Urban Accessibility as a Socio-Political Problem: A Multi-Stakeholder Analysis

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Traditionally, urban accessibility is defined as the ease of reaching destinations. Studies on urban accessibility for pedestrians with mobility disabilities (*e.g.*, wheelchair users) have primarily focused on understanding the challenges that the built environment imposes and how they overcome them. In this paper, we move beyond physical barriers and focus on socio-political challenges in the civic ecosystem that impedes accessible infrastructure development. Using a multi-stakeholder approach, we interviewed five primary stakeholder groups (N=25): (1) people with mobility disabilities, (2) caregivers, (3) accessibility advocates, (4) department officials, and (5) policymakers. We discussed their current accessibility assessment and decision-making practices. We identified the key needs and desires of each group, how they differed, and how they interacted with each other in the civic ecosystem to bring about change. We found that people, politics, and money were intrinsically tied to underfunded accessibility improvement projects—without continued support from the public and the political leadership, existing funding may also disappear. Using the insights from these interviews, we explore how may technology enhance our stakeholders' decision-making processes and facilitate accessible infrastructure development.

CCS Concepts: • **Human-centered computing → Accessibility;** Accessibility theory, concepts and paradigms

KEYWORDS

physical accessibility; civic engagement; advocacy; policymaking; digital civics; urban technology; politics

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1 INTRODUCTION

The United Nations' *New Urban Agenda* positions equity and inclusion as core principles of modern urban development [93]. However, understanding, planning, maintaining, and even defining *urban accessibility*—from sidewalks to public transportation to buildings—is complex and has long-challenged urban planners and governments [16]. While early work focused on

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understanding the impact of *physical* barriers on access and quality of life [31,54,69,78,84], more recent work investigates the underlying and often less visible *social* and *political* barriers [40,64,69,71,84]. Though valuable in broadening the foci of urban accessibility research, this work has focused on only one or two stakeholder groups such as occupational therapists, architects [64] or people with disabilities [84].

In this paper, we present a complementary, multi-stakeholder analysis of the priorities, perspectives, and local decision-making around urban accessibility—specifically, pedestrian infrastructure (Figure 1)—in three US cities: Seattle, Washington DC, and New York. We performed semi-structured interviews with 25 participants drawn from five stakeholder groups: (1) *policymakers* who develop city-wide accessibility policies and regulations, (2) *department officials* who implement and maintain these regulations (*e.g.*, Department of Transportation, Office of Aging), (3) *accessibility advocates* who work towards changing ineffective policies, (4) people with mobility impairments (*MI individuals)* who have some form of mobility disability and directly experience (in)accessible environments; and (5) *caregivers* who are friends, family members, or professionals that care for MI individuals.

The semi-structured interview had two-parts: a formative component, which asked about perspectives of, approaches for, and decision-making processes around urban accessibility, and a design probe component, which examined reactions to envisioned urban accessibility analysis and visualization tools. In this paper, we focus solely on the former to examine urban accessibility as a socio-political problem and how civic technologies may support change in this context. Here, change refers to improving accessibility development efforts. We seek to address the following research questions:

RQ1: Across stakeholder groups, what are the information needs and challenges for assessing and making decisions around urban accessibility and the role of data and technology in these practices?

RQ2: How do stakeholder groups communicate and interact together to assess priorities and make decisions?

RQ3: What are the future design opportunities to improve existing assessment and decision-making practices?

Using iterative qualitative coding, we identify and present three high-level themes related to: data and technology practices, decision-making, and challenges impeding accessible infrastructure development. Our findings highlight the technological barriers in assessing urban accessibility as well as the socio-political barriers to infrastructure development. For the former, we identified disparities amongst groups in data and tool access. For example, policymakers had the least data/tool access while advocates had insufficient tools to fit their needs. For the latter, we found the presence of many actors, organizations, and their conflicting interests complicated decision-making and made accountability towards accessibility improvements hard. Combined with limited funding and public disinterest, political will to bring change was also affected.

Our work contributes to the growing CSCW/HCI literature on urban governance and civic systems using multi-stakeholder analysis as a method [7,19,61]. Using this approach, we extend prior work [64] by presenting the first US-focused study that brings multiple perspectives to

Figure 1. Examples of sidewalk accessibility barriers. The last sub-figure shows multiple barriers present together: missing ramp, no sidewalk, and uneven surface. Images from Project Sidewalk [78].

understand accessible infrastructure development processes. Our contributions include: (1) understanding current practices and challenges of working within the socio-political realities of a civic ecosystem, (2) the role of technology in supporting and potentially undermining existing practices, (3) a *civic interaction space* that lays out the roles of and interactions between stakeholders in the civic decision-making structure, and (4) identifying points of future technological interventions in the form of data-driven assessment and civic engagement tools for improving accessibility through planning, advocacy, and policymaking.

2 BACKGROUND AND RELATED WORK

In this section, we provide background on mobility disabilities and the corresponding physical access needs, followed by a review of urban accessibility, what constitutes an accessible environment, and the laws and regulations that govern infrastructure development. We then provide a review of CSCW/HCI literature on the use of data-driven civic technology for assessing accessibility needs and city-scale decision making for infrastructure development.

2.1 People with Mobility Disabilities

People with mobility disabilities have some form of mobility impairment, which can be caused by sensory impairments (*e.g.*, loss of vision or hearing), motor impairments (*e.g.*, loss of function in the lower- and/or upper-body), and cognitive impairments. Depending on the type and severity of disability, MI individuals may choose to use different forms of mobility aids such as wheelchairs, canes, and/or walkers. Both the type of MI and form of mobility aid impacts how an individual may move about and navigate a city. For example, people with vision impairments may use canes or guide dogs and use physical features of the environment as landmarks for navigation [8,33,77]. People in wheelchairs require wide sidewalks without path obstacles such as poles, surface degradations, or missing curb ramps. In this paper, we focus on individuals having an impairment affecting their lower and/or upper body extremities and whose mobility is directly impacted by inaccessible physical infrastructure. We refer to them as MI individuals throughout the paper. The implications from our findings on data/tool needs to support daily living decisions would likely apply to other groups as well.

2.2 Urban Accessibility: Confluence of Accessibility, Mobility and Disability

Urban accessibility is a wicked problem[1] spanning multiple disciplines such as transportation and urban planning, disability studies, human geography, and urban sociology. To understand what makes a '*built environment*' inaccessible, we need to understand the confluence of *accessibility*, *disability*, and *mobility*.

Since the 1950s, urban accessibility has been primarily studied within transportation and urban planning. Here, researchers broadly characterize accessibility as "*interactions between human and lands*" [51], and more specifically, "*the ease or difficulty for people to reach opportunities and services*" [21,88]. These definitions strongly tie accessibility to mobility within cities [65], however, they do not account for mobility and physical differences across individuals [16,81]. In contrast, the socio-political model of disability defines disability as "*a product of a dynamic interaction of human and the environment*", an expansion of the earlier definition [51], and shifts the emphasis from "*the individual" to "the broader social, cultural, economic, and*

[1] Wicked problems are "*ill-defined and they rely upon elusive political judgment for resolution*" [18,76]. Rittel and Webber cast public policy and planning problems such as urban accessibility as wicked where there is no definitive formulation or clear solution to such problems.

political environment" [49,50,58]. In this paper, we adopt this socio-political model to advance understanding of the barriers to infrastructure accessibility [53,68].

Prior work has shown that built infrastructure [31,69,84] and socio-economic status [2,9,29,48,88] can lead to inequities in access to opportunities and services of an MI individual. Beyond availability of built infrastructure, *quality* of access across the entire spectrum of physical access needs is crucial: from accessible pedestrian infrastructure (*e.g.*, sidewalks) to public transportation (*e.g.*, buses, trains) and transit infrastructure (*e.g.*, elevators, subway platforms) to the accessibility of destinations (*e.g.*, buildings and facilities). In this paper, we focus on pedestrian infrastructure accessibility, specifically *sidewalks*; however, our interviewees often referred to accessibility issues along the entire spectrum, allowing us to draw broader implications on factors influencing accessible infrastructure development.

Our focus is on sidewalks which are a part of the 'public right-of-way', defined as the land or property reserved for transportation purposes [94]. According to the *US Access Board* and *Federal Highway Administration* (FHWA) guidelines [95–97], accessible sidewalks include wide pathways and clearly defined zones such as pedestrian clear zone, sidewalk furniture zone (*e.g.*, utility poles), and the frontage zone (*e.g.*, storefront entrances)—Figure 2. The guidelines also require that sidewalks have minimal obstacles and protruding objects, moderate grades and cross slopes. For example, sidewalks must have as a minimum width of 1.525m (5ft) for pedestrian zones (Figure 2a) and a four-by-four foot length for perpendicular curb ramp at intersections (Figure 2b). Non-compliance constitutes a disabling built environment for an MI individual [50,57].

2.3 Urban Accessibility Laws and Regulations

In the US, the first public policy measure by Congress was the *Architecture Barriers Act of 1968* (ABA) [66,98]. However, a growing movement of disability rights activists began reframing disability not as a problem of mind or body but as a socially constructed form of societal oppression [30]. Bolstered by these efforts, the Rehabilitation Act of 1973 was passed stating that no qualified individual with a disability should be excluded from or denied benefits of any program receiving federal assistance (29 U.S.C. 794d. Section 504). It was not until the landmark Americans with Disabilities Act (ADA) in 1990 [17,66], however, that protections were extended beyond the government sector. Critically, the ADA recognized the minority status of Americans with disabilities—modelled after the Civil Rights Act of 1964—and required places of "*public accommodation*" to provide people with disabilities appropriate aids or services [59].

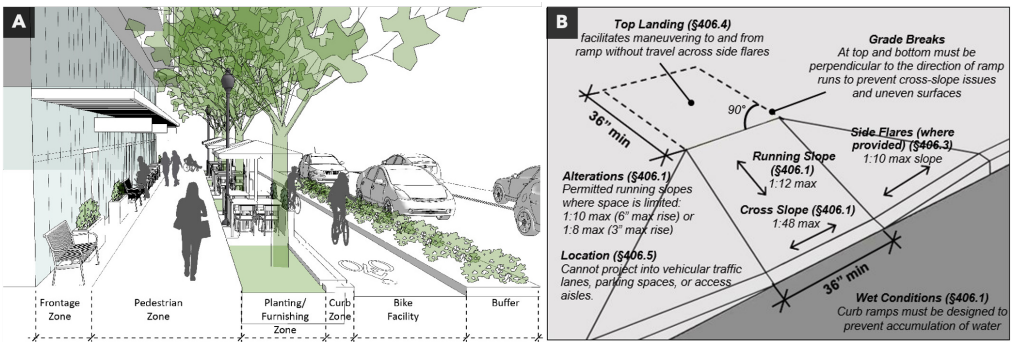

Figure 2. Illustrations of sidewalk and curb ramp design. Figure A shows City of Montgomery's Urban Design Guidelines on designing sidewalks [134]. US Access Board requires a minimum of 5ft width for Pedestrian Zones. Figure B shows the design of an accessible curb ramp [135].

Together, the Rehabilitation Act and the ADA regulate the accessibility of public rights-of-way and facilities in the US [96]; however, they do not define the specific accessibility standards themselves. For this, the US employs the US Access Board—an independent federal agency responsible for developing official accessible design requirements [60,96] (Figure 2). Compliance is mandatory and enforced by the Department of Justice.

The impact of these policies on pedestrian infrastructure can be seen in cities, where, for example, curb ramps are increasingly common at street intersections [99–103]. However, despite 30 years since the passage of the ADA, most cities still remain inaccessible [104]. In the US, lawsuits typically led by advocacy groups are the most common way of holding cities accountable [100,105–107]. However, lawsuits only draw attention to the problem after the fact—*e.g.*, an accident due to a cracked sidewalk [108]. Alternatively, proactive measures to assess and track urban accessibility can promote accountability; however, with few exceptions [109,110], these measures are not yet part of a city audit process due to time-consuming and expensive traditional physical audit methods. Crowdsourced data collecting tools (*e.g.*, [78,111]) offer promising opportunities to quickly assess accessibility at scale. Additionally, new efforts demonstrate the power of involving citizens early in the infrastructure planning process and the use of technology to formulate and implement better policies [112]. We look at the existing models of how data and technology is employed for digital governance and urban planning, specifically relating to urban accessibility.

2.4 Civic Technology for Accessible Infrastructure Development

CSCW and HCI literature [6,27,28,75,113] suggests that civic engagement practices and the supporting civic tech have the potential to: (1) enable transparent interaction between the government and the public, promoting accountability [6,114]; (2) help public officials make decisions around project planning [23]; (3) guide advocates [5,6,38,42] and engage the public to participate in city decision-making [20,63,73,79]. While civic tech has been studied broadly for infrastructure planning [19,22–25,70], we explore the largely underexplored needs of urban accessibility planning and infrastructure development.

In the last decade, there has been a rise in data-driven civic participation tools for crowdsourcing data around urban accessibility, such as 311 service requests [115] and citizen-reporting apps (*e.g.*, *SeeClickFix* [116], *StreetBump* [117], and others [24,67,80,118]) to log broken sidewalk and other physical infrastructure issues. Beyond citizen-reporting apps that require physical presence at locations, remote inspection tools such as *Project Sidewalk* [78] crowdsource accessibility issues via online streetview imagery. These data-based civic participation systems address the first major challenge for developing tools supporting urban accessibility planning decisions: lack of data collection at scale [36]. In this paper, we further investigate the role of data and technology in urban accessibility beyond daily living needs for MI individuals (*e.g.*, [11,52]) and identify differences in needs and availability of data-driven decision support tools for advocacy, city maintenance, and policymaking.

More recently, Olivier and Wright argued going "*beyond volunteerism toward a model of citizen-led service commissioning*" that encourages long-term engagements with *multiple* stakeholders through relational models of public service instead of transactional models where citizens act as consumers of government-led services [75]. Rooted in participatory design methods [72], the relational model encourages shared governance via collaborative decision-making practices [112,136] that ensures citizens' voices are heard and reflected in government policies [15]. While participatory methods have been used to design accessibility-aware assistive tools [52], no efforts have yet been made to study the needs for developing tools that support citizen participation in infrastructure planning decisions to address accessibility issues. In this paper, we introduce a civic interaction space based on our findings and insights from prior

CSCW case studies [19,20,73] on understanding the challenges in operating within complex socio-political urban contexts with participatory tools and processes.

3 INTERVIEW STUDY

3.1 Methodology

To better understand contrasting perspectives, decision-making practices, and socio-political factors surrounding urban accessibility in US cities, we conducted semi-structured interviews with five stakeholder groups (N=25): (1) *policymakers* (*e.g.*, elected officials from city councils or their legislative staff members), (2) *department officials* (*e.g.*, employees from city transportation departments (DOTs) and related organizations), (3) *accessibility advocates* (*e.g.*, those working or volunteering in disability advocacy groups or organizations), (4) *MI individuals*, and (5) *caregivers*. The interview session had two parts: a *formative* inquiry asking about experiences with urban accessibility and a *design probe* inquiry soliciting reactions to interactive visualizations of sidewalk accessibility data. Below, we focus our analyses on Part 1 that investigated the decision-making practices and uncovered socio-political factors affecting accessibility development efforts.

Our Part 1 interview script included questions shared across all five stakeholder groups as well as a group-dependent set. For the shared questions, we asked about urban accessibility

P#	Group	Affiliation	Role(s)	Additional Notes
P1	M			Powered Wheelchair User
P2	M			Powered Wheelchair User
P3	D & C	DOT	Sidewalk Repair Program Manager	Father under care
P4	C			Husband under care
P5	M			Powered Wheelchair User
P6	C			Daughter under care
P7	A & C	Tech-based Disability Adv. Org.	Director	Daughter under care
P8	D	DOT	Asset Management Strategic Advisor	
P9	M			Manual wheelchair User
P10	M			Cane User
P11	A	Walkability Adv. Org.	Vice Pres., Policy Committee Chair	
P12	D	DOT	ADA Coordinator	
P13	A & M	Disability Adv. Org.	Senior official	Manual Wheelchair User
P14	A	Neighborhood Adv. Group	Co-lead	Former Mayoral Candidate
P15	A & M	City Commission for Disabilities	Member	Cane User
P16	A	Law Firm	Partner, Lawyer	
P17	PM	City Council	Policy Analyst	Assists all city council members and is a liaison between DOT and the council
P18	PM	State Legislation	Ex-State Representative	Former Mayoral Candidate
P19	D	Office of Disability Rights	ADA Architect	
P20	A & C	City Commission for Disabilities	Volunteer	Husband under care
P21	D	DOT	Chief Performance Officer	
P22	D	DOT	ADA Coordinator	
P23	PM	City Council	Analyst	
P24	A	Disability Adv. Org.	Executive Director	
P25	PM	City Council	Elected Official	

Table 1. Participant demographics. For groups, M=MI individuals, C=caregivers A=advocates, D=department officials, and PM=policymakers. Five participants self-identified into multiple group categories.

perspectives, how they assess "accessibility", and the role of data and technology therein. For the group-specific questions, we asked department officials, policymakers, and advocates groups about their role in their organization and the citizen engagement practices used. We also enquired about accessibility considerations during decision-making such as when moving to a new neighborhood (for MI/caregivers) or when determining where to allocate time and resources (for department officials, policymakers, and advocates). The full study session lasted approximately two hours (Part 1 was approximately 30 minutes). Sessions were audio and video recorded and conducted in person by the first author in the participants' respective city. At the beginning of the interview, participants completed a pre-study questionnaire gathering demographic data, where participants self-identified with a group(s). Participants were compensated US$25/hour and up to US$30 for transportation costs.

3.2 Participants

We recruited 25 participants (11 female) aged between 25–72 (*Mean*=48.3, *SD*=14.5) across three major US cities: Washington DC (*N*=5), Seattle (*N*=19), and New York (*N*=1). All three cities have a mayor-council form of government, where the city council members are elected members responsible for developing policies (legislative branch) and the mayor directs the city departments (*e.g.*, DOT) for implementing those policies (executive branch) [119]. Across these cities, we had six department officials (D), eight accessibility advocates (A), four policymakers (PM), seven MI individuals (M), and five caregivers (C). Five participants identified with two stakeholder groups and were interviewed from both perspectives (Table 1). Participants were recruited through mailing lists, word-of-mouth, social media, and directed emails. Below, we refer to participants by 'P' suffixed by their participant number and stakeholder group [M | C | A | D | PM].

3.3 Analysis Method

The audio recordings were transcribed and we thematically analyzed the interviews using a mixture of deductive and inductive coding [13]. The primary researcher prepared an initial codebook based on the interview questions. Four researchers coded a randomly selected transcript. We used Cohen's Kappa [85] for establishing inter-rater reliability (IRR); three pairs

Major Themes	Description
T1: Participant Roles	What roles did stakeholders have as an official in their organization towards accessibility development? Applicable only to advocates, policymakers, and department officials.
T2: Barriers to Travel	What do stakeholders look for when assessing state of accessibility and needs? Describes the barriers that people with mobility disabilities face. Code examples include personal barriers, physical barriers, building accessibility.
T3: Assessment Methods	What were the assessment methods used for accessibility? Code examples include visual inspection, taking pictures, physical audits, surveys, ask people.
T4: Accessibility Metrics	How did stakeholders quantify accessibility? Code examples include sidewalk feature measurements, priority index, building feature measurements, travel time.
T5: Data Sources	What data do they rely on for making these assessments? Code examples include citizen provided data, internal data sources, external/agency data, open data.
T6: Digital Tools Used	What digital tools do participants use (if any) for making accessibility assessments? Code examples include online streetview imagery, imaging equipment, satellite imagery, GIS and mapping tools.
T7: Prioritization Practices and Factors	What parameters/factors are considered when making assessments and decisions? How do they or would want to prioritize when making decisions (*e.g.*, for resource investments, policy making, advocacy efforts, daily living)? Code examples include infrastructure utilization, population density, area demographics, decision-making questions, limitations

Table 2. Codebook summary of our seven high-level themes. Detailed list of codes available in the supplementary material. T2 and T4 are not covered due to their prominence in prior work (see [69,84]).

of IRR values were calculated with respect to the primary researcher. For the first iteration, the average IRR was 0.41 (pairwise IRRs: $R1_{\kappa}$=0.63, $R2_{\kappa}$=0.35, $R3_{\kappa}$=0.24) suggesting more iterations [85]. The codebook went through three such iterations of removing and/or collapsing conflicting codes and resolving disagreements, before establishing substantial agreement (*range*=0.61–0.80) at an average IRR of 0.68 (pairwise IRRs: $R1_{\kappa}$=0.81, $R2_{\kappa}$=0.62, $R3_{\kappa}$=0.61). The final codebook contained 62 codes grouped into seven high-level themes, including assessment methods, data sources and tools used, and prioritization practices and factors (Table 2). The remaining transcripts were divided amongst the four researchers and coded independently using the final codebook, which is included as part of the supplementary material.

4 FINDINGS

We categorize our findings into four groups: (1) data and technology practices for accessibility assessments, (2) interactions between stakeholders influencing accessible infrastructure development, (3) decision-making practices related to urban accessibility, and (4) complexities and challenges for city-scale decisions. Across these categories, we highlight similarities and differences in perspectives among our stakeholder groups. Participant quotes have been lightly edited for concision, grammar, and anonymity.

4.1 Overview of Stakeholders and Perspectives

To contextualize our findings and establish each stakeholder group's position, we first synthesize their key needs, goals, and responsibilities related to urban accessibility. Upon analysis, we recognized that both MI and caregivers voiced similar perspectives, leading us to subsequently combine them. MI individuals make up 58.3% (7/12) of the combined group.

MI/Caregivers (N=12). MI individuals and caregivers emphasized safety and quality of physical access—to transportation and destinations—as well as the freedom and support to move around a city. For example, "*Is it going to be a smooth [curb ramp], is it going to end in a safe place, not out in the middle of the traffic?*" (P6C), "*How accessible is the entrance to the building? Are there stairs?*" (P10M), "*Is there transit and where is it?*" (P15AM). These decision-making factors are dictated by personal needs and are granular in nature.

***Policymakers* (*N*=4).** Policymakers care about the *prioritization* and *distribution* of resources amongst several urban issues, one of which is accessibility. A key concern and tension is funding: "*Making the funding pie for walking facilities as big as possible when we would have budget negotiations, really putting a strong stake in the ground*" (P18PM). Policymakers must carefully balance new proposed capital projects, which are typically easier to fund, with maintenance projects: "*Do we only invest in new sidewalks or do we invest in repairing our existing sidewalks?*" (P25PM). Given that policy decisions affect the entire city, equitable distribution of resources is an important consideration especially for serving historically underserved neighborhoods. This involves "*…working with my constituents, particularly my constituents who may be disabled. […] We would literally just talk about parts of the district that were in need of additional investment. I would then go and specifically advocate for those investments.*" (P18PM).

***Department Officials* (*N*=6)**. Department officials are the implementers. They are responsible for executing policy and making accessibility improvements to create ADA-compliant infrastructure. Their primary concern is understanding how best to utilize allocated funds: "*what are potentially the highest priority sidewalks?*" (P12D). To do so, they first understand current infrastructure conditions to identify unsafe or inaccessible locations (*e.g.*, "*Are there minimum clearance issues? […] Cross slope issues?*" —P8D, *"If it's lifted, is it sunk in?*"—P21D). To inform their decision making, department officials conduct precise, onsite measurements of infrastructure and potential accessibility issues.

***Advocates* (*N*=8).** Advocates represent people in need. They closely engage with the disability community to understand and change the status quo, gather support around issues, and act as an intermediator with the city leadership: "*We [an advocate] ask a representative from either the council, […] or [city] department to come to a commission meeting so that we can ask them about any upcoming ideas or projects that might be happening to address that concern*" (P15AM). Their primary concern is to maximize the impact of their advocacy efforts and affect change, which requires raising awareness around issues: "*We do a tremendous amount of what's called systems advocacy, and we do a great deal of education of community leaders in [city-name] and [state-name] concerning the status of people with disabilities*" (P24A). In addition to understanding the city infrastructure, advocates are interested in understanding city politics for efficient and impactful communication with the government. They identify and investigate ongoing problems and hold administrators accountable, as P14A explained: "*There's a new curb bulb or new curb ramp, but they didn't install it correctly. Like when did that happen and how? Was it a part of this administration […]?*".

4.2 Data and Technology Practices for Accessibility Assessments

To understand how our stakeholders perceived, experienced, and assessed pedestrian accessibility—in their daily and/or professional lives—we asked participants about their assessment practices and the role of data and technology therein. Across stakeholder groups, two primary methods emerged: in-person and technology-mediated approaches.

4.2.1 In-person Methods. The two primary in-person methods were (1) physical inspections, where participants went out to assess the built environment and (2) engaging with people, where participants interacted with others to gain knowledge.

Physical inspections. All stakeholder groups used some form of physical on-site inspection—which were perceived as the most accurate and up-to-date technique—but they differed in terms of purpose, measurement approach, and outcome. MI individuals and caregivers constantly "inspect" as part of their everyday lived experience, taking note of safe, accessible routes *in situ*. As P5M describes: "*If [a sidewalk is] too steep of an angle, I have to tip my chair back. Or if there's a big bump, I'd have to go extra slow.*" In contrast, department officials took precise measurements using specialized civil engineering tools to ensure ADA compliance and inform maintenance and construction efforts. Though this quantitative data lacked the qualitative nuance of the MI experience, it could be easily input into planning tools. As P8D, a DOT official, explains:

> *"We use non-subjective data measurements to collect that [sidewalk] information...apply a condition algorithm, in addition to what we found along the sidewalk to say is it very poor, poor, fair, good, or excellent condition sidewalk? An excellent condition sidewalk has at least 48" of width, it has a cross slope of no more than 2%. It has no observable issues along the sidewalk for barriers." (P8D)*

Similarly, but with varied measurement technique and purpose, advocates used both physical measurements as well as taking pictures of sites to gather evidence for accessibility litigations and advocacy campaigns. As P24A described,

> *"In our survey, […] people used actual measurements of each curb ramp. We documented that at least 77% of the curb ramps in [city] were missing, not constructed according to Americans with Disabilities Act standards, or were not maintained and were broken in a way that is dangerous not only for people using wheelchairs but also canes and walkers." (P24A)*

Advocates also resorted to creative methods such as using their shoes as an instrument to gauge surface issues: "*I use my shoes. If the heave is bigger than that, then that's really bad.*" (P11A).

In contrast, policymakers did not conduct precise physical audits themselves but instead relied on formal reports from city departments. They did, however, participate in neighborhood

walk-throughs [120] with their constituents to better understand issues in their localities either proactively or reactively to citizen complaints. A department official described a walkthrough involving all stakeholder groups, which blends physical inspections with citizen engagement:

> *"We'll do mayor's walk through [...] that'll be a walk with the mayor and the community and all the agencies. We walk for two miles and look at everything from signs to sidewalks to ramps to abandoned cars, vacant buildings. So, it's usually 30 or 40 government employees and anywhere from 30 to 100 citizens." (P21D)*

Engaging with People. While physical inspections provided visual validation, direct measurements, and experiential evidence, engaging with people enabled understanding on-the-ground "*lived*" experiences of MI individuals as exemplified by an advocate (P24A): "*people being stuck at the base of an improperly constructed curb ramp, or being jettisoned from their chair into the street as a result of a wrongly-designed curb ramp.*" Similarly, for MI individuals and caregivers, these personal experiences became the next most trusted information source after their own when making life decisions (*e.g.*, traveling to unfamiliar locations): "*I've found that able bodied people, they're not reliable because they don't look with the eyes of a disabled person.*" (P1M).

Each group differed in their approach and purpose to gather these personal accounts. Similar to prior work [19], we found department officials performed both transactional service engagements and relational engagements. Transactional engagements involved acquiring subjective experiences *reactively* through 311 service requests or *proactively* through large-scale field surveys to inform project priorities and investments. Relational engagements [19,75,86] involved engaging with advocates and the public through community meetings to gain deeper understanding of issues: "*We go to seven to 12 ANC [advisory neighborhood commissions] meetings every two weeks, roughly. Those are representatives of the community. [...] We go to those meetings [...] where the public is supposed to work through those [ANC] people*" (P21D). In contrast, policymakers primarily performed relational engagements through townhalls, the aforementioned neighborhood walk-throughs, and digital media to develop trust and build public support from potential voters. Unlike government officials, advocates collected lived experiences primarily through personal interactions with people with disabilities and the community to run campaigns for raising awareness, educating community leaders, drawing public attention to an issue, and gathering evidence for issue-based litigations. Depending on the goal, often a combination of the in-person methods was utilized to complement the gathered qualitative evidence. An advocate explained,

> *"We created this class action based on, at first, anecdotal evidence obtained through focus groups, interviews, review of data, public notification, and [then] direct on-the-ground, monitored surveys using an approved instrument, so that we could be confident that we [were able to] generalize beyond anecdotal evidence, which is often disdained, despite its validity." (P24A)*

Despite the benefits, policymakers found it challenging to engage with a wide range of people due to the need for additional effort, time, continued motivation to participate, especially for unpaid volunteers and resource-constrained engaged citizens:

> *"Usually, we'll only have the ANC commissioner, the hyper-local representative for that area and ANCs tend to be somewhat representative but it's also not paid so people have to either have the time or the resources to do it. And then usually on top of that, we'll maybe get like one or two other residents that generally are already pretty well plugged in to that process. So yeah, I will say it's difficult to hear from a wider range of people but that's a problem everywhere." (P23PM)*

4.2.2 Technology-based Assessment Methods. All groups utilized some form of a digital tool to help locate and assess inaccessible areas. Unlike other groups, department officials had access to specialized mapping and analytic tools such as ArcGIS's *Collector* [121] and *Cyclomedia* [122], which enabled complex geo-spatial analyses such as connecting demographics with accessibility

conditions to help inform planning. In contrast, policymakers desired summary reports and visualizations to help gain broad overviews and make resource appropriation decisions. For example, P18PM mentioned using geo-located dot maps: "*Nothing super sophisticated but city maps with dots saying, 'There is a broken sidewalk here. There is a curb cut here.'*" (P18PM). Advocates created maps for their own analytical understanding and to aid advocacy efforts: "*We have created maps of the city and we have used them to overlay obstacles to transportation, so that we can identify on a map showing where people in the greatest need live, the transportation deserts for people with disabilities*" (P24A). Finally, MI and caregivers used publicly available mapping tools, such as *Google Street View* (GSV) or *AccessMap* [11], to assess both the accessibility of routes and destinations (reaffirming work by Hara [52]).

Our stakeholders relied on a variety of *data sources* for achieving their group-specific goals and tasks such as using online streetview imagery to perform initial remote assessments. However, for some stakeholders such as policymakers, the availability, quality, and accessibility of datasets limited data-driven analyses and decision making; many city data sources were only available-on-request. As a result, advocates and policymakers relied on external sources (*e.g.*, from transit agencies) and open data sources (*e.g.*, collision and incident reports, planning documents, academic research). Advocates desired up-to-date data that were often not readily available (*e.g.*, pedestrian and bicycle incidents). Consequently, they often resorted to unconventional data sources such as news articles about accessibility issues in an area, subpoenas, and depositions. In contrast, MI individuals and caregivers did not explore these avenues, likely due to high costs of access and low returns.

Limitations. Despite their advantages, the value of technology-based methods was limited by the appropriateness of tools and underlying data sources. Most commercially available tools did not provide up-to-date information, a key need of advocates and people with disabilities—for example, locations of construction blockages. The most common tool used by all groups, especially MI/caregivers, was GSV, yet participants found it insufficient due to a lack of precise information (*e.g.*, curb ramp slope), obstructed views, and outdated imagery: *"Often they are so delayed in reaching the Internet that they're not relevant to current conditions, or they may have been remedied or they may have been assessed by us as being fine, but then become damaged because they are so delayed*" (P24A). These limitations can be attributed to the fact that GSV was not designed with accessibility concerns at the forefront.

Similar concerns of lack of reliable, up-to-date, and granular data sources also hold true for open city data sources. Department officials mentioned maintaining an accurate reliable dataset of sidewalk issues is challenging due to high maintenance costs. Beyond mapping tools, existing visualization tools were insufficient to inform and aid people in making goal-oriented decisions around urban accessibility. Policymakers and department officials both described a lack of visual tools in legislator and city meetings: "*As a legislator, we very rarely got briefed with visual tools. It was very sad.*" (P18PM). The policymaker P18PM, who previously worked as an advocate, further noted: "*Honestly as an advocate, we would have been much more likely to use finely grained visual tools so that we could, from the ground up, help develop policy*"

4.3 Interactions between Stakeholders for Accessible Infrastructure Development

In this section, we explore interactions between stakeholder groups and their decision-making practices around accessible infrastructure development. We focus on *policymakers* and *department officials* who govern, plan, and implement infrastructure development and *advocates* who attempt to influence policy decisions and voice MI/caregiver concerns.

Figure 3 summarizes the role of the three stakeholders in accessible urban development, which we expand on below. All stakeholder interactions were to achieve two key goals: (1) setting city priorities and agendas and (2) prioritizing investments. We first elaborate how

policymakers and department officials interacted and worked together and then explain the various roles advocates adopted to participate in the decision-making process.

4.3.1 Role of Policymakers and Department Officials. To achieve the two decision-making goals, both stakeholders worked together to investigate accessibility issues, evaluate the issues' impact, set funding priorities, develop policies and courses of action, and monitor progress. As legislators and elected representatives, *policymakers* are responsible for developing laws and regulatory measures. As advisors, investigators, and implementers, *department officials* assist policymakers to meet the set agendas by developing and implementing infrastructure maintenance plans.

As the first step of developing action plans, policymakers identified the most vulnerable populations affected by inaccessible infrastructure. To do so, further analyses into the specific accessibility issues and their impact were determined with the help of department officials, who conduct analyses using field data such as sidewalk condition assessments. Further, both stakeholders interacted with the affected communities to ensure citizen needs were represented in the decision-making process. While department officials engaged with people with disabilities to inform their maintenance plans, policymakers focused on communicating process and potential outcomes to their constituents. Policymakers also oversaw departmental progress on identified priorities: *"[one role of] the legislative department is oversight. Bring in the [city DOT] to explain themselves [...] - what is their approach for addressing scooter use on sidewalks?"* (P17PM).

Beyond determining citizen needs, budgeting was the next crucial element for developing action plans. Policymakers controlled the budgetary allocations. When formulating plans, they asked questions such as: "*how efficient is this [an action plan]; how much money are we spending; can we move things around? [...]"* (P17PM) and relied on department officials to bring policy recommendations forward. Based on allocated funds, department officials determined the specifics of the action plan: "*I will work on identifying, given the budget we have, usually around $3 to $5 million a year, which sidewalks are in greatest need of repair. And then we work on drawing up plans and scheduling those projects with our internal crew staff.*" (P8D).

4.3.2 Role of Advocates. While policymakers and department officials had significant control from within the government, advocates externally influenced policies and investment plans by taking on several roles: *investigator* for locating issues, *advisor* for providing policy recommendations, *educator* for raising awareness around issues, *mediator* for bridging the gap between government and the public through communication, and *litigator* for fighting on behalf of the people in need.

As investigators, advocates identified communities in need of assistance and the barriers

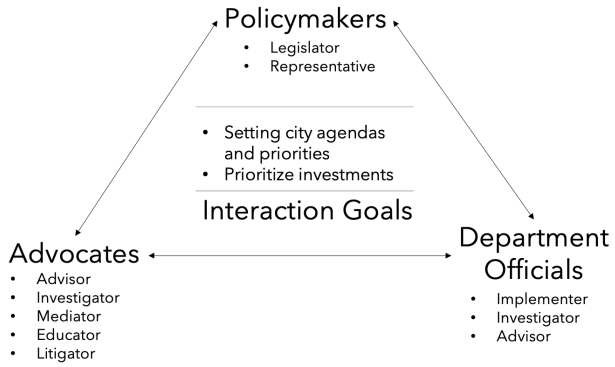

Figure 3. Roles and Interactions between groups involved in city-scale decision-making.

they faced. Based on their investigations, they sought support from the political leadership to make them *aware* of accessibility issues in their constituencies by educating them: "*We look at disparities between people with and without disabilities on each of the issues and across each of the populations and publish reports that we make available to policymakers [and] community leaders*" (P24A).

Communicating with policymakers involved understanding the political atmosphere, dynamics of city politics, and building relationship. For instance, advocates identified who had the most power and who they had to convince or negotiate with for affecting change:

> *"In [our city] for example, the mayor runs the DOT and really has a lot of power. And in theory, the city council controls the purse strings, controls how funding is doled out. [...]. And so, I'd look at that and see, is this something where I'd be butting heads with the mayor all the time... or is it something where the council members could actually make something happen?" (P14A)*

To effectively communicate, advocates identified policymakers' priorities and concerns and accordingly framed their requests: "*Trying to get to know legislators and sort of understand them so that you can [...] frame the issue in a way that makes sense to them.*" (P11A). Additionally, serving on advisory boards to the mayor, city council, and/or city departments allowed for closer interactions and influence over policy decisions. As advisors, they had "a voice at the table" (P18PM) representing community needs, helping set agendas, and crafting ADA transition plans for barrier removal:

> *"The city council or the mayor or a department [DOT] would reach out to myself, my co-chair or liaisons and say 'Hey, we are thinking about putting curb cuts in this neighborhood. We want to make sure we do it right. Either can I send a legislative aid to come to your meeting or can you give us some recommendations on how to do that?'" (P15AM)*

Finally, for raising public awareness, advocates conducted campaigns through various media to draw attention to the identified accessibility issues. For example:

> *"...[We] went to the public media—the large newspapers, television stations, radio stations—and talked about these problems and we had them film people with disabilities attempting to navigate, to cross streets, and demonstrating by physically showing what happens when a curb ramp is improper. These were aired publicly, drawing attention to the issue so that the general public might know, including people with disabilities who might then come forward with their issues." (P24A)*

4.4 Decision-Making Practices for Accessible Infrastructure Development

Continuing with the three stakeholder groups—policymakers, department officials, and advocates—we describe decision-making practices related to accessible infrastructure development. In short, all stakeholder groups attempted to maximize impact of the limited funding and ensure equitable distribution; however, groups differed in their goal, data access, and analysis approaches. We elaborate on this decision-making workflow by first discussing impact assessment considerations followed by a set of prioritization factors and strategies.

4.4.1 Impact Assessment Considerations. Participants described two considerations for assessing potential investment impact: equity and gentrification. For equity, stakeholders analyzed how investments reached across socio-economic strata of the city. Similar to past studies [3,47,74,90,91], policymakers and advocates noted that some neighborhoods remained historically underserved and mobility issues disproportionately affected people of color and people with disabilities, who commonly relied on public transit and pedestrian infrastructure: "*People who are Hispanic and Latino, and people who are Black or African-American would be disproportionately affected, because they live in greater concentrations in low-income housing, according to our statistical portraits. And they have less access to transportation due to transportation deserts in their neighborhoods, the lack of access to subway, elevators, ramps,*

escalators." (P24A). An elected official described the need for conscious and aggressive efforts towards making cities equitable:

> *"The city has a commitment, and I have a commitment personally, [...] to try to make our city more equitable. To the extent that inequities exist, and they exist massively in [city-name], we need to be making disproportionate investments to undo the disproportionate investments made by prior generations." (P25PM)*

Policymakers and advocates also assessed the impact of urban development on gentrification and displacement: "*A complicated reality is that gentrified neighborhoods tend to be more accessible neighborhoods, which is complicated for a whole host of reasons*" (P13AM). As urban neighborhoods gentrify, their street-level infrastructure is upgraded, improving accessibility; however, those who could benefit the most are often forced out due to unaffordability. This complex relationship between urban investment and impact on livability and affordability has long-been a concern amongst the urban planning community since the 1960s [35,43–45,92]. However, the specific role of accessibility is still an open question, as P25PM explains:

> *"Another factor that is complicated [...] is will this [...] investment accelerate displacement? If I'm in a low-income neighborhood in a community that doesn't have any sidewalks, I think it would be appropriate to make significant investments in sidewalks to improve accessibility. But if everyone that lived in that neighborhood rents and as soon as they put in sidewalks, their landlords are going to raise the rents because it's now a more desirable neighborhood. And the people [...] that I was trying to help now no longer live in that neighborhood because they had to move to another neighborhood without sidewalks because that's all they can afford, then ... we just think we've fixed the problem, but we haven't. Frankly, it's not often with sidewalks, but it's with bigger transportation investments like light rail or transit investments [...] or road improvements. But sidewalks certainly can fit in there, too." (P25PM)*

4.4.2 Prioritization Factors and Strategies. Building on these considerations, the three stakeholder groups prioritized geographic areas largely based on infrastructure utilization, population density, proximity to important destinations, citizen complaints, demographics, and comparing (in)accessibility levels between regions. As one policymaker summarized, "*[We consider] how many people are using the sidewalk; how high a priority is it? Maybe not just how many people but how many people with special needs are using the sidewalk? What are the destinations around it so that you can assess again from [a] prioritization standpoint*?" (P18PM).

Each approach had its own advantages and limitations and thus required using complementary methods together. For example, infrastructure utilization and population density, both aimed at maximizing impact by serving as many people as possible, can create inequities in serving communities in need if demographics are not considered:

> *"Someone may live in a residential area that typically would not fall high on the list if we were going to prioritize denser locations first. But if we know that there's someone living on that street who uses a wheelchair or has a mobility impairment, we have that separate list where they [citizens] can help generate and prioritize curb ramps to be repaired at those more residential locations that maybe we wouldn't get to as quickly." (P3DC)*

Similarly, citizen complaints (*e.g.,* 311 requests), commonly used as a low-cost decision support tool [89,123], alone would be insufficient as voices of certain communities may never be heard. Low participation may be caused by time constraints, commonly seen in low income communities where people work multiple jobs, or limited technology access [19]. P21D noted that these external circumstances need to be carefully weighed in while making data-driven decisions. P23PM suggested taking proactive measures such as actively seeking out historically underserved communities:

> *"We'll frequently hear from people, constituents actively coming to us more from those western half neighborhoods, and so whenever I hear from someone there, I try to intentionally say, 'Is there somewhere*

else in the ward where this issue might be happening where we may not necessarily hear from someone and actually seek that out?'" (P23PM)

Finally, comparing accessibility between regions was also useful in addressing inequities across areas. For example, policymakers compared conditions between neighborhoods, "*Trying to understand, relative to neighbors, 'Is this a well-served neighborhood by sidewalks or not?' Looking at that, a percentage or some sort of measurement that shows where these [neighborhoods] rank.*" (P25PM). Further, comparing with other cities also aided advocates in pushing for more accessibility efforts by demonstrating success stories to government officials: "*'Look what [City-name]'s doing. You should do more of that, because [...] when you give people a dedicated revenue stream, they can get stuff done.'*" (P11A).

4.5 Challenges in Accessible Infrastructure Development

Across the different stakeholders and their decision-making practices, we highlight socio-political and economic factors that impeded accessible infrastructure development.

4.5.1 Socio-Political Challenges. Social and political attitudes of city decision makers and the general public towards accessibility caused several tensions, including lack of support from city leadership, public disinterest, government inaction, conflicting priorities and responsibilities within and across organizations, and inconsistent regulations.

Lack of Support from City Leadership and Public. Though critical for urban accessibility, a common issue for maintenance projects was their inability to attract elected official or public attention *vs.* new development:

"You have to really make it a priority and keep making it a priority for a long time. And that's hard for our political system. We're not built for that. We're built for crisis. We're built for 'go do this one big thing.' [...] But that's not how it works. [...] I think as a country, specifically as a state, [we] have this obsession with not wanting to talk about the basics. We don't want to talk about maintenance. [...] We don't want to focus on those because they're not sexy. They're not interesting but they're crucial." (P11A)

Similar to prior work [64], obtaining support from city leadership becomes challenging without their vested interests:

"Only if a legislator had a particular interest would you then request to have a [transportation] committee hearing on the state. We often didn't, in part because when I was there, the chair was not particularly interested in pedestrian issues so that was not a real focus of the committee." (P18PM)

Similarly, public disinterest weakens advocacy efforts due to a lack of strong, persistent citizen voices: "*The challenge is that it's competing priorities and that pedestrian voices usually are low in number when people go to advocate for things because everybody wants to talk about the new bright, shiny thing.*" (P11A). Public disinterest can directly influence the interest of decision makers in accessibility issues. P17PM elaborated that anticipating the lack of public interest in an issue—"*will the public pay taxes for this issue?*" —could lead policymakers to reduce the issue's priority on their political agenda:

"At the end of the day, it becomes a political discussion of how much money do we think the citizens are willing to vote for... it's going to be nine council members and the mayor deciding, 'here's what we think the population will bear', and it becomes more of a political discussion and less of a policy one." (P17PM)

Lack of Government Action. In addition to disinterest, lack of proactive action hampered accessible infrastructure development. An advocate (P24A) explained that despite their efforts in presenting a case supported by evidence such as existing citizen complaints and making formal inquiries for an implementation plan, the city DOT only responded when the advocacy organization filed a lawsuit: "*We went to the [City-name] Department of Transportation, which has jurisdiction, and we identified all of these issues and sought a negotiation to create a plan that*

would be very specific and concrete, identifying the work to be done at every curb ramp and at every intersection that's missing curb ramps across the city. We provided our evidence. […] The city having refused to come to an agreement, we were forced to go to court. We won." (P24A). Even with sufficient evidence of inaccessible infrastructure, the communication with the DOT failed, further highlighting the need for change in social and political attitudes.

Conflicting Priorities and Responsibilities. Accountability towards resolving issues becomes challenging when conflicting priorities and responsibilities, and discoordination between agencies results in inaction. Often, for policymakers, making funding available becomes a negotiation between agencies. For example, getting transit agencies to invest in updating sidewalk infrastructure: "*In some areas, it meant asking them to invest in some pedestrian infrastructure that might be a block or so away from their [transit] stations. They would push back and say, 'that's your responsibility'. So, it becomes a negotiation.*" (P17PM). As a result, policymakers spend significant time in encouraging better coordination:

> *"We did spend a lot of time thinking about how best to inspire better coordination between transit agencies. For example, what happens if you were going between jurisdictional boundaries? [Anonymized-org-name] Transit to [Anonymized-org-name] Transit, somebody's trying to get to [City-name]. We spent a lot of time thinking about how to use some of these funds as a carrot to get transit agencies to do a better job of coordinating [...] particularly on the jurisdictional issues." (P18PM)*

In addition to within-city conflicts, state and city governments deflect fault and blame one another. For example, an advocate described a legal case of a sidewalk accident on a public bridge, wherein the state DOT was responsible for bridges and city DOT was for sidewalks:

> *"So underneath the sidewalk was the state's problem, and the sidewalk itself was the city's [problem]. Both of them had a problem inspecting. The state did find this problem, find that there was an unsafe drop off, about two years before Mr. [Anon-name] was injured, but they took no action. They should have contacted the city and they didn't. The city ultimately was responsible for fixing it."— P16A, a lawyer working on a lawsuit against the city for a sidewalk-related accident*

Inconsistent Regulations. Due to the decentralized nature of accessibility infrastructure updates, variance in accessibility guidelines across agencies slowed down or led to ineffective accessibility improvements. P11A described a project where "*[Anon-org-name] Transit decided they were going to put a light rail station fairly proximate to Lighthouse for the Blind*". Since the light rail location fell under the Federal Highway Administration (FHWA)'s jurisdiction, cross organizational differences in accessibility guidelines complicated the development process:

> *"All of the other [Anon-org-name] Transit stations fall under the Federal Railway Administration (FRA) guidelines. So, they have guidelines for the touch sensors for people who are both deaf and blind. But FHWA, which controls the rules for that particular station because of where it's located, they do not have that standard. So [Anon-org-name] Transit was going to design this station, which is four blocks away from the single biggest concentration of deaf blind people in the state with no tactile sensors whatsoever." (P11A)*

To resolve this situation, the advocates "*got them to agree to put in electrical conduit and a station marker where the sensors will be*" (P11A). Once the federal rule changes, taking about two years, accessibility features would be added. The result of these regulation differences led to an inaccessible environment for an extended period of time.

4.5.2 Economic Challenges. While the socio-political challenges were often a result of human interactions or lack thereof, there were severe economic constraints to accessible infrastructure projects. Funding for infrastructure improvements is a complex issue that involves public support, competing priorities from capital projects, and political constraints. Cities rely on various funding sources such as levies, property taxes, project specific funding, and grants from local transit agencies and government. However, due to lack of public support as seen earlier, it

can be challenging to levy taxes: "*They [public] understand the importance of doing it, but they also don't necessarily want to pay more taxes to pay for it.*" (P11A).

In general, sidewalks are severely underfunded, particularly for maintenance and repair. P3DC explained, for a total sidewalk replacement value of approximately $5.4 billion, and a 100-year replacement cycle, the ideal yearly required funding would be $54 million. However, current available funding is between $3 to $5 million—a deficit of ~$50 million/year. Most funding goes to capital projects or "*mega projects like the waterfront tunnel downtown*"(P11A). Due to state and federal mandates, capital projects funded with federal dollars lead to the development of peripheral accessible infrastructure. Sidewalk maintenance projects do not get enough funding unless the conditions are severe and need immediate repair. Additionally, P3DC commented on the transient nature of available funding and the challenges to sustain over time without public interest: "*[after] a levy that lasts for nine years, if the voters don't vote to renew that levy then that money potentially goes away as well*". Even though funding is a valid concern, advocates argued that "cost" as a defense for inaccessibility is harmful: "*Very often, people focus on the costs of remedying barriers, but failing to remedy barriers also has costs. […] It affects social isolation, employment, access to health care, and many other factors*" (P24A).

5 DISCUSSION

Our findings highlight how urban accessibility is not just about inaccessible physical infrastructure but also the underlying socio-political factors that influence its development. Building on prior work [40,41,64], we identified how specific socio-political tensions impede infrastructure development, including conflicting priorities, unclear burden of responsibility, lack of public interest and participation, and conflicting regulations. In this section, we discuss two underlying socio-political challenges: lack of accountability and lack of civic participation. We observe that both issues are a result of communication gaps between stakeholders, which requires us to understand the civic interactions more closely when multiple stakeholders are involved in a decision-making process. Thus, we introduce a civic interaction space that looks at interactions between stakeholders and explores opportunities for improving communication.

5.1 Exploring the Role of Civic Technologies in Urban Accessibility

Within CSCW and HCI literature [4,10], civic tech has been positioned as a platform for open collaborative government and community action, facilitating civic conversations and collaborative decision-making practices [20,34,86,124]. Establishing trust between stakeholders is at the core of a successful civic engagement model [46,55]. In our findings, *lack of accountability* and *civic participation* were two significant issues in accessible infrastructure development. Trust strongly interconnects both issues: increasing accountability leads to increased trust in the government, which further reinforces and encourages civic participation. Below, we elaborate on these two issues within urban accessibility and present open questions for the CSCW community working on civic tech.

Lack of accountability. Due to the decentralized nature of accessibility improvements, the seamless blend between private and public spaces in urban centers, and current governmental policies, individuals and agencies lack a clear understanding of *who* is responsible for accessible infrastructure. In US cities, DOTs manage street and sidewalk infrastructure on public land; however, commercial building entrances and indoor spaces are the purview of private businesses and sidewalks adjacent to residences are the property owner's responsibility [125–128]. These interdependencies, though core to urban life, create conflict and obscure accountability [87]. As P22D stated when describing tensions between a privately-owned transit agency and their governmental organization: "*[it's] city vs. private vs. federal". How can civic technology better surface these tensions and allow private citizens and governmental agencies to track and assess accessibility progress and, ultimately, increase accountability?*

Lack of Civic participation. Relatedly, the issue of perceived public disinterest by policymakers and department officials can impact infrastructure development. For example, without voter interest on transportation levies, policymakers have difficulty funding large transportation projects through taxes. Public disinterest is often the result of being unaware of inaccessible environments or lack of perceived personal impact. This suggests a need for *wider awareness* amongst communities about accessibility and the importance of civic participation. Current engagement practices of 311 service requests are largely volunteer based and often have inadequate representation of citizen voices. A successful approach to bring wide-scale policy change has been disability activism [14,50,62] such as the 1990 ADA civil rights legislation [17] and the 2019 block-the-box legislation in Washington[2] [129,130]. The success of such initiatives leads us to ask, *how can civic technology support new practices that strengthen the collective voice of the people to drive change*?

5.2 Civic Interaction Space: Enabling Civic Interactions in Urban Accessibility

Drawing on our findings and prior work on civic engagement practices (*e.g.*, voting, advocacy, and grassroots-level activism) [5,6,19,38,83], we introduce a *Civic Interaction Space* (Figure 4) that (a) highlights the points of interaction between stakeholders in urban accessibility and (b) visualizes the similarities and differences in communication (or, *interaction*) goals between them. The space includes interactions occurring directly through personal communication [5] and indirectly through civic participation apps/tools [23,26]. To simplify the space, we include MI/Caregivers within the larger 'Community' stakeholder group while acknowledging that some interactions do occur between communities, where policymakers or advocates act as mediators. Mapping the similar interaction goals across stakeholders reveal the

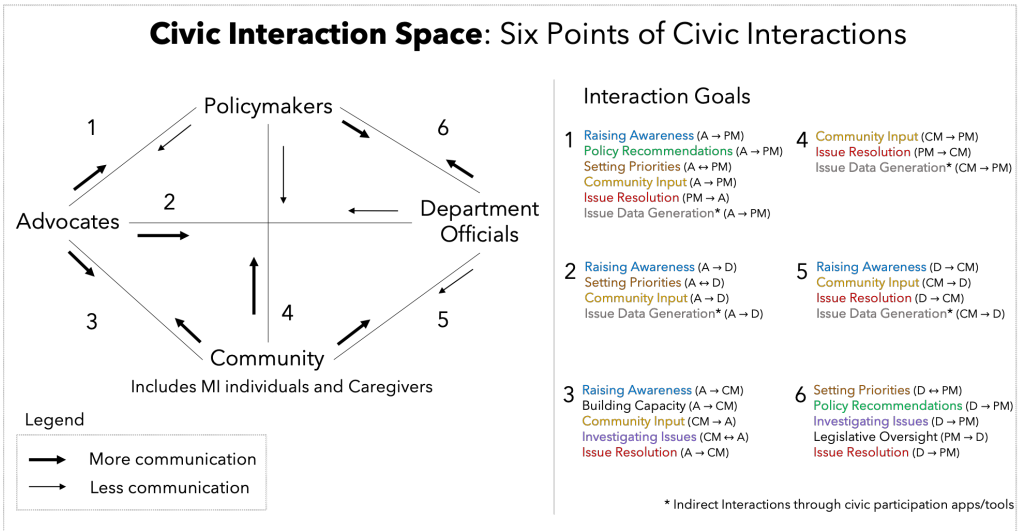

Figure 4. Civic Interaction Space. Illustrates the different civic interactions between the primary stakeholder groups and identifies six points of interactions. Groups are denoted by: CM=community includes, MI/caregivers and general public, A=advocates (and activists), D=department officials, and PM=policymakers. The perceived number of interactions between stakeholders is represented by the weight of the arrows. For example, high interactions between policymakers and department officials due to interdependent roles vs relatively less interactions between government officials and citizens.

[2] 'Don't block-the-box' legislation was passed via House Bill 1793, which permits Seattle to use camera enforcement to fine motorists from blocking crosswalks and bus lanes [130].

varying *contexts* within which they are accomplished—crucial for facilitating better support through civic tech. For example, 'raising awareness' by an advocate for a community (Figure 4: point 3) *vs.* a department official to a policymaker (Figure 4: point 6) would pose differences in message framing as well as environmental constraints wherein the interaction occurs (*e.g.*, rigid and risk-averse political structures *vs.* widely varying interests of the general public). Although applicable to any urban socio-political agenda with multiple stakeholders, we demonstrate the utility of this interaction space by taking urban accessibility as an example.

For urban infrastructure planning decisions, most interactions are between department officials and policymakers, with advocates providing community-specific solutions and policy recommendations to the local government and serving as intermediaries for communities-in-need. To reimagine participatory processes for a *collaborative* decision-making environment, we walk through two areas that need strengthening in urban accessibility–improving community input and supporting advocacy efforts.

Improving Community Input and Government Feedback. From Figure 4 (points 4 and 5), there is an asymmetry between the amount of communication from the community to government officials *vs.* the limited reciprocal government feedback. *How do we increase government response to close the feedback loop, to ensure sustained civic participation over time, and to establish a collaborative decision-making environment*? Currently, the interaction is heavily one-sided with community input such as sidewalk service requests being the primary communication medium for making citizens' voices heard [131] (Figure 4: points 1-5). This is primarily due to the prevalence of transactional service models in most cities, whereby local governments are the service providers [75,86]. However, *how* a government responds to the community input in terms of planning policies, decisions, and actions is not always communicated back–the key for developing a transparent democracy [32]. For example, knowing how a citizen request on fixing broken sidewalks in their neighborhood is being processed and turned into a decision such as whether their neighborhood receives a work order or not and why. Additionally, the transactional nature of service models do not allow iterative decision-making with the public, wherein they can contribute during intermediary decision-making [20]. With the emergence of digital civics [20,75,86], there are a growing number of participatory models that cities could use. For urban accessibility, feedback tools are needed to establish a stronger two-way interaction with the government, bring citizens "in the know" about their inputs' impact on planning decisions, and establish trust leading to sustained participation. Furthermore, new mechanisms for tracking progress based on citizen input and channels to communicate with the appropriate party are needed to improve accountability [12].

Supporting Advocacy Efforts. In contrast, lack of communication is not seen as the major concern with advocates. They are typically in a position of having a dialogue with the local government branches for setting city priorities and agenda through advisory boards (Figure 4: points 1 and 2). However, advocates are resource constrained with insufficient tool support. *How do we better facilitate advocates in their interactions with both the government and the community*? Similar to prior work [5,39], our findings showed that advocates often used *ad-hoc* approaches such as repurposing available data sources to investigate sidewalk issues. While these dynamic practices provide flexibility and agility to advocates, lack of appropriate tools lead to time-consuming laborious efforts to acquire relevant data. Prior CSCW work emphasized designing for such dynamic practices rather than "system designs that rely on stability and persistency" of work processes [5]. New easy-to-use tools are needed to support agile work practices while providing a framework to support organizing efforts. For example, building capacity and raising awareness often require advocates to build alliances amongst groups that have common interests such as pedestrian and bicyclists interest groups, both having a shared goal of making sidewalks better. Tools that support these needs by, for example, facilitating assemblage of relevant information pertaining to their shared interests would better support advocacy efforts.

5.3 Critical Reflection on the Role of Data and Technology for Change

We return to our overarching goal of examining the role of technologies to support change in the socio-political context of urban accessibility. Systemic change requires solutions within social, political, and economic contexts. The use of technology for change, although promising, comes with caveats—technology is not a panacea to socio-political problems; the sheer complexity requires multi-faceted solutions [1,56,82,132]. Despite its limitations, technology can play an important role in social change. Toyama [82] states that technology acts as an amplifier of underlying human practices. In our discussions above, we carefully proposed technical solutions that consider the underlying socio-political challenges and attempted to not overemphasize the impact of these interventions. Similarly, data also comes with its own biases and limitations. By supplementing quantitative with qualitative data, tools can aid stakeholders to make holistic assessments and decisions. However, would technology-mediated solutions impact the quality of civic interactions?

Prior work has shown that the use of technology for facilitating civic interactions is both useful and detrimental. While technology supports advocacy work in creating better infrastructure policies [6] and increases engagement with policymakers [133], the use of technology can also reduce the relational aspect of engagements valued by policymakers [19]. Along the same thread, HCI systems built for mediating civic interactions fail when underlying human relationships are strained [55]. This was seen in the failure of Harding *et al.*'s prototype engagement technology due to fears, vulnerabilities, and mistrust between stakeholders with the "*civic authority fearing litigation and the public anticipating disinterest and inaction from the authorities*" [55]. Although a department official spoke in support of litigations as an accountability measure, lawsuits put the onus on the disability community, prevent proactive measures, and give compliance with accessibility standards a negative overtone. New accountability measures such as feedback mechanisms discussed earlier to track impact of citizen input have the potential to affect change. However, system designers need to first establish trust relationships between stakeholders for such technological interventions to be successful [55]. Finally, consistent with prior work [42], we found equity and inclusion issues may arise with tech-based civic participation (*e.g.*, apps/tools) and can promote systemic exclusion: "*those who have access to tech and identify as technologically adept end up having more power in a movement over those who have less or limited access*" [42]. This brings us to ask, how do we handle power disbalance inherent with these technologies? How do we avoid such inequalities in access while developing tech-mediated solutions? We leave these open questions for future research.

5.4 Limitations

First, the studies were conducted in few large metropolitan US cities with established civic engagement and infrastructure assessment practices. Our findings may only be specific to those local governments and may not generalize to rural areas or international contexts. Future work should study urban accessibility issues across regions, cultures, and political structures, as we have begun to do in our recent preliminary work [37]. Second, we had a limited number of participants and diversity within each stakeholder group (*e.g.*, out of four policymakers, two were elected officials). Though interviewing more elected officials would have been useful, we found similar challenges in civic engagement practices as prior work [19]. Further, the proposed civic interaction space should include other tertiary stakeholders such as transit agencies who address accessibility needs. Finally, our study interviews were primarily with people with lower body impairments. Future work should include more perspectives from people across a broader set of sensory, physical, and cognitive abilities.

6 CONCLUSION

In this work, we investigated urban accessibility as a socio-political problem by studying the various assessment, decision-making, and citizen engagement practices. Using multi-stakeholder analysis, this work presents an expansive view of methods and challenges in making accessibility improvements. We tease apart each stakeholder's roles and interactions within the urban decision-making structure for accessible infrastructure development. Our study found several socio-political tensions impeding infrastructure development, including conflicting interests, unclear burden of responsibility, public disinterest, and limited funding. To facilitate accessibility efforts in this socio-political context, we identified six points of civic interactions and proposed directions for future technologies to utilize complementary data- and citizen-driven approaches, while acknowledging that technology is a facilitator rather a solution to socio-political problems.

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