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Hostile Ecologies: Navigating the Barriers to Community-Led Innovation

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This paper describes how the contemporary technology innovation ecology is hostile to community-driven design. These hostilities are important to understand if we want to intervene in the policy landscape of technology innovation to support viable alternatives to big tech consolidation and more democratic ways of developing and maintaining technology. We contribute a thick description of the hostile ecologies faced by transportation workers, community organizers, and allied technology researchers as they work toward building a cooperatively-owned taxi business with a digital dispatching technology. Our findings show that the hostile innovation ecology manifests as constrained access to resources, an inequitable regulatory framework, diminished agency in the software design process, and limits to the will of our community partners. We discuss the paths toward innovation for United Taxi Workers San Diego as compared with transportation network companies (e.g. Lyft, Uber) in terms of access to funding, regulation, labor, expertise, and market. We argue that a critical examination of institutions and policies in the innovation ecology is a necessary step toward charting fair, equitable, and community-strengthening pathways for technology innovation in the future.

CCS Concepts: • **Human-centered computing** → **HCI theory, concepts and models**; • **General and reference** → **Empirical studies**.

Additional Key Words and Phrases: innovation, community-driven design, policy, labor, platforms

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1 INTRODUCTION

Innovation policies allocate society's resources to professional classes, STEM education, and startups with the promise of improved products, services, and systems for all [61]. Policies meant to support innovation, and the implementation of useful systems prioritize the inventions of formal experts – research and development labs, startups led by college educated workers and managers, and large

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corporations. These policies often prioritize the production of intellectual property such as patents and copyrights and the kinds of brands, drugs, and software that companies work to monopolize under these regimes [21, 75, 119]. Left unchecked, such policies gather resources, such as taxes, land, and investable wealth, and distribute them to realize the visions of societies' elites – those who have gained the most formal education, sufficient access to capital, and fluency in the languages and cultures of those with capital [75]. These approaches have been widely critiqued as upholding the interests of American and European corporations across the world [36, 43, 119].

More equitable approaches to innovation are possible. In Scandinavia in the 1970s, trade unions partnered with computer scientists to innovate computer systems to enhance workers' power and skill rather than undermine them [15]. In 1975, unionized workers at Lucas Aerospace presented a plan to save the bankrupt defense manufacturer by turning its infrastructures of military production towards socially useful products under collective worker control and ownership [84]. In India, the Honeybee Network led by Dr. Anil Gupta developed a "Technology Commons" license to ensure rural people get paid when corporations pick up their inventions while allowing individuals to freely share techniques and knowledge [18][75, pg.191].

The "techlash" has also precipitated a global, public conversation about the impact of favoring for-profit, highly scaled companies like Google, Facebook, and Amazon as providers of key infrastructures of everyday life. These debates have highlighted negative impacts of highly-concentrated corporate power over the media environment, labor rights, and civil liberties including privacy [1, 69, 123]. These critiques also call into question whether the contemporary technology innovation landscape gives big companies undue power to determine how we use technology in our everyday lives, and, in turn, the power to decide how the technology makes use of its users. In the United States, while the majority of people agree that the biggest technology companies make more problems than they solve [1], imagination and political will are needed to transform the situation. Anti-trust regulation [23], self-regulation through ethical design practices [60], and tech worker movements [97] have all been proposed as ways of gaining some semblance of democratic control over widely shared digitally-enabled infrastructures. Scrutiny tends to converge on a few major companies and their platforms, rather than recognizing the wide range of private technology actors and the policies that shield them from community accountability. These debates tend to hold moments of design, innovation processes, and design methods separate from policy and regulation. In most practical and analytical accounts, they tend to follow a rigid order: design and innovation happen first policy and regulations follow later. Instead, we call for attention to what Jackson et al. call "policy knots", mutually contingent assemblages of technical design, social practice and policy that highlight the irresolvable complexity of socio-technical worlds [80]. "Policy knots" shape the kinds of technologies that can be developed and maintained in the first place, as well as limit the communities empowered to design and implement them.

What barriers do non-tech communities face when trying to bring technological visions into being? This paper details efforts to design and launch a community-driven transportation technology initiative, documenting the barriers they faced finding markets, accessing capital, and navigating laws and policies along the way. This project lives the "policy knot" – and self-consciously so. The project, a digitally-enabled taxi cooperative, seeks to extend public transit networks into "transit deserts" [6, 55] while restoring dignified and essential transportation work. The project builds on the existing relationships, know-how, infrastructures, and regulatory frameworks of city taxis, reorganizing the industry to address problems that the rideshare (e.g. Uber and Lyft) industry has little incentive to solve. These problems include reducing carbon emissions, preventing congestion, serving less profitable neighborhoods, and ensuring access to wheelchair accessible vehicles [76]– while also allowing taxi drivers to make decisions about the role of digital platforms in organizing the conditions of their work. We describe what happens when an organization of taxi drivers

and driver advocates — United Taxi Workers San Diego (UTWSD) — attempts to re-imagine and intervene in the transportation infrastructure landscape of a large US city.

This paper contributes a thick description of the hostile ecologies faced by transportation workers, community organizers, and allied technology researchers in implementing technology visions. We do this to define new pathways to innovation that are not bound to classical notions of “innovation” that might, ironically, stymie local innovation and social change. We argue that this case signals challenges likely faced by others with innovative visions but who do not match the policy-makers’ imaginations of “innovators” who might direct the futures of technology. Transportation workers lack strong ties to the practices, networks, and capital of “big tech”. As they attempt to design, develop, and deploy a complex technological platform, they encounter an ecology hostile to their practices and vision. These hostilities arise despite the overwhelming assets that the group has — deep work process know-how, local community organization, long-standing connections to municipal and regional government actors, and collaborations with various technical experts.

We draw on over two years of work as technology design researchers supporting UTWSD with design, technology assessment, and technology and transportation technology research. We approach the projects as participant-observers, analyzing the requests UTWSD made of the research group as well as our collective project work to understand the limitations of the ecology in which we have worked together. The paper begins by explaining why we account for barriers and assets as hostile ecologies. We then review the literature on community-supported technology design and infrastructural transitions and argue for sustained inquiry into the paths that communities take through existing policy and institutional landscapes to bring their designs to fruition. Next, we introduce the transportation workers and community organizers we worked with for this two-year study and detail the conditions of labor they continue to demand. We then provide an overview of our approach and a case study of key events that shape our understanding of the hostile ecology that militates against community-driven technology design. The next section builds on the events to unravel the interlocking elements of the ecology to show how hostilities arise at different organizational levels, and can manifest as constrained resources, inequitable regulatory frameworks, diminished agency in the software design process, and limited will of actors facing these barriers. Our discussion breaks down the different paths to innovation faced by actors like UTWSD versus high-capital, high-tech actors like Uber and Lyft. We argue that a critical examination of institutions and policies in the innovation ecology is a necessary step toward charting fair, equitable, and community-strengthening pathways for technology innovation in the future.

2 RELATED WORK

2.1 Who are innovation ecologies for?

Analysts of innovation use the concept of ecology to describe contexts and arrangements that enable technological innovation¹. These can include interpersonal relationships, institutions, and inter-firm networks. While technological innovation can be thought of as design, invention, or creativity, the turn to innovation ecologies (e.g. [57, 58]) recognizes that the creation of technological systems can be supported or stymied by institutions such as intellectual property law, local educational opportunities, or the presence of actors with complementary and necessary

¹Some analysts of innovation have also used a very related concept of an ecosystem to understand contexts that enable technological innovation and strategies that foster value creation in relation to those innovations [59]. The ecosystem construct makes inter-dependencies between firms or companies as partners or collaborators more explicit [3]. We choose not to incorporate the concept of innovation ecosystem into our literature review because it takes as its focal point of analysis a well-established firm or company and the networks that sustain it [74]. In writing of ecology, we emphasize the landscape of capital, firms, and policy actors attempt to innovate among.

skills. Annalee Saxenian's work has been particularly influential in highlighting how interfirm collaboration, social practices among engineers, and transnational flows enable flexible technology production in a region across firm boundaries [109, 110]. Other researchers and policy makers have tried to formalize mechanisms to encourage such innovation-stimulating flows and practices, advocating for the creation of specific places, infrastructures, research investments, and legal reforms to encourage high-tech innovation [48, 58, 127]. Such interventions seek to reorganize financial networks, educational priorities, and even city housing and zoning policies to prioritize the needs of patent-generating and data-monetizing industries [75, 129]. Finally, some governments massively invest in basic and applied research funding that allows scientists and engineers time, space, and equipment to work towards complex goals [42, 96]. An ecological analysis moves beyond an understanding of innovation as acts of collaborative creativity or implementations of design process. We cannot understand what creativity gets built and maintained in the world without understanding an ecology of institutions and policy.

In economic policy, innovation typically stands for processes and industries that create intellectual property, whether copyright (e.g. music, brands) or patents [29, 46, 47]. As a result, public investments in education and infrastructure tend to emphasize such products as the prized end goal [75, 117]. Neoliberal economic policies also tend to assume private sector finance and priorities as the vehicle for selecting and supporting such research and development [87]. Finally, they presuppose the need for scaling to be successful [62, 75, 99].

Innovation policy typically imagines lower income communities as irrelevant except as users or economic actors to be uplifted through technology access and "skilling" [61] or as consumers [101]. Lower income entrepreneurs are typically understood as engaged in low-capital intensity, "necessity"-driven entrepreneurship [40, 72], such as freelancing or the informal economy. Scholarship on the former emphasizes small business formation, access to loans, and resources from communities [22, 34, 40]. Exclusion from key institutions and rights of citizenship can also be a barrier; these exclusions can be a product of racism, exploitation, and colonialism [10].

Some have hoped that technologies such as crowdfunding platforms might open up innovation pathways closed in the current configuration. Crowdfunding, for example, could widen the pool of funding available to a more diverse pool of entrepreneurs. Experimental [128] and large-scale data [103], however, show consistent evidence of bias against crowdfunding projects and founders that potential funders read as Black. Funding campaigns require people to construct themselves as worthy through narrative and savvy social media tactics [16]. Crowdfunding efforts are not well equipped to undertake the sustained transformation of cultural narratives that cast some as less worthy along lines that justify oppressive social relations.

Our community partners, United Taxi Workers San Diego, fall between the worlds of high-tech innovation and "necessity"-driven entrepreneurship. Many drivers and organizers are African refugees, trained abroad in professional fields but facing racism, anti-immigrant sentiment, and language barriers once in the United States [53]. Yet in our project, they pursue "opportunity"-driven entrepreneurship while making money in other ways. Policy assumptions that target the high-tech entrepreneur or low-capital intensity lower-income entrepreneurs leave a vast universe of community-driven technological visions unsupported. Our task in this paper is to document the ways that an ecology designed to privilege high-tech innovation leaves alternative forms of innovation – ones that might be more sustainable and equitable – unsupported.

2.2 Community-driven technology design

A growing body of work in CSCW calls for communities to determine the technologies they use, both in design and implementation. Community-driven (e.g. [4, 5, 51, 68, 85, 125]) and community-led

[35] design, along with other methods such as participatory design, collaborative design, and co-design, are part of a continuum of approaches that challenge the authority of professionally-trained technology designers. The continuum is defined by the balance of local and technical expertise that drives design process and the focus of the resulting intervention [125]. While approaches like participatory design, collaborative design and co-design can have varying degrees of expert involvement community-driven design in particular centers the collective capacity and knowledge of communities. It emphasizes the role of “local people” in “developing their environment, including buildings, open spaces, services, and neighbourhoods” [5]. Design by “local people”–or “proximate community” as Carroll argues– draws on the shared meanings, mutual obligation, and other social mechanisms people develop as they live in proximity of each other, with mutual obligation and shared meanings as existing social mechanisms [25, 88].

Prior research on community-driven design has identified the benefits and possibilities of this method. First, it challenges assumptions about technology design practice by demonstrating that a more inclusive and representative approach to designing technology is possible. Second, as many have argued, community-driven design produces better design outcomes. This is because community-driven design methods leverage local knowledge to surface local concerns and design interventions that meet local needs [5, 50, 105]. Other benefits to community-driven design include opportunities for supporting future organizing and activism [66], community development (e.g. by bringing people together with a shared sense of purpose), and individual development (e.g. through skill building) [5].

Research that supports community-driven design warns of many dangers. Inclusive design processes can further race- and class-based exclusion by imposing languages of design professions over other ways of discussing and addressing problems [120]. Even as they facilitate participation, community design workshops and other forms of participatory research methods themselves can reproduce inherent power differentials, further historical injustices, and also fail to recognize moments of creative intervention that do not fit within the narrow parameters of “innovative” design [65, 66]. For example, a petition to housing management to improve community living conditions was one of the design outcomes proposed by participants in Harrington’s community-driven research on understanding perceptions and practices related to health management of Black elders in lower-income neighborhoods. This creative act could be missed if one was to focus exclusively on typical notions of “technology innovation” [66]; political projects to promote innovation often devalue such democratic contestation [75]. Resource constraints also pose a challenge to community-driven design. Participatory and community-driven design approaches emphasize the value of already-existing community resources and community capital (forms of human, social, environmental, and economic capital) as “assets” but, as prior research shows us, some of these existing assets may be unresponsive or insufficient for realizing community-envisioned design outcomes [39, 50, 52]. In this paper, we examine what happens to community-driven design as it moves out of the workshop and challenges practices in the world. We detail an account of a community attempting to understand the existing infrastructural fabric and positioning themselves within it to be able to push for favorable transitions. In doing so, we surface “the work before the work, and the work to keep the work going” [88] to identify further opportunities and challenges to bringing community-driven design into being.

2.3 Infrastructure, Institutions and Transitions

Prior literature in HCI and Science and Technology Studies details the ways that infrastructures are negotiated, assembled and maintained. Large technological infrastructures are comprised not only of artifacts but also the institutions and regulations that govern them [71]. Key findings of this scholarship are that infrastructure is best seen not as a thing but as a set of relationships between

people and technologies that undergird shared and standardized practices [118]. Infrastructure works when these relationships among people, technologies, and institutions are well aligned. It takes ongoing work to maintain these alignments and find new ones [19, 20, 89]. Infrastructures are therefore neither fixed nor finished, rather always processual and emergent [26]. As a result scholars have turned their attention to the doing of infrastructure or “infrastructuring” [82, 100]. Karasti et al. show that when communities with trust, experience, a common cause and shared interest participate in infrastructure transitions or “infrastructuring,” it produces better systems that are more attentive to the community’s needs [83]. At the intersection of speculative design and “infrastructuring,” Wong et al. call attention to the cultural, regulatory, environmental, and repair conditions that allow for an artifact or system to exist in the world, and what forms of social, technical, and institutional forms would be required to sustain it [126]. Bottom-up community engaged literature in “infrastructuring” is concerned with supporting future use[49], democratic action[37, 86], reconfiguration[100], maintenance and repair[79, 116]. This paper offers a community-driven account that takes up all those concerns in pushing “infrastructuring” work forward in a regional and municipal institutional context. We surface the barriers and limitations that are faced by communities in the doing of infrastructure (i.e. “infrastructuring”) and how it looks different for high-capital, high-tech actors.

Participatory Design (PD) scholars have grappled with institutional processes, challenging existing “institutional frames” that shape and constrain design processes and outcomes [27, 73]. As PD steps outside the workplace, it targets other institutions in the public realm. PD scholars argue that design, as well as participation in the design process, meets with ideological mismatches and gaps between administration and planning [92]. Some have called for ongoing research and experimentation to move beyond those constraints to create lasting institutional impact [41, pg. 134]. The literature on managing sustainability transitions offers one possible approach, detailing a multi-scalar process to engage stakeholders in imagining, aligning, and promoting long-lasting institutional change [93]. It specifically emphasizes a coalition of actors (“transition team” or “frontrunners”) strategically intervening at the level of policies and institutions by aligning a diverse network of actors that can exercise transformative power [9, 64, 70]. This paper offers one example of such work, and how it looks different when led by a local worker organization rather than high-level municipal agenda setters. We detail the efforts of that community organization to transition existing policies and institutions to bring their speculative technological vision into being.

3 UNITED TAXI WORKERS SAN DIEGO: VISION AND STRUGGLE

United Taxi Workers San Diego (UTWSD) is a refugee-led worker advocacy organization formed in 2009, uniting taxi drivers across races and ethnic groups to achieve better working conditions. Though they face an ecology hostile to their innovations, they have overcome racism, exploitative permit systems, and institutional exclusion through policy advocacy and direct action [53]. The challenges they have faced are not unique to our city, as the taxi industry in the United States has a long history of exploiting drivers [44, 95].

The permit system, sometimes called medallions, is one source of exploitation. Prior to UTWSD’s activism, permits in our city cost more than \$100,000. Drivers who could not afford permits leased their cars from permit owners. These “lease drivers” suffered from high fees paid to permit owners, low net incomes, long hours of work to make ends meet, and decades of work without labor protections. This exploitation reinforced racial and class lines as drivers in the industry are primarily immigrants (more than 90% as of 2013) and people of color (65% East African and 15% Middle Eastern as of 2013) [53]. UTWSD’s first strike organized lease drivers who could not afford the permits – 90% of taxi drivers prior to 2014 [53]. Their goal was to lift the city’s regulatory cap

so anyone could buy permits from the city, eliminating the private market for permits. They won in 2014.

As a stepping stone to this victory, they also fought for and won representation on the city's Taxicab Advisory Committee. This committee provides feedback to San Diego Metropolitan Transit System, the taxi's regulator, on policies related to taxis. Seats were elected, but permit owners often punished drivers who ran for seats. UTWSD successfully pushed to allocate three seats for lease drivers on the Committee; today, the Committee also has a seat specifically for UTWSD.

UTWSD built on their prior victories to mediate better relations with City and Harbor police, partnered with UC San Diego School of Medicine to train drivers on occupational health and safety, and participated in a six-month process to reform airport taxi regulations. UTWSD established a legion of allies among lawyers, labor organizers, and volunteers to support these efforts. Through these efforts, UTWSD also built durable relationships with political leaders aligned with labor issues. They draw on these relationships to build towards their vision in the present.

UTWSD's vision is to unify taxicab workers, to improve working conditions, and to improve professional transportation services in the city. As part of this, UTWSD has consistently striven to create platforms for dignified driving work. Through 2015 and 2016, they established their own dispatch, including an attempt to make it app-based. Though their first attempt at an app failed, it set them on the path to the work we undertake together here.

4 APPROACH AND METHODS

United Taxi Workers San Diego (UTWSD) and our research group have collaborated over two and a half years to develop and advocate UTWSD's vision. This paper offers a thick description of this joint team's efforts to launch a digitally-enabled taxi cooperative in San Diego. Thus, the community under study here is the team itself. We do this to reflect on how technology innovation works amidst profound social inequality, how groups of people come together to intervene on status-quo technology practices, and how configurations of capital, policy, and institutions militate against community-driven innovation.

This paper primarily uses fieldnotes from team meetings held at least weekly where we planned, organized with driver workers, and worked with experts and political offices. In addition, we draw data from co-design workshops, semi-structured interviews, informal oral histories, analysis of policy documents and media artefacts. Throughout our collaboration, UTWSD and the research group co-developed the analysis presented in this paper that was recorded by the research group as fieldnotes on conversation. The writing process of the paper was primarily led by the research group. Once a final draft of the paper was ready the research group sought input from UTWSD and incorporated the changes they requested. We follow calls for more inclusive and engaged design research[35, 65, 67] in including UTWSD leaders as co-authors to reflect their significant contributions. In what follows, we champion the work the team has done together with the hope that the findings presented in this paper will play some role in propelling UTWSD's vision forward and guiding more equitable design and policy processes.

We draw on community-based design research methods that commit to pursuing questions communities find valuable with active participation from those communities. These methods are an alternative to extractive research collaborations [65, 88]. Even still, Harrington, Erete, and Piper argue that seen through a longer-term lens, histories of research-community encounters have left universities much better off than the communities they engage with. They argue for sustained, long term relationships beyond the project [65] (see also [77, 124]). We take up this commitment. We also take up cautions to center community creativity rather than narrowly pursuing technology advances [14, 65]. Here, UTWSD explicitly sought a technical solution before the research group became involved. However, both UTWSD and the research group were well aware of the ongoing

challenges of technology repair and maintenance. Hence, the research group's task has not been to design, per se, but rather to contribute their expertise, labor, and institutional legitimacy as technology academics to help UTWSD gain resources, negotiate the design of systems they adopt, and advance our collective vision. As we negotiate real world software, we oscillate between designing, configuring [12], negotiating, and working towards institutional change [73, 92] without full design agency over the systems available to us [78, 124].

5 OVERVIEW OF EVENTS

In this section, we give a brief summary of key events that have taken place over the course of our work with UTWSD. First, we will give a timeline of our collaboration with UTWSD, including the design and outcomes of our co-design workshop with the taxi drivers. Next, we describe the partnership between UTWSD and the technology company LogistiRide that offered to build a digital dispatch platform and their subsequent pilot. This section functions as a timeline of key phases that unfolded over the course of our collaboration. In subsequent sections, we will describe how the moments along this timeline illustrate the hostile ecology that militates against the group's progress toward achieving their goals.

5.1 Taxi Futures Workshop

In November 2019, UTWSD invited Udayan Tandon and Lilly Irani to collaboratively design and conduct a workshop with taxi drivers. UTWSD organizers and the research group entered the workshop with a broad vision of a public-sector supported digital dispatch with regulated wages and prices – to ensure affordable point-to-point transportation. Inspired by debates about the need for public competitors to private providers of essential services in the United States, we called this "the public option" amongst ourselves.

The goal of the workshop was to understand the experiences and challenges of taxi drivers and to understand how they envisioned the future of transportation in the city in which they lived. The workshop convened 25 drivers associated with UTWSD and presented examples of transportation experiments, such as app-based shuttle buses, rideshare co-ops, and taxi co-ops. Throughout the workshop, taxi drivers asked pointed questions, critiqued information they disliked, and drew on their taxi driving expertise to provide rich feedback on ideas about a tech-mediated future of the taxi industry. Some salient outcomes of the workshop were as follows:

- Drivers, some of whom had driven for transportation network companies (TNCs) such as Uber and Lyft, elaborated on why they preferred to drive taxis. First, TNC app platforms inundated drivers with ride requests and threatened to deplatform them should they reject too many rides. Second, TNCs also charged a significant percentage of driver earnings as platform fees. Third, the intensity and low pay of TNC work means drivers are continuously on the road, damaging their own health and their car. Finally, drivers preferred to build a relationship with their customers such that known customers could reach out to them whenever they needed a ride.
- Drivers articulated a nuanced vision for the design of a digital dispatch platform. They did not want the platform to replicate features found in gig-work platforms run by TNCs such as incentive schemes (e.g. surge pricing) or a driver rating system as a mechanism for ensuring quality of service. Instead, taxi drivers wanted to move towards a digital dispatch platform while retaining core elements of the current taxi system: fixed and municipally regulated pricing and a dedicated troubleshooting and complaint helpline that allowed for problem solving rather than penalizing drivers.

- Drivers highlighted the imbalance between TNCs and the taxi industry. TNCs, in their words, manipulated the industry and gained an advantage through marketing and lobbying practices. In our city, they had gained preferential treatment over taxis at the airport. Drivers also believed that San Diego Metropolitan Transit System (SDMTS) showed undue preference for TNCs, despite the fact that (or perhaps because) TNCs were outside of SDMTS's regulatory purview. Taxi drivers argued that because taxis pay SDMTS fees and submit to city regulations to achieve public safety, SDMTS ought to prioritize integrating taxis as service providers for first- and last-mile connectivity solutions.
- Drivers expressed interest in establishing a cooperatively-managed taxi dispatch. Drivers saw the cooperative as a way to collectively provide a high quality of service to customers while also maintaining control over their work conditions (e.g. their driving hours).

Over the course of this workshop and other discussions, UTWSD's vision for taxis continued to evolve. The project coalesced around the need for a democratically controlled, publicly regulated, and just workplace for taxi drivers supported by public agencies with broad reach to riders.

5.2 LogistiRide Partnership

In July 2020, UTWSD was approached by LogistiRide², a small software company that was already developing a digital dispatch platform. LogistiRide promised to provide a working digital dispatch and demonstrated their nationally-certified meter system, a GPS-powered algorithm for calculating the cost of a ride by distance traveled. They had made the system compatible with local taxi regulations. UTWSD asked our university team to consult with them as they evaluated, tested, and gave feedback on the dispatch platform in hopes of deploying it with drivers and customers. To this end, our team participated in regular meetings, pitch presentations, tech demos, driver trainings, troubleshooting and design sessions over eighteen months as UTWSD worked with LogistiRide.

LogistiRide's pitch was promising and they were eager to find a market for their product. They promised a metering and navigation app for the driver, a ride hailing app for customers, and a web-based management dashboard for dispatchers. They offered to set up and support the hardware, software, and train drivers on the new system. They also planned to develop logistics contracts that could employ drivers as couriers during their idle time. Crucially, UTWSD and LogistiRide mutually agreed on a contract that protected the taxi drivers' interests by ensuring drivers paid only a low, fixed monthly fee. The contract also ensured that LogistiRide would not provide its app to other taxi companies in the city, giving UTWSD a much hoped-for competitive advantage. UTWSD had been seeking a regulation-compliant digital dispatch infrastructure for over 6 years after failing to maintain one on their own. LogistiRide would pay the cost of technical deployment and maintenance; UTWSD would only pay with their time assisting in development and eventual fees. They signed the contract.

Over the next year, UTWSD and LogistiRide attempted to work from a software demo to a working digital dispatch system. Unfortunately, LogistiRide had difficulty resolving persistent bugs or making user interface improvements requested by UTWSD. Despite the lack of a smoothly working app, they launched pilot projects to add features and markets. In December 2021, after continued delays in fixing critical bugs, UTWSD's board decided to renegotiate the terms of the partnership as UTWSD began looking for a different technology partner. A digital dispatch is essential to UTWSD's vision of reinventing taxis' place in their region. They will attempt to partner with an already established taxi software company to reduce uncertainty, though they may lose flexibility in contract terms or technology design.

²The name of the partner company has been anonymized for this publication

5.3 The Pilot: Finding a Market

To realize the vision of a digital dispatch with dignity, UTWSD needed to reestablish a market. In mid 2019, UTWSD became aware of a ballot initiative called “Elevate 2020” being put forth by the San Diego Metropolitan Transit System (SDMTS) to improve the public transit in the city [113]. They participated in an “Elevate 2020” community group meeting where they learned of the city’s hope to address the gap of the first and last few miles in the transit system. In late 2019, we approached SDMTS, the taxi regulator and public transit agency, to explore whether they could add taxis to their widely-deployed transit app. We proposed that taxis could help transit riders complete the first or last few miles of their journey, advancing already articulated public climate and transit goals.

SDMTS agreed to explore this vision through a collaborative grant application to the NSF. The proposal scoped a first- and last-mile pilot project to integrate digital dispatch into the transit app and to place taxis at a trolley stop to provide connectivity to office parks and hospitals beyond walking and biking distance. We garnered the support of domain experts in transportation, driving safety, public health and cooperative development to aid in planning and implementing our proposal. UTWSD leveraged their past relationships to obtain signed letters of support from a Councilmember and SDMTS staff. The process of crafting the grant proposal had also (at least temporarily) strengthened UTWSD’s relationships with legal counsel, engineering staff, and the taxi administration at SDMTS. After the grant proposal was submitted, UTWSD and our university team continued to work with SDMTS staff to further plan the pilot. We explored user experience workflows and identified legal and bureaucratic steps to realizing the plan. This shared effort resulted in SDMTS putting out an official Request for Information (RfI) in December 2020 to seek software vendors who could build the pilot app. Soon after, we heard back from NSF in February of 2021 that our proposal had not been funded. With the promise of a grant gone, SDMTS staff tapered down their engagement citing pressing priorities.

UTWSD reached to its connections beyond SDMTS to keep the vision of a first- and last-mile pilot alive. They contacted multiple city and county representatives, targeting their outreach efforts to members of the SDMTS’s governing boards and towards representatives from low-income suburban regions in need first- and last-mile connections. They asked politicians and staff for resources as well as political and planning support for the pilot. UTWSD continued pressing SDMTS to commit to a first- and last-mile pilot, should another source of funding arrive. Finally, the research group co-authored a policy report with UTWSD that identified climate, equity, and access problems caused by TNCs and suggested regulated taxis as an alternative infrastructure to build on [76]. This report, together with the grant proposal, created legitimacy and research backing for UTWSD’s vision as they lobbied. UTWSD now circulates the policy report and grant documents to policymakers as a way to share their vision with people who can shape policy in the organization’s favor.

5.4 Fundraising

Despite two failed NSF grant attempts, we won funding from sources that were better—though not perfectly—aligned with the goals of our project. In 2021, we received a grant from a state employment training agency in collaboration with the Democracy at Work Institute to form a taxi cooperative. We also won a Kauffman foundation grant that allowed us to fund UTWSD’s and hire community members to develop deeper Community Based Participatory Research [122] on the opportunities of and challenges to UTWSD’s entrepreneurial efforts. These grants allow the group to continue moving towards their vision. However, as the next section shows, the path they follow meets with an ecology hostile to their community-based innovation.

6 HOSTILE ECOLOGIES: BARRIERS TO COMMUNITY-LED INNOVATION

In this section we show how the technology innovation ecology is designed to exclude community-led innovation. We first show that UTWSD's access to resources is constrained both by the effort required to obtain grant-based funding and restrictions imposed on the use of those grants. When UTWSD seeks support from local government institutions in turn, those institutions enforce policies that constitute an inequitable regulatory framework. Within this framework municipally regulated taxis have to self-sustain and compete for bids against venture capital-backed Transportation Network Companies (TNCs) rather than being supported as a regulated infrastructure in the public's interest. Limited access to resources from grants or local government institutions then pushes UTWSD into partnerships with technology companies where they must make trade-offs between guaranteed technical functionality and a chance to exert control over design decision-making in the digital dispatch platform. Finally, we show how struggle for resources and the lack of a digital dispatch platform constrains the will of drivers to participate in moving the vision of the project forward.

6.1 Constraining Resources

This section sheds light on the structures that distribute resources to turn community-driven infrastructural visions into real projects. We describe the sheer effort required on the part of UTWSD, along with the research group and the organization's collaborators in city government, to put themselves in a position to apply for grant-based funding. Most grants only have a small chance of being funded, but even when they are funded, we show how grants impose restrictions and new demands on their recipients. In our case, this led the project in directions that are parallel to its initial goal of building the digital dispatch. We discuss the effects of short-term funding and the ways that grants torque the project towards the needs of funding agencies, which often have tenuous or at best a partial relationship to the needs of the community.

In order to apply for a grant to innovate in the transportation ecology landscape, UTWSD must first do the work to identify grants that are likely to fund all or part of this work. Then, it must craft new, grant-specific narratives about the project that align with the grant's stated goals. They also need to persuade their allies in academia and the public sector to also craft narratives about the project via letters of support. In April 2020, our group's faculty participant led an effort with UTWSD and the research group to enroll stakeholders from the municipal transit and regional planning agencies, local government, and a politically-aligned non-profit to put together an application for NSF CIVIC, a grant that was aimed at funding projects that could create a significant community impact within 12 months after a short 4 month planning phase. We proposed the first- and last-mile taxi pilot at a transit stop, supported by a transit integrated digital dispatch. Applying for this grant required difficult bureaucratic forms from our community partners. It also forced us to promise a one year timeline on a project that involved slow-moving public sector actors and democratic processes that take the time they take. Despite these challenges and eventual failure to win the grant, the process of writing it seemed to strengthen our relationships with staff at San Diego Metropolitan Transit System (SDMTS). The grant failed to fund our vision, but it did produce concrete and public steps by SDMTS in support of our vision.

Subsequently, the group applied for three more grants: one additional NSF grant, which was also not successful, and two successful grants from the Employee Training Program (ETP) and the Kauffman foundation. These grants illustrate the choreography of patchy funding that aligns with only part of the work needed to realize a vision. UTWSD partnered with Democracy at Work Institute (DAWI) to apply for a state grant from ETP for building a cooperative business. UTWSD had laid out a vision for a driver cooperative-based taxi dispatch several years ago. The grant

would allow UTWSD to pursue this vision by providing an investment of cooperative-building resources and expertise which drivers were unable to access on their own. From the beginning of the ETP grant application process, it was clear to our team that this grant would not provide the financial resources to build or acquire a digital dispatch platform. Grantmakers imagined high labor, low capital intensity cooperatives as their target and the team had to craft narratives and pursue deliverables to fit that brief.

A cooperative of drivers was necessary to maintain a reliable digital dispatch platform; yet at the same time, a digital dispatch was necessary for sustaining the taxi business. The grant provided funding for the cooperative, but our experience proved that members were hesitant to build the coop absent the digital dispatch itself. Because the funding period began immediately and because the grant did not fund the development of the technology, receiving this grant put the group in an uncomfortable situation. They had to move immediately toward cooperative development while pragmatic barriers to the project's technical development remained unresolved.

Another issue was the timeline of the grant itself. The ETP grant was one year long, but, upon getting into the work of co-developing a cooperative with taxi drivers we were advised by legal and cooperative experts that building a stable cooperative with functional democratic decision-making mechanisms can take much longer than a year. As a result, the team was perpetually splitting its capacity between to meet ETP grant requirements (e.g. trainings, update meetings, milestone deliverables) while simultaneously seeking out and fulfilling the requirements to apply for the future grants necessary to keep the project alive.

UTWSD and the research group also successfully secured a grant from the Kauffman foundation. Unlike the previous grant, the Kauffman grant required us to frame the project as a research project. The award provided us the resources to conduct research on the barriers to community-led tech development with the goal of producing an analysis and proposals for institutional change based on UTWSD's visionary effort. This grant allowed funds to support UTWSD staff, strengthening their organizing capacities. It also represented a way for the research group to leverage their academic expertise to truly act as academic accomplices [8] by securing monetary resources for their partner organization. The grant also allowed us to allocate resources towards building research capacity in the community proximate to the taxi workers through a CBPR training program. However, since the emphasis of this research grant is on producing research outputs, we had to direct significant resources for compensating student researchers and community members to participate in interviews, surveys, and workshops. While the grant infused resources into UTWSD and the surrounding community, it also added a new layer of work on top of the work of building towards the vision. And there was still not enough funding for the digital dispatch we hoped to integrate with SDMTS.

From our two successful grant experiences, we see that even in the best case, UTWSD's reliance on grant-based funding to achieve their goals of creating a community-driven technology has introduced several challenges to the success of the project. The process of applying for grants exhausts the team's capacity. The funding from awarded grants – if it comes at all – is often short-term, and within that short time, the team must reinterpret the project and its political processes in terms of the goals of funding agencies, resulting in additional demands that UTWSD must fulfill as it works to accomplish its original goals. The grants UTWSD has been able to win have not provided support for technology design, development, and maintenance. As we will see in the next section, this gap bears knock-on effects for our ability to support democratic technology production.

6.2 Inequitable Regulatory Frameworks

This section examines how policies that fail to consider equity shrink state actors' support for community-driven solutions. We describe how structural constraints of resources detailed in the previous section pushed UTWSD to seek a partnership with the San Diego Association of Governments (SANDAG), the regional planning agency. Then we show how specific invocations of the existing regulatory framework by SANDAG and San Diego Metropolitan Transit System (SDMTS) put UTWSD in direct competition with Uber and Lyft. Finally, we document UTWSD's work to challenge this through calls for policy change.

UTWSD had built relationships with staff and boardmembers of two local government institutions that regulate the taxi industry: SDMTS and SANDAG. Initially, UTWSD hoped that SDMTS or SANDAG would fund or develop the digital dispatch platform outright. When funding from either institution failed to materialize, UTWSD sought to fund their vision through grants. UTWSD also attempted to build support for a more modest commitment from SDMTS and SANDAG to favor taxis as a solution to what SANDAG called "Flexible Fleets" – their name for first- and last-mile solutions from transit hubs [106].

However, the group quickly discovered that SANDAG's vision for the future did not include taxis. According to their regional plan, Flexible Fleets "offer people shared, on-demand transportation services that provide convenient and personalized travel options for all types of trips at all times of day" [106]. The draft of the regional plan made no mention of taxis but explicitly named TNCs like Uber and Lyft. This omission signaled to our team that SANDAG had not considered municipally regulated taxis as part of their plans. When probed at Taxicab Advisory Committee meetings, SANDAG staff expressed a commitment to what we understood to be a regulatory framework committed to neutrality: "we are agnostic about achieving the goals for the transportation system ... Whatever industry can help us achieve those goals will be at the table" [115]. By being "agnostic" about partners, SANDAG staff implied that they would pursue their goals via a purely technocratic and seemingly neutral process. This meant that taxis would have to compete with Uber and Lyft. This was surprising because the City Attorney's office was, at the same time, suing these very companies for employee misclassification [91]. SDMTS staff also conveyed to UTWSD that under the current regulatory framework they could not be seen "favoring" taxis over other agencies because they regulated taxis.

In order to inspire and re-enroll the political actors whom we had previously identified as potential levers at SDMTS and SANDAG, the group wrote and disseminated a policy report synthesizing existing research on the environmental, social, and economic impacts of ride share services [76]. Our hope was that the policy report would give our allies in local government technocratic legitimacy to champion policy-level interventions that would favor immigrant-led and racialized workers as partners who could advance broader social equity and climate goals. UTWSD alongside the research group pushed the merit of the policy report to be considered under the recently adopted rubric of equity by SANDAG [107]. These efforts renewed SDMTS support for UTWSD's vision. However, majority of the planning and funding authority in the region lies with SANDAG where the group continues to push for support.

To summarize, we have shown in this section how resource constraints pushed UTWSD to seek to intervene at an institutional level. The actors we encountered in municipal transportation and regional planning institutions adopted a regulatory framework committed to neutrality (i.e. not favoring taxis over TNCs). This commitment to neutrality, ingrained in the policies of public procurement processes, pushes community-driven innovation to compete with companies backed by private venture capital. To be clear, we do not call for an end to regulatory neutrality as it surely plays a significant role in safeguarding against corruption. However, neutrality without

consideration of economic and social inequity militates against community-driven solutions. The ill-effects of this are amplified in a longer trajectory of neoliberalization of city services and austerity policies [24], in which state institutions feel unable to invest in competitors to highly scaled, private companies (i.e. TNCs in our case). Neutrality without equity becomes austerity, ensuring the future dominance of high capital dominance in much of the technology landscape.

6.3 Diminished Driver Agency Over Software

This section documents the challenges UTWSD faces in their efforts to develop and deploy a functioning digital dispatch platform for taxis drivers that also reflects the values of the organization. We have described how financial constraints, state austerity, and a logic of regulatory neutrality exercised by local government institutions pushed UTWSD to partner with third-party technology companies, unable to pay for its own or public software. Then we described how this partnership made the organization beholden to that company's aspirational goals. By partnering with a smaller, less established company, UTWSD had hoped to retain some degree of control over the technical-decision making in their platform. When the gulf between UTWSD's needs and the partner company's goals became too wide—and the path towards a timely and functional dispatch platform became too tenuous—UTWSD felt pressured out of need to trial an “off-the-shelf” solution by partnering with a more established company at the cost of giving up the promise of greater control over technical decision-making. Here, we discuss the consequences of this decision for taxi drivers' ability to realise their collective technological vision.

UTWSD knew from its past experience of attempting to build a digital dispatch that building, testing, and maintaining this kind of platform was expensive. They also knew that drivers did not yet have enough business to “bootstrap” startup capital to pay for the system's development and deployment. As discussed in the constrained resources section, grant-based funding had failed to provide sufficient resources for building a platform of this scale. Efforts to seek public funding through municipal and regional institutions had also been unsuccessful. UTWSD was no longer interested in relying on volunteer time from activist software engineers as they had previously suffered consequences from longtime volunteers dropping out, and they knew that the research group too was unlikely to be able to secure the resources to build and maintain a platform like the digital dispatch over the long term.

UTWSD agreed to a partnership with LogistiRide. As we described in the overview of events, UTWSD were encouraged by the company's regulation-compliant meter, prototype, favorable terms for drivers and desire to come up with innovative solutions to boost the taxi business. Over time, however, our confidence began to wane. We began to realize that LogistiRide's goals as a company, though they overlapped with the goals of UTWSD, were substantially different in kind. First and foremost, UTWSD wanted a simple, and functioning digital dispatch platform that is affordable for drivers and reliable and convenient for riders. As UTWSD began testing LogistiRide's software, we found it buggy and difficult to use. We provided heuristic analyses and wireframes for improvements. UTWSD and the authors urged LogistiRide to focus on critical bug fixes.

LogistiRide lagged behind in fixing critical bugs, but frequently used meetings to “pitch” additional features and new marketing ideas. The company's tendency to slip into business rhetoric and pitch presentations jarred us because we had already signed a contract agreeing to work with them. They also especially sought feedback from the faculty member with tech industry design expertise. Our team began to wonder whether LogistiRide was testing pitches on us to get feedback in advance of presenting to potential venture capital investors. UTWSD had wanted to influence how LogistiRide designed the technology they would use, but feedback on new demos and business lines was not what they had in mind. LogistiRide was focusing their limited resources toward developing promising but minimum-viable implementations (e.g. MVPs) of new technologies and features to

attract potential funders. UTWSD also presented an opportunity for LogistiRide to demonstrate to others that their platform could work, or was working (which they could do regardless of its actual functionality in practice) [94]. We worried that they were using UTWSD as "a testing ground," as UTWSD's president put it, while failing to deliver the reliable but unsexy software drivers needed.

UTWSD was reluctant to abandon the relationship with LogistiRide because they feared that working with an established digital dispatch would limit their ability to advocate for changes that drivers wanted. UTWSD saw an opportunity to influence LogistiRide's design not only because it was still being built, but also because UTWSD was LogistiRide's only pathway to drivers and a market of riders. Eventually, however, the research group rallied to hold LogistiRide accountable to a schedule for critical bug fixes. As the company failed to invest resources into these tasks, the research group pushed UTWSD to reconsider their partnership with LogistiRide and to instead develop a relationship with a "next best alternative" software provider with an established reputation and functional software that had been deployed in other cities.

As we met with UTWSD to look over a sample contract from this "next best alternative" company, we saw few opportunities for customization beyond a pre-articulated software package. Since the platform had already been deployed, and since this city was not the exclusive or even a very large point of access to ridership markets, UTWSD lacked leverage to influence algorithmic decisions in it. Drivers wanted a voice in how rides are assigned, how far a driver would have to go to pick up a passenger, and whether drivers could be deprioritized in the ranking algorithm for declining rides that did not align with their preferred style of work. Our move towards a more promising technology partner made us susceptible to the inflexibilities of an off-the-shelf configuration of platform work despite a cooperative ready to influence the software.

To summarize, resource constraints contributed to diminished agency over the technology development process in two ways. A lack of funding for the technical development of the project pushed UTWSD to partner with a technology company, first making UTWSD beholden to the company's efforts to appear as a promising innovator over providing a fully-tested and functioning product. Constrained access to resources for technology development then ultimately forced UTWSD's hand to move toward considering adoption of an "off-the-shelf" platform with fewer opportunities for the drivers to exert agency over the design of the platform.

6.4 Limited Will

In the previous sections, we showed how constrained access to material resources from grants and local government institutions contributes to a diminished ability for communities to control the implementation of the technologies they imagine. In this section, we show how drivers resist imagining futures clearly impeded by present, practical conditions. The hostile ecology presents barriers that community members recognize as limits to "blue sky" plans [65].

In the early stages of planning the taxi drivers cooperative, discussions about taxi insurance regularly permeated our meeting agendas. As publicly-regulated transportation providers, individual taxi drivers are legally required to purchase driver insurance. The terms of this insurance policy must be compliant with requirements that San Diego Metropolitan Transit System (SDMTS)'s for-hire vehicle administration sets such as qualified insurance companies, and a \$350,000 public liability coverage [112].

Initially, some on the research group felt like the ongoing discussions about insurance were a distraction and sought to help UTWSD organizers re-route these discussions to other fora where they would not interfere with planning the driver cooperative. After many discussions with the drivers and with members of UTWSD, we began to understand insurance troubles in a different light. Discussions about how, and who ought to address the issue of insurance were not a disruption

to the planning of the coop but instead a deliberation on the barriers to drivers' full participation in the cooperative itself.

Taxi drivers knew insurance, a fixed monthly cost, to be a recurring problem. During the height of the pandemic, UTWSD helped drivers leverage different varied government funds to provide short-term financial relief as they struggled to stay afloat. Still, many drivers parked their cars, unsure that they would be able to get enough business to pay for insurance and still make a living after the monthly premium. As individual drivers began to contemplate getting off the ground again, they were hit by the future reality of also paying for insurance. As evidenced by the regularity with which it was discussed during the co-op meetings, insurance costs in the future presented a barrier to drivers' will to speculate and envision. Meanwhile, the monthly insurance premium had held steady at around \$450, despite a steep drop in the amount of public liability coverage the insurance provided [112].

During our co-op meetings, drivers argued among themselves about what needed to be done to find a more viable insurance policy. The problem of insurance demanded a long-term solution. A less expensive insurance provider required regulatory approval. Drivers deliberated whether the regulatory intervention ought to take place at the municipal or state level, and expressed that they felt lack of capacity and influence at the state level to attract a new insurance company to the city.

UTWSD worked with the for-hire vehicle administration manager to identify an existing commercial auto insurance company who agreed to provide more affordable insurance. After the insurance issues were resolved, individual drivers could think more clearly about the future of their cooperative business. This moment shows resource barriers limit people's will to imagine and move toward alternative futures. The "capacity to aspire" [7], this suggests, requires real, material interventions to make aspiration seem possible and speculation worthwhile.

7 PATHS TO INNOVATION

As we did this work, we encountered people – often other Computer Science researchers – who believed that if only taxi drivers could muster access to a digital dispatch with a smoothly functioning interface, then they would be able to compete with TNC tech giants like Uber and Lyft on the same (or similar but smaller, regionally-specific) playing field. We too began from a similar position, with the hopes that our collaboration with UTWSD would help bring the digital dispatch into fruition and push taxi drivers into the high-tech future. Through our collaboration, however, we began to see crucial differences that lay beyond the digital interface in the ways that taxis and TNCs organize labor, capital, expertise, market, and regulation to survive (or even thrive). These differences reveal a technology innovation ecology built, maintained, and adjusted to favor TNCs over taxis. In this section, we discuss these differences.

7.1 Access to Funding

The magnitude of funding resources available to TNCs and UTWSD could not be more different. Uber, for example, was able to raise 1.24 US million dollars in venture capital funding within its first year of operations and has since amassed over 25 billion US dollars [2, 98]. They accomplished this on the promise of expanding the market for on-demand rides while classifying workers essential to their business model as independent contractors [44, 102]. Venture capital funders look for investment opportunities that promise expansive growth in the future and do not, in turn, require the startups they fund to generate immediate profit. In fact, Uber has not been profitable since it started in 2009[98].

By contrast, UTWSD, even with a willing transit agency partner, struggles to identify funding sources that could pay \$400,000 for software and system integration costs. Employment training

grants are not suited to fund software. US National Science Foundation grants, even ones geared for civic software, do not pay for the maintenance of solutions.

The ecology of funding is too complex to map here, but we note several trends and biases in the funding ecology we argue stifle UTWSD's ability to innovate in socially beneficial ways. In the United States, Department of Defense funds by far provide the greatest amount of R&D funding in the US, and the funding most tied to technology innovations in broader public use [42] (see also [96]). The National Science Foundation has long been earmarked by Congress to enhance national competitiveness, meaning that funding programs are earmarked for areas critical to national security or sectors deemed most economically profitable (e.g. creativity, technology, innovation) [17]. In OECD countries, private funding dwarfs even this public funding [42]. Crowdfunding campaigns rarely raise the quantities of money UTWSD and the transit agency would need to create a public software integration; one could argue that taxation is the original and more appropriate source of "crowdfunding" here. Finally, loans are not appropriate for high risk endeavors like UTWSD's as they would saddle lower income communities with debt.

UTWSD's work falls in the cracks between public funding that sees technology elites as innovators to invest in and most people as workers to be trained to find their way in an innovators' world [61].

7.2 Regulation

While Uber, Lyft, and taxis all provide chauffeur services, they are subject to completely different regulatory regimes [32, 44, 45]. Uber and Lyft have followed a pattern of "disruptive regulation" [32]. According to Collier et al.'s analysis, TNCs entered municipalities extra-legally, ignoring the existing for-hire vehicle regulatory regime applied to taxis, jitneys, and shuttles. When municipalities put regulations in place specifically for TNCs, TNCs made use of their venture capital funding to hire lobbying firms (insiders) and their platform to mobilize drivers and customers (outsiders) against elected officials pushing for regulation [38]. TNCs then focused their efforts on preempting municipal regulation by lobbying state legislatures to pass model regulation co-drafted by them that regulates them at the state level rather than the local level where their impacts are most felt [63]. Being regulated at the state level also means that any changes a group of drivers or riders need has to be approved by a state legislature and affects the whole state.

In contrast, municipal agencies have taken the primary responsibility for regulating the taxi industry [44, 53, 95]. This gives workers and riders more local control over policies to align with local needs. For example, municipalities can calibrate pricing to local cost of living and equity goals. Their working conditions, however, are crucially shaped by the actions for TNCs. Drivers who seek to contest or modify TNC policies must build much wider, state-wide coalitions to convince state regulators and lawmakers.

Actors invested in innovation have long engaged in regulatory advocacy [108], though this is rarely examined in HCI and CSCW. UTWSD's path to innovation draws them into the offices of elected officials who sit on San Diego Metropolitan Transit System's and SANDAG's boards, as well as agency staff offices to champion their vision and seek resources. However, they are not networked with cab companies statewide. It is difficult for all but the largest cab companies to have a voice in regulating their TNC competitors.

7.3 Labor

Company owners and managers have long claimed that strong unions or worker power stifle innovation by slowing down experimentation in new products and processes.

For TNCs, the weakness of labor's voice has allowed the companies to experiment with approaches that offer workers little choice about how work is distributed [90, 104]. TNCs draw on

techniques from the science of behavior change, including bonuses and competitions, to manipulate driver behavior [111]. These techniques push drivers to drive tired or speed to high-demand zones [13]. Because TNCs make it simple for many people to sign up, they employ less experienced drivers, almost 70% of whom leave in the first 6 months [33]. TNCs can experiment to innovate, but these experiments might be undemocratic, dangerous, and wasteful.

Taxi drivers have more of a say about what rides they want to take and where and how they want to drive. UTWSD has been working for over a decade towards preserving the distinctions between taxi work and the disempowering elements of gig-work embedded into TNCs platforms. Their path towards building a digital dispatch requires, as we have described, opening up decisions about the dispatch platform and its policies to negotiation by drivers. This more democratic path toward innovation and preserving worker autonomy is, as we have seen, difficult to realize in the contemporary technology innovation ecology, where resource constraints push UTWSD towards more conventional, less empowered relationships to digital platforms and their designs.

7.4 Expertise

Sociologist Gil Eyal defines expertise as the capacity and ability to do something better and faster [54]. Crucially, here, expertise is not just formal knowledge that tends to be associated with education, certification, and professions, but also as a capacity to effectively do. An immense access to capital resources allows companies like Uber and Lyft to hire and maintain experts with the relevant education and certification to manage digital technologies. UTWSD and taxi workers have to largely rely on their own experience, volunteer work, community support and advocacy of coalition networks. We find at least two kinds of expertise relevant in the work we have described here:

- **Computational:** Uber and Lyft are able to attract and at times even poach technology workers with computational expertise who can build, know, and maintain their digital dispatch systems. By contrast, UTWSD and taxi workers require alliances with organizations they do not control, often software companies or contractors, to build and maintain the software. They face difficulties assessing whether those allies are doing good software work, knowing what software changes they can ask for, or negotiating changes because of that knowledge asymmetry.
- **Policy:** As noted in the regulation section above, Uber and Lyft have gone to great lengths to be regulated at the state level instead of by municipalities. They hire experts to push favorable policy at the state level. For example, Uber hired lobbying firms in Sacramento and the Obama campaign's chief political strategist to oppose commercial insurance regulation legislation by the California Public Utilities Commission (CPUC) [11]. In a sharp contrast, taxi drivers, regulated by municipal agencies for decades, do not have the means to hire professional policy expertise. Instead they utilize grassroots organizing methods such as strikes, issuing written statements, building alliances and lobbying municipal legislators themselves. Over time UTWSD has developed local policy expertise, and lobbied for policy change.

TNCs have a continuity of expertise that is geared towards de-territorialized accumulation and the speculative pursuit of capital. In contrast, taxi workers and UTWSD rely on a patchwork of their own and borrowed expertise, along with alliances and solidarities geared towards the regulatory structures that govern them. With sufficient funding, the latter political and expertise formation would likely result in technologies that would be more accountable to the places they're built in and the people they're built for. At present, this funding does not exist. There is inadequate support to realize the innovations that their knowledge can generate. This path to innovation in the current ecology is steep and hostile.

7.5 Market

Marketing usually means appealing to particular groups as customers, such as through advertising, product design, or pricing and distribution strategies. This commonsense notion of marketing emphasizes reaching customers and gaining their recognition. We also emphasize, with digital media scholar Wendy Chun, that "our media matter most when they seem not to matter at all, that is, when they have moved from the new to the habitual" [30].

Uber and Lyft have become habitual in many ways. TNC's access to capital allows them to run massive advertising campaigns, buying ads on billboards, televisions, and even bus stands. They are able to create pervasive brand awareness in these ways, and also use location-specific ads to take riders from public transit (as outcome studies of Uber and Lyft confirm [31]). The city's transit agency, San Diego Metropolitan Transit System, even advertises Lyft on its website [114]. As well-resourced, international firms, Uber and Lyft also have the resources to negotiate powerful corporate partnerships with near-monopoly Google Maps, which invites users to book Lyft rides when they search for directions. Google Maps has over 70 percent market share [28, 81]. They also become habit by making design choices that prioritize quick rider gratification over social and environmental goals. For example, they reduce customer wait times by keeping many drivers on the road. Because these drivers rarely have places to wait, they "deadhead" or drive without passengers creating congestion and emitting carbon into the atmosphere [13, 56].

UTWSD does not enjoy the massive financial resources to advertise like TNCs. Their marketing strategy relies on older forms of signaling such as physical signs and taxi stands in key public spaces. In the past, they have relied on word-of-mouth advertising, flyers distributed to local establishments, and painted messages on taxis circulating around the city [121]. In San Diego, politicians and business owners have let these taxi stands disappear as they outsource transportation responsibility to TNCs and disappear drivers-in-wait from the landscape.

UTWSD's path to innovation cannot rely on the venture-capital fueled partnerships with centralized, global corporations or massive ad buys employed by TNCs. Rather, their path may lie in claiming key urban waiting spaces and influencing institutional action, retrofitting the know how and equipment of an industry to meet new consumer habits and expectations.

8 CONCLUSION

Like with all successful innovations, UTWSD's vision requires aligning municipal, technical, financial, and other actors. As they have pursued their vision of reinvigorating taxis as a first- and last-mile solution, they have worked to enroll municipal actors, resisted the encroachment of TNCs, and inspired the political will of drivers, all while finding the resources to assemble and maintain a socio-technical platform. The innovation ecology, however, we argue has worked against them every step of the way. Community groups pursuing technologically enabled opportunities lack access to appropriate funding sources or software support. They are also regulated by policies that fail to consider equity forcing them to compete directly with companies that are subject to less regulation with more access to capital. As a result, communities experience diminished agency over the design of the systems they live by. In this hostile ecology, they also have to struggle to create political hope, despite their longstanding assets in local organizing, connections to municipal and political actors, and support from researchers and allies. Their struggle to innovate stands in stark contrast to those faced by elite educated and resourcefully networked "tech innovators."

Design, HCI, and CSCW researchers have argued that as technologies enter the public realm, we must engage with the institutions that shape the technologies we use in common. Jackson et al. show how the technologies we use are forged at the intersecting "knot" of design, human (user) practice, and policy [80]. Lodato and DiSalvo analyze design projects to explicate institutional

constraints that bear down on them in the public realm [92]. Huybrechts et al. argue that design practices can be an opportunity to affect institutions in turn [73]. Hostile ecologies conditioned the "institutional terrain" in which our work with UTWSD happened. Our work with UTWSD also tried in small ways to transform our institutions in turn, working to change taxi insurance options so drivers would be able to feasibly drive in the coop and beginning to push for other policy changes that are beyond the scope of this paper.

Some may be tempted to argue that UTWSD could make shrewder choices to succeed in this ecology. In keeping with arguments about equity, however, we argue that the ecology of innovation resources and policies in the United States requires UTWSD to be twice as good to forward their practical and practicable vision. Recall that Elizabeth Holmes raised close to \$1 billion with a turtleneck, a Stanford network, and a dream. Her class position, racial identity, and networks aligned with widespread imaginations of what an innovator looks like and what support they deserve. It is difficult not to conclude that our contemporary institutional and policy ecology landscape reproduces race and class injustice by directing social wealth towards realizing the visions of an elite strata that makes exclusionary claims to innovate.

This case study advances our understanding of localized entrepreneurial practices that take advantage of platform technologies developed for the gig economy (e.g., flexibility, capacity for individuals to not be bound to any one occupation) without the assumptions of large-scale capital investment or extractive "big tech" investment models which have come under public scrutiny. Understanding how the current tech innovation ecology militates against these endeavors in the present is critical if we seek to chart new pathways of innovation towards a fair, equitable, and community-strengthening approach to the technologies of the future.

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