Transcending Transit Deserts: Participatory Design of Interactive Bicycling Advocacy Tools in an American City

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Recent HCI research has focused on developing interactive technologies for cyclists and using technology to promote this activity. However, the community-building and advocacy aspects of cycling remain relatively unexplored. In this study, we explored the integration of urban cycling and participatory technology design to address transportation inequities and promote cycling advocacy in a US city characterized by infrastructural and social disparities. We engaged with nine bicycling advocates from five organizations in Baltimore, USA in participatory design activities to understand their motivations for promoting cycling in urban areas and how interactive technology can aid in creating a cyclist-friendly city. Along with the various practical motivations, we found the participants also promote cycling with a desire to challenge historical discriminatory practices and infrastructural inequalities and as a means of community building and identity expression. We identify three interconnected directions for future change: supporting ancillary bicycle infrastructure and DIY repair practices, changing perceptions through community engagement, and using technology to support community awareness and inclusion. We argue cycling can be a tool for resistance and identity shaping in this context, and participatory design can offer innovative directions for urban designers, policymakers, and system designers to strengthen efforts toward creating inclusive and equitable urban environments.

CCS Concepts: • **Human-centered computing → Empirical studies in HCI**.

Additional Key Words and Phrases: Participatory Design, bicycling advocacy, urban design

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1 Introduction

Cycling in urban environments is being increasingly explored by Human-Computer Interaction (HCI) researchers, not only as a site of interactive technology innovation, but also due to its potential as sustainable and equitable transportation [19, 36]. While the majority of HCI research has explored the use of interactive technology for cyclist safety [8, 22–25, 30, 40], communication among cyclists in different settings [12, 38], and promoting sustainable transportation habits [13], the role of community building and advocacy through cycling is still understudied. Specifically, it is unclear how interactive technology can support the activities of cyclist activists who use this activity as a tool for community building and changing attitudes in urban context. In this study, we explore the motivations, challenges, and opportunities for urban cycling, and the role of interactive technology in supporting cycling advocacy in a mid-sized city in the Eastern united States. By

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examining the perspectives of local cycling community organizations and cycling advocates, we intend to contribute to the intersection of HCI, participatory urban design, and digital advocacy.

The city in focus, Baltimore, has a long history of infrastructural and social disparities, including systematic racism and divestment from public projects, leading to unequal access to many resources and services, including robust cycling infrastructure[6]. We find this context a rich ground for understanding the practical motivations for urban cycling advocacy, the role of cycling as a form of activism and identity expression, and the potential for technology to foster community building and resistance against a car-centric culture.

In this study, we worked with urban bicycling activists to investigate the following research questions:

(1) What are the practical and social motivations of urban bicycling activists for enabling, promoting, and supporting cycling in urban US contexts?

(2) What are the visions of urban bicyclist activists for the future of urban cycling advocacy and how can interactive technology support them?

Through remote interviews and participatory design sessions, we worked with 9 cycling advocates from local cycling community organizations. The participants provided insights into their motivations, experiences, challenges, and aspirations related to urban cycling, which form the basis of the findings presented in this paper. In addition to clarifying the roles that bicycling advocacy can play in urban engagement and renewal, our findings point to ideas about how interactive technology, and social networks, specifically, can support and amplify advocacy efforts in this space. We make three contributions to HCI literature at the intersection of interactive technology design for cycling, digital advocacy, and participatory urban design. First, we present the practical and aspirational motivations for urban cycling advocacy in the context of infrastructural and social disparity. Second, we demonstrate how in an urban context, cycling can become a tool for community building, identity expression, and resistance. Third, we present an analysis of participants' future visions to identify three design directions for a better future.

The remainder of this paper is organized as follows: In Section 2, we review the existing HCI literature on urban cycling, interactive technology, and community advocacy. In Section 3, we detail the methods employed in the study, including participant information, and data collection and analysis methods. In Section 4, we present the findings of the study, including practical motivations for urban cycling, cyclist identity in a car-centric infrastructure, the use of interactive technology in urban cycling advocacy, the envisioned future of urban cycling, and the resulting design directions. Finally, in Section 5, we discuss the implications of the findings and their contribution to the existing body of research.

2 Related Work

Previous HCI research that intersects with bicycling can be categorized into efforts for amplifying opportunities for transportation advocacy and community building using interactive technologies, and those to improve the cycling experiences of bicyclists by creating interactive systems for them. In the following subsections we will review this previous research.

2.1 Bicycling Advocacy as a site of Participatory Urban Design

HCI researchers have previously considered bicycling advocacy as a potential site for their works on digital civics, more particularly, digital advocacy, and participatory urban design. For example, Asad and Le Dantec's design-based fieldwork with bicycle advocates and transportation planners of two US cities, Atlanta and Pittsburgh, revealed mobile technologies can support cycling advocacy by making cycling communities more visible as political actors, improving safety through accountable feedback loops, and empowering the community by facilitating communication [1]. Their

findings suggest that when creating tools for social or political change, designers must consider the complexities of resources, identities, and issues entangled with cycling advocacy. They highlight the importance of recognizing individuals' different roles, such as urban planners, community members, and cyclists, each with unique perspectives on cycling infrastructure and policies, keeping in mind the conflicts that may arise among these roles, as individuals balance professional responsibilities with personal cycling experiences and advocacy goals. They argue, to support advocacy work, digital artifacts should be built keeping in mind these multiple identities that support advocacy, and should accommodate the various attachments individuals have to an issue. These attachments are not only to the act of cycling itself but also to broader urban issues such as transit access, gentrification, and social equity. For example, advocating for a bike lane benefits an individual not only as a cyclist but also as a driver, since separate facilities can improve car traffic flow, and as a citizen, because multi-modal transportation infrastructure is key to transit resilience. So, design efforts should support these multiple, interconnected civic concerns. For example, design of digital tools may consider how data on cycling routes can serve both cyclists and accessibility advocates

In another study in the UK, Maskell et al. developed and deployed a system named Spokespeople, which allowed cyclists to record, curate, and share data about their cycling experiences and journeys and analyzed how such data can be actively utilized to advocate for safer and improved cycling infrastructure engaging with cycling advocates, participants, and transport planners of Newcastle, UK [21]. They emphasized on how engaged citizens can contribute beyond data collection and go on to use data to create meaningful changes. Their system enabled cyclists to collect detailed experiential and journey data which they term as "annotated routes" which provide affordances for data curation, storytelling, and analysis. Their analysis also identified the role of technology to support the prioritization process by enabling filtering and crowd-sourcing features to assess the relative importance of issues, and community commissioning where citizens could set micro-tasks for the community through technology.

Literature from urban studies and planning also underscores the importance of participatory approaches towards urban design. For example, Ferster et al. explored the role of social media in understanding public discourse and engagement with new bicycle infrastructure projects in Canadian cities, suggesting that platforms like Twitter can capture diverse voices often missing from traditional planning processes [11]. This aligns with participatory urban design principles by incorporating public opinion into urban development. Hagen et al. presented a qualitative methodology for assessing bikeability, highlighting the importance of a holistic approach that considers various scales of the built environment to promote cycling through urban planning [14]. Simon Batterbury explored the role of grassroots environmental activism in promoting sustainable transportation in West London [2]. They argued that sustainable development in urban environments requires cooperation between citizen groups and local authorities, emphasizing a shift from radical opposition to strategic partnerships for effective policy influence.

Similar to other recent works on grassroots and DIY approaches to interrogating and navigating infrastructural inequities (e.g., [15, 26, 33]), these works show the potential of exploring cycling advocacy to better support HCI's broader goal of building community capacity and enabling communities to self-organize and drive change through the strategic use of technology. In this paper, by employing participatory approaches, we explore how interactive technology can further enhance the effectiveness of cycling advocacy.

2.2 Interactive Technology Design with and for Bicyclists

In addition to supporting advocacy described above, the development of interactive technology to enhance bicyclists' experiences has garnered significant attention from HCI researchers. Explored areas include addressing safety concerns for using mobile devices while cycling [8, 22–25, 30, 40],

creating tracking and monitoring apps and studying their impact on supporting healthy lifestyles [31, 35], supporting data collection while bicycling [38], and investigating associated related privacy concerns [27]. Research has also looked into implementing AR technologies for cyclists [18], and studying the experience of group cycling [12].

The majority of this previous research has focused on developing and studying interactive interfaces for cyclists. For example, Porcheron et al. ethnomethodologically studied the cyclist behavior of using technologies while cycling [32]. They showed how cyclists select moments of opportunity to use technology for different purposes. To address the safety concerns posed by mobile device use while cycling, HCI researchers have explored a range of innovative interface solutions. In one study, Dancu et al. presented Gesture Bike which enables cyclists to control turn indicators through hand gestures [8]. Similarly, Pielot et al. designed Tacticycle which utilizes vibrating handlebars to provide directional cues to cyclists [30]. In another study, Woźniak et al. introduced custom handlebar controllers to facilitate interaction with smartphone features, prioritizing safety by minimizing visual distractions [40]. A group of researchers also concentrated on improving child cyclist safety by exploring various unimodal [24] and multimodal [22] interfaces, including tactile [22], gesture-based [25], audio [24], and projection-based [23] approaches, to enable safer interaction while cycling. Focusing on augmented reality (AR) technologies designed for cyclists, Kosch et al. assessed the performance of different notification interaction modalities used while using AR when cycling and suggested boundaries for more comfortable and easier interaction with notifications in AR [18].

Alongside interface design innovations, the rise of tracking and monitoring apps has offered new opportunities for cyclists [31, 35]. These apps cater to both performance-oriented athletes and casual riders, providing essential metrics such as speed, time, and distance [31]. Furthermore, there is growing interest in leveraging tracking data to enhance cyclist safety, with potential applications including the dissemination of real-time hazard information to cyclists. This proactive approach could help prevent accidents by alerting cyclists to potential dangers ahead [38]. While most of these studies focused on individual riders, Franz and Reilly studied road cyclists while riding in group training sessions and identified there is a lack of technological support for group-wise coordination tasks such as managing effort and consistent pacing [12].

As more data is collected during cycling, it is important to also study their privacy implications. For example, Mink et al. explored the privacy concerns of fitness tracking users about using the respective application's privacy zone feature and found that users' privacy-sensitive locations are at risk even when using a privacy zone [27].

In this study we explored both the use and role of interactive technology among cycling advocates and the envisioned future of the use and deployment of interactive technology to benefit cycling and better urban landscape.

3 Methods

In this study, we worked with five local community organizations during two phases, consisting of remote interviews and co-design sessions. In this section, we describe our participants and data collection and analysis methods.

3.1 Participants

We initially contacted six organizations that are active in our city and whose activities focus on cycling community events, bicycle sharing programs, and events to raise awareness about cycling practices and cyclist rights. We found these organizations through a combination of social media searches, word of mouth, and flyers distributed at cycling events. Of these organizations, five agreed to participate in the first phase of our study (interviews), and two continued to the second

Table 1. Participant Information

Number	Gender	Age	Race	Organization	Research Activity Participation
P1	Male	40s	African American	Organization 1	interview and co-design workshop, 3
P2	Female	30s	African American	Organization 1	interview and co-design workshop, 3
P3	Male	40s	African American	Organization 2	interview
P4	Male	30s	White American	Organization 3	interview and co-design workshop, 1 and 2
P5	Female	20s	Asian American	Organization 3	interview and co-design workshop, 1 and 2
P6	Male	30s	White American	Organization 4	interview
P7	Male	40s	African	Organization 3	interview and co-design workshop, 1 and 2
P8	Male	20s	Asian American	Organization 5	interview
P9	Female	NA	White American	Organization 3	co-design workshop, 1 and 2

phase of study (co-design). Overall, nine cycling community organizers and activists from five local organizations participated in the study. Every participant received 25 USD (United States Dollar) for their time and efforts. Table 1 shows demographic information about the participants.

3.2 Data Collection and Analysis

We obtained Institutional Review Board (IRB) approval for our study prior to collecting any data. All study activities took place during the COVID-19 pandemic (Spring and Summer 2020) when social distancing measures were in effect. Therefore, we collected all data remotely.

For phase one of the study, we conducted individual remote semi-structured interviews using Zoom or Google Meet with individual participants, each lasting between 48 and 78 minutes. We asked participants about the work of their organizations, their perspectives on bicycling in general and specifically within our city, and possible future directions for interactive technologies to support bicycling in the city. Sample questions included, "What is your role in the organization and how did you get involved?", "What are some of the activities of your group?", and "Are you familiar with digital and electronic technologies like smartphones, social networks, wearables, and assistive technology for bicycles?" The second author transcribed and thematically [4] analyzed each of the interviews using an inductive approach. She discussed codes and themes with the last author, who provided feedback on the analysis and helped interpret the data and resolve ambiguities. The first and last author then discussed all refined findings and wrote them for this presentation.

For phase two of the study, we conducted three remote participatory design sessions. The first two sessions were with representatives from Organization 3 and each lasted approximately 60 minutes. The third session was with representatives from Organization 1 and lasted 120 minutes (since participants preferred a single longer session than two shorter ones). We organized the sessions similar to the Future Workshop format [37], where we first asked participants to criticize the current situation of bicycling in the city, then invited them to dream about a preferable future situation, and finally to brainstorm ways to transform the current situation to a preferable one. The first stage instigated infrastructural and social challenges related to cycling and urban mobility in the city. The second stage produced seven imagination spaces in the form of collaborative slides. The third stage produced a set of directions for solutions to help us achieve a favorable future.

In each session, we asked participants to annotate a Google Jamboard, using text, drawings, or images downloaded from the web that represents their ideas. Figure 1 shows an example annotated Google Jamboard created during one of the sessions. To stimulate discussion, we used prompts

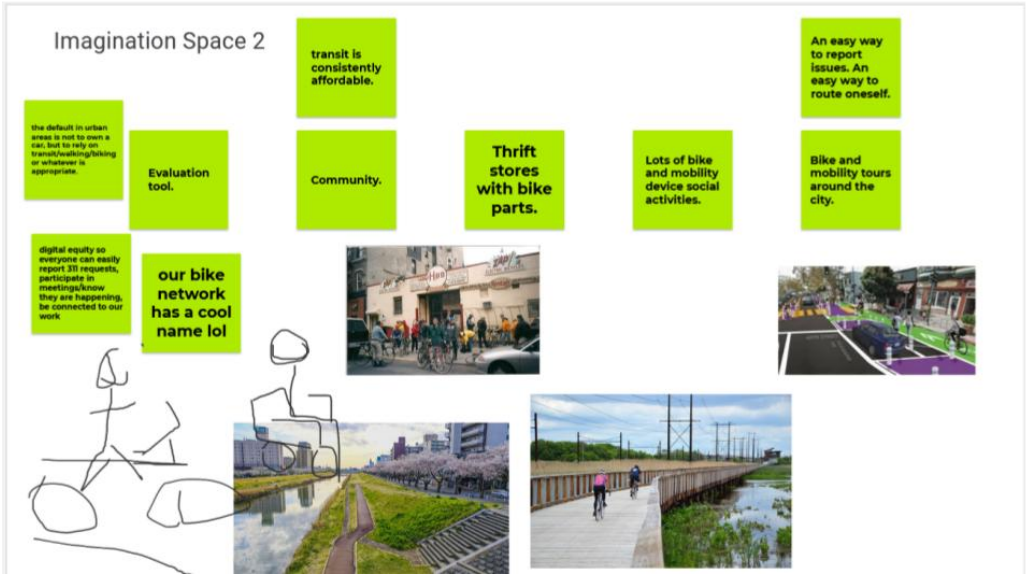

Fig. 1. A slide collaboratively produced by participants using Google Jamboard. It contains ten digital sticky notes which participants wrote and placed on the slide, and four photos of different cities, street layouts, and street activities, selected by participants by internet image searches and added to the slide.

designed to inform the future creation of physical and virtual spaces conducive to the safe and sustainable use of bicycles in the city. For example, participants were encouraged to engage in a creative exercise called the "Imagination Stage," where they were asked to fantasize about a utopian or ideal situation for bicycling in Baltimore. The prompt was open-ended, allowing participants to think beyond the constraints of reality, even suggesting that "magical things" were acceptable. This stage was designed to generate a wide range of ideas without worrying about their feasibility. For this phase, we transcribed the discussion and thematically analyzed the data, using a combined deductive and inductive approach where we used findings from phase one to guide the initial analysis of the data and build additional interpretations given the content of the annotated Google Jamboard.

4 Findings

Our findings show that participants have both practical motivations for urban cycling as a sustainable mode of transport, as well as seeing urban cycling as a form of activism and identity expression. Furthermore, participants shared visions and desires for potential future interactive technology applications to support urban cycling activism. In the following subsections, we described each of these findings in more detail.

4.1 Practical Motivations for Urban Cycling

Participants described several practical motivations for cycling. These include using cycling as an alternative to inadequate public transport, forming cycling groups and organizing rides to advocate for robust and equitable infrastructure in the city, cycling as an activity to prompt health and fitness, and cycling as a community building and strengthening tool.

Fig. 2. Images from a group bicycling event in Baltimore which is held once in a month. In some months, the event can be themed. Group bicycling event participants gathered in a local park before starting the ride (Right). Bicycle riders participating in a LGBTQ+-themed ride wearing rainbow flags.

4.1.1 Complementing Inadequate Public Transportation. All our participants, described the existing public transportation infrastructure in the city as inadequate, inconsistent, or dysfunctional in many cases. They found cycling as an alternative option to get around in the city, and describe this practical reason as a major motivating factor. Additionally, they found cycling as an affordable alternative to owning or driving a car or using taxis or ride-sharing services. For example, P2 talked about the inadequacy in transportation services as comparable to "food deserts":

> "We talk about food deserts, there's also transportation deserts. A bike eliminates that instantly. A bike eliminates the transportation desert. ... It doesn't matter where you are. You have a bike, you're instantly able to be mobile."

A food desert refers to low-resource urban areas where residents have limited access to affordable and healthy food [7]. A transportation or transit desert similarly refers to an area with limited affordable public transit options [17]. According to this participant, in the absence of adequate public transportation, bicycles work as a viable option to move around in the city.

Participants also recognized that bicycling is not the solution to the public transportation problem and cannot replace it. According to P6,

> "Not everybody is physically able to ride a bicycle, so they are not for everybody. I don't think it's a save all, for Baltimore. It's like, we don't have a red line and we're not going to build it, and we don't have good bus transportation, and we have too many cars on the street. The answer to all that is just more bicycles. I don't think that's true. ... It's like, we need more bicycle infrastructure and more promotion of bike riding in the city. But we also need buses and light rail, and better public transportation. It's never the answer to everything, it's just another tool."

Here, P6 recognized that, bicycles are one part of the solution and that by virtue of requiring a high degree of fitness and cost, riding bicycles is not accessible to everyone. However, for many, it can provide an alternative mode of transportation in the absence of more robust infrastructure. This issue is amplified in US cities that have a legacy of car-centric infrastructure, making it harder

for cycling support to be added to existing urban spaces. Thus, the motivation of using bicycles practically for transportation mostly comes from the inadequate public transportation and the affordability of cycling compared to driving cars.

Participants also discussed opportunities for using bicycles as part of a multi-modal transportation scheme that combines them with public transit options. For example, someone might use a bicycle to get to a bus or train, and then use the bicycle again after the ride to get to their final destination. Participants mentioned that supporting such solutions requires collaboration and support, for example, by providing safe storage for bicycles at bus and train stations and enabling commuters to bring their bicycles on buses or trains.

4.1.2 Advocating for Robust and Equitable Cycling Infrastructure. Unanimously, participants informed us about the lack of robust and consistent cycling infrastructure in the city. They also informed us about the inequity that exists in different parts of the city in terms of existing cycling infrastructure. Participants expressed concerns about inadequate and unprotected bicycle lanes, and poorly maintained lanes in the city. We found that advocating for better infrastructure is a strong motivation for our participants and a desired outcome of the group bike rides they organize. The biking groups and communities often organize group rides to raise awareness about the need for better infrastructure in the city.

With respect to infrastructure inequity, participants described how the state of bicycle lanes in the city is inconsistent and often correlates with other patterns of housing and services inequities that have historically haunted the city. Specifically, low-resource neighborhood with majority African-American and Latinx populations have poor and risky conditions for cycling, while affluent majority White neighborhood have robust and well-maintained cycling infrastructure. For example, P1 said,

> "We all know about redlining and that type of thing. In the better, more affluent neighborhoods ... you'll see separated bike leans where the bikes can go as far as they want to go within that neighborhood ... But you may go over to the West side [a low-resource area of the city] ... there's no bike lanes to speak of. But there are a lot of cyclists there. But they don't have safe options. So, they kind of have to risk, 'Okay, let me ride in the middle of the street or on the side of the street with these cars and risk my life riding because I have to go to work.' ... one of our goals and what we're super passionate about is trying to get those areas to also get those bike lanes, like some of the more affluent areas"

Here, by "Red Lining" P1 is referring to the discriminatory practices that consists of systematic denial of different financial services to residents of certain areas, based on their race or ethnicity [34, 39].

P3 also talked about this issue of infrastructural inequality and articulated this factor as there is two cities within Baltimore. In P3's words,

> "There's definitely two cities in Baltimore. There's people who want to live in the [affluent part of the] city, believe in city living, [and] that it's their city. And then there is the other side of the city that doesn't get all of the beautiful buildings, and all of the money [that] gets dumped into [an affluent touristic area]. They're the people who get forgotten."

P5 described about how the car-centric infrastructure is rooted in historical discriminatory practices,

> "A lot of the land use and housing patterns that were created to endorse the automobile are rooted in white supremacy, explicitly exclusionary zoning policies. All the stuff that,

> structurally, through land use patterns, affects all of America racially was invented in Baltimore."

She also mentioned that, if there is safe cycling infrastructure, people would use it. In her words,

> "If you look at the data on people who bike, you've got the majority of people, 80% of Americans [who] are interested but concerned [about safety]."

These reflections aligns with findings from previous studies [20, 28], which shows historical legacies of racist planning and socially unjust investment continue to impact mobility experiences.

4.1.3 Cycling to Promote Health and Fitness. Participants discussed both the physical and mental health benefits of cycling as motivations for promoting this activity in their communities. For example, P3 emphasized cycling's physical health and fitness benefits, and mentioned how it can help with chronic physical health conditions, such as diabetes and heart disease. P3 further shared dreams for building cycling-focused fitness centers in the city to increase the public's access to these benefits. In describing the phisical and mental heath benefit of cycling, P3 said,

> "I definitely feel like biking is an exercise that benefits your cardiovascular system. The recommended exercise is 30 minutes a day, and for some people, they're just going out and biking 30 minutes to an hour daily. What that does is it helps with their heart, it helps with their mental well-being. It's almost like if you've ever been a runner—you get that 'runner's high.' I know you get that same effect on the bike. You reach a point where you're almost floating in your own little world, your thoughts gathering as you ride, with the wind blowing past you, and sometimes it feels like it's just you out there. It's very soothing; it's great for your mental and physical health. I like to say it's a workout that doesn't require a lot of equipment or a gym membership. There's a low-cost entry into biking."

Participants emphasized the mental health benefits of cycling. P1 spoke of getting into cycling as a way to deal with psychological stresses. P2 went further and used the word 'freedom' to repeatedly describe the "feeling" of cycling. In his words,

> "I think the value of a bicycle is freedom, which I know sounds cliche."

Participants also used words like "empowerment", "inclusivity" and "fulfilling energy" to describe group rides. In P3's words,

> "It just brings more of a fulfilling energy to what my experience and my day is going to be versus being cut off from what's around me."

When describing how cycling made him feel, P7 described having control over his health and enjoying the spontaneity involved in this activity,

> "I feel more in control of my health, [when selecting] the route or the course that I may take and just your overall experience. I feel more in control of that versus it controlling me. I have a chance to set the pace for my day even if it's just a 10 minute ride. I'm in control of... Or not, sometimes not being in control can also be rewarding because I don't know who I'm going to meet or see along the way. So that spontaneity is something that I really appreciate."

P6 also emphasized the joy associated with cycling as itself healthy in the midst of stressful city life,

> "Fun, joy and exercise are good for everybody. Baltimore is a stressful city, and a lot of the youth that I work with come from stressful backgrounds, with a lot of pressure and a lot of challenges. I think just allowing young people to be kids and have fun is really healthy. "

4.1.4 Community Relationship Building. Our participants also mentioned cycling as a tool for community building and strengthening social relationships. This aspect involved both promoting connecting to urban communities within the cycling community and also promoting cycling in specific communities in the city (e.g., in particular neighborhoods or areas). For example, P5 described cycling as,

> "...one of the easiest conversation pieces to get people started on. Once you get on a bike, you instantly start to see the sense of community around you of fellow people biking. You start to see how your life can change in accessing these different things. And there's maybe a lower bar to jump over than becoming reliant on an unreliable public transit system in the city ... or trying to walk places if your personal security might be at risk, or something like that."

P6 also talked about how he saw bicycling as a way to engage youth,

> "I discovered the bicycle as sort of an expressive tool but also a community building tool. I started doing youth bicycle projects, focused around mechanics and helping youth learn how to repair their bikes."

These quotes shows that while participants value cycling as an in of itself, they are keenly aware of its capacity to work to open up new conversations and possibilities for engagement.

4.2 Cycling as Activism and Identity Expression

4.2.1 Cycling While Black. Three African-American participants who took part in our study (P1, P2, P3) discussed their first-hand experience of being Black bicycle riders in a high crime American city. For example, P3 mentioned the stereotypical treatment of black people in the city.

> "In the city, a lot of times as African Americans and as young African Americans, we get painted with a broad brush that we're all about violence, selling drugs. We are looked at as the people who commit the crimes just based on being profiled."

He further mentioned incidents where he had seen people complaining on neighborhood forums about their cycling group riding through a particular neighborhood.

> "We get the messages from the message boards [for two predominantly White neighborhoods]: 'Why are these people riding through our community? Why do they have to come this way? We don't want them here,' stuff like that."

P3 even discussed a terrible incident of someone from outside of the city intentionally running his truck into members of his group during a ride, even dragging one person. Miraculously, no one was seriously injured. At the time of the interview, the attacker had been indicted, and the case was waiting to go to trial.

In contrast, P2 talked about how White people in the city treat him differently when he is cycling compared to when he is walking. He described how it is more likely for him to receive smiles, waves, or nods from strangers in the street while riding his bicycle. He said the difference in treatment is very noticeable, further elaborating:

> "When I'm on my bike and I run into non-Black people ... it's totally different than when I'm not on my bike [as opposed to walking] ... I'll get waves and smiles."

P3 specifically mentioned that one of his motivations for organizing rides is to challenge racial stereotypes. He said that the commonly broadcast societal message that large groups of black people cannot get along, the "black-on-black" violence narrative for example, and mentioned the benefit of people in black neighborhoods seeing large groups of black people doing something enjoyable together without conflict.

These instances indicate how that the experience of bicycling in the urban context of the study is shaped by racial identities.

4.2.2 Experiencing the City Differently. Understanding urban spaces through the lens of cycling was another key motivation for participants. P1 and P2 emphasized the exploratory nature of leisure cycling, discovering parts of the city that might remain hidden when using other transportation methods. For example, P1's said,

> "There's so many places that you can go on a bike that you would never go in a car. There's some places that I ride maybe even just five or ten miles outside of the city that I didn't even know existed. There's parts of the city that most people who've lived here all their lives don't know about, and I've been able to experience them through cycling, but I would never drive there, because there would be no purpose. But just being on a bike and just getting out, I get to explore."

P2's experience of exploring Korea on a bicycle illustrated the unique perspective cycling offers. In her words,

> "I was stationed in Korea. And in Korea, I borrowed somebody's bike. And because I was able to leave the base and go ride into the villages, and just keep going out to ... Again, this is before I was a biker. ... I was able to ride and traverse the countryside, and to travel, and to just get away from my area and see things, and meet people, and get to see firsthand how real Koreans lives. Not in the city. I'm out, I'm five miles away from base in rice paddies and kimchi fields. ... And this is somewhere I could not have walked to, and would not have walked to. ... But because I was on a bike, I was able to experience a part of life that I never would have experienced."

P3 mentioned that he discovered "different places and restaurants and things in the city" he "never knew were there" through cycling and in his views, he never would have "run into" those places without being on bike. P5 talked about her observations of the city architectures, new coffee shops through cycling. In her words,

> "The intricacies of architecture on a building, the coffee shop that just opened that you might have missed before, the new mural that went up, the tree that's dying and needs water. All of those things you notice."

4.2.3 Cyclist Identity in a Car-centric Infrastructure. Participants described how participating in cycling and group rides can form an identity, and sometimes work as a tool to change the dominant narrative of what it means to be a cyclist. For example, P1 described how their group works to build a community that works towards making everyone feel welcome to be cyclists and removing stereotypes of what is needed, in terms of gear and material possessions, to be be a cyclist.

> "Our main goal, first and foremost, was to build community, to build a community of cyclists that look like us and for them to not have to feel as if they have to have this perfect kit, they have to have the shoes, they have to have the helmet, they have to have this, they have to have that. All they have to have is a bike. Of course we want them to have a helmet to be safe, and we want them to have a properly working bike, but we don't want them to feel as if they have to be in a certain class or have the right type of thing to be able to cycle."

At another instance, P8, talked about how in a car-centric culture, people who use bicycles or public transportation are marginalized and perceived as poor or disadvantaged. He talked about how participating in these group cycling activities can help participants to change their own internal beliefs, too. He said,

> "I mean, everyone rode a bike as a kid, but I never really considered it a form of transportation until I got involved with [name of their biking group] and that sort of thing. I'm originally from California and unless you're in a major city, car is the only way to get around. The only reason to take the bus is if you have a DUI [a restriction on driving due to being caught driving under the influence of alcohol or drugs] or something, and the only reason to own a bike is you just have no other option."

These findings show that cycling has developed into an important aspect of identity for our participants, which also helped them to reconsider dominant narratives on using bicycles for transportation or recreation.

4.3 Use of Interactive Technology in Urban Cycling Advocacy

When asked about current technology use, participants overwhelmingly talked about how the use of social networks, especially Facebook, helps them with connecting with other people with similar interests and to help organize groups rides, share information, and also engage in advocacy.

For example, P3 highlighted the important role of social media for organizing activities.

> "We use social media to connect for all of our rides. We never have to make any paper flyers or anything like that. Everything we do is just posting in the group, creating invites, posting on social media, people share it, people tag people."

In the above quote, we can see that the use of social media helps cyclists to share information about and coordinate their rides easily and efficiently. P3 also added,

> "It's just a beautiful thing when you look at the way social media has allowed us to connect with all groups... They're updating me on different things that have already been going on in the bike community that I didn't know about."

P1 also talked about using Facebook and Instagram to post information and coordinate rides. Additionally, P1 mentioned the ride-tracking application "Strava" which helps them to create a sense of community and competition among cyclists by tracking, sharing, and comparing ride information. The emphasis on 'showing off' achievements through social media serves not only as a means of personal expression but also as a way to attract and connect with like-minded individuals.

> "Strava is a platform that cyclists use to 'show off,' in the sense of I rode 25 miles today ... or, ...'Let me join this challenge.... We have a group within Strava, and a lot of people, thousands of people across the US and in other countries have found us through that. So we've used that as a way to let people know we're here."

In another instance, P5 discussed the importance of social media in their work of organizing, advocacy, and action. In her words,

> "There are great organizing opportunities through social media, for just organizing recreational or fun rides, but also maybe organizing people into advocacy and action.... we have the [anonymized organization's] unofficial forum, which is like a big Facebook group where people communicate about bike stuff. And we have our Facebook page, and Twitter, and Instagram ... where people [can] communicate with us."

Further, she mentioned people in Baltimore use Facebook heavily to build and maintain bicyclist enthusiast communities, a process that help community growth organically, since the social network is already widely used:

> "Social network-wise, I think Baltimore is a big Facebook city, like most cities aren't. People don't organize on Facebook anywhere else I know. But during the pandemic, [names three local Facebook groups] ... and no relation to our advocacy group. These

> are Facebook groups that have sort of organically grown and exploded as social groups around riding regularly in the city, with thousands and thousands of members."

These finding show the significant role of interactive technologies and, especially social networks, in enabling coordination, communication and organizing among cyclists.

4.4 Future Visions for Urban Cycling

During the participatory design sessions participants shared desired futures for the city, and articulated three interconnected directions that can potentially help us reach there. We will discuss these in detail next.

4.4.1 Envisioning Imaginary Spaces. During the participatory design workshops, participants collaboratively produced seven slides in Jamboard, which included texts, images, drawings, and annotations to express their vision for the city, which we call "imagination spaces."

When discussing and analyzing the Jamboards, we found infrastructural enhancements as a central theme of the participants' imagination spaces. For example, in Figure 3, they expressed a collective desire for more secure places to lock and store bikes and a comprehensive network of protected bike paths throughout the city. The vision extended to the creation of beautiful car-free and bike-friendly boardwalks cutting through nature. On the front of safe and inclusive streets, participants expressed a yearning for environments where children could play without fear of car crashes, a wish for culturally diverse and car-free street markets, and aspirations for consistently affordable and accessible transit options. Participants expressed these vision in words and phrases in the Jamboards like, "people of varying abilities have educational opportunities to learn how to bike and feel comfortable doing so in our streets", "transit is consistently affordable", "community-led street design for new projects", "Gardens and other nice rest stops for pedestrians, bikers, etc", "Lots of bike and mobility device social activities", "streets for only pedestrians, bikers, and public transport"

Another prevalent feature of their envisioned future included environmental revitalization with visions of clean bodies of water suitable for swimming and transforming urban spaces and natural environments. Their emphasis was on community-centric infrastructure promoting social life at this stage.

As the dreams and aspirations unfolded, participants also acknowledged the challenges that stood in the way of realizing their visions for urban cycling. Perceived inequity regarding who uses bike lanes and an understanding of the varying abilities and experiences among cyclists were among the expressed concerns.

In analyzing the data, we noticed that participants used pictures of existing cities and projects from different parts of the world as examples of bike-friendly, walkable environments. For example, P2 used a picture of Amsterdam as an example vision of what Baltimore can be. They said,

> "[In] Amsterdam and in the Netherlands and other places, cycling is actually the main form of transportation, so they take a lot [of care of] ... cyclists. So, Baltimore is becoming a similar hub right now, and we need to, you know, take this seriously."

These findings show that while focused on cycling, participants visions went beyond enabling one form of activity but connected to many other aspirations for what they view as a friendly, safe, and inspiring city. Furthermore, despite being aware of the challenges of achieving these goals, participants are inspired by other similar efforts that have been successful in other parts of the world.

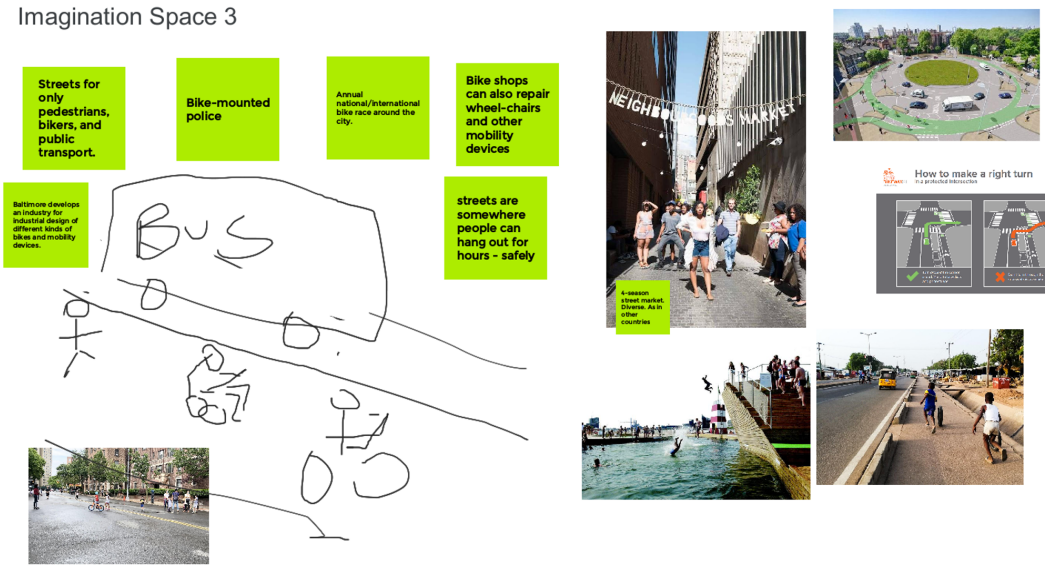

Fig. 3. A slide collaboratively produced by participants using Google Jamboard. It contains six digital sticky notes which participants wrote and placed on the slide, a drawing of an envisioned city street with dedicated bike lanes and a bus, and six photos of different cities, street layouts, and street activities, selected by participants by internet image searches and added to the slide.

4.4.2 Envisioning Participatory Futures for Urban Cycling. Our analysis of participants' design activities and reflections have resulted in three interconnected directions for future change described as follows:

Ancillary Bicycle Infrastructure and Supporting DIY Repair Practices: Participants envisioned a dynamic expansion of urban bicycling infrastructure beyond conventional bike lanes to create a comprehensive ancillary bicycle network in the city. This included implementing secure bike parking and storage facilities to deal with theft concerns and promoting a secure environment for cyclists. They also advocated for integrating bikes into various public transit modes, with dedicated spaces on buses, water taxis, trains, and potentially taxis. To support commuting cyclists, they suggested incorporating showers and changing rooms at workplaces, potentially through partnerships with nearby gyms. Additionally, participants emphasized catering to diverse cycling preferences through features like BMX/trick riding bike parks.

Recognizing the importance of accessible and affordable repairs, participants advocated collaboration with existing repair facilities to provide widely dispersed options. To further empower the cycling community, they proposed the establishment of DIY workshops and hubs dedicated to emergency repairs, ensuring that maintenance and repair services are readily available to cyclists throughout the city. Participants in their discussions also emphasized that repair facilities should not only focus on bicycles. Instead, they envisioned these repair facilities to support and promote accessibility and mobility. For example, P9 said,

> "I could foresee bike shops also doing wheelchair and other mobility device repairs so that it becomes like not just a biker thing, but like a [broader] mobility thing."

This vision for inexpensive and widely distributed repairs has the potential to enhance sustainable urban mobility in a broader, more inclusive sense, not limiting itself just in bicycles.

While admitting the challenge of locating resources and political will to achieve this goal, the participants shared that planning and prioritizing the expansion in terms of stages could provide a workable direction towards this vision. The participants went further to describe this transformation of infrastructure, combined with cultural change (see below), as an opportunity to transform Baltimore into a Mobility Innovation Hub. An initiative that would involve connecting bicycles and other personal mobility devices, including e-bikes. The participants described how design opportunities could arise from such an initiative which can be used for collaboration with local design schools that can encourage students to experiment with mobility, cycling, and storage ideas, gradually positioning the city as a hub for this niche of industrial design, urban planning, and community development.

When discussing this possibility, the participants also described leveraging the city's abundance of empty buildings, historical manufacturing roots, and skilled workforce, to enable its transformation into a hub of urban mobility and transition. Participants described that Baltimore's strategic location near regional train lines and recreational bike paths further solidified its potential as a mobility innovation center.

Changing Perceptions through Community Engagement: Complementing the vision for expanding infrastructure and pursuing transit and mobility innovation, the participants also envisioned changing perceptions about cycling, especially by people of color, to redefine it as a positive community-based practice. To address the need to change perceptions about cycling, participants proposed advocacy efforts to alter the negative narratives surrounding urban cycling that associate them with poverty and crime.

In an effort to cultivate a vibrant and positive street culture, participants suggested designing and advocating for more outdoor public spaces that encourage social gatherings. For example, participants discussed a vision of having street performances in public spaces to support creating friendlier and warmer community spaces. This direction included identifying and promoting fun events across the city to not only celebrate cycling but also showcase the positive impact of infrastructure solutions.

Using Technology to Support Community Awareness and Inclusion: Participants also described several potential technological design directions that could support the visions of enhanced infrastructure, mobility innovation, and shifts in attitudes and perceptions, described above. To increase effective communication among cyclists, participants proposed the development of a localized interactive system for broadcasting and receiving messages about local cycling issues, with features for finding the best routes and evaluating pathway characteristics. The proposed system could also include features for soliciting and receiving feedback from the community, such as ideas or notifications about bike-related events, creating a more connected and informed cycling community in Baltimore. According to participants, the system would need to address broader community concerns by offering tools to find the best cycling routes and evaluate pathway characteristics like bike friendliness, pedestrian accessibility, and mobility device compatibility. This kind of tool can take the form of mobile apps and social media platforms cyclists already are using for communication and organizing as we described in section 4.3. By making information more accessible and engaging, these interactive solutions could also encourage more people to take up cycling, contributing to a healthier and more active population. Additionally, to increase community participation and the inclusion of diverse voices, the participants suggested the development of an evaluation tool to assess and address community needs, fostering a comprehensive understanding of the diverse perspectives within the city. Collectively, this tool would increase community engagement, which in this context refers to a critical direction that encourages community-led street design to determine useful amenities and active participation of the biking advocates in community meetings to bridge gaps in understanding. While brainstorming about the features of this tool, participants suggested

incorporating features like sketching interfaces, drag-and-drop functions, and collaboration spaces that allow residents to visualize and contribute to community planning. For instance, users could annotate photos of neighborhood locations or use maps to suggest changes, helping bridge the gap between community members and decision-makers.

5 Discussion

Our findings show how a physical activity (i.e., bicycling) can easily take on social and political significance depending on the context, and turn into an act of resistance and protest as well as community building and creativity. Our participants discussed how by riding their bicycles in a car-centric city and navigating infrastructural and safety issues, they not only achieve the practical goals of getting from point A to point B but also demonstrate alternatives to the status quo. In this way, we can view bicycling as a way to enact alternative futures, a practice that is increasingly familiar to HCI research [5, 10]. In our case, the enactment of alternatives does not merely *show* others (i.e., the public) what is possible, but rather, *does* what is possible. Of course, in the racialized context of our city, issues of identity, including race and socioeconomic factors, play a significant role as the existence of a person-of-color riding a bicycle by choice (as opposed to a car or motorbike) is a challenge to racist and classicist stereotypes [1, 29]. This brief discussion of the social and political aspects of bicycling activism should make it clear that efforts to use interactive technologies to amplify the work of our participants should similarly have clear commitments to both serve the needs of local underserved residents by encouraging their participation and representation, and contribute to a broader cultural shift focused on sustainability and transportation alternative. Thus, by revealing how cycling serves as a form of activism and identity expression, particularly in challenging historical discriminatory practices and infrastructural inequalities, our work extends previous HCI research on supporting cycling as a sustainable mode of transportation [13].

Another point of discussion from our study is that we observed that the participatory design sessions produced what we would term "imagination spaces" that articulate a collective vision for the city's future through text and visual media. These spaces encompass desires for secure bike storage, a comprehensive network of protected bike paths, car-free zones that promote community engagement, and ideas like transforming the city's abandoned buildings into urban mobility hubs. The envisioned use of technology to support community awareness and inclusion presents opportunities and perspectives for HCI researchers and designers, such as the proposed localized interactive systems for broadcasting cycling issues and evaluating pathway characteristics. We found this activity helpful in furthering the goal of mutual learning in our community-based participatory design project [9]. Further, it demonstrated the use of participatory online collages as a way to describe visions of the future.

As is clear from the results, this study is just the beginning of conversations that should include many other stakeholders, including policy makers, city residents, and urban planners to actually make the visions and aspirations of the cycling advocates reality. As previous research has shown, facilitating these conversations can be challenging due to the diversity of perspectives [1]. Materials produced through the kind of multimedia participatory design activities we facilitated may be good resources for achieving this goal, and be used as tools for telling [3]. The materials like collaborative Google Jamboard slides produced in the study contain rich visual contents that can further be transformed into zine-like promotional and awareness building materials, for use in both online and offline organizing. Similar work in HCI has used zines An interesting direction could be to use these material to create zines through PD activities [16]).

6 Limitations

While our study provides insights into urban cycling advocates' motivations, experiences, and aspirations, it also has limitations that we will discuss in this section. First, it is focused on a specific urban context in the US, making our findings most relevant for this context. Further studies should inquire into how these would translate to other contexts with different histories and culture. Additionally, we only interviewed organizers and advocates which limits our findings to those arising from their perspectives and experiences. Future research could benefit from a more extensive and diverse participant pool to provide a more complete analysis on bicycling in the city. We didn't collect information about participants' level of education, annual income or how many hours they ride bicycle in a week which might be important for interpreting the results. Finally, the study was conducted during the COVID-19 pandemic, and due to the COVID-19 restrictions, we have conducted the participatory design workshops, remotely. This caused some restrictions in more hands-on and contextualized conversations in the field.

7 Conclusion

In conclusion, our study sheds light on the motivations, experiences, and aspirations of urban cycling advocates in the context of an American city. Our findings highlight the practical and social motivations for urban cycling and the challenges and opportunities associated with advocating for robust and equitable cycling infrastructure. The participatory design sessions revealed a collective vision for the future of urban cycling, emphasizing the importance of secure infrastructure, community engagement, and the use of interactive technology to support cycling advocacy. While we did not implement a specific solution following these sessions, we have maintained the relationships built during this process and remain committed to continuing our collaborative research efforts in the future. Overall, our study shows that cycling advocacy is an active and potent community-building and urban renewal practice in our city, and that advocates use it effectively to promote positive attitudes and constructive community-driven city planning. It also shows that interactive technology, especially social media, can amplify and support these efforts. This work contributes to the intersection of HCI, participatory urban design, and digital advocacy, providing insights for researchers, policymakers, and urban planners seeking to promote sustainable and inclusive urban mobility. Further research is warranted to explore the experiences of urban cyclists in diverse contexts and to address the limitations of this study.

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