

**Data Visualization and Analytics to Support
Accessible Pedestrian Planning and Decision-Making**

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Abstract

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Transportation planners cannot begin to address inaccessible pedestrian networks if they are not aware of the type and location of the network deficiencies. Unfortunately, planning tools that visualize these networks are not widely available and are only applicable to select jurisdictions. Therefore, we want to develop a flexible tool that can answer a diversity of planning questions and complete a range of PROW analyses all while incorporating accessibility considerations for people with mobility disabilities. We aim to improve our Walkshed Generator App tool by understanding what capacity-building tools we can provide urban and transportation planners to improve decision-making processes for accessibility projects and improvements to the PROW. To address this objective, we engaged active transportation planners via a pre-interview questionnaire that informed prototype visualizations developed with the Walkshed Generator App, and were subsequently demonstrated to the interviewees during a co-design interview. From these interviews, we developed 6 recommendations to guide the development of a useful and flexible planning tool to support the inclusion of accessibility in transportation planning.

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Executive Summary

People with disabilities are a large and growing part of our population; 26 percent of the adult population in the US has a disability, and 11.1 percent have a mobility disability (Centers for Disease Control and Prevention, 2022). However, their ability to fully participate in social and public life outside their homes is obstructed by the accessibility of the public right of way (PROW). Interconnected pedestrian networks support a healthy, connected lifestyle for all. Thus, a transportation planner's ability to characterize the current state of pedestrian infrastructure is crucial for expanding and improving these networks. But, their ability to do so is only as good as their knowledge of the infrastructure conditions.

Active transportation planning divisions are addressing these changes through programs such as Complete Streets and Vision Zero to ensure multimodal travel is incorporated into transportation and infrastructure planning. Jurisdiction-level tools created by SEMCOG, Minneapolis, Louisville, and to an extent, pathVu, have increased our understanding of accessible PROW infrastructure. Unfortunately, such tools are not widely available, are applicable to other jurisdictions, or do not incorporate important data uniformly. Additionally, they require staff time, contractors, and technology typically only available to jurisdictions with ample resources (Proffitt et al., 2019).

Transportation planners cannot begin to address our inaccessible pedestrian networks if they do not know where and what the gaps are. We also recognized that planners are unlikely to use a tool that only centers on accessibility due to current planning paradigms and funding; therefore, we want to ensure that we make a flexible tool that can answer a diversity of planning questions and complete a range of PROW analyses. We hope to improve our Walkshed Generator App tool by engaging with transportation planners to understand what capacity-building tools we can provide urban and transportation planners to improve decision-making processes for accessibility projects and improvements to the PROW.

To engage key stakeholders, we interviewed 11 transportation planners through 8 interviews. Before the interviews, each interviewee completed a pre-interview questionnaire where we learned more about their current planning focus and pedestrian planning questions. From the questionnaire responses, we developed a series of 4 visualizations using the prototype Walkshed Generator App. During the interview, we asked questions about the interviewees current planning tools and then led them through a co-design process where we demonstrated the visualizations and solicited feedback on the visualization method, data included, and scale. After the interviews, we used thematic coding to identify themes and develop a series of recommendations to improve the current tool.

Interviewees stated that the demonstrated visualizations could help them answer their planning questions about where to place specific infrastructure, how projects impact the population, and how easy a trip is to take. Most interviewees said that walkshed analyses are helpful to their work. They also added that origin-destination and scenario planning visualizations would be helpful. Interviewees mentioned a total of 63 different types of data they would like added to the tool to help them with their work. Most interviewees mentioned data related to pedestrian infrastructure, urban planning, and traffic design. For each of these data types, interviewees stated that they would be best incorporated into the tool via additional data

layers. Relating to this, most interviewees said that they would like to be able to download the tools analyses to incorporate into their own data sets. Most interviewees mentioned that they would use all the scales in their work, and the most relevant scale would depend on their current task.

Eight interviewees mentioned that metadata, such as date and method of collection, date of updating, and steward information, would be key for them to understand the data and its trustworthiness. Some interviewees mentioned policy barriers to using public data, where even if the data is updated and they trust it, the internal policy would not allow them to use the data.

Based on the interviews and associated analysis, the following considerations should be included to guide the development of a useful and applicable active transportation planning tool:

- 1. Develop a tool that visualizes data at different scales and creates downloadable analyses for further integration into agency-specific data to support broader use.***
- 2. Include walkshed, origin-destination and scenario planning analysis to help planners understand network connectivity.***
- 3. Provide supplementary quantitative analyses to support a deeper understanding of the mapped data and to communicate the findings to a broader audience.***
- 4. Include basic data on pedestrian infrastructure (including curb cut locations, crossing locations and attributes, and sidewalk attributes), traffic design (posted speed), and urban planning (zoning, land use, and trip generators), to support planners' current work.***
- 5. Ensure the tool is managed by an external party (i.e. not any one agency) to reduce barriers for use and application.***
- 6. Consider current agency data-use policies to ensure we develop a tool that agencies trust and therefore are able to use.***

By developing a tool that provides active transportation planners, and planners in general, the ability to visualize network connectivity from the perspective of people with mobility disabilities they will be able to prioritize infrastructure projects and improvements that meaningfully improve accessibility. Future research should integrate the findings from this study into another iteration of the prototype tools. The subsequent version should be brought back to transportation planners, either through another interview process or through pilot testing.

1 Introduction

People with disabilities are a large and growing part of our population; 26 percent of the adult population in the US has a disability, and 11.1 percent have a mobility disability (Centers for Disease Control and Prevention, 2022). However, their ability to fully participate in social and public life outside their homes is obstructed by the accessibility of these networks. Interconnected pedestrian networks support a healthy, connected lifestyle for all. Thus, a transportation planner's ability to characterize the current state of pedestrian infrastructure is crucial for expanding and improving these networks. But, their ability to do so is only as good as their knowledge of the infrastructure conditions. We aim to identify the current planning direction and questions related to accessible transportation planning as well as current and emerging data sources to support the development of an accessible public right of way (PROW) data visualization tool. Thus, the central research question guiding this research is: What capacity-building tools can we provide urban and transportation planners to improve decision-making processes for accessibility projects and improvements to the PROW?

An initial literature review was conducted to understand the current direction and state of accessible transportation planning, impact of inaccessible PROW on people with mobility disabilities, and existing PROW visualization tools and analysis. Key search terms included accessibility, pedestrian, disability, public-right-of-way, Safe system; vision zero; and disabled pedestrian traffic safety. Literature and potential sources were scanned for information on pedestrian and PROW accessibility for people with mobility disabilities, data visualization, and data analysis.

2 Background & Literature Review

2.1 What is Accessibility in the Public Right of Way (PROW)?

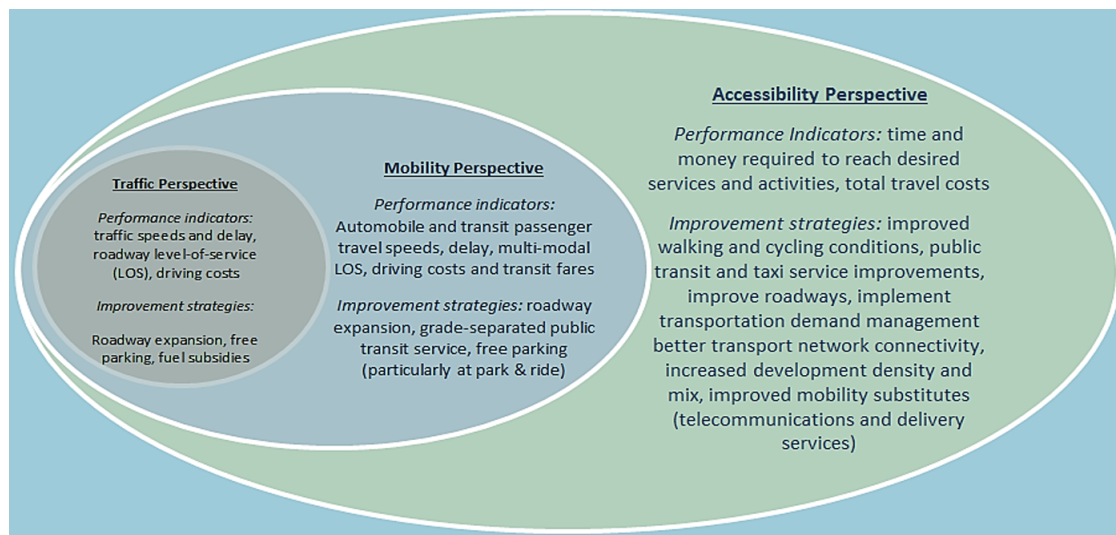
The public right of way (PROW) refers to land reserved for mobility, such as sidewalks, crosswalks, curb ramps, and streets (*(Proposed) Public-Rights-of-Way Accessibility Guidelines*, n.d.). These areas serve as vital public spaces, allowing people to move freely within public spaces to access everything outside their homes, from employment, healthcare, economic opportunities, education to leisure. Historically, PROW funding and projects have focused on improving vehicular movement and not the experience of pedestrians (Polanski, 2015). However, the paradigm is shifting as urban planners and other stakeholders begin to recognize

the social, health, and economic benefits of robust and interconnected pedestrian PROW infrastructure. Planning programs such as Complete Streets and Vision Zero champion this idea, working to improve pedestrian infrastructure to support and encourage pedestrian travel and increase safety (*Complete Streets*, n.d.; *What Is Vision Zero?*, n.d.). However, these programs are only as successful as they are inclusive of the people in our communities. Ensuring that our sidewalks and street crossings are accessible for all is federally legislated and essential for ensuring all people, regardless of ability, are able to take part in public life.

2.1.1 Accessibility and Accessible Transportation Planning

Transportation planners tend to focus on improving accessibility *or* mobility within their physical jurisdiction. Accessibility is often defined as time spent or distance traveled to opportunities, activities, or employment, with mode focus differing based on the planner's focus area (Levine et al., 2019; Litman, 2022). Mobility is defined as the number of places in general that a person can reach in terms of time spent or distance traveled (Levine et al., 2019). Transportation planners, however, tend to take a siloed approach to their planning, either addressing accessibility or mobility. For example, accessibility-based planners focus on multimodal planning and compact, pedestrian-friendly neighborhoods that increase the ease of connection between points of interest. In contrast, mobility-based planners may define accessibility problems based on the connectivity of roads or the time spent traveling between general areas, thus prioritizing vehicular travel via freeways and other major arterials. In

Figure 1: Traffic, Mobility, and Accessibility perspectives of transportation planning (Litman, 2022)



Hansen's seminal work on how accessibility shapes land use, "accessibility is defined as the potential of opportunities for interaction" (Hansen, 1959). This definition combines accessibility and mobility-based planning, making them a relationship between the number of jobs or people at an activity center divided by the time or distance it takes to travel there (Hansen, 1959). Litman's transportation planning model inherently links mobility and accessibility planning, and he notes a paradigm shift towards a more accessibility-focused approach, as seen in Figure 1 (Litman, 2022).

Accessibility and mobility-based planning definitions do not always specify transportation methods or account for "mobility and physical differences across individuals" (Saha et al., 2021). Depending on how planners define accessibility for a specific transportation project, they may prioritize specific modes over other, more inclusive travel modes. As Proffitt et al. point out, the gap between accessibility theory and practice may be closing, but it is not perfect yet. In their study, of the 42 surveyed regional transportation plans, only 10 percent of plans defined what is meant by 'accessibility,' thus leaving the policy open to interpretation and potential infrastructure improvements that are not accessible for people with disabilities (Proffitt et al., 2019). Measuring access requires transportation planners to identify travel mode, beginning and ending destination, and time spent traveling (Levinson & Wu, 2020). This way, accessible transportation stakeholders can fully understand who has access and by which travel method. A jurisdiction's chosen definition of access and associated metrics are used to assess current conditions and allocate resources (Blanchard & Waddell, 2017). Thus the specific definitions of accessibility are influential in determining what projects get funded and who benefits.

People with disabilities are a heterogeneous group, with PROW infrastructure design impacting different types of disabilities differently (Bolten et al., 2017; Stafford et al., 2022). However, specific pedestrian infrastructure designs can make an area more accessible for people with various mobility disabilities, such as curb ramps, smooth, low-grade sidewalks, and improved connectivity between points of interest (Saha et al., 2021).

Accessibility guidelines did not exist when most of our existing pedestrian infrastructure was built (Eisenberg et al., 2020). Guidelines from the Americans with Disabilities Act (ADA) require the PROW to be accessible for people with disabilities (28 CFR Part 36, 2022). Unfortunately, it only requires updates when responding to a lawsuit or replacing aging or broken infrastructure (Eisenberg et al., 2020; Saha et al., 2021). This replacement and updating method leads to very piecemeal updates and an incomplete PROW network (Eisenberg et al., 2020). Well-connected PROW networks support increased pedestrian travel and can "improve health by increasing access to health care, goods and services" (*Promoting Connectivity*, 2015).

Suppose accessible infrastructure improvements are only completed in the current patchwork style. In that case, people with disabilities will get stuck in pedestrian 'islands' where pedestrians can travel only within a defined geographic area surrounded by inaccessible infrastructure, leaving them disconnected from other points of interest (Bolten & Caspi, 2021). As seen in Figure 2, due to the drainage improvement and associated project ADA requirements, a curb cut was installed in an area that lacked sidewalks making ineffective and disconnected accessibility 'improvement' (Ferguson, 2014). Jackson proposes the need for neighborhood-level accessibility mapping to support accessible infrastructure improvements that provide interconnected PROW pathways for people with disabilities (Jackson, 2019).

Figure 2: Curb drainage and associated disconnected, but required, ADA improvements completed in Bakersfield, CA (Ferguson, 2014)



2.1.2 Connection between Transportation and Public Health

It is well established that transportation is an essential social determinant of health, impacting other social determinants of health, such as food access and social engagement (*Transportation and Social Determinants of Health Destinations*, n.d.). Urban and transportation planning can significantly influence physical and emotional well-being and social involvement (Sandt et al., 2020). Accessibility within the PROW directly impacts a person's, specifically those with mobility disabilities, ability to participate in public life and access jobs, healthcare, and recreation - critical aspects of social determinants of health, all of which can affect a person's health (Eisenberg & Maisel, 2021; Sandt et al., 2020). As the American Association for People with Disabilities aptly pointed out, accessibility in the PROW is critical as it provides connection

between peoples homes and other transportation options, such as personal cars parked on the street and transit stations. Without these important connections it may be impossible for a person to get to their critical destinations (American Association for People with Disabilities, n.d.).

2.1.3 Disparate Health Impacts on People with Disabilities

This lack of accessibility within the PROW has led to disparate health outcomes for disadvantaged communities, particularly those with mobility disabilities (Jackson, 2019). Over time, the number of trips people with disabilities take outside their homes has decreased. In general, people with disabilities take fewer trips per day than those without disabilities (Brumbaugh, 2018). Not only that, these same people may have additional trips they want or need to take than they are able to; “7 out of 10 respondents with disabilities [reduced] their day-to-day travel because of their disabilities” (Brumbaugh, 2018). According to the CDC, “close to 50 percent of seniors and people with disabilities live within two blocks of a bus stop,” but in accessible pedestrian infrastructure, or no infrastructure whatsoever, hinders their ability to access the transit (Centers for Disease Control and Prevention, 2017). Transportation is a main barrier for people with disabilities in accessing preventive care, which is important for addressing preventable health issues and mortality, health outcomes which are exacerbated for people with intersectional experiences (i.e. person with a mobility disability and low income) (Marrocco & Krouse, 2017). These severed pedestrian travel networks stymie social inclusion, physical activity, and important health care access leading to poorer health outcomes (Jackson, 2019).

Additionally, people with disabilities experience higher rates of food insecurity than people without disabilities and inaccessible transportation networks serve as a common access barrier. When traveling to essential destinations such as grocery stores, Huang et al. found that absence of sidewalks, steep street slope, and roadway obstructions were all perceived barriers, thus limiting food access and exacerbating food insecurity (Huang et al., 2012). In 2021 up to 33 percent of households with an adult with a disability were food insecure, which can lead to higher rates of diabetes, high cholesterol, amongst other poor health outcomes (Swenor et al., 2021). Even when people that use wheelchairs travel in the PROW, their risk of deadly pedestrian crashes is higher than that of non-wheelchair users (Kraemer & Benton, 2015). Kraemer & Benton attributed this to environmental *and* driver behavior. A lack of crosswalk or traffic control devices, failure to yield, and inappropriate speed were all attributed to heightened crash risk and mortality for people using wheelchairs (Kraemer & Benton, 2015). Limited or

eliminated access to the PROW reduces access to employment opportunities, education, health care, and general social interaction outside the home, all impacting health outcomes (Bezyak et al., 2020).

2.2 Current Questions and Direction in Accessible PROW Transportation Planning

Planners and stakeholder’s goal to address accessibility within the PROW is a “wicked problem,” one without a clear path to fulfillment and hindered by the current lack of interdisciplinary approach and funding sources (Eisenberg et al., 2020; Proffitt et al., 2019; Saha et al., 2021). As stated before, prior to the ADA, there were no guidelines for PROW infrastructure design. Planners focused on accessibility-based transportation planning recognize that there is no one-size-fits-all approach to transportation and that providing quality transportation options leads to the most efficient system (Litman, 2013). Now, while there are accessibility design guidelines, PROW updates are piecemeal, leaving planners unable to identify what areas are actually accessible to people with disabilities and the current state of continuity within our travel networks (Eisenberg et al., 2020). Generally, the mission of transportation departments (DOTs) around the country focuses on improving “safety, efficiency, mobility, accessibility, and quality of life.” In contrast, state and local health departments (DOHs) “include protecting, promoting, and improving the health of people,” both of which influence each other and the efficacy of projects and policies (Sandt et al., 2020). Historically, integrating these two missions, while seemingly inherently connected, has not happened. However, this is changing. Transportation departments nationwide have started integrating accessibility for people with disabilities into their planning programming; some DOTs have even created departments focused on this task (*Accessible Services*, 2013; *Vision Zero Communities*, n.d.).

Identifying what questions DOTs are asking when implementing these new programs and prioritizing projects is important for understanding how data visualization can best support them in this endeavor. Publications from organizations such as the National Cooperative Highway Research Program and legal direction

Figure 3: Safe System Design Structure (Demystifying the Safe System Approach, n.d.)



from the Americans with Disabilities Act (ADA) highlight some of these questions, seen in action through transportation programs such as ADA Transition Plans and Vision Zero.

2.2.1 National Cooperative Highway Research Program

The National Cooperative Highway Research Program (NCHRP) is the United States highway research program that identifies current and emerging areas of transportation research (*NCHRP Overview*, n.d.). Research direction is developed based on needs identified by DOTs and committees, which the NCHRP then uses to develop project scopes and budgets to address these issues (*NCHRP Overview*, n.d.). In the NCHRP 2020 research report by Sandt et al., *A Research Roadmap for Public Health*, authors identify under-researched areas of the impacts of transportation on health and the social determinants of health. Sandt et al. calls attention to the importance of an interdisciplinary approach to understanding how these two topics impact each other, such as research in economic development, land use, transportation, and multimodal connectivity, amongst other disciplines (Sandt et al., 2020). These research focus areas, questions, and knowledge gaps highlight the need for interdisciplinary consideration of how transportation projects and general transportation access impact health. Although prior research has identified transportation as a seminal social determinant of health, they have yet to be entirely incorporated into current transportation planning practices.

Another current research project funded by the NCHRP works to understand how to apply the Safe Systems Approach to transportation planning in the US. The Safe Systems approach rests on the idea that people make mistakes, people are vulnerable, and safety is proactive (*Demystifying the Safe System Approach*, n.d.). This design approach focuses on systemwide, connected pedestrian networks to ensure safety and accessibility, benefiting pedestrians, especially those with mobility disabilities (*Demystifying the Safe System Approach*, n.d.).

This NCHRP project recognizes the need for more tools for planners to prioritize and implement Safe Systems projects (Jared, 2022). The Safe System approach, Figure 3, focuses on changing infrastructure and roadway operations rather than the behavior of pedestrians and ensures that all users' needs are incorporated into the transportation network (Jared, 2022). Understanding geographically where projects are most needed and what issues need to be addressed is the foundation of the Safe Systems approach. However, the current lack of support for planners and stakeholders in implementing this approach hinders progress (Jared, 2022).

2.2.2 ADA Transition Plans

The Americans With Disabilities Act (ADA) of 1990 provides discrimination protection for people with disabilities, defined as a person with “a physical or mental impairment that substantially limits one or more major life activities, has a history or record of such an impairment. . . , or is perceived by others as having such an impairment” (Introduction to the Americans with Disabilities Act, 2022). These protections cover many federally regulated entities, including employers, state and local governments, businesses open to the public, and transportation providers (Introduction to the Americans with Disabilities Act, 2022). The Code of Federal Regulations (CFR) §35.150(d) requires public agencies with more than 50 employees to develop an ADA transition plan (28 CFR 35.150, 2022). Transition Plans mandate that these agencies identify physical obstacles in their facilities, which includes the PROW if under their authority, and develop a plan that outlines the methods and timeline for achieving ADA compliance. These plans also serve as accountability documents for DOTs, laying out infrastructure inventories, current issues, and project prioritization work plans (*ADA Title II Action Guide*, n.d.; Eisenberg et al., 2022).

While transition plans are mandated, few agencies are in compliance. In a random sample of 401 local planning agencies required to develop a Transition Plan, Eisenberg et al. found that only about 14 percent of these agencies have done so (Eisenberg et al., 2020). Barriers to transition plan development and execution include a lack of information and data on existing conditions of public infrastructure and fear of litigation due to uncovering ADA noncompliance (Eisenberg et al., 2020). Some public agencies and private companies use emerging data collection and visualization techniques to support a deeper understanding of accessible PROW conditions and subsequent project prioritization (Eisenberg et al., 2020). However, transportation planners have yet to adopt these technologies widely.

2.2.3 Active Transportation Planning

Active transportation planning, a planning issue that focuses on developing multimodal transportation options and infrastructure, has grown tremendously recently. As people drive less, rely more on walking and biking to get around, and choose to move into multimodal areas, multimodal transportation options demand increase (Litman, 2013). Active transportation planning divisions are addressing these changes through programs such as Complete Streets and Vision Zero to ensure multimodal travel is incorporated into transportation and infrastructure planning. Complete Streets and Vision Zero are widely known as programs that consider all

travel modes, from vehicular travel down to the bike and pedestrian travel, in order to design accessible and travel-option inclusive PROWs.

2.2.4 Complete Streets

Complete Streets is a transportation planning approach that focuses on designing and maintaining streets that are accessible by all that use them, including motorized vehicles, transit, and pedestrians of all ages and abilities (*Complete Streets*, n.d.). This approach recognizes that street design is a huge factor in influencing transportation behavior and that current incomplete street design severs pedestrian networks and creates unsafe pedestrian environments. There is no prescribed 'complete street' design; instead, they are designed based on community context and needs. While the complete streets approach hopes to increase safety and accessibility for all users, Elliot et al. found that many Complete Street policies lack explicit language about strategies to improve accessibility for disadvantaged communities, including people with mobility disabilities (Elliott et al., 2022). As discussed above, specific definitions of accessibility used in transportation infrastructure projects are powerful and influence which projects receive funding and for whom the project will benefit.

2.2.5 Vision Zero

Vision Zero is a multidisciplinary approach to transportation planning that aims to eliminate traffic fatalities (*What Is Vision Zero?*, n.d.). The programming tackles this issue from many different angles, one of which is creating a more connected pedestrian network (*Safe System Strategies for Bicyclists and Pedestrians Toolkit*, 2022). While Vision Zero programming does not explicitly aim to increase accessibility within the PROW, pedestrians with disabilities face a disproportionate risk of death and injury while traveling in the PROW caused by environmental and behavioral variables, as discussed prior (Kraemer & Benton, 2015). The Safe Systems approach, discussed above, is a central component of Vision Zero programming. Forty-five communities have committed to Vision Zero programming and associated infrastructure investments (*Vision Zero Communities*, n.d.). Cities such as San Francisco, Madison, and Houston have developed Vision Zero plans and specifically named accessibility for people with disabilities a priority (Houston Vision Zero, 2020; Vision Zero Madison, 2020; Vision Zero SF, 2021). San Francisco has incorporated accessibility for people with disabilities into their Vision Zero planning through the Vision Zero Coalition. The Vision Zero Coalition formed the Senior & Disability Workgroup to increase pedestrian safety for these groups, which experience a disproportionate mortality rate from PROW crashes (Natalie, 2017). Their work

focuses on lowering speed limits and increasing walk signal timing, amongst other goals (Vision Zero SF, 2021).

2.3 Current Tools for Accessibility Visualization

In order for planners to improve accessibility within the PROW, they need to know the current state of their jurisdiction's infrastructure and gaps. Eisenberg et al. point out that "a key problem in the literature is that most local governments do not know how much of the pedestrian infrastructure is still lacking in accessibility or how much is actually accessible for that matter" and technological barriers further limit stakeholders' ability to assess the current conditions (Eisenberg et al., 2020; Saha et al., 2021). While planners and stakeholders have worked to develop data analysis and visualization in sustainable mobility, fire engineering, and improving existing roads, sidewalk details are often left out of data collection and GIS databases (Jackson, 2019). Additionally, transportation projects are often evaluated based on mobility instead of accessibility. They focus on vehicle transportation level of service, prioritizing roads rather than ensuring the PROW is accessible for pedestrians, especially those with mobility disabilities (pg. 37) (Litman, 2022). Characterizing emerging and existing data collection and visualization tools will support our understanding of the current direction and progress in improving accessibility within the PROW.

2.3.1 Emerging Data Collection and Integration

To comply with the ADA, DOTs must create an ADA transition plan by completing an inventory of existing infrastructure to identify infrastructure that requires updating (28 CFR 35.150, 2022). Municipalities approach these inventories and data collection in a variety of ways. Data is commonly collected by hand, with surveyors marking locations of infrastructure, obstructions, conditions, and issues using tablets or other electronic devices. The Federal Highway Administration (FHWA) Measuring Multimodal Network Connectivity Pilot Grant Program Final Report outlined the data challenges and opportunities. The authors highlighted that unavailable and inaccurate data constrain analysis and application. They add, however, that novel data sources can provide or fill in data gaps. While new data sources could be beneficial, they are also resource and time intensive. Once established, the data could allow for quicker data integration and analysis in the long run (*Measuring Multimodal Network Connectivity Pilot Grant Program Final Report*, 2021). While DOTs collect much of the data, supplemental data sources such as OpenStreetMap or privately developed data could support network analysis

(Twaddell et al., 2018). These emerging technologies have the potential to make data collection not only easier and provide transportation planners with key insights into current PROW accessibility conditions.

The cities of Tempe, Arizona, and Minneapolis, Minnesota, combined hand-collected data and additional demographic and built environment data to support their project prioritization process. Tempe, AZ, layered transit stops, housing locations, and known concentrations of people with disabilities data on top of hand-collected infrastructure condition data to create a project prioritization list (*Becoming and More Accessible City StoryMap*, n.d.). Minneapolis, MN, explicitly incorporated equity data into its analysis. Based on community input, Minneapolis added street average crash rate, non-white residents, low-income population, number of household vehicles per resident over 16, population density, designated activity centers, pedestrian needs such as complex intersections or bridge needs, and existing transit routes data to their infrastructure condition data (City of Minneapolis & Kimley Horn, 2022). Each of the equity indicators were assigned points, calculated at the intersection level, and then combined with the calculated accessibility score (infrastructure conditions) to prioritize curb ramp projects (City of Minneapolis & Kimley Horn, 2022, pp. 65–72).

Digital image collection and analysis can potentially automate some of this data collection. Light Detection And Ranging (LiDAR) technology surveys the environment and records a 3D representation (“What Is Lidar?,” n.d.). It is not a new data collection method but has historically been too expensive to use widely or at scale. Improvement in this technology has made it cheaper to use and is even available on iPhones. A current study by Marshall and Janson at North Dakota State University hopes to apply iPhone LiDAR technology for mapping ADA compliance that can later be integrated into GIS software for analysis and mapping (Marshall & Janson, 2021). This technology has the potential to streamline data collection and integration. At a larger scale, orthophotography data, or digital aerial imagery, collected in LA county, aids planners in mapping PROW infrastructure. They can analyze the imagery to collect data on sidewalks, driveways, parkways, curbs, and curb ramps. This data is then aggregated and made available in LA's geodatabase, which can be combined with other available data for deeper analysis (City of Los Angeles Hub, 2022).

2.3.2 Pedestrian Route Navigation Tools

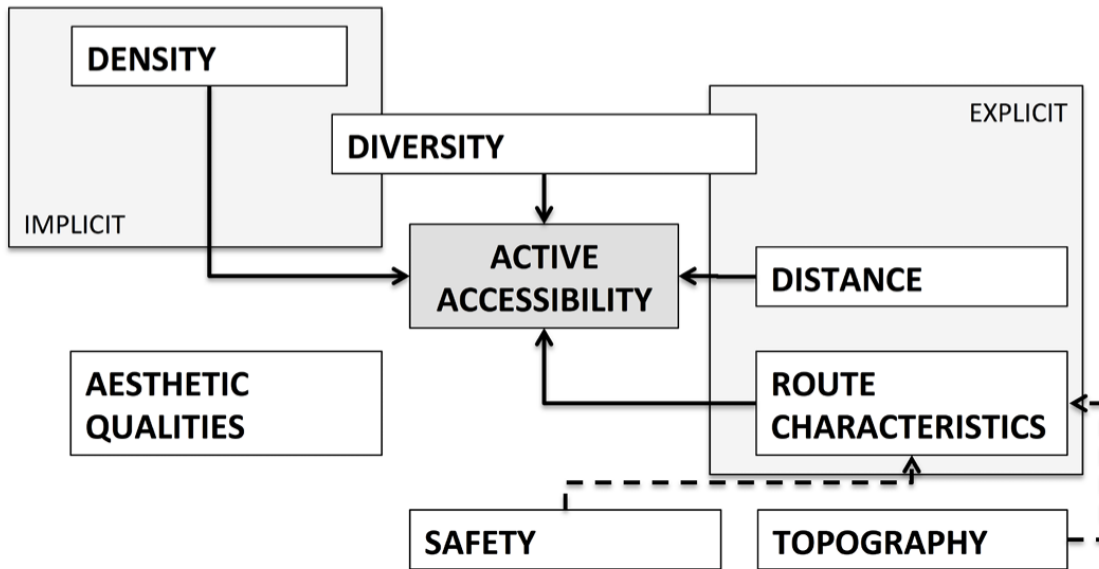
Route planning is integral to pedestrian travel and general environment navigation (Park & Chowdhury, 2018). For people with disabilities, route planning is more difficult due to limited information on data on sidewalk presence, curb cuts, stair placement, and obstructions in

traditional route planning applications (Park & Chowdhury, 2018). Researchers and developers have created a series of mapping tools that provide accessible routes to users with disabilities. Tools such as U-Access (Sobek & Miller, 2006), Web-based Navigation tool (Beale et al., 2006), OurWay (Holone et al., 2007), RouteCheckr (Völkel & Weber, 2008), The Wheelmap Project (Mobasheri et al., 2017), and the Personalized Accessibility Map (Karimi et al., 2014) provide accessible route mapping, primarily focused on people who use wheelchairs. These data visualizations provide essential information to people with disabilities on accessible routes and potential barriers, which informs the route and whether the person can take the trip. But, limitations of these tools include limited geographic scale and scalability due to hand-collected data. Limited map scale hinders planners' and stakeholders' ability to understand the state of accessible pedestrian connectivity between places of interest, which Jackson notes as an integral part of accessibility (Jackson, 2019).

2.3.3 Existing Transportation Planning Tools

Planners currently use a range of variables to analyze and characterize the built environment. Vale et al. grouped these variables into six environmental characteristics: “density (residential, employment, or both), diversity (land-use mix and destinations), distance (proximity or accessibility), route characteristics (street connectivity and quality of the infrastructure), safety (both personal and from traffic), and aesthetic qualities (trees, parks, and open spaces, bus shelters, etc.)” (Vale et al., 2015). Vale et. al argues that infrastructure and the built environment are closely tied to and influence accessibility, therefore they cannot be separated (Vale et al., 2015). Therefore, analyzing our built environment through these variables supports planners in understanding the current state of accessibility. Existing analyses completed by Vale et al., Maghelal, and Woldeamanuel et al. have each used some combination of these variables to assess the built environment, accessibility, and access existing analyses for accessibility in the PROW include network completeness, network density, route direction, access to destinations, level of service, population impacts (Magehelal & Capp, 2011; Vale et al., 2015; Woldeamanuel et al., 2020).

Figure 4: Relationship between factors in the built environment and active accessibility, or accessibility by active travel mode (Vale et al., 2015).



Active transportation planning data visualization tools are hindered by funding, staff time, and limited data and data collection standards. But, some jurisdictions and private companies have started developing visualizations that support a broader understanding of pedestrian accessibility and PROW conditions. Tools such as the Southeastern Michigan Council of Governments (SEMCOG) Multimodal Tool (SEMCOG & Michigan Department of Transportation, 2022), pathVu (*PathVu*, n.d.), and the Walkshed Generator App (The Taskar Center for Accessible Technology, n.d.), provide larger-scale data visualizations of pedestrian networks.

The SEMCOG Multimodal tool provides information on many transportation networks. Relevant to this research is their pedestrian modal network, which models bike and pedestrian demand areas and existing and planned infrastructure, which can support planners in identifying gaps and priority project areas (SEMCOG & Michigan Department of Transportation, 2022). A limitation of this tool is that it does not include curb cuts, sidewalk slope, or sidewalk width, all of which are vital PROW infrastructure information for pedestrians using wheelchairs.

pathVu, a private technology company, is also developing technology to streamline sidewalk and curb ramp assessments to support cities in mapping current infrastructure conditions. pathVu provides sidewalk and curb ramp assessment data via hand data collection, but they have developed technology to make the collection process quicker and more standardized. They can provide clients with this data, visualizations, analysis, and maps at

different scales (*PathVu*, n.d.). They have partnered with a few municipalities, including Louisville, KY. Louisville, KY, contracted pathVu to complete a sidewalk assessment to support their infrastructure update prioritization. Louisville then incorporated pedestrian volumes into the infrastructure conditions data to prioritize maintenance projects (*3 Year Sidewalk Repair Program*, 2021).

Finally, the Walkshed Generator App, a tool developed by the Taskar Center, aims to help visualize walkshed extents depending on pedestrian profiles. Within this tool, users can generate walksheds around specified points depending on a person's ability to cross streets with or without a curb cut, sidewalk grade they can navigate, and whether they can use streets as sidewalks if no sidewalks exist. This map can help planners understand gaps in the sidewalk network and visualize accessibility depending on a person's mobility ability. This map, however, does not incorporate additional travel-behavior informing data such as census data, economic or employment centers, or transit stops. Adding these types of data would support transportation planners in understanding the current conditions around areas of higher pedestrian activity and prioritizing improvements that would be most impactful.

2.4 Research Direction

Gaps in the literature about accessible PROW mapping and data visualization are evident, with a lack of resources and information as the norm rather than the exception. Current accessible PROW data research and tools have generally focused more on individual pedestrian-level route planning and have not included demographic information. While this type of mapping and information is beneficial, there need to be more tools that support transportation planners and stakeholders in identifying areas of priority infrastructure improvements. Jurisdiction-level tools created by SEMCOG, Minneapolis, Louisville, and to an extent, pathVu, have increased our understanding of accessible PROW infrastructure. Unfortunately, they are not widely available, applicable to other jurisdictions, or incorporate important health-related data uniformly. Additionally, they require staff time, contractors, and technology typically only available to jurisdictions with more resources (Proffitt et al., 2019).

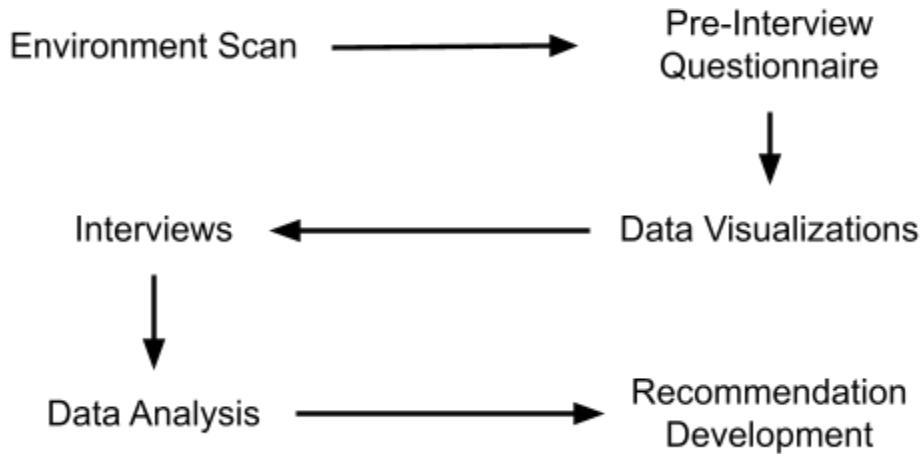
Transportation planners cannot begin to address our inaccessible pedestrian networks if they do not know where and what the gaps are. Transportation access is a key social determinant of health, supporting increased access to everything outside a person's home. Thus, to make our PROW more equitable and improve health outcomes for people with disabilities, we must deepen our understanding of what questions planners are tackling and

what data visualizations could support them while we work towards prioritizing accessible PROW infrastructure. Through co-design interviews, we hope to improve our Walkshed Generator App tool by engaging with transportation planners to understand:

1. What visualization method best supports active transportation planning work;
2. What types of data are important to support answering current questions in active transportation planning;
3. At what scale would planners like to visualize the data to answer their planning questions?

3 Methods

Figure 5: Methods flow chart



3.1 Pre-Interview Questionnaire

The initial list of potential interviewees was developed based on prior involvement in the TDEI project or current work in active transportation planning or an associated field. Thirty-three planning professionals from 7 Maryland, Washington, and Oregon agencies were contacted.

Before scheduling the interview, each individual that indicated interest completed a pre-interview questionnaire. The questionnaire collected background information on the interviewees, including their current position, current pedestrian planning questions their agency is addressing, and existing tools they use to support their work. The list of planning questions was developed based on current literature and planning direction, as outlined in the background. The question format included Likert scale, ranking, open answer, and single selection. The results from this questionnaire were used to include or exclude professionals depending on their current planning focus and ensure they were the suitable agency representative for this study. Questionnaire responses were grouped into current active transportation decision-making processes and related planning questions.

Of the 15 questionnaire respondents, 2 were not invited to participate, and 2 did not follow up to schedule an interview. One respondent indicated that another person at their agency would be more equipped to answer questions related to the study goals; the other's questionnaire responses did not align with the study goals. Of the 11 interviewees, 6 self-identified as male, and 5 as female. At the time of the interview, 4 had received a bachelor's

degree, 6 a graduate degree, and 1 an associate's degree. See Tables 1 and 2 for an overview of the respondent's backgrounds and Tables 3 and 4 for current planning questions [See Appendix A for the full pre-interview questionnaire].

Table 1: Summary of planning decision types and associated number of respondents

Decision Code	Active Planning Decision Type	Number of Respondents
1	Single project evaluation	1
2	Project prioritization between multiple potential projects	1
3	Both single project evaluation and project prioritization between multiple potential projects	8
4	Other	1

Table 2: Summary of interviewee profiles including agency ID, agency planning scale, and active planning decision type

Interviewee ID	Agency ID	Planning Scale	Decision Type
001	A1	State	3
002	A1	State	4 (ADA planning)
003	A2	City	3
004	A3	State	3
005	A2	City	3
006	A1	State	3
007	A1	State	1
008	A4	City	3
009	A5	State	3
010	A6	Metropolitan Region	3
011	A7	City	2

Interviewees ranked their project-specific planning questions and project prioritization planning questions from most to least important.

Table 3: Ranked project-specific planning questions and associated number of responses (note: some questions received equal votes and therefore are listed together under the associated rank)

Ranked Project Specific Planning Questions	
Rank	Question (no. responses)
1	Access to destinations (5)
2	Network completeness (2); Route Direction (2); Access to Destinations (2)
3	Network completeness (3)
4	Network Density (4)
5	Network density (3); Route direction (3)
6	Impacts on the population (4)
7	Level of service (2)

Table 4: Ranked project prioritization planning questions and associated number of responses (note: some questions received equal votes and therefore are listed together under the associated rank).

Ranked Project Prioritization Planning Questions	
Rank	Question (no. responses)
1	Access to destinations (4)
2	Network completeness (3)
3	Network completeness (2); Access to destinations (2); Level of service (2)
4	Network density (3)
5	Route direction (3)
6	Impacts on the population (3); Level of service (3)
7	Other (2)

“Other” responses included level of traffic stress, data completeness and availability, project feasibility, and equity.

3.2 Data Visualizations

Four data visualizations were created using the Taskar Center’s Walkshed Generator App (WGA). Each visualization addresses one or multiple of the project-specific or project prioritization planning questions as identified in the pre-interview questionnaire. The WGA is an

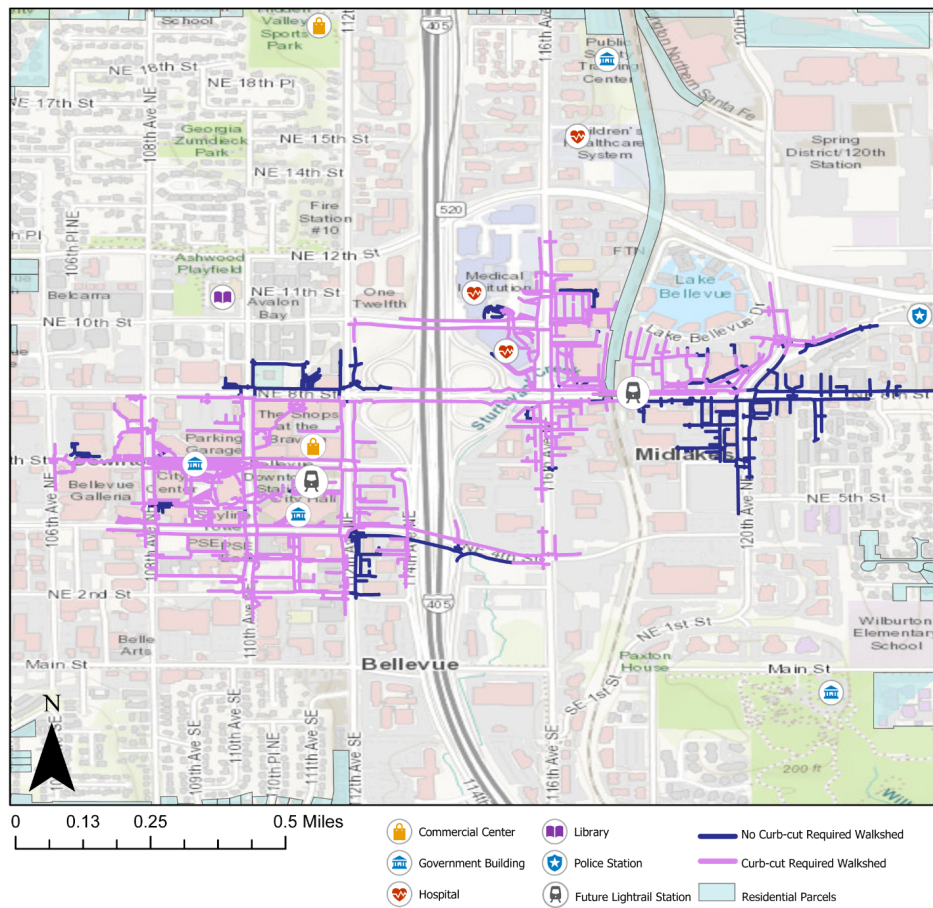
under-development API tool that uses OpenSidewalk data and sidewalk networks to develop network analyses. The WGA was developed to generate walksheds around user-indicated locations based on specified environmental and pedestrian mobility criteria. We developed a case study of walksheds around two future Bellevue, WA Link light rail stations (Downtown and Wilburton stations) to solicit feedback from interviewees. For the walkshed, we indicated the grade uphill and grade downhill (up to 10 percent) the pedestrian is able to traverse, whether the pedestrian requires curb cuts to cross the street, if streets can be used as sidewalks when no sidewalks are present, and total effort for the indicated walkshed. The effort unit (such as "900 units") is a unit that attempts to combine and normalize different factors that affect pedestrian effort in traversing pathways, like time, distance, and effort exerted in overcoming infrastructure barriers and impedances. Overall the effort variable is about equivalent to effort in seconds (for example, 900 effort is about 15 minutes of travel).

For each starting location input into the WGA, two walksheds were created, one that required the presence of curb cuts to cross the street and one that did not. Both walksheds did not differ on the grade up and down (maintained at 10 percent), did not allow the use of streets as sidewalks, and had a 900 effort (or about 15 minutes). The resulting walksheds were downloaded from the WGA and imported into ArcGIS Pro for further analysis and manipulation. Along with the walksheds, additional data layers were obtained from the Bellevue GIS Data Portal, Puget Sound Regional Council, King County OpenGIS Portal, and Washington Geospatial Open Data Portal. In sum, a total of 4 visualizations were developed. This number of visualizations was chosen to ensure we could solicit feedback on most of them during the about 60-minute interview.

3.2.1 Visualization 1 (V1)

Using the WGA, we developed four 15-minute walk sheds around the two planned Link light rail stations in Bellevue, WA (Figure 5). Additional data layers, including individual parcels, zoning, population, trip attractions and producers, and Bellevue-identified attractions (a shopping center, government buildings, a library, medical centers, and a police station) were overlaid to show accessibility of local attractions within the station. Along with the maps and additional data layers, supplemental mock graphs and numerical analyses were developed in Microsoft Powerpoint and provided alongside the maps. This visualization aimed to depict access to destinations and network completeness and solicit feedback on the analysis method (i.e. walkshed analysis), understand what planning questions interviewees thought it answered, and identify additional data they would like included to answer their questions further.

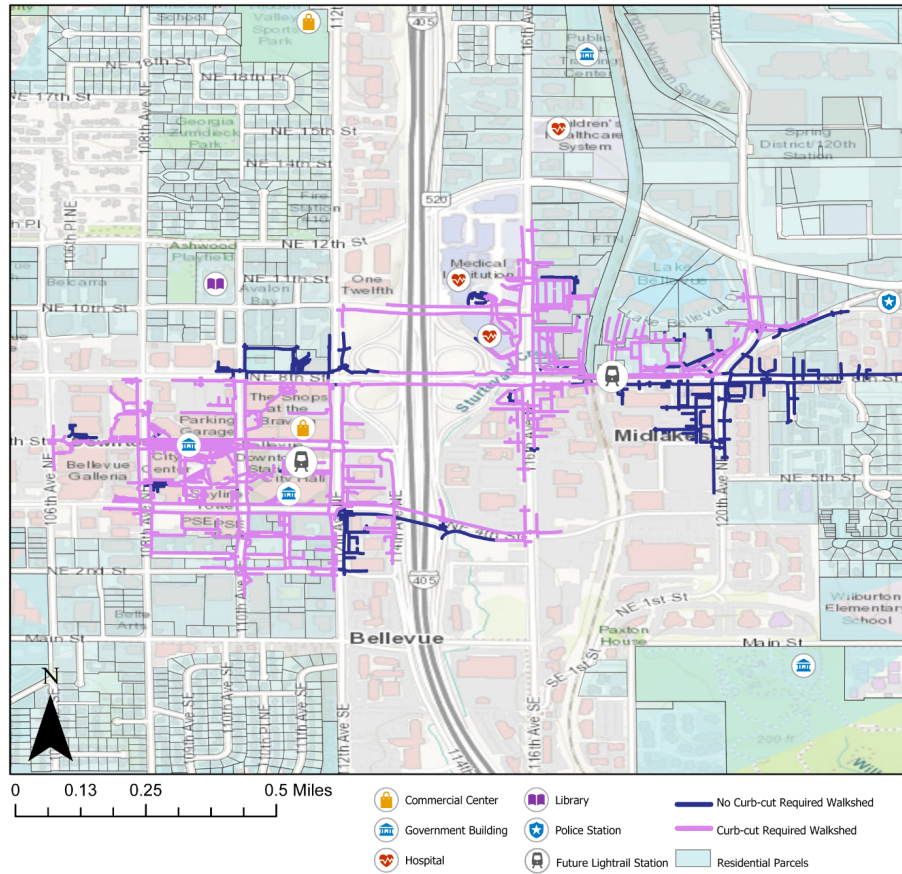
Figure 6: Downtown and Wilburton Future Light Rail Stations Curb-cut Required vs Not-Required 900 Effort Sidewalk Walksheds and Attraction Access



3.2.2 Visualization 2 (V2)

The second visualization showed the same analysis as V1 with the addition of semi-opaque residential parcels (Figure 6). This visualization was developed to visualize access to destinations and impacts on the population.

Figure 7: Downtown and Wilburton Future Light Rail Stations Curb-cut Required vs. Not-Required 900 Effort Sidewalk Walksheds, Attractions, and Residential Parcels

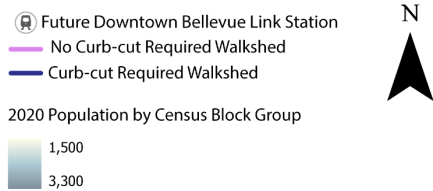
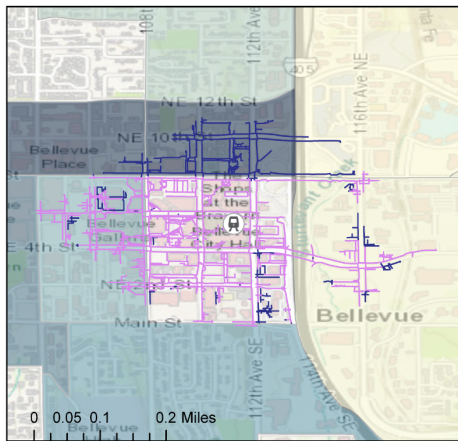


3.2.3 Visualization 3 (V3)

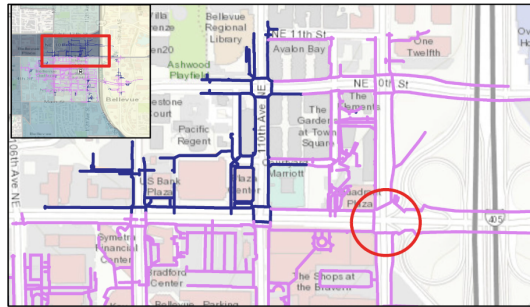
The third visualization depicted a 1200 effort walkshed (about 20 minutes) overlaid over census block group level population data (Figure 7). This map was further processed in Adobe Illustrator, where we created two project scenarios where curb cuts are installed in intersections currently without them. These were developed to simulate the walkshed's potential extent for those requiring curb cuts to cross streets. This visualization included a map of the 1200 effort walkshed and two additional maps, including two potential scenarios where curb cuts were installed at one intersection or two intersections. Along with these maps, a supplementary numerical analysis of the walkshed extent was provided for additional quantitative analysis of the visuals. These visualizations were developed to visualize impacts on the population, network completeness, level of service, and network density and solicit feedback on additional map functionality (such as scenario planning) and data scale and inclusion method.

Figure 8: Three maps depicting a 1200-effort sidewalk walkshed. Leftmost map with the addition of population by census block group. Two infrastructure addition scenarios are depicted on the right side: top-right depicts Scenario 1, which adds curb cuts to one intersection currently without; bottom-right depicts Scenario 2, which adds curb cuts to 3 intersections currently without

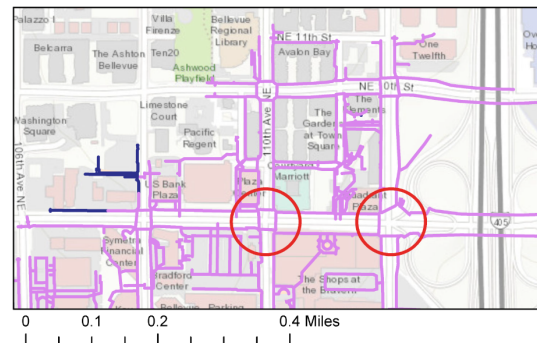
Comparison of 1200 Effort Walksheds With and Without Curb-cuts Around the Future Bellevue Downtown Link Station



Scenario 1: Adding Curb-cuts at One Intersection



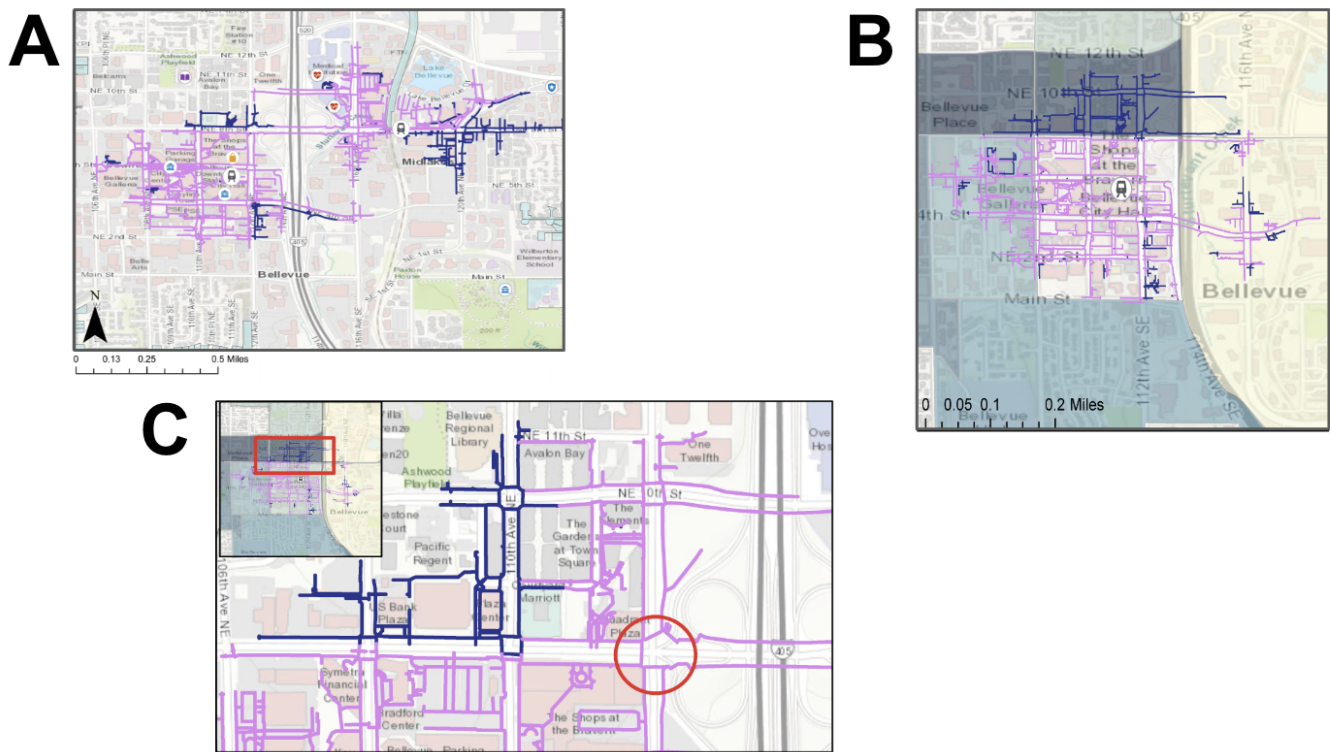
Scenario 2: Adding Curb-cuts at Two Intersections



3.2.4 Visualization 4 (V4)

The fourth visualization contained a snapshot of the prior visualizations to show different map scales (Figure 8). These visualizations were created to understand the scale the interviewees found the most useful for their work and how they would use the different scales to answer their planning questions.

Figure 9: Potential visualization scales: A) multiple walksheds or regional; B) single walkshed;



C) intersection.

3.3 Interviews

In sum, 11 professionals representing 4 professional areas were interviewed, 3 of which were paired interviews, for a total of 8 interviews. Planners that were interviewed for this study represent the following agencies:

- Washington State Department of Transportation
- Oregon Department of Transportation
- Maryland Department of Transportation
- The City of Redmond
- Everett Public Works
- Oregon Metro
- Seattle Department of Transportation

The interview guide was developed with three parts: questions about the interviewees current planning tools, followed by the visualization demonstration and co-design, and finished with questions about data scale and trust. The co-design interview structure was chosen to ensure that the tools we develop can answer the planning questions active transportation planners are asking. This interview style is less structured than a typical interview and was used to limit interview bias and ensure a collaborative tool development process. Most of the interview was spent demonstrating the visualizations and asking relevant questions from the developed interview guide. Interview themes included ease of understanding, applicability to their current planning work, questions and agency goals, additional data inputs, and visualization scale. Example questions include: What planning questions do you think this map is answering; How would you modify this map to support your work; and What data would you like to see added to these maps/tools to complete your analyses [See Appendix B for full interview guide]. Due to the co-design interview structure, not all interview guide questions were asked, nor were they always asked in the same order. After each interview, the transcript was edited, and a synopsis of the interviewee's comments on visualization type, data, analysis scale, and tool functionality was sent back to them for qualitative member checking. Interviewees were asked to review the findings and verify if the initial analysis was correct and add additional thoughts they may have.

Interviews took place between March 10th, 2023, and April 3rd, 2023. All interviews were conducted remotely over Zoom or Microsoft Teams. Transcriptions were created using Otter AI and manually edited.

3.4 Data Analysis

Dedoose, a qualitative data analysis software, was used for interview transcript coding. An inductive and deductive coding approach was chosen for the qualitative analysis. An initial codebook was developed based on the main research questions and included. We started with a deductive approach based on the interview guide and research questions. After an initial review of the interviews, we took an inductive approach and added and changed codes and themes. The final codebook contained 8 themes, 18 parent and 44 child codes [See Appendix C for full codebook].

4 Results

4.1 Pre-Interview Questionnaire

Eight interviewees reported that their agency has existing planning tools to help them answer their pedestrian planning questions, 1 indicated that they have no tool, and 2 were unsure. Of those with existing planning tools, the most common tool used is a mapping tool (10/11), which was most commonly used to answer planning questions about network completeness, network density, and access to destinations. Scoring systems were also common (7/11) and used to investigate the same questions as the mapping tools. Many interviewees noted that their agency has a tool that addresses network completeness (8), access to destinations (8), network density (7), and impacts on the population (7). Only 3 interviewees noted tools that assess level of service.

Table 5: Current planning tools the planning questions they answer

Tool (no. indicating use)	Uses (no. responses)
Checklist (1)	Network completeness (1)
Decision Tree (1)	Other (1)
Scoring System (7)	Network completeness (4); Network density (2); Access to destinations (5); Level of service (2); Route direction (1); Other (1)
Mapping Tool (10)	Network completeness (7); Network density (7); Access to destinations (8); Level of service (1); Route direction (5); Other (1)
Other Tool (5)	Network completeness (1); Network density (1); Access to destinations (1); Impacts on the population (2); Level of service (3); Route direction (2)

For their existing tools', interviewees mentioned strengths including flexibility, easy data access and communication, and decision making support. Some weaknesses or areas for improvement included data inaccuracies, incompatible tools and data sets, unroutable sidewalk networks, and incompatible scale for the associated project. When asked what type of tool would be most useful for their work, 8 mentioned GIS or map-based tools, and 2 indicated that additional quantitative tools would help them answer their pedestrian planning questions.

4.2 Interview

4.2.1 Research Question 1: *What visualization method best supports their active transportation planning work?*

After showing the first walkshed visualization, interviewees were asked if the type of analysis would be useful for their work. Eight indicated that walkshed analysis would be useful for their planning work. Six interviewees also added that origin-destination analyses would be useful for their work and understanding the availability, directness, and accessibility of potential travel paths between two defined points. The second to last visualization presented to the interviewees, V3, presented a scenario planning tool prototype. Nine interviewees mentioned that this would be useful, with one interviewee stating that “this is a tool that I want, like, tomorrow.”

Six interviewees said that supplementary visualizations, such as graphs, charts, or other quantitative analyses, would help their understanding of the data and even help communicate this information to a wider audience. When asked how they would like to interact with this tool, either through a fully developed “black box” tool that could allow them to complete analyses or to complete an analysis for download and further integration with their own data sets, 7 indicated that they would like both options. Only 2 interviewees indicated they did not want a “black box” tool and only wanted a downloadable analysis to integrate with their own data.

When asked what planning questions the interviewees thought each visualization could help them answer, interviewees provided a wide range of answers. Common question themes included:

1. Specific infrastructure location (e.g. where the curb cuts and crossings are located on the street)
2. Population impacts (e.g. how many people in the area would have access to the infrastructure)
3. Trip ease (e.g. how direct is the trip route)

Interviewees also provided additional questions they would like to be able to answer using this tool, but may require additional data, visualizations, or analysis. Additional questions planners mentioned included:

1. Where are the infrastructure gaps and what kind of infrastructure is needed?
2. How do different communities’ (e.g. comparing those with mobility disabilities and those without, income brackets, neighborhoods) access to important destinations compare?

3. How would certain infrastructure projects, such as new sidewalks or crosswalks, impact access to jobs, housing, and demographics and populations?
4. How far would a person need to travel before the next accessible crossing?
5. How direct are the routes between two locations, such as from a transit station to a grocery store, and do routes differ by pedestrian needs?

4.2.2 Research Question 2: What types of data are important to their current active transportation planning work?

Interviewees provided a total of 63 different types of data they would like to have or need to have to answer their pedestrian planning questions [See Appendix D for a full list of data types]. Data sources that interviewees mentioned would support their decision-making generally fell into 9 categories: demographics, destinations, pedestrian infrastructure, urban planning, population, safety, street infrastructure, and traffic design (See Table 5 for a list of data categories and examples). Pedestrian infrastructure was the most common category of data mentioned by interviewees, with all interviewees mentioning data related to pedestrian infrastructure, such as sidewalks, curb cuts, or crossing type. City planning data, mentioned by 10 interviewees, was the second most mentioned data category and included data on city zoning, land use, and trip generators. Traffic design, which includes posted speed and type of traffic stop was also by 10 interviewees. Population data, such as population and number of households, gained 8 mentions. Street infrastructure, which includes the number of traffic and parking lanes, and demographics such as low-income communities, each were mentioned by 7 interviewees. Finally, destinations, such as schools and grocery stores, were indicated as important to 6 interviewees' work.

Table 6: Interviewee indicated important data categories (for $n \geq 6$), examples, and the number of interviewees that mentioned data in the associated category.

Data Category	Example	No. Category Mentions
Demographics	Low-income communities Communities of Color	7
Destinations	Parks Schools Grocery Stores	6
Pedestrian Infrastructure	Curb cut locations	11

	Marked/Unmarked crossings	
Urban Planning	Trip Generators Zoning/Land Use Housing Density	10
Population	Population density Number or density of households	8
Street Infrastructure	Number of traffic lanes Parking Lanes	7
Traffic Design	Posted speed Level of vehicular traffic stress/traffic volume Traffic signals	10

Almost all interviewees mentioned that they would like the additional data to be included in the map tool via map layers. They mentioned that this would allow them to turn on and off the data layers to dive deeper into the current conditions of the target area.

4.2.3 Research Question 3: At what scale would they like to visualize the data and map to answer their planning questions?

Interviewees were asked to indicate what data scale would best support their work: regional, walkshed, intersection, or other. Most interviewees mentioned that they would use all the scales in their work, and the most relevant scale would depend on their current task. Interviewees mentioned that it would be helpful to have a higher-scale walksheds analysis but also be able to zoom in to see what specific infrastructure or other data either connected or severed the pedestrian network to understand what changes need to be made.

Interviewees mentioned a regional scale tool would support them in making project funding decisions and understanding how their jurisdiction fits into the larger region. They indicated that a walkshed scale would also support their project funding decisions and identify the critical infrastructure connection points. Finally, interviewees mentioned that an intersection or specific infrastructure level tool would allow them to understand what infrastructure exists, project funding prioritization, and project design and scoping. Only 2 stated that the intersection scale would not be useful since they already have a tool for that, but that it is still a useful scale for analysis. Once they get to that scale, they are more likely to use public engagement or engineering to address the infrastructure changes or needs instead of a mapping tool.

4.2.4 Additional Findings

In addition to the core research questions, we also asked what it would take for the interviewee or agency to trust the data included in the analyses and the tool itself and be able to use it in their work. Eight interviewees mentioned that metadata, such as date and method of collection, date of updating, and steward information, would be key for them to understand the data and its trustworthiness. Some interviewees mentioned policy barriers to using public data, where even if the data is updated and they trust it, the internal policy would not allow them to use the data. A common internal policy barrier mentioned by a few interviewees is that they are unable to use crowdsourced open data sources for fear of inaccurate data and inability to steward the data themselves. One interviewee mentioned that in order for them to use this tool, they would have to gain approval from their city's City Council. When asked if adding a tool function that would allow them to flag inaccurate data, 5 indicated that would help them trust the data. In one case these additional features would actually be the difference between their agency not being able to use the tool and being able to use it.

5 Discussion

It is critical to understand how to develop a planning tool that supports increasing accessibility within our PROW and applies to other active transportation planning work for meaningful agency buy-in. As we can see from the interviews, the current planning questions, data, scale, and functionality needs indicate a wide range of planning focuses and applications well beyond just accessibility. It is clear that planners have the will and interest to complete PROW accessibility analysis, but lack a tool to do so. As such, developing a planning tool that only assesses pedestrian accessibility in the PROW will 1) not be useful to planners' broad scope of work and 2) is unlikely to gain users since its application is so limited. To make a useful and applicable tool, we must consider planners' needs as identified by the interviewees to ensure we are addressing their needs while ensuring accessibility is integrated into all PROW analyses.

Planners indicated that they work at many different scales and that the scope of their work changes from project to project. Engineers may focus more on the intersection and specific infrastructure scale data, while state-level planners may be more interested in the city and regional scale visualization and data. As we can see from these findings and the many different types of data and scales that were mentioned, there is a wide range of planning focuses and needs. This aligns with the varying nature of active transportation planning and planning in general. What is important to one planner may differ from another planner depending on local planning, policy, and the current PROW landscape. But, we also recognize that no one tool will rule them all. There are many accessibility needs, and we will need many tools to serve a diversity of challenges. We will never be able to include every type of data that every planner needs to address their jurisdiction's questions, especially as communities have different populations, goals, and attributes. Therefore, providing a flexible planning tool that allows users to visualize the current state of the PROW as well as download analyses for further integration into their own datasets could make for a widely applicable tool.

Many jurisdictions, and even intra-agency departments, work in silos, where they collect and steward their data in but do not work with surrounding areas to share and collaborate on data. One agency is currently working on an inter-jurisdiction data collaboration between them and surrounding cities. They currently share vehicular data and are working on sharing pedestrian and bike data; but this agency and model is an exception and not the norm. As some interviewees mentioned, their constituents don't stop walking when they cross from state to city-owned infrastructure; therefore, regions need to collaborate and share their data. One

interviewee even mentioned that, “a lot of times [I] go in and do my own research and manually manipulate the network too. Because, you know, people don't walk, knowing where the boundary is for [City A] or [City B].” The interviewees highlighted what the US FHA found; while mapping tools are useful, most GIS data is housed by the individual agency, whether local, metropolitan, state, or federal. This siloed approach leads to delays, challenges, and extra effort when collaboration on projects is necessary (U.S. Federal Highway Administration, 2016). The current data-organization process limits planners' ability to understand the inherent interconnectedness and that people do not restrict their movement to one defined geographic region. Additionally, this kind of data-sharing requires lots of time and capacity, which can limit feasibility for smaller jurisdictions and those with less funding. Therefore, providing data and visualizations from multiple agencies and geographies is important for supporting inter-agency collaboration to improve accessibility and transportation planning.

From the literature research, environmental scan of current planning tools that assess accessibility in the PROW, and interviews we can see that there are limited tools available to planners. While there are planning tools under development by private companies, technology integration into transportation planning beyond individual-agency tools is behind. As discussed prior, agency funding, capacity, and limited data hinder a broader approach to PROW visualization and accessibility analyses. As one interviewee stated, “We don't have a tool per se . . . we're very interested in having something that could be systematic because the way we do it is more of like on a project by project basis.” As such, a more comprehensive planning tool housed outside of the agency itself could reduce the burden of data discovery and tool maintenance on already capacity-limited institutions and provide more insight into inter-jurisdictional accessibility and connectivity.

Transition Plans mandate that agencies identify physical obstacles in their facilities, which includes the PROW if under their authority. As Eisenberg et al. pointed out, a large barrier to the development of these documents is lack of data on the existing conditions (Eisenberg et al., 2020). Therefore, providing a tool to agencies that does this visualization for them could relieve the burden of data collection and visualization on the agencies, freeing up capacity to address the inaccessibilities. But, as some interviewees brought up, there are barriers for agencies to use open source data tools. As such, it will be incredibly important to work with our target audience to ensure the tools we create are actually usable. We could create the best pedestrian planning tool to support accessible transportation planning and Transition Plans in general, but if policy and institutional barriers bar planners from using it, all our work will be for not.

Data format and compatibility seems to be an issue for some agencies, where existing GIS data is not formatted correctly for network analysis. As one interviewee stated regarding their current data format, “this is an area where we've been really struggling and we cannot do it all with our data because of that, it's just not set up in that network format.” Another interviewee shared the same sentiment and indicated that a tool like the one under development at TCAT could help them shift from “Instead of saying you know, like this block here on this side of the city [should be prioritized] really highly, and then this block on complete other side of the city [should be prioritized]....[And shift to] looking at you know, more clusters of, you know, making sure that the connections are made within communities.” This planning style creates the ‘pedestrian islands’ mentioned prior thus walkshed and network-level analyses are critical to understand inter- and intra-community connectivity. This illustrates that these agencies’ current project prioritization schemas seem to focus more on individual infrastructure improvements and do not include critical considerations for broader network connectivity analyses that improve accessibility and community-level improvements.

It is not surprising that most of the commonly-mentioned data types focused on physical infrastructure and land-use planning (i.e. pedestrian and vehicular infrastructure, zoning) as they are discrete data points and easily represented through map visualizations. Additionally, while many different types of data were mentioned, the data are generally consistent with the data currently used to assess pedestrian travel. Not every agency has data on their sidewalks, most have data on their street infrastructure, such as number of lanes, posted speed, and signal location and types since current planning paradigms have prioritized vehicular transportation infrastructure and maintenance. As such, basic data on pedestrian and vehicle infrastructure and planning data should be available for integration into the tool.

Several of interviewees indicated an interest in how traffic design and infrastructure interact with pedestrians and pedestrian infrastructure. At one particular intersection, an interviewee noted that a “person in a wheelchair has to go off to the right, go into an active lane where oncoming traffic is going to come, come around that corner to get into legal crossing to go across.... every time I look at it, I'm like, I can't believe they haven't got sued yet. Because you know, you're putting people into active live traffic to traverse the sidewalk.” At this particular intersection, curb cuts were only installed on one side of the corner, hindering crossing access for those going the other direction. This demonstrates both the real danger that cars pose to pedestrians, and especially those with mobility disabilities, but also the grip that vehicle-focused transportation planning still has active transportation planning in general. Pedestrian

infrastructure was not prioritized at this particular intersection, thus putting people that require curb cuts to cross the street in danger.

This vehicle-based pedestrian planning and safety focus also points to our lack of indicators to measure safety from the pedestrian-perspective other than that that relates pedestrian safety to vehicles. Many interviewees mentioned that they would like to have data on the number of traffic lanes, posted street speed and crashes as a means to assess pedestrian travel comfortability. As one interviewee noted, “our grants are very safety focused. In the last round, it was 40 percent of our criteria was safety, 20 percent was equity, and we did not have that any sort of accessibility data on there.” Vehicle-pedestrian interactions and injuries are important to understand and mitigate, not just for grants but also for project identification and prioritization, but they are not the only factor that impacts pedestrian safety in the PROW. Pedestrian scale lighting, which can contribute to a sense of safety for pedestrians, was mentioned by two interviewees, indicating that some planners may be thinking about factors that could impact safety perception at the pedestrian scale, but it is not widely practiced yet. Ensuring that we include the safety data and indicators agencies rely on while broadening our understanding of safety from the pedestrian’s perspective will be important for improving pedestrian accessibility, particularly those with mobility disabilities, in active transportation planning.

6 Recommendations

The following considerations should be made to support the development of a useful and applicable active transportation planning tool:

1. Develop a tool that visualizes data at different scales and creates downloadable analyses for further integration into agency-specific data to support broader use.
2. Include walkshed, origin-destination and scenario planning analysis to help planners understand network connectivity.
3. Provide supplementary quantitative analyses to support a deeper understanding of the mapped data and to communicate the findings to a broader audience.
4. Include basic data on pedestrian infrastructure (including curb cut locations, crossing locations and attributes, and sidewalk attributes), traffic design (posted speed), and urban planning (zoning, land use, and trip generators), to support planners’ current work.
5. Ensure the tool is managed by an external party (i.e. not any one agency) to reduce barriers for use and application.

6. Consider current agency data-use policies to ensure we develop a tool that agencies trust and therefore are able to use.

The small number of interviewees in this study limits our findings' generalizability. While we were able to interview a number of city- and state-level planners, only one metropolitan planner was included. However, within the small sample size, planning questions and data needs were varied. This indicates the need for a flexible tool which could be used and applied by many different planners with many different goals outside of those identified in this study. Additionally, the scalability of this tool is currently limited by the sparse data agencies have on their PROW. But, as agencies continue to recognize the importance of accessibility and prioritize collecting this data, the tool could support them in meaningfully addressing accessibility within their PROW. Finally, only one interviewee mentioned that sidewalk data was important to include in the tool. We inferred that sidewalk data was important to all interviewees as it was already included in the prototype visualizations and the interview question was framed as "What additional data would you like to see incorporated into this tool." The inference that sidewalk data was important to the interviewees may not be correct, but based on the interview context and conversation, we still believe that it was important to them.

7 Final Remarks and Future Research

While these data-driven analyses are incredibly important as they help planners understand how many different variables come together to impact our PROW, planners must engage with the communities they are analyzing in the tool. As one interviewee aptly stated, "infrastructure barriers [dont] always align with, you know, what you hear from those folks in those communities." Therefore, gaining the perspective of those most impacted is critical for these types of projects. Firstly, this is important because even our best intentions of having accurate data do not always happen and planners must ground truth the existing conditions to ensure their analysis is correct. Secondly, the pedestrian infrastructure and design that may be applicable and important to one community may not apply to another. "For example, the pedestrian needs around a school may differ from those around a shopping or transit center. Parallel work at TCAT includes engaging with people with disabilities to understand PROW access from their perspective. It is important for future work to engage with community stakeholders to collaboratively design the PROW can ensure the project is successful and useful by those using it.

Transportation is a key social determinant of health, but as we have seen, our ability to improve it is limited by our understanding of the current state of accessibility within the PROW. By developing a tool that provides active transportation planners the ability to visualize network connectivity from the perspective of people with mobility disabilities they will be able to prioritize infrastructure projects and improvements that meaningfully improve accessibility. As discussed above, transportation access to critical destinations such as grocery stores and the public realm in general can impact health outcomes, therefore increased access should improve health outcomes. Historically, accessibility has been an afterthought, but by integrating it into all PROW analyses we hope to see a meaningful integration of accessible infrastructure into all pedestrian projects.

Future research should integrate the findings from this study into another iteration of the prototype tools. The subsequent version should be brought back to transportation planners, either through another interview process or through pilot testing. Additionally, as discussed above, further research on what makes pedestrians perceive the PROW as safe outside of pedestrian-vehicle interactions is critical. Many variables impact pedestrians's use of the PROW outside of accessibility, therefore it is important for transportation planners to understand the other variables and how they impact likelihood of use.

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Appendix A: Pre-Interview Questionnaire

Name: [Open response]

Email: [Open response]

What is your job title within your organization? [Open response]

In which department or division of your organization does your position reside? [Open response]

In which area(s) do you have a professional background?

- Infrastructure: Engineering
- Infrastructure: Transportation Planning
- Infrastructure: Asset Management
- Policymaking/Public Policy: Disability Advocacy
- Policymaking/Public Policy: Elected Office
- Policymaking/Public Policy: Equity Officer
- Transit Services: Operations
- Transit Services: Service Planning
- Other [[Open response]

Interview questions relate to the following:

- Current planning questions related to accessible pedestrian infrastructure planning
- Data analytics and visualization techniques currently employed

Can you speak to these topics within your agency?

- Yes
- No

Are you interested in a follow up interview that would further discuss your decision making process and potential visualizations and/or analytics that could support your processes?

- Yes

No

Do you need any special accommodations and support during the course of the interview?
[Open response]

Is there someone else in your agency who I should also speak with to learn more?

Yes

No

If yes, please provide their name and contact information: [Open response]

Within your work, what are the active transportation decision making processes you are involved in? Select all that apply.

Evaluating a single project's impact(s)

Can you please give examples of decisions relating to a single project's impact

Project prioritization between multiple potential projects

Can you please provide examples of decisions relating to prioritization

Single project evaluation AND project prioritization

Can you please provide examples of decisions relating to prioritization

Other

Within your work, what are the ADA-related decision making processes you may be involved in.
Select all that apply:

Responses to ADA-compliance community requests

Ensure accessible features in an otherwise-identified project

Allocation of funds for accessibility improvements

Response to lawsuit/settlement agreement

Grant-related decisions, including application, project identification or selecting grant recipients

Create, review or update agency accessibility policies

We are interested in how important the following questions are in your decision making process:

- Network completeness, or, how much of the transportation network is available for pedestrians, different kinds of pedestrians, or bicyclists?
- Network density, or how many sidewalks connect to other sidewalks, providing multiple pathways to the same locations?
- Route direction, or, how far out of their way do users have to travel to find a facility they can or want to use?
- Access to destinations, or, what destinations can be reached using the transportation network?
- Level of service
- Impacts on the associated population(s)
- Other

Related to those project-specific decisions, rank the following questions from most to least important to your decision making process (rank from most to least important):

- Network completeness, or, how much of the transportation network is available for pedestrians, different kinds of pedestrians, or bicyclists?
- Network density, or how many sidewalks connect to other sidewalks, providing multiple pathways to the same locations?
- Route direction, or, how far out of their way do users have to travel to find a facility they can or want to use?
- Access to destinations, or, what destinations can be reached using the transportation network?
- Level of service
- Impacts on the associated population(s)
- Other questions

Related to project specific decisions, rank the following questions from most to least important to your decision making process:

- Network completeness
- Network density
- Route direction
- Access to destinations
- Level of service

- Impacts on the associated population(s)
- Other

Related to project prioritization decision making process, rank the following questions from most to least important to your decision making process:

- Network completeness
- Network density
- Route direction
- Access to destinations
- Level of service
- Impacts on the associated population(s)
- Other

If you included "Other" - what additional questions are important to your decision making process? [Open response]

Does your agency have any tools in place to help answer questions about network completeness, density, route direction, access to destinations, etc ?

- Yes
- No
- Unsure

If yes, what kind of tool(s) do you use to answer the questions? Select all that apply.

	Network Complete ness	Network Density	Route Direction	Access to Destination s	Level of Service	Impact(s) on the population	Other
Checklist	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Decision Tree	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Scoring System	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mapping Tool	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other Tool	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No Tool	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unsure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

For the questions indicated above, what kind of decision making tools would be the most supportive? For example, visuals such as GIS maps, numerical analytics such as graphs or rankings, etc. [Open response]

Optional Demographic Questions

The purpose of these questions is to understand the demographics of professionals with decision-making authority over accessibility improvements in public rights of way. You are welcome to skip any or all of these questions.

What is your gender identity?

- Female
- Male
- Gender Variant/Non-Conforming/Non-Binary
- Prefer not to disclose
- Prefer to self describe

Optionally self describe your gender here

Do you consider yourself to be a minority or underrepresented in your field of study or profession?

Yes

No

Other:

Please specify the underrepresented group(s) with which you most closely relate. Please mark "none" or skip this question if you do not feel comfortable disclosing, or do not relate to an underrepresented group.
[Open response]

What is your ethnicity?

Hispanic or Latino or Spanish Origin

Not Hispanic or Latino or Spanish Origin

What is your race?

American Indian or Alaska Native

Asian

Black or African American

Native Hawaiian or Other Pacific Islander

White

Anything else you would like to tell us about your racial or ethnic identity? [Open response]

What is the highest level of education you have completed? [Open response]

Optionally tell us your highest degree. [Open response]

Optionally provide context for your answer. [Open response]

Anything else you would like to tell us about your background? [Open response]

Do you self-describe as having a disability?

- Yes
- No

If you answered yes, which types of disability do you identify with? Check all that apply.

- Blind
- Visually Impaired
- Deaf
- Hard of Hearing
- Motor impaired
- Autistic
- Have ADHD
- Dyslexic
- Having other cognitive impairment
- Having other sensory impairment
- Having other learning disability
- Having other social disability
- Having chronic illness
- Having Mental Health Concerns
- Having a disability not listed above

Optionally provide context for your answer. [Open response]

Are you close to people with disabilities in some way? *

- I have an immediate family member with a disability
- I have an extended family member with a disability
- I have a close friend with a disability
- I do disability-related work in at a for-profit business
- I do disability-related work at a non-profit
- I do disability-related volunteer work
- I have a disability
- Other [Open response]

Appendix B: Interview Guide

Part 1: Current Agency Tools

Based on your survey responses, your agency uses X, Y, and Z tools to answer your pedestrian infrastructure planning questions.

YES	NO
<p>i. Does your agency have any other tools to answer these questions, such as:</p> <ul style="list-style-type: none"> ○ Checklist ○ Multiple checklists ○ Hierarchical checklists ○ Decision tree ○ Scoring system ○ Multiple scoring systems, weighting or prioritizing different scores ○ Spatial analysis tools ○ Census-based tools ○ Others, specify <p>ii. Do you believe these currently used tools are suitable for application for different types of projects?</p> <p>iii. Do these currently used tools miss certain aspects or stages of the project (in terms of not being able to apply accessibility impact assessment during that stage)?</p> <p>iv. What are some strengths of the tool's functionality?</p> <p>v. What functionality of these tools would you like improved?</p>	<p>i. How does your organization ensure that projects are assessed for accessibility impacts?</p> <p>ii. What metrics, if any, are currently used to measure accessibility?</p>

Part 2: Visualization Demonstrations

General visualization feedback

<Ask the following questions for each map/visualization>

1. Do you have any clarifying questions about the visualization I just showed you and described?

<Pause to allow interviewee to take in the map>

1. What planning questions do you think this map is answering? What could you answer with this map?
 - Would you use a walkshed map in your work?

- How would you take this type of analysis into your work?
- How would you modify the visualization to support your work?
<Continue onto Question Block 2 for probing questions>
- What additional data would you want to incorporate to dive deeper and answer your question?
<Continue to Question Block 3 for probing questions>
- To answer this question - what scale would be the most helpful?
<Continue to Question Block 4 for probing questions>

Guiding questions depending on general feedback on key information areas

<Based on answers from above questions, follow up with additional probing questions from the list below. Not all questions need to be asked, nor is this a comprehensive list, but should be used as a guide.>

(2) Visualization Type

2. Are we providing the right kind of visualization to answer the question we think we are answering?
 - What other kind of data visualization would be helpful to support your analysis and decision making?
 - Graphs and numerical analyses that maybe show the difference in walkshed extent between the two walksheds, number of turns a certain walkshed requires, elevation change, etc [summary data] would you prefer this or this?

(3) Data Correlation and Additions

3. Are we correlating external data sets correctly - or are there other data you want to add?
 - What kind of data is important to you/do you use in your work?
 - What data would you like to see added to these maps/tools to complete your analyses? For example, in Seattle elevation and grade are important data to include in our analysis since they greatly impact a person's ability to get around depending on their mobility
 - Population data
 - What kind of disaggregated data is important to your work? i.e. , race, disability, etc
 - Data about residents vs offices/commuters?
 - Crosswalk or curb-cut attributes

- Traffic volume, speed
- Level of detail?
- Monetary value of the potential improvements
- Health outcomes
- You said that X data is important to you, how would this data be best incorporated into a tool like this, and at what scale?
 - Index, graph, numerical analysis, map layer, routable map layer, distance from, etc
- For all of this data, is this data that you already have, or is it data that you would like to have collected? Where do you get the data - do you collect it in house, buy it, or get it from another agency/source/company?

(4) Scale

4. At what scale do you want to interrogate the question?
 - How much detail do you need?
 - Comparable scores like walk score?
 - Comparing geographic areas. Do you want to assess each area for its attributes or have a more general map that shows general accessibility based on a series of data that are put into an index
 - Does it depend on the question you are asking?
 - Would you like to be able to see the data at a point by point scale, as well as at an aggregated scale?

Part 3: Map Functionality

1. [Showing visualization #4] So, I have shown you a few different visualizations at different scales, which are most helpful to you?
 - a. Would you or the people you work with use this visualization, how and for what kind of activities?
 - i. Could you describe to me a pedestrian planning question that you have that would require <insert scale of interest> data?
 - ii. In what situation would you use the dual walkshed scale?
 - iii. In what situation would you use the single walkshed scale?
 - iv. In what situation would you use the intersection scenarios scale?
 - b. What would you change?
2. When you are using a tool like this, what kind of functionality is important to you?
 - Download the data for further data incorporation with your own data sets?

- Manipulability within the data tool itself? I.e., edit walksheds to visualize impacts of specific changes
 - Scenario visualizations eg view walksheds for different types of pedestrian walking ability
5. Let's say we were able to make a tool that incorporates all of your feedback, what questions would you ask about the data to make you trust the visualization? Said otherwise, what checks and balances do you use to make sure the data you are using to answer your planning questions is correct and trustworthy?
- If you identified an area in this potential tool that you know has inaccurate data, how important would it be for you to be able to flag inaccuracies and/or edit it directly within the map?

Closing Thoughts

1. Is there anything else you would like to add about the data visualizations I have shown you today, or feedback on the visualization type, data, or scale?

Appendix C: Codebook

TDEI Data Viz Interview Qualitative Codebook				
Primary research objectives: 1) Are we providing the right kind of visualization to answer the question we think we are answering. 2) Are we correlating external data sets correctly, what other data is important to include? 3) What scale is most useful, and for what question?				
<ul style="list-style-type: none"> Total codes: 8 categories; 18 parent codes, 44 child codes (4/9/23) 				
Theme	Parent Code	Child Code	Definition	
Their Existing Tools	tools-strength		Interviewee mentions a strength of their current planning tool	
	tools-weakness		Interviewee mentions a weakness of their current planning tool	
	tools-use		Interviewee mentions how they use their current planning tools	
	tools-improve		Interviewee mentions how they would like to see their tool improved	
	tools-add	tool-add-checklist		Interviewee mentions they also use checklists in their work
		tool-add-multcheck		Interviewee mentions they also use multiple checklists in their work
		tool-add-hierarcheck		Interviewee mentions they also use hierarchical checklists in their work
		tool-add-decisiontrees		Interviewee mentions they also use decision trees in their work
		tool-add-scoringsys		Interviewee mentions they also use scoring systems in their work
		tool-add-multscoringsys		Interviewee mentions they also use multiple scoring systems in their work
		tool-add-spatialanalysis		Interviewee mentions they also use spatial analysis tools in their work
tool-add-censustool			Interviewee mentions they also use census-based tools in their work	
tool-add-other		Interviewee mentions they also use another tool not mentioned in the other categories in their work		

Visualization	viz-type	viz-type-walkshed	Interviewee mentions they find walkshed visualizations helpful for their work.
		viz-type-origindestination	Interviewee mentions they find origin-desitnation visualizations helpful for their work.
		viz-type-index	Interviewee mentions they find index visualizations helpful for their work.
		viz-type-other	Interviewee mentions another type of visualization that would be helpful for their work.
		viz-type-scenario	Interviewee mentions that a scenario planning visualization/function would be helpful.
	viz-add	viz-add-graph	Interviewee mentions they would find a graph analysis alongside the map helpful.
		viz-add-quant	Interviewee mentions they would find another quantitative analysis alongside the map helpful.
		viz-add-other	Interviewee mentions they would find another type of analysis alongside the map.
		viz-add-nothelpful	Interviewee mentions that additional visualizations alongside the map would not be helpful for their work
	viz-application		Interviewee mentions how they would apply the analysis/tool to their work
Data	data-add	data-add-pedinfrasturcture	Interviewee mentions the type of pedestrian infrastructure data they would like to see included in the visualization/data they find helpful (i.e. curbcuts, crossing type)
		data-add-demographics	Interviewee mentions the type of demographic data they would like to see included in the visualization/data they find helpful (i.e. population, race)
		data-add-street	Interviewee mentions the type of street-specific infrastructure data they would like to see included in the

			visualization/data they find helpful (ie.e number of lanes, speed)
		data-add-planning	Interviewee mentions the type of planning data they would like to see included in the visualization/data they find helpful (ie.e zoning, commute sheds)
		data-add-destinations	Interviewee mentions the type of destinations they would like to see included in the visualization/data they find helpful (ie.e schools, long-term care facilities)
		data-add-equity	Interviewee mentions data specific to equity they would like to see included.
		data-add-othertransit	Interviewee mentions wanting to see other modes of transit included in the map such as bus stops, trails, micro mobility, etc.
		data-add-safety	Interviewee mentions any data they associate with safety (both pedestrian and vehicular), such as traffic fatalites, percieved safety, etc. Not attributes associated with the road such as speed, number of lanes, etc - that goes in data-add-street
		data-add-other	Interviewee mentions another type of data they would like to see included in the visualization/data they find helpful (i.e. one that does not fit in the prior categories)
	data-integration	data-integration-layer	Interviewee mentions that they would like to see additional data added to the tool via additional map layers
		data-integration-walkshed	Interviewee mentions that they would like to see additional data added integrated into the walkshed analysis itself
		data-integration-other	Interviewee mentions another way they would like to see additional data added to the tool
	data-trust	data-trust-mapfunction	Interviewee mentions that they need specific map functionality to ensure they trust the data (i.e. flagging inaccurate data)

		data-trust-metadata	Interviewee mentions that they need specific metadata to ensure they trust the data (i.e. date data collected, method of collection)
		data-trust-updated	Interviewee mentions that having updated data would ensure they can trust the data.
	data-scale	data-scale-census	Interviewee mentions census-scale data would be most useful for their work
		data-scale	Interviewee mentions another data scale that would be most useful for their work
Scale	scale-map	scale-map-A	Interviewee mentions that map scale A would be the most useful for their work
		scale-map-B	Interviewee mentions that map scale B would be the most useful for their work
		scale-map-C	Interviewee mentions that map scale C would be the most useful for their work
		scale-map-all	Interviewee mentions that map scales A, B, and C would be the most useful for their work
		scale-map-depends	Interviewee mentions that map scale the would find the most useful depends on the work they are doing
	scale-use	scale-use-A	Interviewee mentions how they would use scale A in their work
		scale-use-B	Interviewee mentions how they would use scale B in their work
		scale-use-C	Interviewee mentions how they would use scale C in their work
		scale-use-all	Interviewee mentions how they would use all the scales in their work
Additional Questions			Interviewee mentions planning questions they are addressing at their agency
Tool Functionality	function-tool-download		Interviewee mentions that they would like to complete an analysis in the tool and then download it for further analysis with their own data

	function-tool-blackbox		Interviewee mentions that they would like a “black box” tool where they can complete their whole analysis without integrating their own data
	function-tool-both		Interviewee mentions that they would like to be able to complete analyses in our tool as well as download them for further analysis with their own data
	function-tool-other		Interviewee mentions any other tool functionality they would like to have
Parking Lot			Information that seems important but does not fit under any specific category or code
Quotes			Good quote that could potentially be used to highlight shared sentiment among interviewees in the report

Appendix D: Full Data Types List

Demographics

Communities of Color
Diabetes
Disability rates
Equity indicators in general
General demographics
Low income households
Obesity rates
Vehicle ownership

Destinations

General destinations
Grocery stores
Hospitals
Parks
Schools
Senior Housing

Environment

Contour/Topographic lines

Pedestrian Infrastructure

Street crossings
Curb cuts
Distance between crossings
HAWK signals
Leading pedestrian intervals and countdown timers
Marked/Unmarked crossings
Median channels
Midblock crossings
Pedestrian islands
Pedestrian scale lighting
Raised crossings
Rapid flashing beacon location
Route directness within crossings
Sidewalk condition
Sidewalk grade
Sidewalk length
Sidewalk surface type
Sidewalk width
Sidewalk location
Trails

Urban Planning

Commute sheds
Housing Density
Land Use
Number of jobs
Residential area
Transit stations and networks
Trip generators
Type of housing
Zoning and Lane use

Population

Population and population density
Number of households
Employment data

Safety

Vehicle crashes
High injury corridor

Street Infrastructure

Curb extensions
Number of lanes
Parking lanes
Pavement condition
Turn lanes

Traffic Design

Level of traffic stress and traffic volume
No right on red
Turn radii
Pedestrian and vehicle phases
Posed speed
Roadway classification
Signals and intersection control
Traffic light timing
Type of traffic stop

