition of transportation assets. Stakeholders from both cohorts expressed the need for more inclusion of people with disabilities' lived experiences to inform transportation decisions. Together, these challenges diminish the quality of mobility options and quality of life and are discriminatory by preventing equal access for people with disabilities. These challenges demonstrate that even with minimum design requirements set by ADA for the public right-of-way, barriers still exist within the built environment and within agencies responsible for managing transportation assets. In order to remove these barriers and create a more accessible transportation environment, planners, policymakers, and engineers must collaborate with people with disabilities to consider how the design of transportation systems can be improved to support accessibility for all.

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1. INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Transportation is a lifeline to accessing education, work, healthcare, fresh food, independent living, and social engagements. When the transportation system fails to provide for the travel needs of individuals, consequences can include reduced access to opportunities in the short term and diminished economic and well-being outcomes in the medium- to long-term (1-3). This is particularly true for people with disabilities, who typically rely more on multi-modal transportation systems than people without disabilities (4). There is a tacit assumption that, since the passing of the Americans with Disabilities Act (ADA) in 1990, the transportation needs of people with disabilities are now routinely considered and realized (5). However, transportation planning and design efforts constantly lack representation of people with disabilities, exemplifying that the evolution of the law in practice with community is not always achieved. This paper seeks to address this disconnect via semi-structured interviews with 37 stakeholders. Among those, 28 are identified as having a disability or as a caretaker/advocate, and nine stakeholders are government officials. Using Denver as a case study, the intent is to shed light on the reality of transportation challenges faced by people with disabilities, by planners whose work operationalizes ADA, and the importance of involving people with disabilities in planning and design processes.

In the United States, the ratio of the population not having disabilities to those having at least one disability is 8:1, while this ratio is 3:1 for those 65 years and older (6). Additionally, the U.S. population is aging, increasing the likelihood that those 65 years and older will develop an age-related disability with direct implications for daily travel (7-10). Within transportation and planning professions, there is an uneven representation of people with disabilities compared with those who do not have a disability – which may suggest barriers to the workforce and a limited level of influence on the effectiveness of accessible design solutions. For example, people without disabilities outnumber people with disabilities working in transportation-related fields, including architecture and engineering, construction and extraction, and transportation and material moving occupations, by approximately 24:1 (11).

There have been improvements to ground transportation systems across the United States since the initial passing of the ADA, such as the addition of lifts on public transit vehicles and compliance training (12). However, significant barriers regarding how transportation infrastructure is prohibitive or dangerous for people with disabilities remain. Much of this is evidenced by recent lawsuits against local governments. Lawsuits document challenges with curb ramps and sidewalk accessibility, failure to install elevators at transit stations, and failure to provide audible feedback for blind and low-vision passengers (13-15). The National Council on Disability has stated that “...lawsuits and forced settlement agreements may be essential tools for ensuring compliance” (16).

In a review of 40 national surveys that asked about people with disabilities’ daily lives, information on travel and transportation was among the least asked-about topics (17). Moreover, there remains an overall lag in developing infrastructure asset inventories that seem critical for people with disabilities’ mobility. Gibson and Marshall, for instance, discuss how local governments still have limited knowledge of sidewalk presence, condition, and existing obstructions (18). A combination of limited survey data on people with disabilities’ experiences and a lack of data on infrastructure may lead to inaccuracies in evaluating infrastructure to truly reflect the needs of multiple groups, including people with disabilities, older adults, and children.

Planners and engineers design systems to help populations such as people with disabilities as required by the ADA. As such, the lived experiences of people with disabilities should be an essential learning tool to help increase a community’s knowledge of infrastructure design, policies, and practices (1, 19, 20). Following in the tradition of learning from local knowledge and community experts, this research relied

on 28 semi-structured interviews, 26 of which were individuals who self-identified as people with disabilities and two were caregivers or advocates, to answer two primary research questions, the first of which was, “Given disability type, how do attributes of the transportation infrastructure impact the daily mobility of people with disabilities?” We then interviewed nine government officials about their challenges in planning for people with disabilities and the ADA (21). Our second question was, “How does the implementation and management of transportation assets impact the accessibility of travel for people with disabilities?” While it is important to recognize that no two persons’ experiences are the same, we used these interviews to inform current practice by identifying common themes people with disabilities may experience during everyday travel.

1.2 Literature Review

In this literature review, we initially focused on papers dealing with the infrastructure challenges faced in the daily lives of persons with disabilities and the resulting opportunity restrictions. We then considered research about how expert knowledge (of designers, planners, and engineers) may be better operationalized through learning from the lived experiences of marginalized groups such as people with disabilities.

1.2.1 Infrastructure Challenges and Constraints to Opportunity

Bjerkan and Øvstedal conducted a detailed literature review on the intersection of disability and transportation (22). They identify eight functional requirements: accessible, centralized information; flexibility; safety and security; physically accessible design; reliability; economic predictability; reduced administration; and short, predicted travel times. Each of these can be viewed as a challenge people with disabilities face in daily travel.

1.2.1.1 Infrastructure and service failures and limitations

Previous research suggests that failures and limitations with infrastructure and transportation services could occur at various phases of transportation life cycles. In a survey of 10 regional and local governments and transit agencies across the United States, professionals indicated that their agency leadership showed high levels of support for pedestrian planning and first-/last-mile initiatives. However, support for projects such as pedestrian access to transit was not viewed as important to leadership (23). In another survey, people with disabilities who relied on buses and paratransit found that public transportation agencies with extensive training still did not provide efficient services, and people with disabilities experienced negative or inappropriate behavior from drivers, who demonstrated a lack of understanding for disability etiquette, and various challenges across different disabilities (24). A study of 16 U.S. cities identified that many cities rarely go beyond ADA requirements, approaching sidewalk maintenance and inventory management from a legal risk reduction perspective rather than prioritizing a fully accessible pedestrian network (18). A study conducted in Cambridge, Massachusetts, for instance, evaluated ADA conditions of sidewalks and found that nearly half of all sidewalks within the city did not meet the minimum 36-inch width ADA standard (25).

1.2.1.2 Challenges with navigating the city for people with disabilities

The built environment, along with personal capabilities – such as vehicle access, attitudes, and health – influence the trips people make. High vehicle speeds may reduce social activities for older adults, who are more risk-averse than younger cohorts (26). Poor street conditions and unstable surfaces exacerbate mobility disparities when traveling even short distances in urban settings (27,28). A person’s type of disability may also influence the kinds and frequency of trips taken (29). For example, persons with a walking disability may reduce their overall trip distance or frequency of trips as a result.

In a qualitative analysis of London's public transit users who use a wheelchair, Velho identified physical and social challenges. The challenges resulted in added anxiety and risk of physical and emotional safety (1). Another U.K. study found that wheelchair users encountered barriers to shopping centers, such as inaccessible or crowded pedestrian environments, poor labeling of handicap parking, and limited information about accessible services (19). In the U.S., Cochran found that negative interactions with transit operators and other customers limited the willingness to use these systems, while Shirgaokar et al. found that the open streets policies during COVID-19 radically changed the navigability of sidewalks, streets, and parking spaces (20, 30).

1.2.1.3 Access to opportunities for people with disabilities

People with disabilities were twice as likely to live in poverty, and only 32% of the working-age people with disabilities were employed (2). The U.S. Bureau of Labor Statistics estimated that half of all unemployed people with disabilities experienced workforce barriers, including transportation access (3). In Toronto, wheelchair users had access to three-quarters of non-wheelchair users' jobs because of accessibility barriers at public transit facilities (31). In a thorough literature review of costs associated with disabilities, Mitra et al. found that households with persons with disabilities experienced higher cost burdens for healthcare and transportation (32).

In the New York Metropolitan Region, people with disabilities earned up to an average of 17.1% less, were more likely to use public transit, and experienced longer commutes than workers without disabilities (33). In the Greater Toronto and Hamilton Area in Ontario, Canada, a qualitative study examined school site design with parents with children who have disabilities (34). The study concluded that even with schools meeting minimum accessibility parking requirements, parents still had to alter arrival and departure schedules, reducing access to education for their students (35). Bascom and Christensen found that persons with disabilities must invest substantially more resources to overcome transportation barriers to participate in social and community events (36). Cochran found that infrastructure barriers and reliance on public transportation led to social isolation and restricted freedom of movement, particularly as people age (20).

1.2.2 Expert Knowledge Versus Lived Experiences

To the best of our knowledge, literature on how planning and design decisions and priorities affect people with disabilities is somewhat limited in research and practice. A literature review of five planning journals found only 36 published papers on disability-related topics (37). Bromley et al. relied on interviews with people with disabilities and recommended strategies to improve mobility for people with disabilities. Strategies include greater inclusion of experiences from people with disabilities to inform policy, raise public awareness, and develop design best practices (19).

Universal Design is increasingly seen as a solution to reducing access barriers in the built environment (38). Imrie argues that Universal Design still enables barriers to decision-making, identifying people with disabilities as informants of a process rather than viewed as experts of their own experiences. Decision-making authority is reserved for professionals, continuing to further the divide between professional practice and lived experience. Costanza-Chock draws similar comparisons across various professional industries, including architecture, urban planning, product design, and medical technology (39). An under-representation of people with disabilities and other marginalized groups in decision-making leads to erasure and ableism in project execution. Corburn argues that incorporating local knowledge from the most at-risk community members should be as crucial as standard professional practices for more inclusive and effective planning outcomes (21).

This discrepancy between expert knowledge and lived experience is also being recognized in other aspects of transportation. For example, a qualitative study comparing cyclists' and planning professionals' perceptions of bicycling showed differences in perspectives between professionals and cyclists (40). Marquart et al. found that professionals view the effectiveness of bicycling infrastructure from a network level, whereas individual bicyclists consider their own human experience along routes. A network may be well connected from a bird's eye view, yet individual factors and travel experiences impact a person's positive and negative associations with infrastructure. In a similar vein, the present study seeks to learn from the everyday lived experiences that impact people with disabilities' decisions about how, where, and when to travel, as well as how these experiences may differ from transportation professionals' decision-making.

2. STUDY CONTEXT AND METHODOLOGY

2.1 Study Context

This study focuses on the transportation experiences of people with disabilities living within the Denver Region. The Denver Region in Colorado consists of nine counties: Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin, and Jefferson counties (41). Like other U.S. metropolitan regions, the city and county of Denver is the region’s primary hub, with smaller urban and suburban communities surrounding it (42). The region has an estimated population of 3.1 million (6). Nine percent of the population identifies as having one or more disabilities (Table 2.1), while 30% of those 65 years and older have one or more disabilities.

Table 2.1 Population with One or More Disabilities

County	All population			Older adults (65+ years)		
	Total Population	Population with disability	Percent with disability	Total Population	Population with Disability	Percent with disability
Adams	500,418	52,006	10.4%	50,041	18,049	36.1%
Arapahoe	637,690	57,415	9.0%	80,198	23,555	29.4%
Boulder	320,329	26,043	8.1%	43,080	11,010	25.6%
Broomfield	67,545	5,479	8.1%	8,876	2,579	29.1%
Clear Creek	9,382	928	9.9%	1,842	418	22.7%
Denver	699,351	67,073	9.6%	79,750	26,730	33.5%
Douglas	334,814	22,459	6.7%	38,204	9,612	25.2%
Gilpin	5,960	572	9.6%	1,079	264	24.5%
Jefferson	568,063	57,029	10.0%	90,245	26,893	29.8%
Denver Region	3,143,552	289,004	9.2%	393,315	119,110	30.3%
United States	319,706,872	40,335,099	12.6%	49,488,873	17,063,045	34.5%

Source: US Census Bureau (6)

Within the Denver Region, ambulatory disabilities constitute the highest recorded disability (Table 2.2) across the population of people with disabilities and those 65 years and older. One in four people with disabilities has a disability that limits their ambulatory capacity: 29% for those 65 years and older. Table 2.2 highlights the variation in disability in the Denver Region’s population. Broadly, we find that the transportation literature has largely been quiet on how individuals with *different* disabilities interact with infrastructure.

Table 2.2 Disability Type* by County and Age

County		Hearing	Vision	Cognitive	Ambulatory	Self-Care	Independent Living
Adams	All Ages	14,784	9,627	19,124	24,886	8,555	15,410
	65 and Older	8,042	3,364	3,999	10,845	3,449	6,702
Arapahoe	All Ages	17,145	10,649	21,073	26,879	10,277	20,660
	65 and Older	10,236	3,995	5,615	13,639	4,468	9,708
Boulder	All Ages	9,029	4,350	9,996	10,527	3,701	7,858
	65 and Older	5,601	2,107	2,234	5,828	1,720	3,839
Broomfield	All Ages	1,955	1,014	1,957	2,237	607	1,364
	65 and Older	1,451	441	517	1,326	335	816
Clear Creek	All Ages	339	170	138	362	172	258
	65 and Older	179	72	58	209	65	172
Denver	All Ages	18,827	13,724	25,797	30,617	12,038	22,769
	65 and Older	10,791	4,813	6,792	16,267	5,984	11,406
Douglas	All Ages	7,990	3,406	7,556	8,161	2,856	6,098
	65 and Older	4,690	1,130	2,028	4,753	1,364	3,331
Gilpin	All Ages	279	36	228	270	53	193
	65 and Older	200	0	77	155	10	39
Jefferson	All Ages	20,603	10,093	19,210	25,250	8,877	18,002
	65 and Older	12,925	4,610	5,968	15,169	4,860	9,943
Total	All Ages	90,951	53,069	105,079	129,189	47,136	92,612
	65 and Older	54,115	20,532	27,288	68,191	22,255	45,956
Percentage (of Total)	All Ages	17.6%	10.2%	20.3%	24.9%	9.1%	17.9%
	65 and Older	22.7%	8.6%	11.4%	28.6%	9.3%	19.3%

Source: US Census Bureau (3) *Persons may identify as having one or more disabilities

The Regional Transportation District services six counties in the Denver region with commuter rail, demand response, Access-a-Ride paratransit, light rail, and bus services (43,44). Other transportation options include various transportation network companies such as Uber, Lyft, Via Mobility Services, and Via Paratransit. Figure 2.1 shows the extent of RTD’s service area. RTD is obligated to provide paratransit services only within three-fourths of a mile of any existing and operating transit route (shown in blue for bus and purple for light rail). Thus, a significant portion of the region does not have any supply of public transportation for people with disabilities, especially for those who live farther away from the more urban areas.

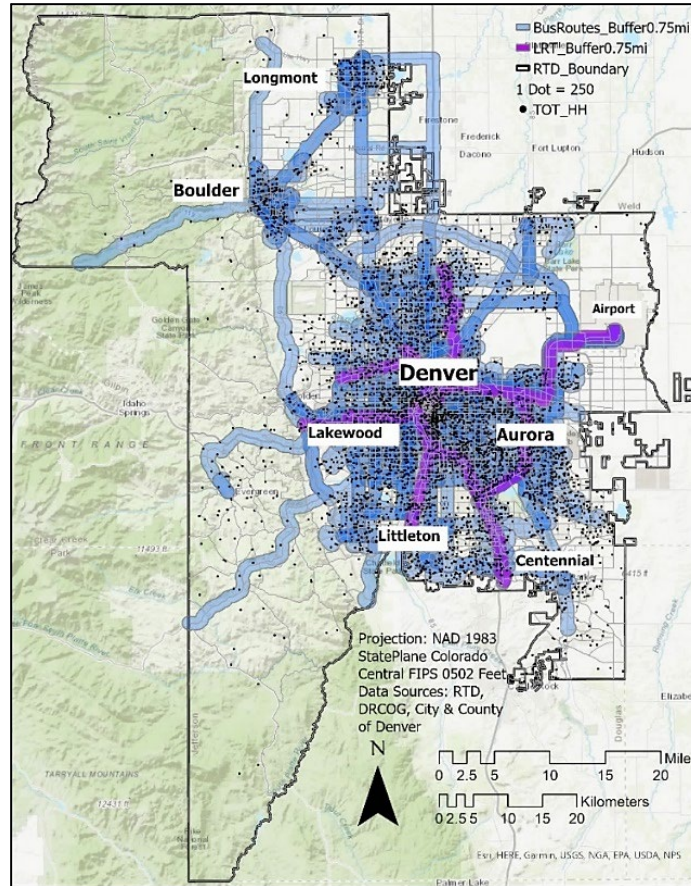


Figure 2.1 RTD Service Area (Denver Region)

Similar to national trends, people with disabilities in the Denver Region are also more likely to rely on modes of transportation where they are the passenger, using public transport, walking, or rolling compared with people without disabilities (Table 2.3) (4). Fewer people with disabilities drive alone compared with people without disabilities, making it critical for planners and engineers to focus on infrastructure that intersects with multi-modal travel.

Table 2.3 Travel Mode Share for Commuting to Work in the Denver Region*

	Total Civilian Non- institutionalized Population	Percent splits	With a disability	Percent splits
Workers aged 16 and over	1,569,915	100.0%	74,877	100.0%
Car, truck, or van - drove alone	1,170,620	74.6%	50,408	67.3%
Car, truck, or van - carpooled	132,095	8.4%	7,690	10.3%
Public transportation (excluding taxicab)	69,774	4.4%	5,522	7.4%
Walked	38,650	2.5%	2,390	3.2%
Taxicab, motorcycle, bicycle, or other means	34,558	2.2%	1,866	2.5%
Worked at home	123,894	7.9%	6,865	9.2%

Source: US Census Bureau (45) *Commute Data for Broomfield, Clear Creek, and Gilpin Counties are unavailable.

2.2 Research Approach

2.2.1 Stage 1 Interviews with People with Disabilities

We conducted one-hour-long, semi-structured online interviews from February 2021 to March 2022 with 28 people to understand what infrastructure limits mobility, when, and how. Twenty-six interviewees self-identified as having a disability, and two interviewees were educators at a local school for children and adults with disabilities. The interview group was relatively diverse based on disability status, use of mobility devices, and gender (Table 2.4). We developed eight open-ended interview questions (Appendix A) about general daily travel, barriers experienced, and variations in travel behavior due to inclement weather or COVID-19. The research team stopped interviews once there was internal consistency and thematic saturation of responses as suggested by Bowen (46) and Creswell & Miller (47).

2.2.2 Stage 2 Interviews with Experts (Planners/engineers)

We spoke with nine transportation professionals working at municipalities or nonprofits throughout the Denver Region (Table 2.5). We conducted 30-minute, semi-structured online interviews during April and May 2022 with nine such planners and engineers. Our agenda was to explore the challenges public sector organizations face in complying with ADA. One interview was with two transportation planners working at the same agency. We asked six open-ended questions (Appendix B, Appendix C) about how infrastructure is planned and implemented in each agency, how each person interacts with accessibility projects, challenges in planning and implementation, and how the ADA interacts with project planning, implementation, and maintenance.

2.3 Procedures in the Field

2.3.1 Stage 1 Interviews with People with Disabilities

Participants for stage 1 were recruited via a digital flyer shared with transportation advocacy groups, centers for independent living (CILs), local government disability and planning offices, and disability rights groups throughout the Denver Region. Groups shared information about the study through social media, newsletters, and one blog post. Interested participants completed an online survey hosted on the Qualtrics platform to ensure eligibility for an interview. Survey questions included photographs with alt text descriptions of missing sidewalks or barriers, such as an electric scooter, asking respondents to share how they would navigate each situation, thus priming the sample for a deeper discussion. Note that alternative (alt) text provides a description of the image so that the text can be read by users, e.g., the blind, who rely on screen reader software. Survey respondents were then invited to schedule an hour-long online interview. Each interview participant was provided with information on confidentiality, with consent obtained per IRB requirements. Participants were sent a \$25 gift card after the interview.

The interviews were facilitated over Zoom's online meeting platform and recorded for subsequent notetaking. The researchers noted key talking points during each interview. Upon interview completion, researchers used the audio recordings to take in-depth notes and add critical insights to a digital whiteboard (47). We then attempted to identify related themes across participant responses. Audio recordings were also used to collect quotes from the participants, which were marginally edited for grammar and content for presentation in this paper. Table 2.4 shows key characteristics of the sample.

Table 2.4 Sample Characteristics of People with Disabilities Interviewees

		Interviewees (n = 28)	Percentage
Gender	Male	15	54%
	Female	13	46%
	Non-binary	0	0%
Disability*	Ambulatory	16	
	Hearing	3	
	Cognitive	2	
	Visual	9	
	Self-Care	3	
	Independent Living	2	
	Multiple	7	
Use of Mobility Aids	Yes	19	68%
	No	9	32%
Drives Independently	Yes	13	46%
	No	15	54%

*Percentage not presented since interviewees identified as having one or more disabilities

2.3.2 Stage 2 Interviews with Experts (Planners/engineers)

Professionals in stage 2 were contacted via publicly available emails and professional connections. Researchers emailed professionals requesting a 30-minute conversation. Conversations were conducted over Zoom but were not recorded due to privacy concerns of public employees. Researchers documented the responses to six questions using Microsoft Word. Responses were then migrated to a separate digital whiteboard to identify themes (48). Professionals were not compensated via electronic gift cards or by any other means. Table 2.5 lists the expertise cohorts for the professional interviewees.

Table 2.5 Sample Characteristics of Professional Interviewees

		Interviewees (n = 9)	Percentage
Agency Type	Regional	2	22%
	City	5	56%
	Public Transit Agency	1	11%
	Nonprofit	1	11%
Position	Engineer	1	11%
	Project Manager	2	22%
	Planner	4	44%
	Executive Leadership	1	11%
	Other	1	11%

3. FINDINGS

Interviews with participants with disabilities revealed several themes regarding how infrastructure affects their transportation experiences and mode choice.

3.1 Failures with Sidewalks

A combination of sidewalk gaps (Figure 3.1), inconsistent curb cuts (Figure 3.2), uneven sidewalks, and sidewalk barriers (Figure 3.3) created physical and safety barriers to travel for all participants. Inadequate sidewalk conditions caused some participants to abandon their route or find alternate routes and other travel options, increasing burdens across time, money, and stress. Participants revealed several experiences along specific routes that still do not meet ADA requirements, particularly in neighborhoods that predate ADA's enactment.

When you go to Globeville or Elyria-Swansea or in South Denver, there's spots where there's literally no sidewalk, and you're right next to a busy street ... there's no way you can do that in a chair, because there's a huge ditch.

– #12-I, Man with ambulatory disability

We were walking, it starts off with paved sidewalks, and then you cross this one street, and it all stops. There's no paved sidewalks; the potholes are huge, and you literally have to walk out into the street to get across. There's railroad tracks that you have to cross and get over. It feels very dangerous.

– #1-I, Blind woman

There is also a lack of sidewalk inventory programs cataloging the presence of sidewalks, conditions, and barriers within local governments in the Denver region. Some professionals indicated that these data programs are in the infant planning stages. Slow progress on these programs was linked to manual labor hours, fear of liability risk, and an overall heavier emphasis on auto-oriented projects compared with transit and pedestrian projects.



Figure 3.1 An example of a sidewalk turning into a dirt path along Walnut Street in Denver. Sidewalk gaps like this can create barriers and safety concerns for people with disabilities.



Figure 3.2 A marked crosswalk leads to a sidewalk without a curb ramp along Downing Street in Denver. The missing curb ramp may require people to find alternate routes with more accessible crossing facilities.



Figure 3.3 A sidewalk along Sheridan Boulevard in Denver contains utility poles in the middle of the sidewalk. The route may be impassable for some due to the narrow width or require pedestrians to step into the gutter space to pass.

3.2 Failures with Intersection Design

Curb ramps, tactile paving, and a preference for perpendicular curb ramps aligned with crosswalks remain essential for all participants. For blind participants, perpendicular curb ramps at intersections indicate where a crosswalk is located to help align with the crosswalk. When asked about blended curb ramps, many said it was more challenging to identify where the crosswalk was located, increasing the fear of unknowingly crossing outside the designated area.

Pedestrian auditory signals can provide supporting information to determine when it is safe to cross the street, particularly in more urbanized areas. Many participants said they do not rely on auditory signals because they are inconsistent in design or only beep, which does not provide helpful information. Roundabouts also present significant challenges to navigate, particularly for blind persons, because the direction and flow of traffic are more complex to identify by sound than a controlled stop intersection.

A lot of people don't know that for a lot of these audible signals you can't just press the button and expect to get that information. You have to hold it for 2 seconds to trip the smart logic, which then says that the walk signal is on and might or might not tell you the intersection that you're about to cross. There's no consistency across different municipalities, nor even within the same municipality, as to how a signal of this type should behave.

– #17-I, Blind man

There's an area in my own neighborhood where I've been hit multiple times. I've spoken to the City about this, and I say, could you at least put a sign that's got "Guide Dog crossing"? I have an email from the City guy saying signs are ineffective.

– #21-I, Blind man with guide dog

Regardless of disability, the lack of safe crossings (Figure 3.4, 3.5) and challenges navigating multi-stage intersection crossings can require people with disabilities to travel long distances to reach a safe crossing. The distance required to travel can be time intensive, physically demanding, or preventative altogether.



Figure 3.4 A traffic light pole obstructs direct access to a crosswalk in downtown Denver.



Figure 3.5 A curb ramp leads to no marked crossing or curb ramp on the opposite side of the street in a residential neighborhood in Denver. The ramp may falsely indicate a safe crossing, but if a person cannot step onto the grass median on the other side of the street, they would be forced to turn around.

3.3 Maintenance Failures

Participants shared that the lack of maintenance for existing pedestrian facilities was frustrating, particularly in residential areas where property owners are responsible for maintaining and repairing sidewalks (Figure 3.6). Where sidewalks and crosswalks exist, they may contain cracks or gaps (Figure 3.7) and may not be up to current ADA standards, increasing people with disabilities' risk of injury or forcing them to travel in the street, use another mode, or not travel at all (Figure 3.8). During the winter, snow and ice often result in people with disabilities becoming homebound for an unpredictable time until sidewalks and transit stops are clear.

Snow is terrible. A lot of times the bus stops aren't going to be shoveled. I end up having to walk on the street because the streets are plowed.

– #5-I, Woman with multiple disabilities

Multiple challenges were identified with the building and maintenance projects, including funding, staffing shortages, and challenges in developing equitable approaches to sidewalk maintenance programs. One professional said, “In America... we love building but do not maintain (existing infrastructure),” noting that maintenance budgets are not given the same weight as new projects. Another professional shared that their city has a sidewalk repair program where residents can request maintenance, but this is only for areas the city maintains. Most professionals shared frustration around sidewalk maintenance programs, which often put the onus on the homeowner, indicating that this is an ongoing challenge with few answers or funding.



Figure 3.6 A sidewalk is displaced by a tree root, causing an uneven walking surface and safety hazard along a residential street.



Figure 3.7 A crosswalk in downtown Denver contains brick pavers and asphalt patches creating an uneven walking surface.



Figure 3.8 A bush encroaches on the sidewalk along Sheridan Boulevard in Denver. There is no room to travel around the bush without stepping off the curb and into the traffic lane.

3.4 Failure with Transit Communications and Services

Participants expressed the need for improving transit communications across multiple areas, including improving real-time arrival and departure data and communicating route changes and cancellations. Persons who are deaf or blind indicated that clear audio and American Sign Language (ASL) communication at stops, stations, and onboard vehicles is needed. The lack of communication led to distrust of transit, especially after some interviewees missed essential appointments due to transit failures. Persons who are deaf found it exceedingly challenging to communicate with transit operators or access ASL interpretation support. People with disabilities shared the desire for increased efforts to notify and involve people with disabilities in decisions regarding service changes.

Any time announcements happen, hearing people can hear drivers speaking over the intercom, but deaf people don't have access to that.

– #15-I, Deaf woman

Since the onset of the COVID-19 pandemic, transportation operators have cut back on service and experienced critical staffing shortages. Particularly in Denver, RTD has made significant cuts to bus routes. Participants expressed frustration about needing to relearn new routes, no longer having access to transit due to changes, and sometimes not learning a route is canceled until they were waiting for the bus.

The bus route that comes by our place got canceled. So now, I have to have a whole binder of all the different local mobility services transportation services that I could access, whether they're free, eight-five, medical only, after hours. So, it's multiple options.

– #10-I, Blind man

3.5 Failure with Paratransit

Participants across all disabilities shared frustrations about paratransit logistics and scheduling. Particularly, they noted the requirement to book rides a day in advance and the reality that a 20-minute trip often turned into a multiple-hour event, requiring riders to miss appointments or take an extended amount of time off work. For many, paratransit is a last-ditch transportation option.

We really have to be smart about where we're going because we don't have the option for impromptu trips. It takes six hours just to get to an appointment and back because you're waiting for two-hour windows before and after the trip, and the trip takes twice as long because they're shared with multiple stops. It prevents a lot of people from even wanting to utilize them because who has time to spend your entire day...?

– #17-I, Man using a wheelchair

I do not own my own vehicle. I gave up my car about four or five years ago. Mostly, because I knew that I would have transportation to medical appointments provided by Colorado Medicaid, and that has been a good thing, but it's also been a difficult thing.

– #5-I, Woman with multiple disabilities

One participant described the approval process for paratransit as humiliating:

The process to me is very humiliating and it's dumb because the government has declared me permanently disabled. I have to go every four years and walk myself embarrassingly with somebody, so they can certify that I still can't get everywhere I want to go all by myself at all times.

– #23-I, Blind woman with a cane

3.6 Failure with Public Transit Facility Designs

Participants found the design of public transit facilities and connections to facilities inconsistent, often leading to frustration. The placement of transit stops and the surrounding conditions of sidewalks and crosswalks influenced participants' decisions to take transit or how far out of their way they would travel on transit to find a safe route. One blind participant expressed the need for improved strategies to identify bus stop locations, such as the consistent design of poles, RFID technology, and other tactile materials at bus stops. Other concerns affecting the health, safety, and comfort of riders at stops included the lack of seating, protection from the weather, and poor placement of bus loading areas (Figure 3.9 – 3.11).

I spend a lot of time poking around. If I could see, I would know the bus stops right there, but the bus stops everywhere are different. They don't even have the same pole, they're not constantly the same distance from the corner, they're not even on the same

side of the sidewalk, or some of them are in concrete, some of them are just in grass. Trying to make sure I'm at the bus stop is very difficult.

– #23-I, Blind woman with a cane

The bus stop will have the ramp that comes down for the bus but that's right where they put the bus stop sign. So, they'd have to stop the bus either before or after it where there wasn't pavement and that would force me to push through grass or dirt to use the ramp.

– #17-I, Man using a wheelchair

Getting dropped off at a (bus) stop, it's like, I'm never quite sure of sidewalks. I have fallen going to and from the bus. I know that sidewalks can be dangerous because they're not eye level. You know there's not always a ramp to go up and down.

– #5-I, Woman with multiple disabilities



Figure 3.9 A dirt path leads to a bus stop along a high-speed, high-traffic road with no sidewalk. For those with a mobility device such as a wheelchair, traveling along this path to access the bus stop may be physically demanding.



Figure 3.10 A bench is placed on a raised platform at a bus stop along a busy arterial street with a narrow sidewalk. For those who cannot easily step up to access the bench, there is no room to wait for the bus outside of the pedestrian path.



Figure 3.11 A mid-block bus stop is placed in the grass with no sidewalk access along the street. For people with disabilities, this stop may be inaccessible or challenging to access, requiring them to find an alternate, more accessible route.

Transportation professionals shared that addressing first/last-mile connections to transit is a barrier when the transit stop property (or adjacent property) is owned and managed by a combination of public and private owners, requiring additional coordination, funds, and time to address issues.

3.7 Failures Around Street Furniture, Emerging Technology, and Temporary Route Closures

With the onset of COVID-19, many local governments acted quickly to allow outdoor dining in the public realm on sidewalks and in parking spaces. Participants shared support for outdoor dining and street furniture that enhances the public realm; however, the additional demands on sidewalk space created barriers for persons with disabilities. Dining tables and other street furniture forced participants to alternate between the sidewalk and the street on the same block, which was not always feasible for people with disabilities (Figure 3.12). More generally, e-scooters and e-bikes parked on the sidewalks were also a significant barrier and point of frustration for many (Figure 3.13). The minimal noise e-scooters, e-bikes, and electric vehicles create is challenging for some to detect in advance. While noise interference near intersections from idling cars, delivery vehicles, and street entertainers made it challenging to assess when to cross streets, particularly for individuals who are blind or visually impaired.

All the dining in the streets is driving me nuts... That cannot be ADA compliant. In the street, out of the street, stuff in the way, stuff not in the way. It's a nightmare. I think they should take the street because we don't traditionally walk there anyway.

– #19-I, Blind woman with a guide dog

People leave them (scooters) in the middle of the sidewalk and curb cuts and it makes it impossible. They get in my way.

– #27-I, Man using a wheelchair

Construction and other temporary route closures remain challenging for participants. At times, construction detours direct participants on the street but do not appropriately account for necessary ramps or other accessibility features needed to navigate detours safely. Persons who are blind indicated it was not easy to cross a street and continue along a route. They must learn an entirely new route that can take time and is stressful, even if it is a one-block detour from their typical route. Participants shared that they often experience negative consequences from these barriers and detours, including being penalized for arriving late to work, rescheduling appointments, missing transit connections, and having to spend additional resources to identify alternate routes.

Close your eyes for a second and just imagine that you learn a route, you got so used to a route, and then one day the street's closed. How are you going to get to work? What do you do? What if you don't have a car and you don't know of any other route? You can't just say, well, I'm blind. I'm going to call into work and not come to work for the next three months 'cause the road is closed. You're not gonna have a job.

– #13-I, Blind woman with a cane



Figure 3.12 Outdoor dining tables at Larimer Square in Denver block an entire sidewalk. No ramp is provided to transition to the street for navigating the dining space. Some participants said they avoid this pedestrian area because of the unpredictability of accessible paths.



Figure 3.13 An intersection with no marked crossings. An e-scooter blocks one ramp crossing, and the other ramp is blocked by a “sidewalk closed” construction sign. This demonstrates how temporary barriers can prevent people from safely traveling to their destination efficiently and effectively.

3.8 Failure to Involve People with Disabilities in Planning, Design, and Decision Making

Many people with disabilities we interviewed shared stories of contacting local government officials about concerns and experiences traveling in the city. However, they all shared an underlying frustration of not being heard or valued in planning processes.

There’s a saying, “Nothing about us without us.” If we don’t have people to ask the questions about accessibility, then sometimes it just doesn’t happen. They (experts) want to make it pretty, not necessarily safe.

- #1-I, Blind woman

They have been doing more bus rapid transit studies between some of our neighboring cities. I’ve given feedback on some of those. Sometimes they take the feedback, but I don’t feel like some of these projects intentionally take the voices of people with disabilities (into consideration). Sometimes the solution seems worse. I wish they would do more disability-focus sessions to understand more things about wheelchair users.

- #8-I, Woman using a wheelchair

One professional called a local government’s community engagement efforts for planning projects well-intentioned but misguided, with pedestrian and transit projects having a much heavier emphasis on extended community engagement processes to auto-oriented projects.

4. DISCUSSION

The ADA is a civil rights law meant to protect people with disabilities from discrimination and ensure they have the same rights and access to opportunities as everyone else. However, our work reveals that people with disabilities do not have equal access. The results suggest that the built environment, particularly transportation infrastructure, consistently fails people with disabilities through physical and programmatic lenses.

People with disabilities experience physical mobility barriers daily. Incomplete sidewalk networks or sidewalks that are too narrow or in poor condition can be dangerous or limiting, regardless of disability. Paratransit time and booking requirements do not allow spontaneity or ease of use. People with disabilities have lost trust in fixed-route transit due to poor communication of route changes and limited access to visual and auditory information services. Negative transit experiences are further emphasized in transit stops with no amenities, poor sidewalk connections, and little consistency in identifying stop locations for blind and low-vision persons.

To contextualize these issues, Figure 4.1 shows the nature of the problem across various neighborhoods in the City and County of Denver. In area 1 (Denver's Central Business District), there is a profusion of transit services and few sidewalks under 3 feet, shown in yellow. Area 2 (Northeast and North Park Hill) are industrial and lower-income neighborhoods and present a case of a location with light-rail and bus services but large groups of blocks with sidewalks that do not meet ADA standards. Area 3 (Montbello) showcases a mixed-income neighborhood with relatively good sidewalk coverage located just at the edge of extensive transit services. Finally, area 4 (Bear Valley) is a typical suburban redevelopment with sidewalks greater than 3-feet wide but a weak transit supply.

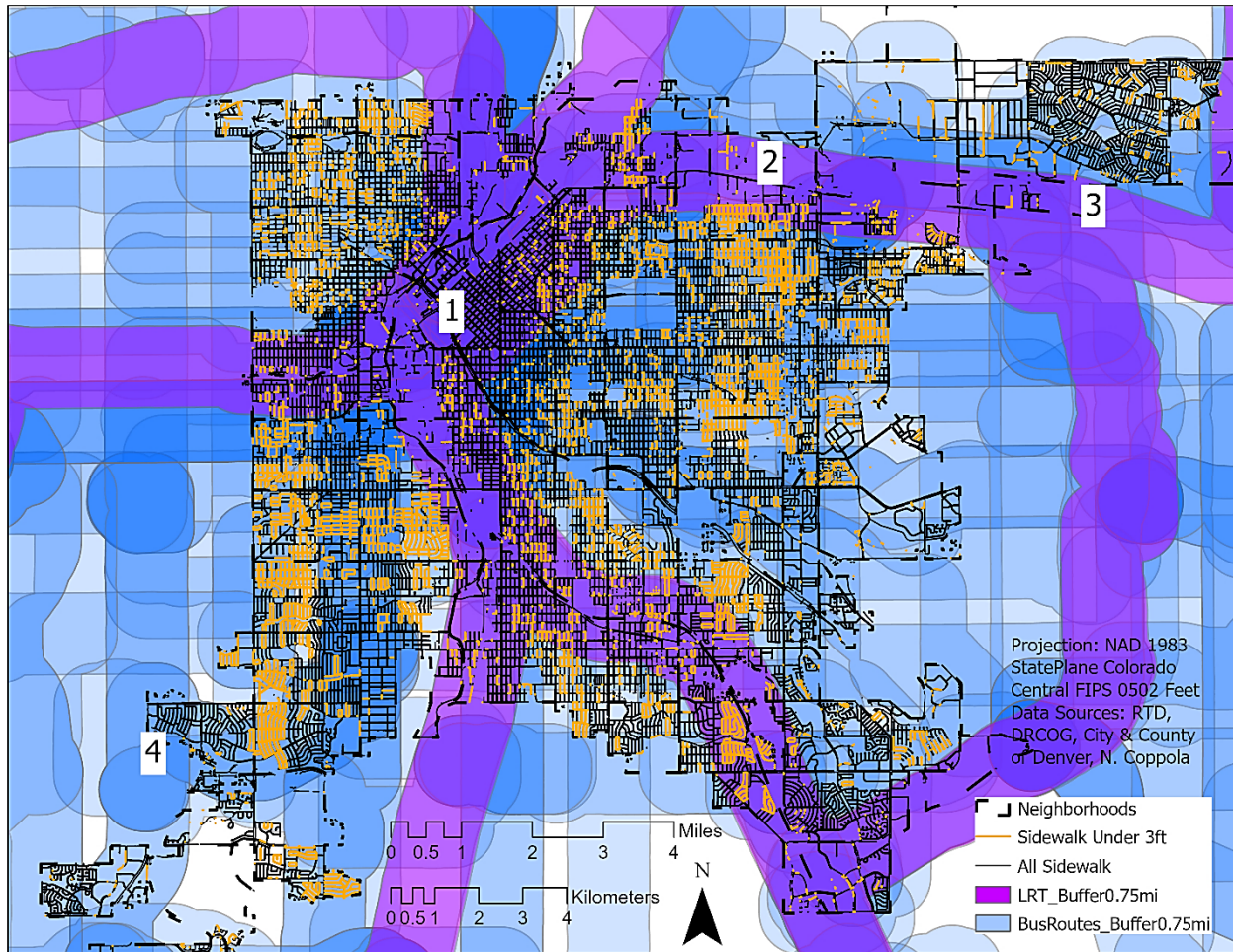


Figure 4.1 Transit supply and sidewalk barriers for people with disabilities across Denver neighborhoods

Barriers extend beyond physical infrastructure to programmatic executions. Paratransit approval processes humiliate people with disabilities, creating barriers to access and service. Communication and consideration for people with disabilities' mobility needs for sidewalk obstructions are not evident in planning practices. Construction detours, increasing demand for sidewalk space for outdoor dining programs, and micromobility pose physical and emotional safety concerns. Access to micromobility options for people with disabilities is also limited, excluding this as an affordable and efficient transportation option. Lack of snow clearing and confusion around who is responsible for sidewalk maintenance programs can lead to people with disabilities becoming isolated or homebound. In general, social isolation can lead to an increased likelihood of persons with disabilities experiencing negative impacts on their mental health. This is exasperated by infrastructure and programmatic transportation barriers (49). A variety of barriers or combinations of barriers such as financial, geographic, weather, personal time, and reliability can require people with disabilities to make tradeoffs between accessing essential services, such as healthcare, and participating in non-essential activities or enjoyments that contribute to overall happiness. Poor communication and insufficient services led many participants to express frustration and anger toward decision-making, resulting in barriers. People with disabilities expressed a desire to be more involved in planning decisions to improve accessibility policies, plans, designs, and implementation.

Conversations with professionals shed light on multiple challenges within their agencies. First, only one of the nine professionals interviewed had a staff position focused on transportation accessibility for people with disabilities. Meeting ADA compliance was left up to team members and checked off along the way. The responsibility of a staff member to advocate for changes and include people with disabilities was largely aspirational. Professionals also shared that ADA was important, but funding, political priorities, misalignment with other transportation projects and plans, and a continued priority for auto-oriented projects limited their ability to address gaps in their jurisdictions. Information databases on sidewalk conditions, ADA compliance, connectedness, and other features are very limited, partially because of the agency's "liability risk" concerns of having that information. These barriers, combined with the lack of people with disabilities in transportation planning positions and as respected experts, further exacerbate discrepancies in infrastructure and programming accessibility.

To our knowledge, no study has specifically looked at experiences of how multiple facets of the transportation environment and programs influence the mobility of people with disabilities. Finally, there was no consistent method or policy for engaging with people with disabilities across agencies and projects. The findings from this study call for questioning how current policies, funding limitations, perspectives, and ADA practices within public planning agencies result in limitations in access for people with disabilities.

5. CONCLUDING REMARKS

For over 30 years, the ADA has intended to protect people with disabilities from discrimination and ensure they have the same rights and access to opportunities as anyone else. However, the infrastructure and current planning processes fail people with disabilities in our communities. There is also a need to reevaluate how current enforcement and monitoring of ADA compliance is managed. The fight to ensure ADA continues to protect persons with disabilities continues today. Currently, there is an effort by some lawmakers to pass an amendment to the ADA that would leave the responsibility of enforcement up to individuals by requiring them to provide written evidence to business/property owners detailing how access has been denied (50,51). The daily mobility challenges that people with disabilities face and the underrepresentation of people with disabilities in the transportation fields risk dangerously reinforcing acts of ableism and othering in transportation planning (52). Planners and engineers, who are “experts,” generally do not have the lived experience to visualize how design standards, features, and programmatic considerations can leave out people with disabilities. Not only are those with disability a small percentage of the workforce in the transportation sector, but those with disabilities who speak up through advocacy organizations or as private citizens do not get their opinions included in the design and running of transportation infrastructure. Moving forward, efforts to include people with disabilities in infrastructure and program development should be offered through decision-making roles and increasing the accessibility of community engagement processes. Strategies such as providing digital and non-digital communication methods and utilizing tactile or immersive technology tools may reduce barriers to engagement (53,54). Including people with disabilities and their lived experiences can improve infrastructure accessibility and the overall quality of travel experiences.

6. AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: Wagner, Shirgaokar, Marshall; data collection: Wagner; analysis and interpretation of results: Wagner, Shirgaokar; draft manuscript preparation: All authors. All authors reviewed the results and approved the final version of the manuscript.

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8. APPENDIX A: PERSON WITH DISABILITY PARTICIPANT INTERVIEW QUESTIONS

8.1 Questions on General Travel

1. What things do you consider when planning to travel locally (to work, run errands, see friends, etc)?
2. How does your choice of travel mode (e.g., bus, walk, car) change based on *when* you are traveling?
3. How does your choice of travel mode (e.g., bus, walk, car) change based on *where* you are going?
4. What is your opinion of the transportation options around where you live?

8.2 Questions on Barriers

5. What are the most frustrating things about travel for you?
6. What makes traveling easier for you?
7. Are there trips you *do not* make or activities/events you *do not* go to because it is difficult for you to travel?
8. How do seasonal weather conditions such as rain or snow impact the way you travel?

8.3 Variations in Travel (secondary questions if time permits)

9. How does your comfort while traveling change when traveling after sundown (or in the dark)?
10. How has COVID impacted how often you travel?
11. How has COVID impacted where you travel?

9. APPENDIX B: PLANNER/ENGINEER EXPERT INTERVIEW QUESTIONS

9.1 Part 1: General Questions

1. Can you give a high-level overview of how infrastructure is planned and implemented in your agency?
2. How do you interact with accessibility projects in your day-to-day work?

9.2 Part 2: Option 1

3. What specific challenges do you face in the design and planning of xxxxx?
4. What other specific challenges do you face in the building and maintenance of xxxxx?
5. How do you think of the intersection of the Americans with Disabilities Act and your work? What are some connections which impact your thinking regarding ADA?
6. At what stages in planning and implementation are there check points for ADA compliance? Is there additional work in your organization for post-delivery evaluation with reference to ADA compliance?

9.3 Part 2: Option 2

3. How do you think of the intersection of the Americans with Disabilities Act and your work? What are some connections which impact your thinking regarding ADA?
4. At what stages in planning and implementation are there check points for ADA compliance? Is there additional work in your organization for post-delivery evaluation with reference to ADA compliance?
5. What are the biggest challenges to achieving ADA compliance in your work?
6. Who oversees ADA compliance in your organization and how does your work intersect with such oversight?

9.4 Additional Questions (If time permits)

7. Are there other partners or agencies you work with to coordinate accessibility and ADA compliance? Who are these other stakeholders/actors/experts?
8. Do you collaborate with people with disabilities on projects? For example, do you seek input from people with disabilities? Can you speak about how this is managed?
9. Who oversees ADA compliance in your organization and how does your work intersect with such oversight?
10. What are the biggest challenges to achieving ADA compliance in your work?
11. At what stages in planning and implementation are there check points for ADA compliance? Is there additional work in your organization for post-delivery evaluation with reference to ADA compliance?
12. What makes (or would make) complying with ADA standards easier?
13. Do you face challenges with funding for the xxxxx? What are some of these challenges with budgets and funds?

10. APPENDIX C: NONPROFIT EXPERT INTERVIEW QUESTIONS

10.1 Part 1: General Questions

1. Can you give a high-level overview of how your organization is involved with planning or implementation of infrastructure?
2. How do you interact with accessibility projects in your work?

10.2 Part 2:

3. What specific challenges do you see public agencies having in the design or planning of transportation projects?
4. What specific challenges do you see public agencies having in the building or maintenance of transportation projects?
5. How do you think of the intersection of the Americans with Disabilities Act and your work? What are some connections which impact your thinking regarding ADA?
6. What do you think are the biggest challenges to achieving ADA compliance in transportation projects?