INTERSECTIONS + IDENTITIES

A Radical Rethinking of Our Transportation Experiences

APA Transport

State of
TRANSPORTATION PLANNING 2022

INTERSECTIONS + IDENTITIES

A RADICAL RETHINKING OF OUR TRANSPORTATION EXPERIENCES

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LETTER FROM THE EDITORS

Welcome to the 2022 State of Transportation Planning Report!

As co-managing editors, it is truly our honor to bring to you the 6th edition of the American Planning Association's State of Transportation Planning (SoTP) Report. Every two years, the APA publishes the SoTP Report with the intention of highlighting innovative ideas, cutting-edge research, and interesting experiments in transportation planning in the United States. This 6th edition of the report - with the theme of ***"Intersections + Identities: A Radical Rethinking of Our Transportation Experiences"*** - promises to deliver that and more.

From seasoned practitioners to recent graduates, advocates to academics, formally trained planners to those whose careers took a bit of a detour, we have learned that the contributors to this report share one thing in common: a desire to continually advance this field and a commitment to creating communities that thrive and prosper. In that sense, this report is also about representation. It's our intention that you'll hear from voices perhaps not typically found in the planning literature.

The last two years have brought challenges previously unimaginable. The pandemic has taken a toll on our existing transportation systems and has been tough on our communities, with a disproportionate burden of suffering often imposed upon those who were already underserved by - and underrepresented in - traditional planning practices. Now more than ever, as a global pandemic continues to impact nearly every aspect of our lives, our personal transportation experiences are profoundly affecting where planning goes from here. Accordingly, we wanted the articles in this edition of the SoTP to convey not just the what, where, and how, but the who. That is, the individuals who are behind the exciting topics you'll read about and the intersectional experiences they bring to their work. We wanted to learn about the stories of the people behind this radical rethinking, with a goal of furthering connections among APA members, as well as engaging those beyond.

As much as this effort is about sharing innovations and learnings in the transportation planning realm, we also wanted this report to serve as a jumping-off point for the digital exchange of ideas. It's not a perfect replacement for those casual conversations at a conference coffee hour or the train commute home - you know, the ones that are sometimes far more illuminating and thought-provoking than a formal meeting or panel presentation - but this is definitely a start.

This report reflects the individualized ways in which planners have been using the last two years to adapt, innovate, experiment, and push boundaries like never before.

As the visionaries of this report, it was our intent to invite discussion and reflection around some of the most challenging issues facing our field. This report accounts for the many examples of how the COVID-19 pandemic led to massive disruptions that in turn allowed for some real innovation. It is about the hard conversations around notions of equity and environmental justice. It is about shifting the urban parking paradigm.

This report is about harnessing open-source technology to improve rural transit. It is about developing a fundamental understanding of the needs of tribal communities by considering a range of contextual factors while planning for their transportation and mobility needs. It is about understanding the true cost of accessibility barriers in transportation for people with disabilities and how inclusive universal design of our transportation systems is the way to move forward. This report is about bikes and buses and cars and trains and all the other myriad ways we move about.

We hear from Secretary Pete Buttigieg about his vision of putting safety first as the foundation for initiatives to not just make roads safer for drivers, but also for people who walk, bike, or use a wheelchair. FTA's Administrator Nuria Fernandez highlights the Bipartisan Infrastructure Law that supports transit expansion to improve access and mobility — encouraging us to rethink our transportation systems and the ways that we can expand opportunities for people in cities, towns, as well as rural areas.

There have been reports compiled before this and there will certainly be more written after. As co-managing editors, we have strived to incorporate what we feel is a fresh mix of research, case studies, and other articles, along with, op-eds, personal reflections, and a series of interviews centered on questions that are critical for all of us. These conversations with pioneers and industry leaders offer so much in the way of a radical rethinking and are meant to shape and advance the future of transportation. We're excited to share that these interviews will be released as podcast episodes on the APA's Soundcloud channel.

We would like to end this on a note of gratitude. To our amazing lineup of over 50 authors and contributors, our infinitely thorough editors and creative designers, our insightful interview subjects, and of course the TPD Board of Directors who have provided tremendous support along the way: thank you. Without you, this report wouldn't be possible.

Welcome to the State of Transportation Planning in America in 2022.

Divya Gandhi

Em Hall

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U.S. Department of Transportation

SPECIAL FEATURE

THE STATE OF TRANSPORTATION

WITH SECRETARY BUTTIGIEG

Pete Buttigieg

U.S. Secretary of Transportation

As mayor of my hometown of South Bend, I was fascinated by the professions of many of my city government colleagues. From fire fighters to water quality engineers, the employees in our city administration held vitally important, and often highly specialized, jobs. Among all of them, the one role I most often found myself curious about, even envious of, was that of the planners. Few residents think much about the role of planning in shaping their lives, yet it affects them daily without their having to notice it. Indeed, as is so often the case in public works, some of the most successful and effective achievements in planning can work with such subtlety that they rarely draw attention to themselves among the public.

Now, I have the honor of leading the U.S. Department of Transportation, a wide-ranging federal agency with responsibilities that range from air traffic control to pipeline safety. Infrastructure is getting more attention (and, of course, funding) under the present administration than at any point in my lifetime. Yet I continue to believe the greatest opportunities for these investments may, like so much elegant planning and policy, be characterized by how quietly they empower people to live lives of their choosing.

Consider safety. The consequences of a car crash could completely change a family's life. But in a well-designed, safe transportation system, a parent need not spend time and energy contemplating, let alone recovering from, the destruction caused by a crash—and instead is freed up to focus on more fulfilling concerns, like raising their children in line with their aspirations and values.

Conversely, but no less importantly, we see how it is sometimes infrastructure that doesn't work that most makes itself known, through profound and wide-ranging effects that touch everyday life. These effects can be as dramatic and sudden as a detour around a collapsed bridge, or as matter-of-fact as the persistent harm of a transit desert in a low-income neighborhood. When infrastructure and planning don't serve people as they should, families are often forced to choose between living impossibly far away from work in order to afford housing, or paying too much for housing in order to have a reasonable commute. Too much time and money stands between people and their access to grocery stores, doctor's offices, or houses of worship. Congestion and pollution build up. Days are less rich. Frustrations and even health problems mount.

On a recent trip I spoke to a mother in New Jersey, advocating for commuter rail, who described in moving terms how the lack of good transportation options between her neighborhood and her workplace meant she was not home enough to be the parent she wanted to be. At an event to unveil new bus funding in Baltimore, the mayor described his experience as a child commuting more than two hours to get to school on the bus system - longer than it had taken me to travel there from Washington that day. In Syracuse, I saw a community divided by a legacy highway, and met civic leaders working to re-establish the connections that had been cut a generation earlier when the roadway was built.

For me, these experiences have helped illuminate the stakes of transportation policy - and in particular, the meaning of the opportunity in front of us with the historic investments made possible by President Biden's Bipartisan Infrastructure Law. The flaws in our transportation infrastructure can frustrate, divide, and harm. But better transportation infrastructure holds the promise of connecting more people to jobs, opportunities, services, and to each other. It holds the power to make life more affordable, reduce inequities, protect against climate change, and make our daily routines much safer.

The transportation moment in which we live - an Infrastructure Decade, as President Biden often says - also accordingly raises the already-high stakes of the work of the planning community. As planners, designers, urbanists, policymakers, researchers, advocates, and engaged citizens, your work has always mattered in connecting grand visions and investments to the rhythms of everyday life. But our current moment is unique, and your work ahead holds even more promise to improve people's lives and make generational progress in transportation.

Much will depend on how your community, and my Department, respond to the realities laid bare in recent years:

- The pandemic has shown us how quickly we can adjust our built environment when needed – bringing dining onto sidewalks, closing streets to vehicle traffic, changing our relationship to offices and commuting. This has led to transformations, both good and bad, in the way people and goods move around our communities.
- With the climate crisis accelerating, Americans have faced increasingly deadly storms in New York, floods in Michigan, droughts in the West that lasted longer than the Dust Bowl (with accompanying wildfires), tornadoes and hurricanes in the South, and more. These events push the limits of what our infrastructure was designed to handle, and in some cases, like in the Pacific Northwest this summer, exceeded them, as streetcars had to be halted due to cables at risk of melting, and the very pavement along I-5 began to buckle. This is forcing us to rethink how we build, how our land use plans will shape our climate and vice versa, and how the right answer for a transportation design selected today might look different within just a few years.
- After the murder of George Floyd, America's understanding of, and discourse around, racial equity took a step forward, with hope that the marches on the street would lead to tangible, lasting changes in every facet of life. The many good intentions expressed during and since that painful summer are now due to be turned into concrete action, including through public policy choices around economic opportunity, transportation, planning, and infrastructure.

- And of course, President Biden delivered the Bipartisan Infrastructure Law, the most important investment in generations to modernize our infrastructure - our roads and bridges, rail and transit, ports and airports, freight routes, and more.

This law will be transformative. But just how transformative – and exactly what our communities transform into – will in many ways be designed by the members of the American Planning Association.

As we undertake this work, here are some of the priorities shaping our approach as a Department, which I hope you will also consider and pursue.

First is the foundation of the Department of Transportation: safety. Even as Americans drove less in the beginning part of the pandemic, traffic fatalities spiked. This trend continued into 2021 with an estimated 31,720 people who died on our roadways in the first nine months of the year. This is an urgent crisis. It is also a preventable crisis that we must do more to reverse.

The Bipartisan Infrastructure Law creates a new Safe Streets and Roads for All grant program, through which local governments, Tribal governments, and metropolitan planning organizations can apply for funds to develop and implement comprehensive road safety programs. Of particular note for this audience, at least 40% of the funding will go towards developing comprehensive safety plans. We expect these initiatives to make our roads safer not just for drivers, but for people who walk, bike, or use a wheelchair.

In addition to providing the funding, we released the first-ever National Roadway Safety Strategy. It is a comprehensive, data-driven plan to reduce injuries and deaths on our roads, and we ask that you take some time to review it, and use its principles as a roadmap in the years to come.

Second, throughout the American experience, transportation and land use have combined as major drivers of either equity or inequity, and that is still true. Major transportation inequities persist today, reflected in the average length of commutes, the safety of simply walking in one's community, and the direct economic benefits of jobs and contracts associated with infrastructure construction and development.

The new law creates the first dedicated program to help reconnect communities that were divided by inequitable transportation infrastructure. We know that the solution will not be identical in each case, so we have significant funding for local planning efforts to engage the community and find the right path forward.

Equity calls for true, deep inclusion of community stakeholders from the very beginning of processes and projects. It also means ensuring historically excluded communities have an opportunity to compete for procurement and jobs that build generational wealth, with approaches like the local hiring policy we recently restarted.

This is another area where your voices and courage will determine success. You help set the tables where these processes play out. You can widen them to include more voices, make them more inclusive, and help increase the capacity of people and organizations in your community to shape, and at times literally build, the infrastructure that will serve them.

Third, we need to prepare for the realities of climate change, even while doing all we can to stop it.

The Bipartisan Infrastructure Law empowers us here in a number of new

> *These past years have shown us we can't predict the future, so when planning, we can't work towards one, single future...We can build in a way that makes future improvement possible, rather than tying us in to one solution for decades.*

ways. It makes a historic investment in transit and rail, walking and biking. It will help electrify buses and ferries. And it includes the first Department of Transportation-administered program dedicated to infrastructure resilience.

I am especially enthusiastic about the law's provisions establishing a nationwide network of electric vehicle charging stations. We will again look to you to help ensure that EV infrastructure is accessible to people who stand to gain the most from not having to pay for gas: rural residents who drive the longest distances, and city residents in dense multifamily dwellings who don't have home garages in which to park and charge.

Fourth, we have the tools, and a renewed necessity, to better prepare for what we know is ahead and future-proof for what we cannot predict.

Where will the next shock to our country and communities come from? It might be a force like the pandemic. It might be a force like climate change. It might be a destructive phenomenon like an armed conflict abroad, or a positive one like a new technology that reshapes our ability to navigate, unlock a bike, or summon a ride.

We must embrace the reality that the way people interact with the world is changing, and meet them where they are, including on their phones. Digital infrastructure is critical to making the most of our physical infrastructure and achieving our goals.

We can steer innovation towards our shared purposes. For example, as I noted earlier, we are supporting the shift to electric vehicles in order to combat the climate crisis, secure American manufacturing jobs, and cut gas costs for families. Slightly further in the future, autonomous vehicles could increase safety and, by delivering themselves on-demand to where people live and work, allow some land to be used for better purposes than parking (and what planner is not thrilled by the prospect of being freed from the constant need to accommodate as much surface parking!). But depending on our choices, this same technology could also induce yet more demand for single-occupancy vehicles and thereby increase sprawl, congestion, pollution and disparities.

These past years have shown us we can't predict the future, so when planning, we can't work towards one, single future. Rather, we can focus on our values and goals, and then plan for multiple future scenarios that reflect them. We can build in a way that makes future improvement possible, rather than tying us in to one solution for decades.

Future-proofing does not mean we should avoid investing in the big, game-changing

projects that we can only do together. Can New Yorkers imagine New York City without the subway? Can people in Southeastern Louisiana imagine life without the Lake Pontchartrain Causeway bridges? The point here is not that we shouldn't take the risk, where justified, of investing in an asset that we will be committed to supporting for decades. Rather, we need to do so in the context of strategies that leave as much room for later refinement or evolution as possible.

Preparing for the future also means preparing our workforce for the future. The workers, especially union workers, who have kept us afloat during a pandemic and accompanying global supply chain disruptions, should be empowered to drive the transportation systems of the future. And with the infrastructure law, we'll be creating many more jobs that offer people a pathway to the middle class. That's why the law includes funding that recipients can use for apprenticeships and training in the transportation and infrastructure skills of the future. These programs must make it easier for people to take the time needed to participate and graduate.

The undertaking of the years ahead, when it comes to our infrastructure, will require us to think in an interdisciplinary fashion, across traditional siloes. Here, I am mindful that many in the planning community have been working in just this way, which does not always come as naturally to the Federal executive branch. A classic example of this is transit-oriented development, which local communities have often led with and which we are striving to better support in my department and our sister agencies across the administration.

The Bipartisan Infrastructure Law provides the largest federal investment in transit in history, and the largest investment in passenger rail since the creation of Amtrak. Driving will always be part of American transportation, but we are determined to also give as many people as possible more freedom and options to get where they need to go – affordably and efficiently. That includes good transit, rail, walking, biking, and using a wheelchair – and it's not limited to our biggest cities. In towns and cities of different sizes across the country, we want people to be able to take a bus or train to the town center, and then have the option to navigate from there, even if they don't have a car with them. People are more likely to take a train to another city if they won't still need a car once they arrive in that city. The infrastructure law increases funding for our Pilot Program for Transit-Oriented Development Planning by 38% and expands our capacity to finance TOD projects.

I am deeply hopeful about the opportunity ahead of us. We can improve American transportation to keep more people safe, create more jobs, increase equity, combat the climate crisis, and thrive well into the future. To succeed, we will need the partnership of America's community of planners. This Administration seeks to not just be a source of funding, but a true partner, in this shared mission. I believe the 2020s will prove a transformational decade for transportation, and I look forward to the work we will all undertake to shape that transformation together.

About the Secretary

Pete Buttigieg

Pete Buttigieg serves as the 19th Secretary of Transportation, having been sworn in on February 3, 2021.

His focus as Secretary is to deliver the world's leading transportation system for the American people and economy. He has worked to achieve organizational excellence in the department's operations, and to focus the department on five policy goals: safety, jobs, equity, climate, and innovation. In his first year at the Department, he prioritized supporting the development and passage of President Biden's signature Bipartisan Infrastructure Law. Since the law's passage, Secretary Buttigieg and his team have focused on effectively delivering the investments provided by this legislation, enabling the most significant improvements in U.S. transportation infrastructure in over half a century.

The first openly gay person confirmed to serve in a president's Cabinet, Secretary Buttigieg previously served two terms as mayor of his hometown, South Bend, Indiana, where he worked across the aisle to transform the city's future. Household income grew, poverty fell, and unemployment was cut in half. His work on transportation as mayor was nationally recognized, including an award for innovative streetscape design from the U.S. Department of Transportation where he now serves. He also served for seven years as an officer in the U.S. Navy Reserve, taking a leave of absence from the mayor's office for a deployment to Afghanistan in 2014.

The son of Joseph Buttigieg, who immigrated to the United States from Malta, and Jennifer Anne Montgomery, a fifth-generation Hoosier, Secretary Buttigieg is a graduate of Harvard University and Oxford, where he was a Rhodes Scholar. He lives with his husband Chasten, their two children, Gus and Penelope, and their two dogs.

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RESILIENCE

THE PANDEMIC AND BEYOND

HOW THE PANDEMIC CHANGED BICYCLING

Lessons from The Midwest

Ali Al-Ramini
Daniel P. Piatkowski
Alison Freifeld
Fadi Alsaleem

INTRODUCTION

Bicycling has garnered headlines in the US and internationally as urban residents seek ways to travel and exercise in safe, physically distant ways during the COVID-19 pandemic. Surprisingly, rates of bicycling (by several metrics) have significantly increased during the pandemic, and the bicycle business is experiencing unprecedented demand. The specifics of how bicycling has changed with the pandemic have immediate implications for planning for pandemic resilience and long-term implications for meeting public demand for infrastructure that supports recreational bicycling.

The outbreak of COVID-19 in the first quarter of 2020 changed our lives in many aspects, forcing governments around the world to implement severe measures to battle this disease (Hale et al., 2020). These measures included some of the following: restrictions on gatherings, workplaces closing or maintaining minimum occupational capacity, and school closing by converting to remote learning (Hale et al., 2020). The sole goal of these restrictions is to minimize the spread of COVID-19 by significantly reducing the number of people in any indoor facility such as schools, restaurants, gyms, and many others (Wimalawansa, 2020).

As a result, many urban residents found outdoor facilities like parks and trails the only outlets to exercise in a safe and physically distant environment (Altavilla, Macrì, & Esposito, 2021). For example, bicycling has experienced a surge in activities at the beginning of the pandemic, and bicycling businesses reported an incomparable demand (Ehsani et al., 2021), which indicates that the pandemic changed cycling behaviors. However, how the pandemic changed cycling behaviors is still unclear.

Therefore, this paper uses fitness app data (Strava) for three years before the COVID-19 pandemic and 21 months (January 2019 – December 2021) following the onset of the pandemic to assess changes in bicycling behavior within the COVID-19 restrictions and after relaxing

these restrictions; including the type of travel (leisure or commute) and trip volume in the state of Nebraska located within the Midwest region in the United States of America (Strava Metro, 2019; Hong et al., 2020; Venter et al., 2021). Moreover, this study aims to understand how the pandemic changed cycling patterns and how other factors like bike infrastructure played a role in shaping this change. This opens the door to model perceptions of safe and accessible bike infrastructure using machine learning algorithms (e.g., Artificial Neural Networks).

Additionally, we can explore how stay-at-home requirements have impacted temporal bicycling at the state level. For example, descriptive analysis reveals that people shifted their riding towards recreational travel instead of commuting by bike. Finally, studying the cycling patterns after relaxing COVID-19 restrictions and eventually introducing vaccines provides an insight into the long-term effect of the pandemic on cycling temporal activities.

METHODOLOGY

Studying the changes in bicycling during the COVID-19 pandemic requires several sources of data, including the following:

- Cycling data extracted from Strava provides the number of cyclists riding in Nebraska categorized by origin (locals and visitors). Also, it includes the number of trips completed by cyclists in Nebraska (Strava Metro, 2019).
- Oxford COVID-19 Government Response Tracker regularly tracks the government's response to the COVID-19 pandemic and provides information about restrictions like limiting social gatherings, workplace closing, school closing, and others (Hale et al., 2020).
- COVID-19 vaccination tracker extracted from the United States Centers for Disease Control and Prevention (CDC) tracks the number of people vaccinated and the percentage of vaccinated people to the overall population in each state over time (CDC, 2021).

We superimposed the COVID-19 data on the cycling data to provide descriptive analysis that describes some of the pandemic effects on cycling behaviors.

RESULTS AND DISCUSSION

Here, we provide data analytics showing the effect of the pandemic on cycling behaviors in the state of Nebraska by utilizing three years of data prior to the COVID-19 outbreak from 2017 to 2019 and 21 months of data at the onset of the pandemic in early 2020) through September 2021. Figure 1 shows the absolute annual number of Strava users and the annual number of trips from 2017 to 2021. The figure indicates that the number of users and trips significantly increased during the pandemic between 2020 and 2021. In addition, the number of users increased by 52%, and the number of trips increased by 48% in 2020 compared with 2019. The number of users increased by 49%, and the number of trips increased by 30% in 2021 compared with 2019. These results indicate a shift in cycling behavior during the pandemic. Therefore, this implies that people were attracted to cycling for leisure purposes like physical exercise or commuting.

The overall increase in cycling patterns shown in Figure 1 does not necessarily infer that individuals started using bikes more often. For instance, Figure 1 demonstrates an increase in the number of people using bikes that led to an increase in the absolute number of cycling trips recorded by Strava. However, Figure 1 does

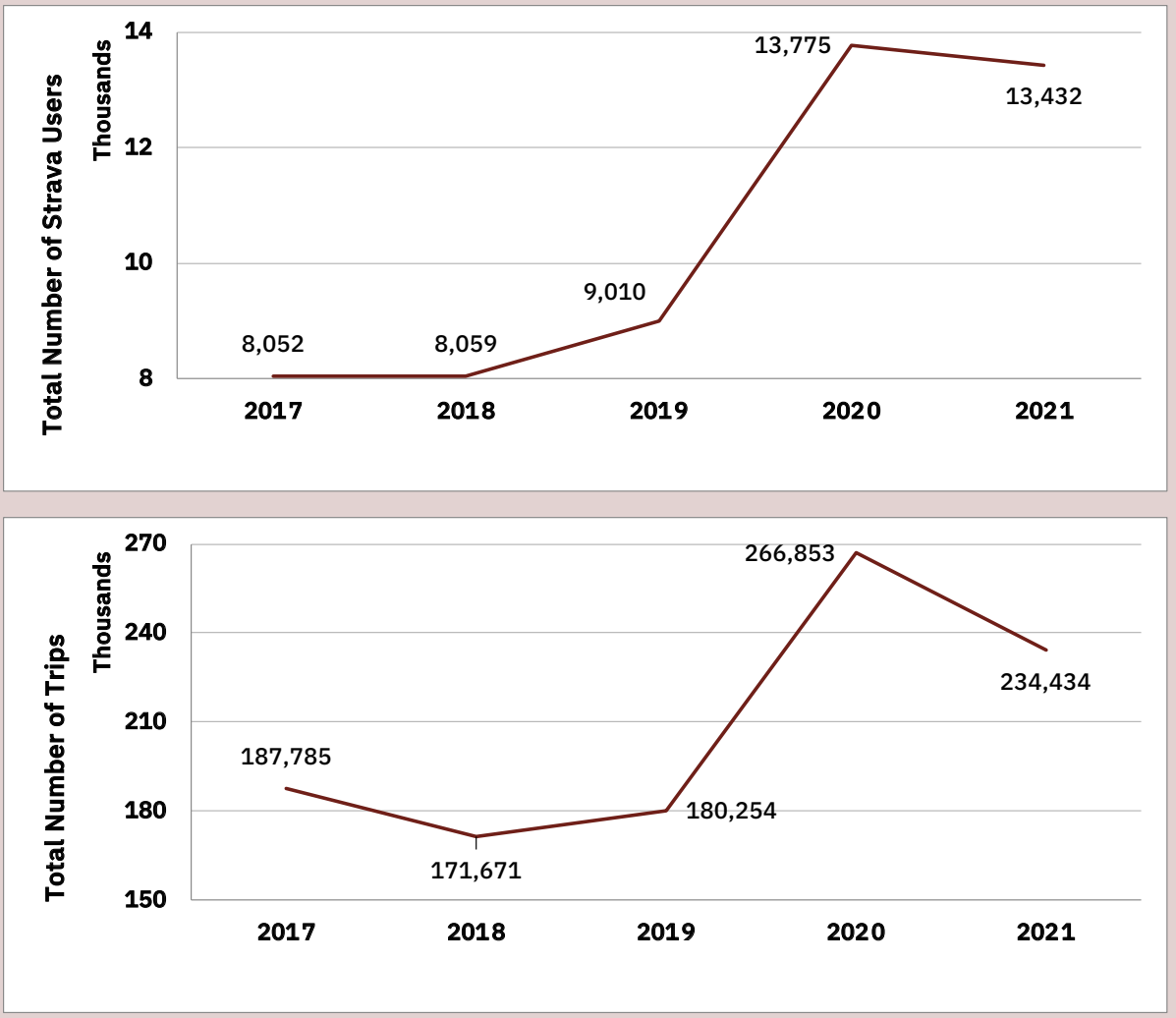

Figure 1: A) The total number of Strava users each year, B) The total annual number of cycling trips completed by Strava users.

not capture the number of trips per user. Therefore, to provide a better insight into cycling behaviors during the pandemic, we need to dig deeper and look at the cycling trips in terms of trips per person and cycling purpose, whether it is leisure or commute.

Figure 2 shows the number of cycling trips per person in terms of total trips, the sum of leisure and commute trips, and in terms of leisure and commute trips separately. Figure 2 shows that total trips per person decreased during the pandemic, but leisure cycling increased, suggesting that the pandemic positively impacted cyclists' recreational behaviors. On the other hand, commuter cycling declined with the onset of the pandemic in 2020 and maintained the same rate in 2021 due to COVID-19 restrictions like school and workplace closings.

Figure 3 demonstrates a monthly breakdown of cycling trips in terms of cycling purpose to show the effect of the COVID-19 pandemic on leisure and commute cycling. In addition, figure 3

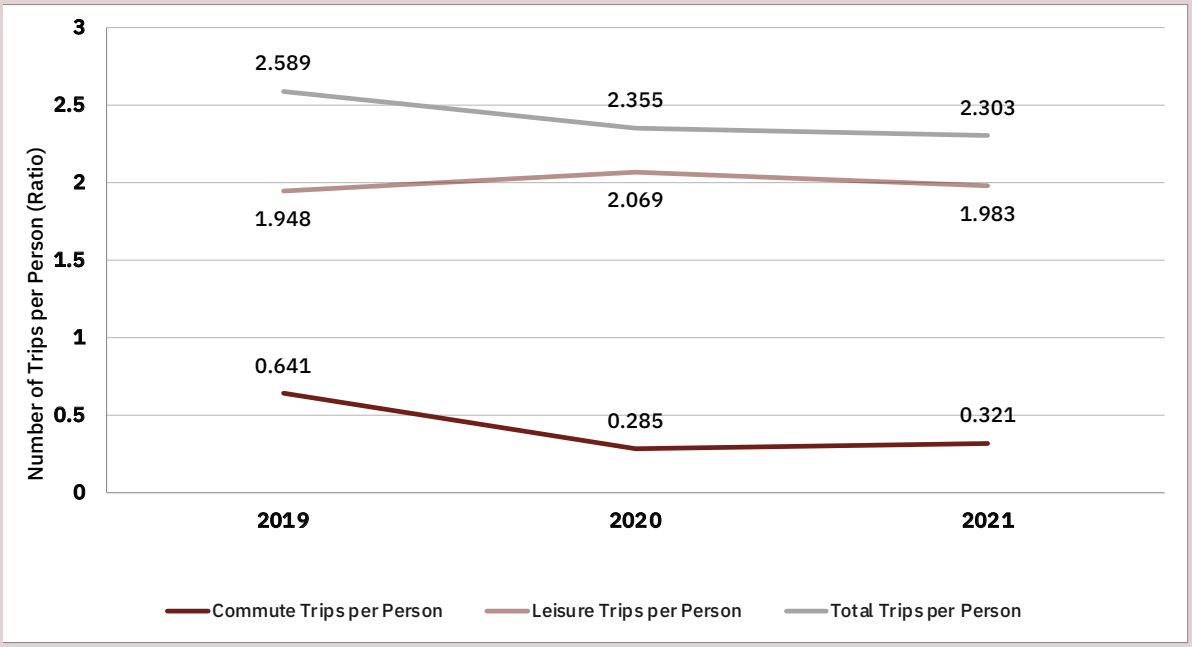

Figure 2: A breakdown of cycling trips per person in total, leisure, and commute trips.

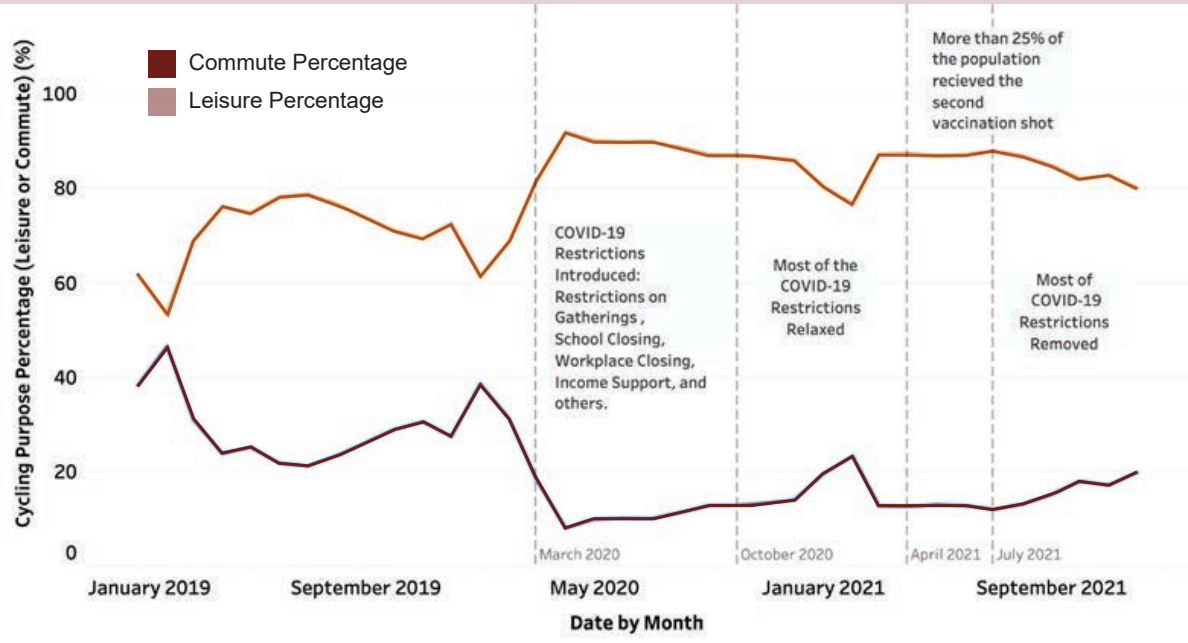

Figure 3: The effect of the pandemic on cycling in terms of purpose.

shows a timeline of COVID-19 restrictions to study the pandemic effect on cycling. Many COVID-19 restrictions were introduced in March 2020, such as closing schools, workplaces, gyms, and other indoor facilities. This caused the commute percentage of the cycling trips to decrease because people were not able to commute or travel to extracurricular activities. Subsequently, many COVID-19 restrictions were relaxed in October 2020, leading to a slight increase in commute cycling as people began returning to their normal activities. However, other factors, including cold weather, cycling infrastructure, and others [10,11,12], could cause the above observations (Dill, 2009; Alsaleem et al., 2020; Zhao, 2018). Moreover, we can see the same increase in commute percentage in 2019 and 2020 before the pandemic.

Therefore, there is no evidence that commute cycling started to recover after the pandemic negatively affected commute cycling trips. Furthermore, the same low commute percentage ,as seen in 2020, continued into 2021, providing further evidence that the pandemic hurt commute cycling even after relaxing and removing many COVID-19 restrictions and introducing vaccines in the first quarter of 2021.

CONCLUSION

In this brief paper, we show a preliminary analysis of how the cycling behaviors changed during the pandemic by comparing cycling patterns before and after the outbreak of COVID-19. We use three years of cycling data prior to the pandemic (2017 – 2019) and 21 months after the rise of COVID-19. We combine the Strava cycling data with other COVID-19 related data, including Oxford COVID-19 Government Response Tracker, which tracks COVID-19 related government restrictions, and the CDC vaccination trackers, which show the percentage of vaccinated people in each state.

In our preliminary analysis of the pandemic's effect on cycling in general / overall, we found that the number of people engaging in cycling activities and the number of cycling trips increased in 2020 during the pandemic. In 2021, the number of cyclists and trips was higher compared to 2019 but less than in 2020, implying the likelihood of a long-term positive effect on cycling in the upcoming months or years.

Then, we studied the effect of the pandemic on leisure and commuter cycling. We found that the leisure trip rate increased in 2020 and 2021, indicating that people were attracted to cycling for physical activity as an alternative during the pandemic. In contrast, commute cycling rates dropped significantly during the pandemic, as shown in Figures 2 and 3, because of school and workplace closures. Besides, in 2021 with further relaxing many COVID-19 restrictions, the commute cycling rates remained lower than 2019 rates before the pandemic. Therefore, with the onset of the COVID-19 pandemic, cycling is used more for recreation and less for commuting in Nebraska.

In summary, our findings show the importance of recreational infrastructure that is accessible to all members of the community. In addition, the pandemic has changed how, when, and why people ride. In this paper – we link these trends to practical approaches to ensuring cities within Nebraska meet this new demand.

Areas for further study include analyzing other factors that might influence leisure and commute cycling. For example, trails are linked to leisure cycling, which is more ubiquitous in Nebraska than on-street infrastructure and commuting cycling (Fishman, Bikeshare: a review of recent

literature, 2016; Fishman, Cycling as transport, 2016; Hong et al, 2019). Also, the number of trips per person could be broken down even more in future research to study the effect of the pandemic in different groups of cyclists, unlike what we show here, which is an overview picture of the cycling patterns before and after the pandemic. Finally, this research does not claim that cycling patterns worldwide were affected equivalently as in Nebraska. Nevertheless, this research provides some key research ideas related to pandemics' short-term and long-term effects on cycling patterns. Thus, researchers in this field could use our preliminary results to study the spatial effect of the pandemic to spot the preferred commute and leisure bicycle infrastructure during the pandemic. Moreover, with enough data, future research could utilize machine learning algorithms to model the effect of the pandemic on cycling patterns for future pandemic response.

About the Authors

Ali Al-Ramini

Ali Al-Raminiis a Mechanical and Architectural engineer with experience in research, development, data science, and machine learning. During his graduate studies, Ali quantified the effect of newly added infrastructure on cycling volumes using machine learning and built a deep learning model that ranked top 10 in the Global XPRIZE Pandemic Response Challenge. In addition, he worked on colocalizing sensing and intelligent computing in micro-sensors.

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Dr. Daniel P. Piatkowskiis an Associate Professor of Integrated Land-Use and Transportation Planning at OlsoMet – Oslo Metropolitan University. His research interests center on active transportation, equitable planning, and emerging technology at the intersection of planning and urban design. At OsloMet Dan teaches courses in Transportation Policy and Urban Mobility as part of the Smart Mobility and Urban Analytics Master's Program and is a member of the Transport Infrastructure and Urban Development (TransFrUrban) research group.

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Dr. Fadi Alsaleem

Dr. Fadi Alsaleem is an Assistant Professor of Architectural Engineering at the University of Nebraska-Lincoln. His current research goals are to advance intelligent wearable sensing technologies and artificial intelligence algorithms and their use in many medical applications. He has more than ten awarded patents, more than 100 publications, presentations, and invited talks in this research area, and over $6M total (nearly $1.5M to his research team) of active funding.

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Cover photo: Silhouette of a person riding a bike at sunset (Pexels)

THE FUTURE OF VIRTUAL ENGAGEMENT

Lessons from the Pandemic and Beyond

K.K.L Bhanuja Damarla
Monica Villalobos

The COVID-19 pandemic has taught us about the need to continuously adapt to new social and environmental realities resulting from changes in regulatory policies. This process of immediate and reactionary responsiveness has led to many innovative developments, especially in the realm of planning and public engagement. New approaches, such as virtual walking tours can be used to create greater reach by increasing accessibility and participation of stakeholders and the public. The virtual space provides new opportunities to effectively manage walking tours, casting a wider net for online participation, offering flexible times for participation, and accommodating greater numbers and types of engagement. Virtual walking tours have proved to be a highly-effective planning tool during the pandemic. Virtual engagement has also proven an effective complement to traditional in-person engagement arguably with a promise to stay.

Walking tours have been an effective engagement tool on many planning projects where site-specific input is needed at the local level and where neighborhood context is key. Walking tours are especially critical for decision-making and project prioritization, often used for planning related to First-Last Mile (FLM) and transit planning projects. Traditional (in-person) walking tours involve project teams physically walking through sites and organizing charrettes, surveys, or facilitated question and answer sessions with stakeholders to receive community feedback. In contrast, virtual tours allow for self-guided participation on an online platform. They are mostly limited by internet access. They present opportunities to easily facilitate information sharing and input requiring less in-person labor and management while shielding the process from adverse weather events.

In the spring of 2020, Los Angeles County like much of the country was under strict lockdown orders due to COVID-19, rendering in-person walking tours infeasible. Los Angeles County Metropolitan Transportation Agency (Metro) had plans to conduct in-person walking tours for areas along with the proposed C (Green) Line Extension Project

(Project), which will extend light rail to Torrance. The Project, currently in the environmental phase, had hoped to engage residents and stakeholders by walking the neighborhoods that abut the proposed alignments and soliciting input. Given that COVID-19 safety measures were in play for the foreseeable future, Metro had to come up with an alternative solution to receive feedback during the project timeline without the need to physically gather.

Metro and the consultant[1] team decided to organize a series of virtual neighborhood walks with an emphasis on using an interactive platform that was accessible, educational, and easy to gather input. The team decided to curate the walks using ArcGIS StoryMaps (an Esri software program) combining traditional online content with narrated video and survey questions to allow visitors to virtually explore segments of the light rail alternatives at the local level. The idea of online engagement is not new, yet technology innovations, emerging platforms, and the intentional creation of more interactive formats are changing how we engage with the public on planning projects.

The virtual neighborhood walks (Figure 1) for the C Line Extension project utilized an interactive platform and media to increase participation. The platform allows visitors to follow a guided map and view key aspects of the neighborhoods along with the proposed alternatives. These maps virtually explore the two alternative alignment options with narrated pre-recorded videos at key stops along the moving walking route. At the end of each walk, questionnaires were available to provide feedback on key design elements, along with an option for open comments.

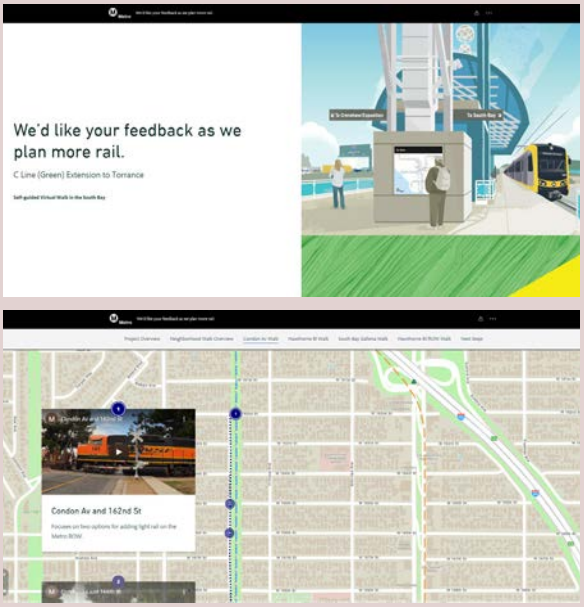


Figure 1: Screenshots of a virtual neighborhood walk. Source: Metro, 2022. Available online https://storymaps.arcgis.com/stories/f06979716e0542f093b55fff8c15082e

The platform was designed to easily gather feedback on what is important to the community. In traditional walking tours, teams usually assign a scribe who takes notes to capture feedback and communication during the tour. Hence there exists an opportunity for communication gaps and interpretation of feedback. Using virtual platforms helps reduce these drawbacks as the communication originates directly from the stakeholder within the survey window. The feedback and comments are safely stored by the system and the data is easily retrievable and sortable.

Metro is not alone in the shift towards increasing online participation and engagement. Other public agencies like the San Diego Association of Governments (SANDAG) and the City of Lafayette, California have used similar online platforms to receive localized input (Figure

[1] The C Line Project team involved in the development of the virtual neighborhood walk tours includes STV, The Robert Group, City Works Design and Vicus Planning.

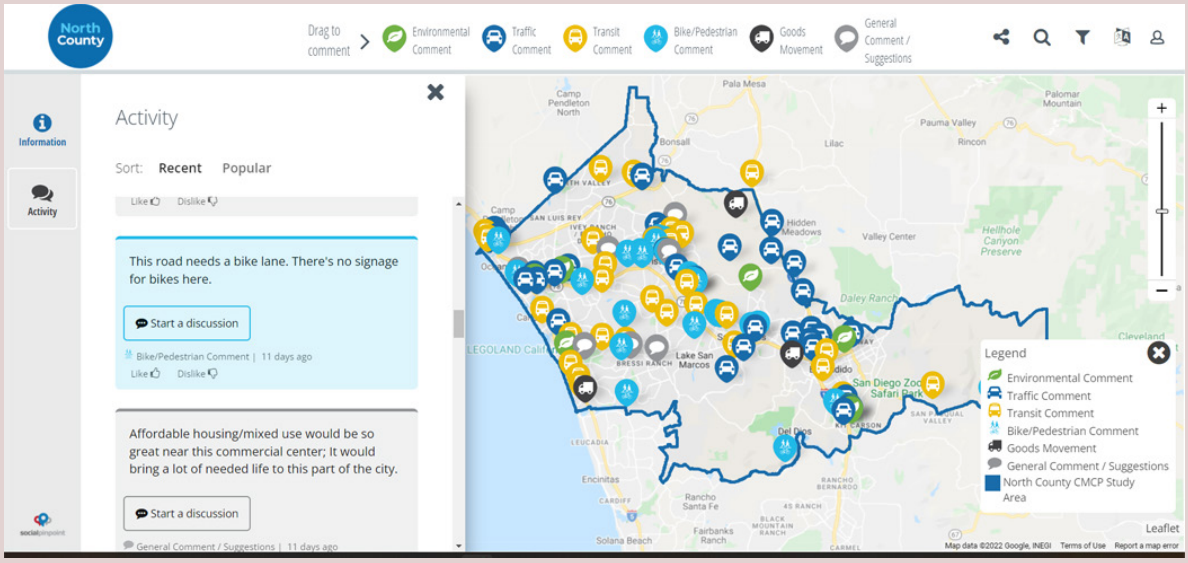


Figure 2: Screenshot of the Socialpinpoint virtual platform. Source: North County Comprehensive Multimodal Corridor Plan (CMCP SANDAG, 2022). Available online https://sandag.mysocialpinpoint.com/northcounty

2). SANDAG used the Socialpinpoint virtual platform to receive public input on the North County Comprehensive Multimodal Corridor Plan (CMCP) (Sandag, n.d.). The Socialpinpoint platform combines base maps with geo-specific comments using icons for planning topic areas and survey questions.

The City of Lafayette used a similar walking tour concept for their Housing element update. They incorporated a YouTube video embedded on the site along with a digital map of the route to share information with the public (Robles, 2021).

In addition to the examples stated above, there is a body of research on virtual tools and public participation in the planning field (Iroz-Elardo et al., 2021). As the research suggests, aside from online platform tools such as Geographic Information System (GIS), renderings and photo-simulation have been effective in promoting greater stakeholder participation in planning and design processes (Al-Kodmany, 1999).

For the C Line Extension Project, using the virtual tour platform proved highly engaging, resulting in a large number of participants (Figure 3). Metro tracked the participation over six weeks and found that more than 1,600 people visited the site. With 2,500 views, some people visited the site more than once. A total of 232 surveys were submitted. The numbers are impressive and outweigh the levels of engagement typically allowed from traditional in-person events. The responders included diverse groups who do not or cannot usually participate in traditional walking tours.

While the response to the virtual neighborhood walks was a good turn-out, Metro plans on conducting additional in-person walking tours later this year. The hope is that while the virtual walks provided a key avenue for engagement during the pandemic, when possible in-person activities help to further relationship building with residents in the area. The

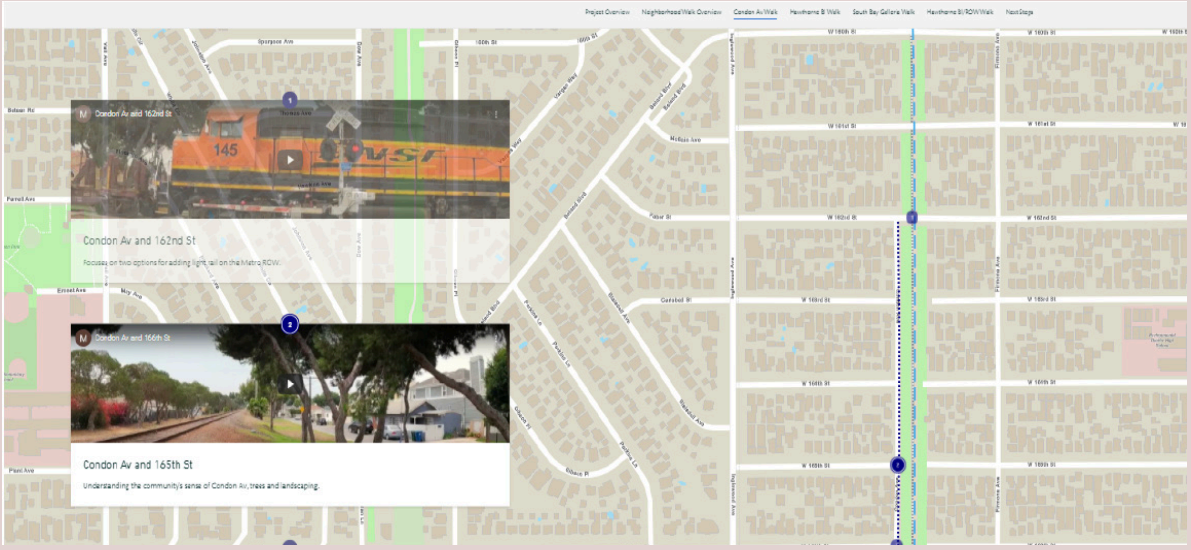


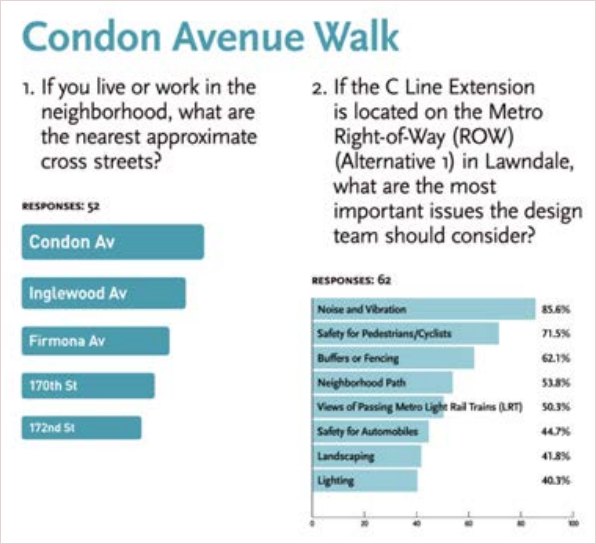
Figure 3: Screenshot of the C Line Extension Project virtual tour. Source: Los Angeles Metro, 2022

virtual walking tours were an effective way of gathering input and foreseeably could continue to be used as a complementary public engagement tool (Figure 4). Despite all the encouraging signs, virtual tours have drawbacks that need to be addressed to improve their use and widespread adaptability.

As noted earlier, internet access can be an obstacle for those who have limited access, especially for low-income households. Additionally, improvements to allow for visually impaired participants should be explored. In addition, virtual tours provide fewer opportunities for relationship building - an important component of consensus building and trust between agency representatives and the public.

Metro is the first of many agencies trying new platforms to keep participants engaged during a pandemic and health crisis. Metro synthesized feedback from the survey and posted infographics on the same website to be easily viewable to the public. The virtual neighborhood walks have proven to be a valuable step towards continued public engagement and hopefully, a valuable complement to other in-person activities as in-person social gatherings commence.

Using these kinds of platforms places public feedback as the topmost priority, with an emphasis on broader accessibility and enhanced engagement. The combination of both virtual and in-person walking tours might offer even greater public participation and a valuable way to sort and quantify input. Innovations such as these are a starting point for planners and designers to consider as they plan for meaningful public participation during the pandemic and beyond.



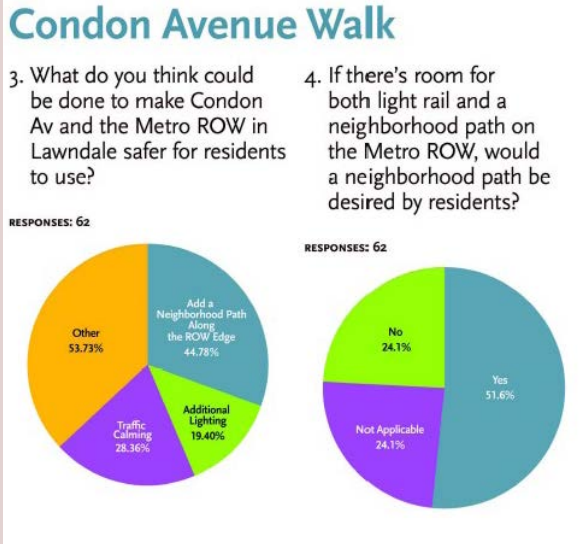


Figure 4: Examples of the types of information collected as part of the Condon Avenue Walk questionnaire. Source: Los Angeles Metro, 2022

About the Authors

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Bhanuja is a trained architect and urban designer experienced in working with private and public sector clients. She brings a fresh design-oriented perspective to planning projects and studies. She is motivated by a desire to transform space into a healthy, equitable, and sustainable urban environment. Bhanuja has worked as an architect and project planner developing master plans, hospitality projects, large-scale commercial projects, streetscape design, first/last mile plans, transit-oriented communities, and transportation planning studies.

Monica Villalobos

Monica (she/her) brings over 15 years of experience in the planning and transportation field. Her passion and commitment to the field are evidenced by her extensive experience and leadership roles. As Principal of VICUS (a Los Angeles-based company), Monica leads an organization dedicated to client service, delivery of high-quality products, and innovative solutions. She brings a unique cross-disciplinary perspective having worked in the fields of transportation planning and policy, NEPA/CEQA, Transit-Oriented Communities (TOC), land use, active transportation, first/last mile, and award-winning community engagement strategies.

Bhanuja and Monica are part of the consultant team (TOC and UD-TOC coordination leads) for the C Line extension to Torrance project for the Los Angeles Metro.

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Cover photo: Gold Line train on East 1st Street, July 2017 (Wikipedia)

TACTICAL URBANISM REVISITED

How the Pandemic Forced Cities to Rewrite the Rules of the Road, and What That Means for Citizen Stewardship of The ROW

Ariel Ben-Amos

In 2020 Philadelphia wrote a temporary new rulebook for managing its streets. To help Philadelphia's vibrant restaurant ecosystem survive, the city administration (City) allowed restaurants to claim parking spaces, sidewalk space, or even whole blocks to create space for outdoor dining. The results were staggering: 15 blocks closed entirely to automobile traffic and over 520 parking spaces instantly became al fresco dining rooms directly in the right-of-way (ROW). These dining spaces represented an interesting hybrid, an extension of pre-existing private rights into the public ROW, using a palette of interventions more typically associated with public space programs from parklets to open streets, all in service of mitigating the impacts of the pandemic.

In doing so Philadelphia expanded the number of people interested in (relatively) low-cost streetscape interventions often called "tactical urbanism" and usually associated with a smaller constituency. Before the pandemic, most such streetscape interventions (utilizing flex posts, parklets, planters, and other 'temporary' structures) were led by Community Development Corporations (CDCs) and Special Services Districts. These organizations were at the forefront of bringing structures, seating, and road closures to neighborhood streets and commercial corridors (Ben-Amos et. al., 2020). The advent of the pandemic made small businesses more interested in engaging with the ROW, also using parklets, seats, and flex posts, and in larger numbers than before.

This marks an important shift in the stewardship of the ROW, especially in Philadelphia. Stewardship, the development, and maintenance of public spaces via programs or volunteer activities, has long been the province of CDCs, Business Improvement Districts (BIDs), and others, who hire staff and contractors to build and maintain parklets, pedestrian plazas, and other seating and public space amenities within the ROW. This work requires significant capacity, and as noted in the 2019 Lindy Institute report: "Limitations of capacity mean that ROW stewardship is largely the province

of well-resourced BIDs or CDCs with staff or volunteers experienced in design, law, insurance, or other fields helpful to navigating the ROW approval process, limiting geographic impact to only the most well-resourced neighborhoods" (Lindy 2019).

Measuring this capacity in terms of budgets, staff, and salary reveals significant disparities. Philadelphia's CDCs that hosted parklets in the mid 2010s were likely to have twice as many employees, and five times the revenue as but served similar neighbourhoods that did not host parklets (Ben-Amos et. al., 2020).

In changing the rules to support expanded dining, the City of Philadelphia demonstrated that revisiting the rules for design and review can make ROW stewardship accessible for a wider constituency. Philadelphia was not alone in its efforts. Other cities joined Philadelphia to update how they reviewed designs for new projects, what standards these projects were held to, and how applications were managed and administered. In 2021, a local non-profit program (StreetBoxPHL, founded by the author) surveyed 6 cities with more robust ROW public space programs, like New York and San Francisco, and Philadelphia's peer cities, like Baltimore, Boston, Chicago, and Detroit, all of whom wrestled with similar concerns (Ben-Amos 2021). At the same time StreetBoxPHL (StreetBox) also surveyed (separately) local community development professionals, and streetery operators, and followed up those surveys with focus groups.

The changes to these rules, and later reactions to the same changes, revealed deep political divisions that still remain associated with ROW transformation. These changes evidenced both how important a profit motive is for galvanizing individuals to steward ROW interventions, and how much more work remains to make it easier for community groups with less capacity or profit motive to transform their streets.

NATIONAL RESPONSES TO THE PANDEMIC

Philadelphia was not alone in experimenting with new ways to support the creative reuse of the ROW. According to the Boston University Initiative on Cities, nearly half the cities surveyed in the 2020 Menino Survey of Mayors (2021), "shut down some roads to through traffic and just under a third closed roads entirely to all traffic [...] Forty percent of mayors reported widening sidewalks and 38 percent created new bike lanes during the pandemic" (Lusk 2021). Chicago, Boston, Baltimore, Detroit, New York, San Francisco, and others all tried new solutions to our common problem. For instance, Detroit created restaurant curbside pickup zones in lieu of outdoor seating during cold winter months, an innovation later adopted by San Francisco despite a more temperate climate. Boston exempted specific interventions (flex posts, paint, etc.) from Public Improvements Commission approval (which is required for any change in the public ROW) if they followed the Tactical Public Realm Guidelines (Ben-Amos 2021).

Cities' solutions often fell into two broad categories: closing down streets to automobile traffic, allowing for walking, biking, and socially distant outdoor activities, or enabling restaurants to serve patrons outdoors. These solutions did not suddenly appear. Instead, both programs were built upon decades worth of programs and initiatives, from long-standing outdoor seating statutes to more recent Open Streets interventions. All at once, both solutions had to be deployed at a scale and speed unimagined for

City officials, restaurateurs, community members, and citizen stewards.

To accommodate this unprecedented need, American cities changed design review processes, design standards, and approval and permitting processes. They made these changes quickly in response to the pandemic to support these outdoor activities. The 2021 StreetBoxPHL survey revealed different examples of how different cities responded:

REVIEW PROCESS

Cities needed to update which agencies and officials needed to review applications for outdoor dining, and how those applications were processed. San Francisco went from a 12-month procedure (including a Department of Public Works check and architectural plan review) to a 3-day review. Nationally, many cities:

- drastically cut down on the review time associated with project approval,
- streamlined multiple specific programs into one or two broad programs, and
- replaced up-front reviews (e.g. detailed design plans) with increased emphasis placed on back-end enforcement.

DESIGN STANDARDS

Cities had to revise design standards to make it easier for restaurants and communities to implement these new public spaces. Chicago's DOT re-imagined it's public space program, creating "Chicago al Fresco." They created a new set of design guidelines to support its activities. Other cities also:

- expanded what sort of structures could be allowed in the ROW and what sort of protections were required,
- created new typologies of loading zones and pedestrian enhancements to the ROW, and
- developed more detailed design guidance documents.

APPROVAL, PERMITTING, AND MANAGEMENT

Cities had to change how projects were approved and managed to facilitate the growth of public space within the ROW. In Detroit, the Department of Public Works (DPW) worked with the City Council to get blanket approval for DPW to approve outdoor dining. The DPW submits monthly reports to the City Council. Other cities:

- empowered and encouraged local DOT's to approve projects, sometimes overruling or expediting review from local community boards or legislators in exchange for new reporting requirements and
- moved more application processes online.

In limited cases, cities made targeted investments to support these initiatives. The City of Boston paid for portable ADA ramps for use on commercial corridors. The City of Baltimore invested in the development of detailed design guidance. (Ben-Amos 2021).

These programs' successes have prompted several cities to develop permanent versions of their pandemic-era program, which had typically been implemented via emergency order. In some cases these permanent programs' review processes became more stringent than the pandemic era programs, but generally less stringent than those from pre-pandemic.

Adapting to life during the pandemic required rethinking the network of agencies' and departments' permitting and approval structures. Restaurateurs,

architects, engineers, and a myriad of small businesses and service providers have, for decades, operated under an established, inefficient approval process from City Inspectors, Plan Reviewers, and middle management to get designs approved and permitted and food and alcohol permits issued. The pandemic forced everyone not only to rewrite the rules but also to rewrite how those rules are approved and administered. In doing so, it serves as a reminder that change is both possible and critical to engaging citizen stewards of the ROW.

PHILADELPHIA'S RESPONSE TO THE PANDEMIC

Like other cities, Philadelphia changed permitting processes and standards to expedite restaurateurs' ability to turn parking spaces and streets into outdoor seating. In doing so, the City dramatically increased pedestrian and commercial space throughout the city. Before the pandemic, Philadelphia had fewer than twenty locations across the city where community members and restaurants had transformed the ROW on behalf of pedestrians.

Streeteries, parklets, or pedestrian plazas reached far more neighborhoods than previously served by pedestrian enhancements. Pre-pandemic, only four of 18 planning districts across Philadelphia featured at least one pedestrian enhancement. Some had as many as three. Post-pandemic, every planning district had pedestrian enhancements, ranging from 11 in the Upper Far Northeast to over 450 in the Central District. The vast majority of these new pedestrian spaces are streeteries.

Temporary, but dramatic changes to the design/review process reduced the administrative burden of ROW stewardship. Pre-pandemic, citizen-stewards of the ROW could wait for 6 months or more for a pedestrian-enhancement permit and design approval and had to engage and manage a cross-disciplinary design team to get project design approval. Before COVID-19, most citizen-stewards were large, well-funded nonprofit organizations, not ordinary Philadelphians or small businesses. The devastating pandemic showed that a different way was not only possible but also desirable and achievable.

The City's pandemic response up-ended these long-standing process and design norms. The streetery application is a single page document, a drastic reduction from 25 page Parklet and Pedestrian Plaza applications associated with the Philadelphia's Pedestrian Enhancement Permit. This application consolidation accompanied a review consolidation by uniting site and design review and reducing site map requirements. Also reduced: review management. No longer did applications require the Chief Engineer's direct input, a 3-day turnaround on reviews was made standard, and integration with License and Inspections (L&I) was achieved. Philadelphia's pandemic response enabled hundreds of small businesses to become stewards of public spaces within the ROW and supported ROW reuse in more communities than ever before.

These businesses rushed outside out of a profound panic created by the pandemic. In focus groups and surveys of streetery permit holders in Philadelphia, StreetBoxPHL reported that without streeteries and changes to outdoor dining "we could not have survived," and that streeteries "were the reason we could survive" (Ben-Amos 2021).

The traumas experienced by the restaurant industry are real. Restaurateurs' avowed adaptation to streeteries speaks not just to their sincere belief that these were the

only tools available to them in an uncertain public health environment, but also to their discovery of new ways to engage with communities via Philadelphia's streets. These restaurateurs noted that streeteries helped make for "great social interaction," increased "community connection" and helped put "more life on the streets" (Ben-Amos 2021) A Philadelphia Inquirer article chronicled restaurateurs who used streeteries as an opportunity to create spaces that differentiated their restaurants on crowded corridors (Palmisano, 2021). The streeteries, in certain cases, reminded some restaurateurs of their home, far and away, perhaps below the Mason-Dixon line or even across oceans.

This new normal comes with some major concern: officials suggest that the 750+ permitted streeteries on Philly's streets represent just 10% of those deployed across the city (Cohen, 2021). It's also not clear if the level of maintenance and amenity provided by these new spaces is worth the trade-off in the privatization of the public sphere (e.g. a sidewalk that's now a de facto extension of a restaurant). Unlike parklets and pedestrian plazas, the standard bearers for pedestrian-supported alternative uses of the ROW, streeteries are not open to the (non-paying) public. Clearly these installations often complicate the already-precarious balancing act of accommodating multiple modes, and users, in a single narrow cartway.

Accommodating multiple modes in the cartway is not simply a technical issue, but also a political one. By late 2021 streeteries were a significant political concern. In Philadelphia, restaurants, looking to survive in an ever lengthening pandemic, lobbied to make the rules enabling streeteries permanent. This move was met with opposition from communities worried about the design and impact of these streeteries on their neighborhood, and with council members worried about relinquishing more control (Saffron 2021). The bill, which made streeteries permanent, preserved the expedited review and management process for select portions of the city, corridors designated by district council members, but also effectively banned them from all other portions of the city (Marin 2021). Codifying lessons learned proved problematic in other cities as well. In San Francisco, making permanents (and Streeteries) permanent led to significant permitting and code violation confusion that imperils remaining structures (Bitker 2021).

Streeteries evidence an even more complex and emerging market for curbside space than was imagined in a pre-pandemic period already replete with tight competition of uses for that space. Adapting the rules that governed pre-existing alternative uses and structures in the ROW for a new use (both enabling the conversion of public parklets into private seating and reducing the design and permitting requirements therein) made it easier for more diverse actors to engage in a changing streetscape. In doing so it revealed, or reinforced, a stark lesson. Significant barriers face citizens looking to participate in the design and governance of what is approximately¼ of Philadelphia's land mass (Mayor's Office of Transportation and Utilities 2013). Even with a drastic reduction in barriers, actors motivated by an existential need to remain in business capitalized on these opportunities for citizen-led stewardship of ROW interventions.

WHERE TO GO FROM HERE

The COVID-19 pandemic forced citizens, City officials, business owners, and community development organizations alike to reimagine how Philadelphia's streets serve citizens and neighbours. Clear themes emerged for street-based placemaking in the last two years. In 2022 and beyond, it's critical to revisit how cities such as Philadelphia manage their streets.

Like other major American cities, the Inquirer has reported that Philadelphia's roads became more dangerous during the pandemic, with Philadelphians driving faster and crashing more often (Madej, 2020). As commuting patterns continue to evolve, and public health concerns fluctuate, it's ever more important to support active transportation options, like walking, biking, and scootering.

As the virus continues to mutate and affect public safety statuses, cities need to maintain the appropriate tools in their built-environment-toolbelt to support outdoor public spaces. Close to 90% of retailers surveyed by StreetBoxPHL were interested in continuing their expanded activation of the ROW. These tools (tactical urbanism stalwarts such as planters, parklets, flex posts and chairs) are critical to and in demand by restaurants and retail shops struggling to rebuild their businesses.

The emergence of restauranteurs as a critical constituency in ROW transformation both highlights the growing market for alternative uses of the ROW, and the remaining capacity gap in communities without the resources to do so. More neighborhoods than ever before are home to low-cost safety and streetscape interventions, stewarded by small businesses that previously avoided engaging with the cartway. However, the changes that made it possible for small businesses to do so have not been met with a similar explosion in growth and use by CDCs and other more likely citizen stewards. This indicates that changing design and management rules alone won't make it easier for community groups to transform city streets, but that investments in people and capacity are the critical investments required.

About the Author

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Ariel Ben-Amos is a city planner for the City of Philadelphia. He has over a decade's worth of experience coordinating transformative projects at the intersection of people, place, and infrastructure. Ariel has contributed to design manuals, built complete and green streets, and developed programs to support community stewardship of the ROW. Ben-Amos is a former Peace Corps Volunteer, an instructor at the University of Pennsylvania, and founder of StreetBoxPHL.

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Cover photo: A block of Sansom Street in Center City is closed to traffic for outdoor dining. (Emma Lee/WHYY)

THE THERAPEUTIC CITY

What COVID-19 Taught Cities About Transport and Mental Health

Chris Bruntlett

As urban streets emptied and cities quickly locked themselves down in the spring of 2020, the impact of the built environment on mental health was suddenly brought to the forefront. Wide expanses of asphalt formerly dedicated to the movement and storage of private motor vehicles were—at least partially—reclaimed as public space that could be temporarily used for physical and social activity. In Oakland, 120 kilometers (74 miles) of "slow streets" were opened to walking, cycling, scooting, jogging, skateboarding, and playing (Oakland to open up 74 miles of city streets to pedestrians and cyclists, 2020). In Bogotá, 76 kilometers (47 miles) of segregated cycling infrastructure was built to help essential workers travel around the city (Bogotá expanding bike infrastructure to respond to coronavirus, 2020). And in Rotterdam, over 1,000 on-street parking spaces were turned into "parklets" for outdoor businesses such as restaurants and hairdressers ('Liveable streets': How cities are prioritising people over parking, 2020). These welcoming and restorative places allowed residents of all ages, ethnicities, and economic means to move their bodies, reduce their stress levels, and access some form of nature. As these cities now emerge from this pandemic, they face the decision of whether to return their public realm to the car-first status quo or establish a "new normal." In doing so, they must ask two questions: Could a car-dependent and dominated transport system increase the risk of mental illness? Could a city with fewer cars improve our mental health?

This unprecedented reallocation of curb and road space was motivated by a sense of urgency: in the EU alone, 2,600 kilometers (1,600 miles) and €1.7 billion of cycling measures were implemented; largely to make up for lost attractiveness of public transport (Covid-19 cycling measures tracker, 2021). In London, for example, social distancing requirements meant buses and trains could only operate at 20% capacity; a shortfall of eight million trips per day. Two scenarios were quantified by the Italian government: doing nothing would cause an increase in car use whose externalities could cost society €20 billion

per year, while intervening and replacing these trips with active travel could save €20 billion per year (Bikenomics and post-COVID mobility scenarios in Italy, n.d.). The question was no longer whether cities could afford to invest in walking and cycling. It was whether they could afford not to. While rooted in practicality, these interventions had the bonus of addressing a mounting mental health crisis, which was only exacerbated by lockdown conditions.

When we collectively discuss the global mental health crisis, we often speak as if it's occurring in a vacuum. While the contributing factors are complex and not completely understood, the built environment might be one of the most important and ignored (How urban design affects mental health, 2020). This is a crisis of epidemic proportions, which according to data from the National Alliance on Mental Illness, affects 52.9 million, or one in five American adults (Mental health by the numbers, n.d.). Depression is particularly devastating, affecting 6.9% of Americans; including 63% of teenagers and 47% of millennials. While some of these numbers can be attributed to growing awareness and understanding of and reduced stigma around mental illness, one cannot ignore the underlying structural conditions built into communities.

In short, by building our cities around the automobile, we've managed to engineer social and physical activity out of our lives. A seminal 1971 study by Donald Appleyard, for example, found residents on streets with heavy volumes and high speeds of traffic have fewer friends and acquaintances, and are less likely to know and visit neighbors. To make matters worse, much of the world's population now lives in obesogenic environments, or places that promote obesity in their residents. Not only has a car been made mandatory for getting from A to B, but the simple act of going for a walk, jog, or bicycle ride is made difficult by the threat of motor traffic (see, for example, Lake & Townshend, 2006).

Concerns of isolation and inactivity are worsened by the fact our species are spending an overwhelming amount of time indoors, with little access to sunlight, fresh air, and snow and rain. In the past two centuries, we've gone from a significant majority of the population working outside to less than 20%. The average American spends just 7.6% of their daily lives outdoors, barely more than the 5.5% they spend in a car (Klepeis et al., 2001). And when it comes to our emotional well-being, movement—not laughter—may be the best medicine: moving our bodies—even just a short walk at 5 km/h (3 mph)—creates many of the feel-good chemicals our brain requires, which can be a great way to recover from stress.

Not only has a car-first design made us less social and less active, but it has reduced our exposure to nature, another important preventative measure. Three theories explain how this has positive effects. The first, stress recovery theory, suggests being in nature improves our mood; helping to restore cognitive resources and improving our ability to deal with stress (Ulrich et al., 1991). The second, attention restoration theory, suggests the demands of being in a natural space require us to be less hypervigilant than when responding to threats, affording us with a mental break (Ohly et al., 2016). The third, processing fluency theory, suggests humans need rich, diverse experiences in our lives, and the visual and experiential complexity of the indoor environment can't compete with that of the outdoor environment (Reber et al., 2004).

With its insatiable demand for asphalt, the car-centred city is incongruous with nature,

All photos courtesy of the author.

insisting on monotony over complexity, and requiring the removal of trees, vegetation, and waterways for real estate dominated by automobiles. In Los Angeles County, for example, no less than half of its landmass is used for the movement and storage of motor vehicles, with surface lots accounting for 101 square miles; an area four times bigger than Manhattan. That's a lot of public space that could be otherwise used for parks.

To the surprise of some, one country didn't experience the same "mad dash" to reallocate space during the pandemic: the great cycling nation of the Netherlands. To explain this inaction, historians point to six weeks in 1973, when their country experienced a crisis eerily similar to the one in 2020: the OPEC oil embargo. Since then, they have spent fifty years building tens of thousands of kilometers of cycle lanes and traffic-calmed streets, and in many ways, were perfectly placed to weather this crisis. While not the explicit purpose of these networks, the Dutch also enjoy some of the highest levels of physical and mental health—and the happiest children—in the world (Dutch youth continues to rank among the healthiest and happiest in Europe, 2020). Now millions elsewhere have experienced similar conditions first-hand, with fewer cars and more interaction, the question becomes: can we establish a "new normal," and transform this moment into a movement for meaningful change?

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Chris Bruntlett is Marketing and Communication Manager at the Dutch Cycling Embassy, and co-author of the book *Curbing Traffic: The Human Case for Fewer Cars in our Lives*.

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RETHINKING PUBLIC TRANSPORTATION FOR A BETTER FUTURE

Nuria Fernandez

On November 6, 2021, President Biden signed the Bipartisan Infrastructure Law, which authorizes $108 billion for public transportation over five years. Thanks to this legislation, the most significant federal investment in transit in our history, we now have more resources to build truly sustainable and equitable transit systems while creating good-paying jobs in communities across the country.

For too long, Americans have had to say that if we had better funding, we could have better transit. Now, the federal programs and funding resulting from the Bipartisan Infrastructure Law will transform communities, with public transportation playing a major role in expanding travel options, combatting the climate crisis, improving equity throughout the nation and creating jobs.

For planners, who set the stage for positive change in our communities, now is the time to rethink our transportation systems and how they can expand opportunities for people in cities, towns and rural areas.

At its core, the Bipartisan Infrastructure Law supports transit expansion to improve access and mobility. It will provide safer, faster, more frequent, and more reliable service to underserved and overburdened communities; address transit deserts; and expand equitable access. It also will transition 10,000-plus transit vehicles to operate using greener technology to help address climate change.

Now, with the opportunity to invest billions of new dollars into transit, planners and state and local officials in towns, cities, counties, and regional organizations can reconsider what future plans could look like. Too many of our neighbors still lack certainty in how they can get from place to place, and too many neighborhoods remain unconnected. How can planners re-envision the design of our communities and transportation systems to expand equity and affordable housing, improve environmental sustainability, and create more access to transit systems?

After all, everyone should have a right to safe, reliable transportation in today's America.

FTA has made funding available for thousands of public transportation

Aerial with overlay of Haines Borough Lutak Dock Replacement project in Haines, Alaska, which received $20M in grant funding as part of the RAISE program.

providers to create tangible change on the ground. Among the priorities of the legislation is to improve Metropolitan and Statewide Planning programs, which provide the underpinning for state and local transit projects with long-range transportation plans. Support for planning programs – both metropolitan and statewide planning – were expanded by approximately 35 percent through the Bipartisan Infrastructure Law over five years.

With the Federal Highway Administration, we recently updated our Planning Emphasis Areas to encourage metropolitan planning organizations, state departments of transportation, transit agencies, and federal land management agencies to incorporate into their Unified Planning Work Programs and State Planning and Research Work Programs. Several of these emphasis areas focus on the Biden-Harris Administration's goals of advancing equity and environmental justice in transportation planning, which will help achieve greenhouse gas reduction goals and increase resilience to extreme weather events resulting from climate change.

These efforts will better support regional and local governments as they plan for future transportation needs in their communities.

To expand local opportunities to tie transit to economic development and increase access, the legislation boosts funding for FTA's Pilot Program for Transit-Oriented Development (TOD) Planning by 38 percent over five years. An expanded TOD planning program will allow FTA to award more grants to support comprehensive planning efforts that improve access to transit and create more mixed uses – including affordable housing near stations. Walkable, mixed-use development near transit attracts people and creates vibrant, connected communities. Truly equitable TOD will also provide housing options for people of all income levels.

FTA will continue to invest in transit expansion through the Capital Investment Grants (CIG) program, which provides grants to support high-capacity transit expansion projects like bus rapid transit and rail lines. Under the new law, the CIG program could double our annual

investment and create more communities centered around high-quality transit.

In addition to FTA's CIG program, the U.S. Department of Transportation's Rebuilding America's Infrastructure with Sustainability and Equity (RAISE) program provides funding for regional capital and planning projects. Of the $1 billion in RAISE awards announced for Fiscal Year 2021, $30 million was awarded to planning grants, all of them benefiting Areas of Persistent Poverty. Metropolitan Planning Organizations are among the eligible applicants.

The success of our transportation systems is critical to the economic health and sustainable future growth of our cities, towns and rural communities. As planners, your work is vital to ensuring transportation systems truly address the needs of everyone.

With the Bipartisan Infrastructure Law, we are entering a new era, with opportunities we never had before to improve safety, accessibility and equity; drive economic development; and combat climate change, particularly addressing the disproportionate impacts on vulnerable communities.

An extensive transit network creates better connections to opportunities. Planners are key to helping us expand those opportunities to everyone. FTA looks forward to continuing its work with planners nationwide to help ensure that, regardless of how people travel, everyone has an equal opportunity at getting where they need to go.

Cover photo: Administrator Fernandez visits a Chicago Transit Authority station (FTA)

About the Author

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Nuria Fernandez serves as the Administrator of the Federal Transit Administration. Fernandez has served in leadership roles at some of the largest transit systems in America and was most recently the General Manager and CEO of the Santa Clara Valley Transportation Authority (VTA), delivering projects, programs, and transit services that provide mobility solutions for people that live and work in Silicon Valley. Prior to leading VTA, Fernandez served as Chief Operating Officer of the New York Metropolitan Transportation Authority (MTA), and Sr. Vice President of Design and Construction for the Chicago Transit Authority and the Washington Metropolitan Area Transit Authority, consecutively.

2

EQUITY

TRANSPORTATION AS A TOOL FOR JUSTICE

FOR JUSTICE IN TRANSPORTATION, WE CANNOT JUST BE PLANNERS

Laurel Paget-Seekins

In 2003 my girlfriend and I were (unwisely) hitchhiking through the Southeast. While sitting outside a Metropolitan Atlanta Rapid Transit Authority (MARTA) station we decided to move to Atlanta. However, we did not have a car. By riding my bike and MARTA and talking to my fellow transit riders, I soon realized that transportation is at the intersection of social and racial justice, environmental, and energy issues. Like many in this profession, I chose to study transportation planning and engineering in the hopes of making sustainable structural changes to address all of these issues simultaneously.

Almost 20 years later, those changes can't come soon enough. We are in a moment of urgency with the Movement for Black Lives organizing for liberation and climate change requiring immediate action. Changing how transportation resources and spaces are allocated, designed, and enforced is critical to dismantling white supremacy and reducing emissions. The question is not what needs to change, but how to make changes to systems where the people in power benefit from the status quo.

We cannot just be planners; we must also be implementers and change-makers. To be successful, we have to be very intentional about how we, as transportation planners, shape relationships between government and communities and change power structures inside and outside transportation agencies. In addition to creative technical skills, we need organizing skills and strategies rooted in impacted communities. Moreover, those of us who are white have to commit and recommit to our journey of continually growing in how we understand our power and privilege.

Grassroots movements, largely led by Black women and women of color and youth, continue to push change and gather votes. They are electing officials to positions from City Hall to Congress with agendas to pass policies and investments aimed at rebuilding transportation infrastructure, tackling climate change, and upending systemic inequity. Whether legislation, including the 2021 Federal infrastructure package, will lead to achieving our goals will depend on implementation across state departments of transportation

(DOTs), metropolitan planning organizations (MPOs), transit agencies, and local governments. Transformative implementation requires continued organizing power and political leadership pushing from the outside and internal efforts to overcome the status quo and build functioning bureaucracies.

I am fond of saying that government agencies are a collection of people managing technical systems, physical assets, and business processes that are tenuously connected through years of patchwork and infrastructure related under-investment (Kane & Tomer, 2019). The patchwork of systems, digital and analog, creates considerable complexity, and inequities and dependence on fossil fuels are hard-coded in (Chester, 2021). Even with investment, the maze of funding sources and requirements adds to the complexity. Transformational change will require maintaining the essential functions of transportation agencies while implementing new programs and technological systems; changing how we design and build infrastructure; and reshaping the relationships between many communities and government, all while overcoming the human dynamics inside large organizations that impede change.

While everyone in the transportation sector has a responsibility to address the crises of racism and climate change, transportation planners have a significant advantage in that they usually are not responsible for operations. Most transit agency or transportation department employees are responsible for daily operations (or construction) and deal with emergencies. In contrast, planners have the time, and capacity in their job duties, to learn from the past and think about the future. Also, planning teams are often well-positioned within an agency to work across the department silos, and between leadership and operations. This makes planners well-positioned to push and implement change inside their agencies.

Transformation requires both the idealistic belief that a better world is possible and the pragmatic understanding of how to make changes work in the world we have today. The key is to keep our eyes on the future vision while our daily experience finds us deep in the weeds of implementation. Planners are trained to look at the future and at current conditions, and imagine ways to bridge the gap.

In the six years I worked at the Massachusetts Bay Transportation Authority (MBTA), I ran processes to rewrite the major public-facing policies: from service delivery to fares, implemented programs to lower fares for students and low-income youth, shepherded several service pilots into permanent service, and successfully pushed the agency to change the state law to decriminalize fare evasion and lower fines. While graduate training in transportation planning and engineering provided the subject matter expertise I needed, the skills I learned in a previous experience as a community organizer were needed to implement these changes inside a complex agency like the MBTA (Figure 1).

For institutions to change, people within them have to depart from the accepted norms that perpetuate the status quo. This divergence is a constant balancing act to determine when to compromise and keep pushing past the point of comfort for the harder-won and more just outcomes. It is easier to focus on advancing to the next position with more power instead of using one's power. I constantly remind myself that my power comes from my principles, and not my position, and that my principles come from my responsibility to the community.

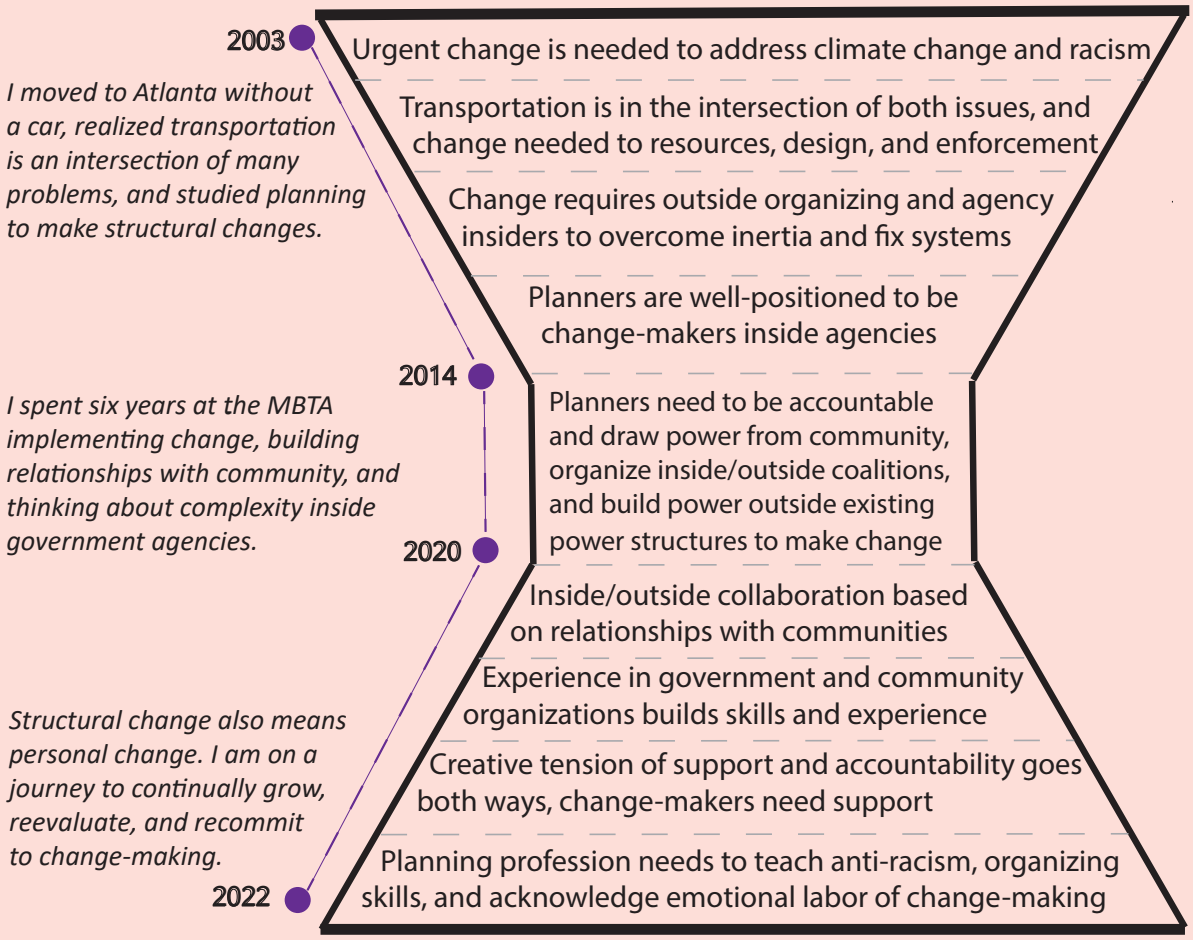

Figure 1: Graphical abstract of the author's journey

In a government agency (especially a public-facing agency), it is easy to fall into the group defense mechanism often called the "fortress mentality." In the face of constant criticism that lacks a nuanced understanding of the daily challenges, employees have the tendency to pull up the proverbial draw-bridge which blocks them from hearing reasonable and necessary complaints and concerns. During my time at the MBTA, I intentionally built relationships with people who were accountable to transit riders to make sure my insider thinking was consistently challenged. The practice of personal accountability (by listening to people directly impacted by the decisions in my purview) helped me know when to compromise and when to keep pushing.

The difficulty of implementing change across a patchwork of government systems is very real and not usually transparent. Change-makers must understand and communicate the challenges of implementation internally and externally, while not using these challenges as excuses for inaction. Pragmatic empathy

helped me understand both the urgency for change from outside and the internal impediments to achieving it. By building relationships with my colleagues across departments, I was able to strategically assess the impediments and figure out how to best advocate for the resources to address them. Supporting my colleagues in their battles was critical to my success.

Just like organizing for progressive change in general, change inside government agencies requires diverse coalitions with clear objectives and the strategies and tactics to achieve them. Change-makers have to act outside existing power-over structures to build power-with people internally, across government entities, and between government and community partners. Outside organizations can provide political cover, reshape priorities, and speed up timelines.

Making the needed transformational change in transportation will require the collaborative work of dedicated organizers both inside and outside of government. I am aware of many encouraging examples of these collaborations across the country and likely there are many more happening outside public view, solving problems deep in the weeds of bureaucracies.

Collaboration requires relationships between people working inside government agencies and people in the communities they serve, particularly the communities most impacted by the agency's lack of change. This reinforces why more transportation planners need to come from and reflect the lived experiences of these communities. Representation and accountability are currently lacking in the transportation sector. Instead of the proverbial revolving door between government and private sector, we need to encourage a revolving door between government and community organizations. Experience in both sectors builds the skills and perspectives needed to strategically make transportation more just.

Government and community relationships should be grounded in the creative tension of accountability and support. While it is the job of public employees to serve the community, the relationships need to go both ways. Trying to make change from the inside of a large government agency can be lonely and career jeopardizing. Employees are not encouraged to have their own public voice. Not unlike the private sector, public sector workplaces can replicate structural inequities that make change-making challenging, particularly for people of color and women. Change-makers need support from community organizations and the planning profession.

The profession needs to provide transportation planners with the skills and support systems to be change-makers, starting with planning education. What is needed is a deliberate analysis of power and the difference between power-over and power-with; discussion of how white supremacy shapes our current built environment and how it shapes the planning profession; and the development of organizing strategies and community building skills. Planning organizations should provide opportunities for members of our profession to exchange strategies and share the joy of the victories and the pain of the losses. There is an emotional component of working to make change that often is not acknowledged or supported.

This is not a time to just plan; we have to act to address climate change and structural racism. Change in transportation has to be part of the solution, and planners are well situated within transportation agencies to push for change from the inside. We have to use our bifocal planning vision to strategize how to make changes to the existing patchwork of complex

systems. Planners need to build and support inside/outside coalitions to overcome the inertia and existing power structures. We have to be rooted in the community for accountability and support.

In reflecting on the state of planning in transportation (in December 2021), I realize that I am not the same person who moved to Atlanta seeking community and found transportation. It turns out making structural change also requires making personal changes.

I chose to embrace change as a constant learning journey to figure out how my identities shape my understanding of the world and what I can best contribute. I have benefited from personal and professional relationships that have pushed me to grow, reevaluate, and recommit. By the time this essay is published, my thinking will already have changed a bit, so consider this a work in progress. Please get in touch to continue the conversation!

About the Author

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Laurel Paget-Seekins is a 2021 Leadership in Government fellow with Open Society Foundation. Previously she was the Assistant General Manager for Policy at the MBTA in Boston. Laurel co-edited Restructuring Public Transport through Bus Rapid Transit from Policy Press. While living in Atlanta without a car, she supported transit organizing. She received a Master's in City and Regional Planning and a Ph.D. in Civil Engineering from the Georgia Institute of Technology. Contact her at laurelintransit@gmail.com.

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Cover photo: MARTA N3 (North Avenue) station in 2005 (Wikipedia)

REPRESENT THE UNDERREPRESENTED

Reflecting on How We Looked at Disadvantaged Populations in the Transportation Planning Process and How this Practice Evolved Over Time

June Lai

EVOLUTION OF EQUITY IN TRANSPORTATION

From the Civil Rights Act of 1964 until today, the acknowledgment of equity in transportation has evolved in many ways, from a mandatory box-checking afterthought to a boundary-pushing forethought (Legal Highlight: The Civil Rights Act of 1964, n.d.). Although every agency defines its equity goals differently, based on its particular role in the process, at the heart of equity is the achievement of an equitable distribution of transportation investments. As used today, the term equity refers to the flexible but equitable distribution of impacts and benefits to different communities depending on income, social class, or mobility needs. On the other hand, equality refers to an equal distribution of impacts and benefits, regardless of social class, income, or mobility needs. The concept of equality in the American society is grounded in the Civil Rights Act of 1964 which prohibits discrimination based on race, color, religion, sex, or national origin.

The principle of equality in transportation is applied horizontally and process-based, i.e. treating all people the same, regardless of existing structural barriers and inequalities (Camporeale, et al., 2019). In comparison, transportation equity is more vertical and outcome-based, i.e., adopting practices to ensure that people at different starting points reach the same destination (see Figure 1) (Litman, 2022).

The concept of equity in transportation planning is based on the historical application of the principles of environmental justice in evaluating potential environmental impacts on proposed projects. Environmental justice is a concept first made official as a federal mandate by President Clinton in 1994 by Executive Order 12898 (Summary of Executive Order 12898, 2021). It requires federal agencies to identify and address disproportionately adverse effects of an agency's programs, policies, and activities on minority and low-income populations to achieve an equitable distribution of benefits and burdens. Executive Order 12898 also requires all potentially affected

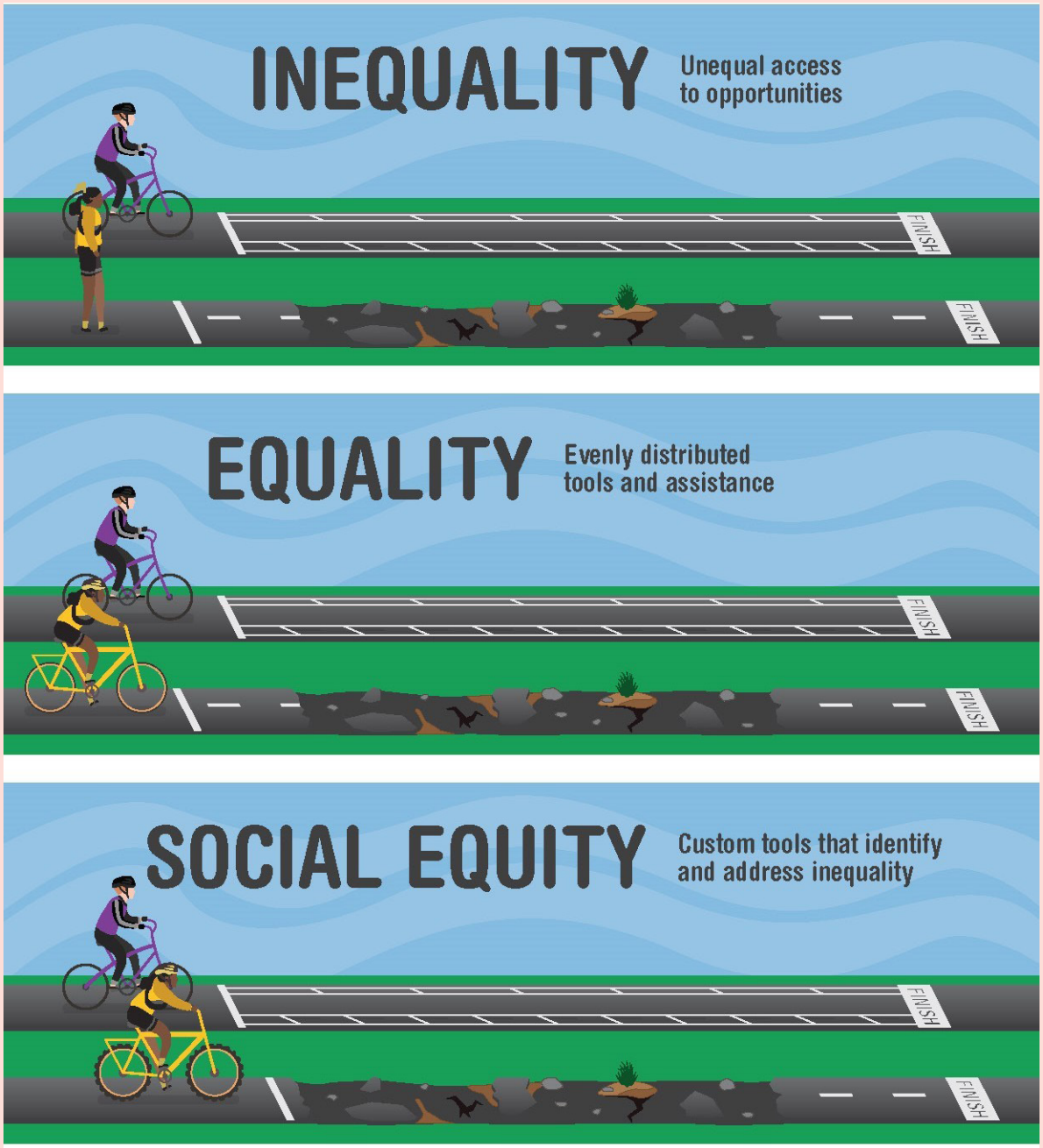

Figure 1: Using cycling as a metaphor for the difference between equality and equity. Source: https://vitals.sutterhealth.org/equality-vs-equity-do-you-know-the-difference/

communities' full and fair participation in the decision-making process. Another legislation, the transportation provision included in Title II and Title III of the Americans with Disabilities Act (ADA) of 1990, ensures equal opportunity and access for persons with physical or mental impairments, just one area that ADA addresses in regards to discrimination for persons with disabilities. Both EO 12898 and the 1990 ADA are foundational to the consideration of equity principles in transportation planning practice. In addition, Title VI of the Civil Rights Act of 1964 prohibits any federal action from discrimination on the basis of race, color, or national origin (49 CFR Part 21). As such, for any federal funding that comes from the U.S. Department of Transportation (USDOT), including the Federal Transit Administration (FTA), recipients need to demonstrate compliance with Title VI by conducting equity assessments and developing Limited English Proficiency (LEP) Plans (Title VI Guidance, 2020). Other guidance and regulations include theNational Environmental Policy Act (NEPA),which requires environmental justice evaluations as a part of NEPA's Environmental Impact Statements (EIS) (Environmental Justice Guidance for National Environmental Policy Act Reviews, n.d.).

More recently, President Biden's Executive Order (EO) 13985, Advancing Racial Equity and Support for Underserved Communities through the Federal Government, defined equity as the consistent and systematic fair, just and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality (Exec. Order No. 13985, 2021). Executive Order 13985 also defines underserved communities as those that share a particular characteristic and geographic communities that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified by the list in the preceding definition of equity.

Equitable transportation planning allows disadvantaged groups to achieve the same level of success as everyone else, perhaps with necessary additional support and more favorable policies and programs. In order to custom-build tools that identify and address inequality, transportation agencies need to start with a full understanding of the communities they serve (Williams et al., 2019).

This reflective article explores how transportation agencies, particularly Metropolitan Planning Organizations (MPOs), identify and define equity populations and analyzes how these definitions have evolved in the United States. This analysis is particularly important as our understanding of equity has grown beyond simply avoiding adverse and disproportionate impacts on environmental justice communities, which only focus on minority and low-income populations, to ensuring that all persons, especially historically underserved populations, also receive a fair share of the benefits of transportation. Transportation planners are bringing more underrepresented groups into the fold for special consideration in transportation plans, programs, and projects. To illustrate notable practices in equity-based transportation planning, this article features the Metropolitan Transportation

Commission's Equity Priority Communities metric, the Chicago Metropolitan Agency for Planning's Economically Disconnected Areas metric, the Atlanta Regional Commission's Equitable Target Areas metric, and the Hillsborough County's Underserved Communities metric because of their extensive equity metrics and detailed methodology.

CASE STUDIES

METROPOLITAN TRANSPORTATION COMMISSION (MTC)

The Metropolitan Transportation Commission (MTC) is the MPO in the San Francisco Bay Area responsible for transportation planning in the nine-county region. It uses a broad definition for vulnerable communities. Formerly called Communities of Concern, Equity Priority Communities (EPCs) are census tracts that have a significant concentration of underserved populations, such as households with low incomes and people of color (Equity Priority Communities, 2021). To designate EPC status, MTC uses the 2014-2018 American Community Survey (ACS) five-year tract-level data and compares each census tract against a threshold value for each demographic factor. The threshold value is determined by using a value that is 0.5standard deviation higher than the regional mean. The eight demographic factors MTC used are:

- People of color (70% threshold)
- Low-income[1] (28% threshold)
- Limited English proficiency (12% threshold)
- Seniors 75 years and over (8% threshold)
- Zero-vehicle households (15% threshold)
- Single-parent families (18% threshold)
- People with disabilities (12% threshold)
- Rent-burdened households (14% threshold)

Suppose a census tract exceeds both threshold values for low-income and people of color shares or exceeds the threshold value for low-income and three or more variables, then MTC uses the EPC framework to guide its decisions to ensure historically underserved communities have equitable access to housing and transportation. Plan Bay Area 2050 (the long-range strategic plan), the Transportation Improvement Program (TIP), and the Lifeline Transportation Program utilize the EPC framework to determine funds and prioritize projects that would meaningfully reverse existing disparities. For example, in the newest update of Equity Priority Communities for Plan Bay Area 2050, 343 out of 1,591 (21.5%) of all census tracts in the 9-county Bay Area are designated as an EPC (see Figure 2).

CHICAGO METROPOLITAN AGENCY OF PLANNING (CMAP)

As part of the On To 2050 Comprehensive Regional Plan effort, Chicago Metropolitan Agency of Planning (CMAP) states that one of its principles is inclusive growth, which refers to "economic processes that enable the broadest possible proportion of residents and communities to contribute to and benefit from the region's prosperity" (Economically disconnected areas, n.d.). Hence, this principle required identifying places in the region least connected to

1 Person living in a household with incomes less than 200% of the federal poverty level established by the Census Bureau.

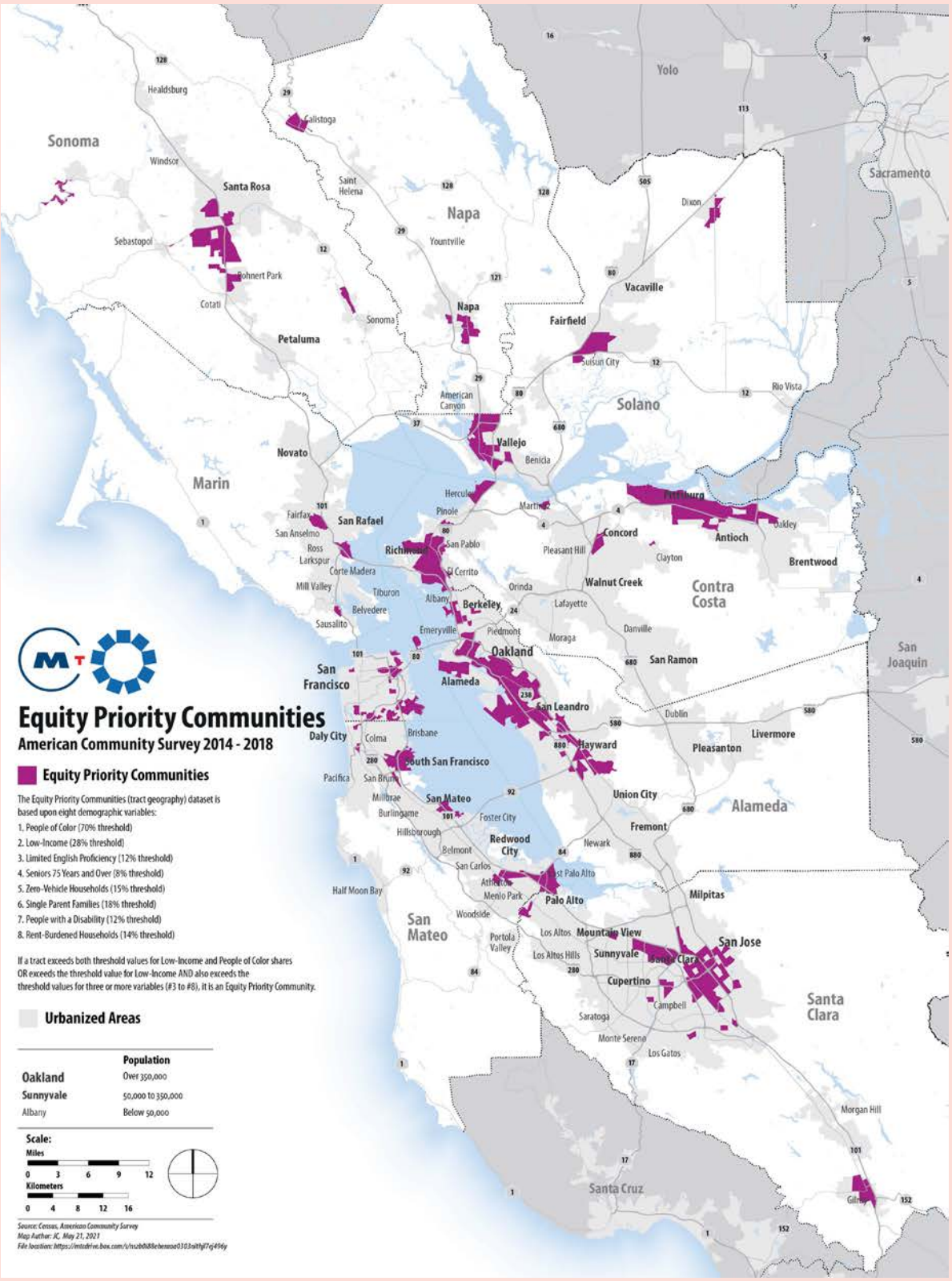

Figure 2:Equity Priority Communities in the 9-county San Francisco Bay Area. Source: https://mtc.ca.gov/planning/transportation/access-equity-mobility/equity-priority-communities

prosperity and experiencing disinvestment so that the agency could prioritize policy solutions targeting those areas.

Economically Disconnected Areas (EDAs) are areas with a concentration of low-income residents and either minority residents or residents with limited proficiency in English (Economically Disconnected Areas Local Strategy Map Methodology, n.d.). These areas are targeted through strategies that improve connections between residents and the region's economy to promote inclusive growth. Disinvested areas are primarily non-residential areas that exhibit characteristics of long-term market weakness, including employment loss, low rates of small business lending, and relatively low commercial real estate values. Places with a weak market can lead to community issues that perpetuate a cycle of disinvestment, like declines in property values and tax revenue. Figure 3 shows the location of EDAs and disinvested areas and where they intersect. CMAP could visually identify places that call for additional policy and funding support to prioritize investment and advance equity by overlaying the two datasets.

THE ATLANTA REGIONAL COMMISSION (ARC)

The Atlanta Regional Commission (ARC) uses the Protected Classes model to identify the concentration of populations that are specified in the Civil Rights Act of 1964 and EO 12898 (Equity Analyses Methodology, 2019). In addition, ARC uses this data to guide policy and funding decisions combined with qualitative knowledge and input from the Transportation Equity Advisory Group (TEAG). The nine population groups (indicators) are:

- Ethnic minority
- Female
- Foreign born
- Limited English proficiency
- Low-income
- Older adults
- People with disabilities
- Racial minority
- Youth

After collecting the above data from the ACS, the ARC uses a standard deviation scoring method to determine each indicator's relative percentage compared to the regional mean. Every census tract is classified into one of the five bins: well above average, above average, average, below average, and well below average. Each bin is scored from 0 to 4 depending on the intensity. Then, the scores for each of the nine indicators are added to obtain a cumulative numeric score between 0 and 36 (see Figure 4).

HILLSBOROUGH TRANSPORTATION PLANNING ORGANIZATION (TPO)

The Hillsborough TPO recognized that underserved and underrepresented people were historically disenfranchised from the decision-making process, disproportionately burdened by negative planning outcomes, and needed special accommodations to be included in planning processes (Plan Hillsborough nondiscrimination & equity plan, 2021). Hence in the 2021 Title VI Nondiscrimination Plan, the agency transitioned from the term Communities of Concern to Underserved Communities to better reflect the historic disinvestment by the public and private sectors in vulnerable groups and certain areas instead of placing the burden of disinvestment onto these communities.

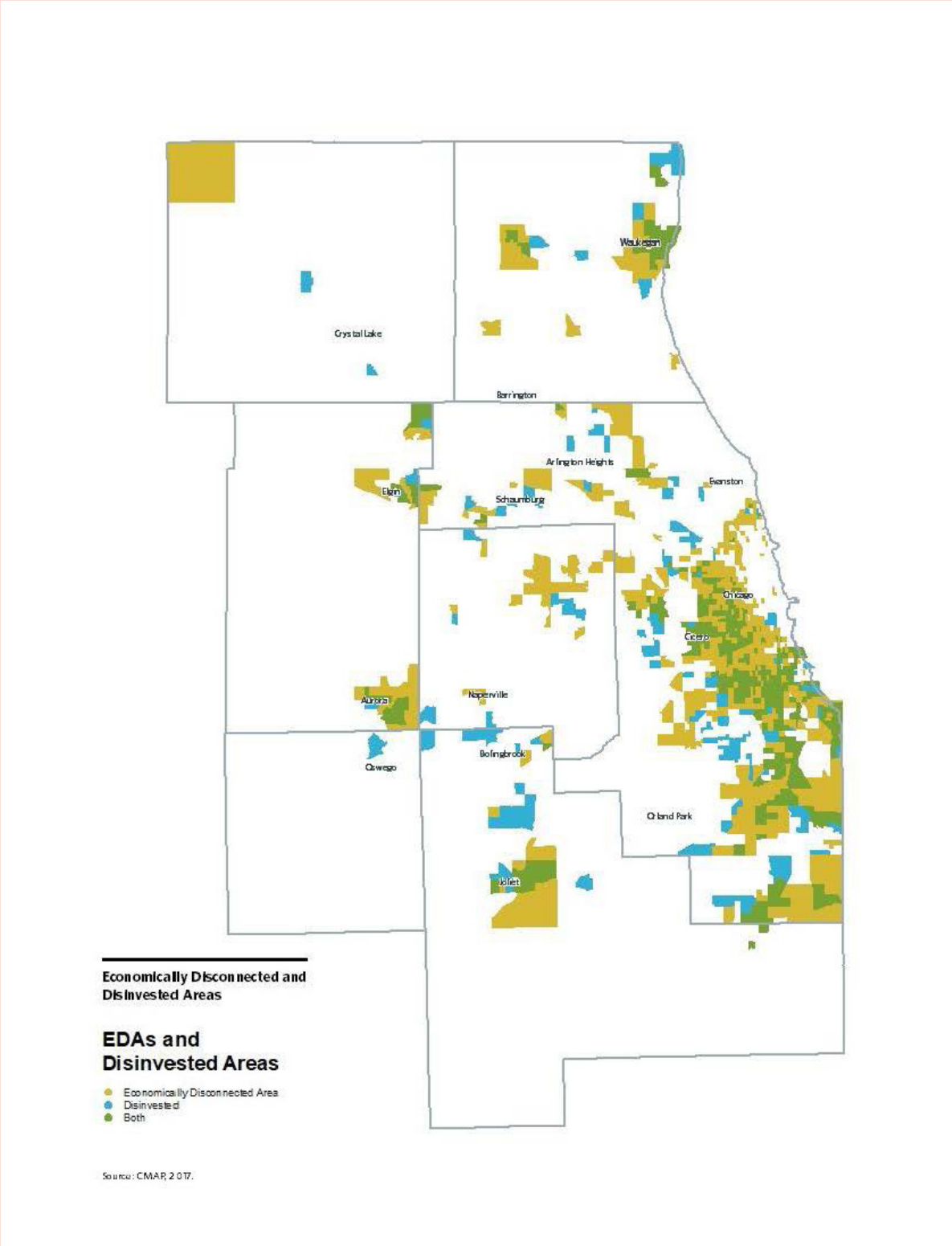

Figure 3: Economically Disconnected Areas in the Greater Chicago region. Source: https://www.cmap.illinois.gov/2050/maps/eda

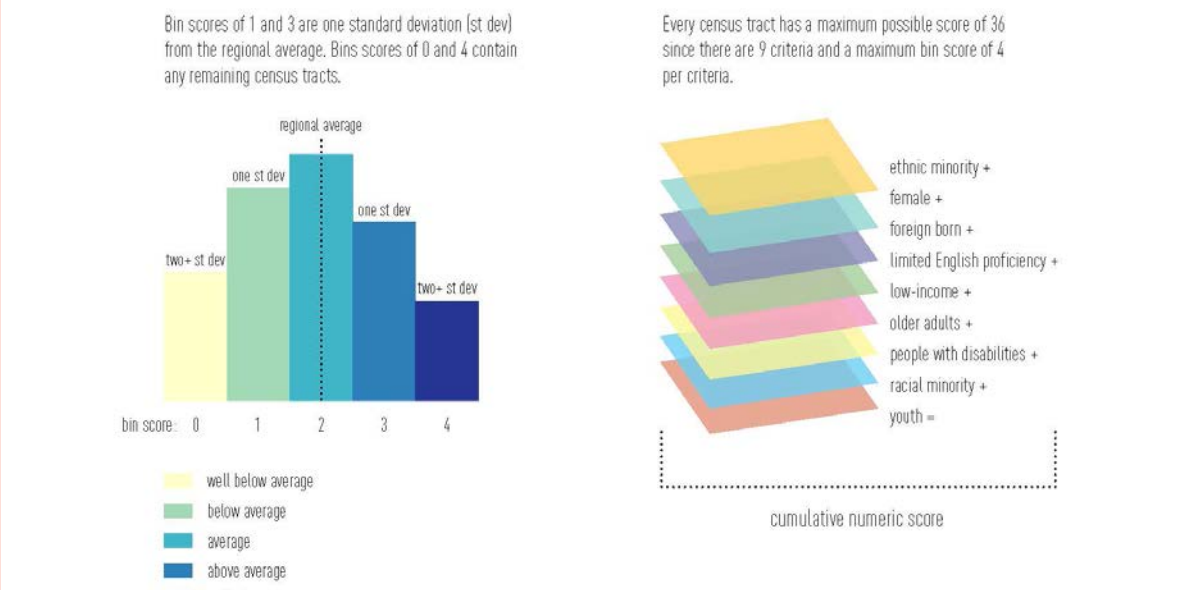

Figure 4: Protected Classes Model Methodology. Source: https://cdn.atlantaregional.org/wp-content/uploads/arc-equity-methodology-june2019.pdf

The methodology identifies census tracts and block groups with a higher than county average, using ten demographic indicators:

- Racial minorities: non-white residents
- Ethnic minorities: Hispanic or Latino(a/x)
- Low-income households, those with household incomes at or below the poverty line; for this effort, the Census Bureau's definition of poverty is used, which varies based on total household size.
- Persons with disabilities, those households with at least one person with a disability
- Limited English proficiency households, those in which English is not the primary language and/or who do not speak English well
- Zero vehicle households.
- Low educational attainment: Persons without a high school degree
- Female heads of households, those with a female listed as head of household, with no husband present
- Youth. Residents who are between the ages of 10 and 17
- Older adults. Residents who are 65 years old or older

A census tract block group is identified as an underserved community by being in the 80th-100th percentile of block groups (very high concentrations) based on the concentration of the ten indicators (see Figure 5). The most underserved communities are block groups with four to nine indicators within the 80th-100th percentile range.

DISCUSSION AND ANALYSIS

Traditionally, environmental justice has been the standard for transportation planning agencies in evaluating project impacts and determining whether a proposed plan/project would impose disproportionate burdens and adverse

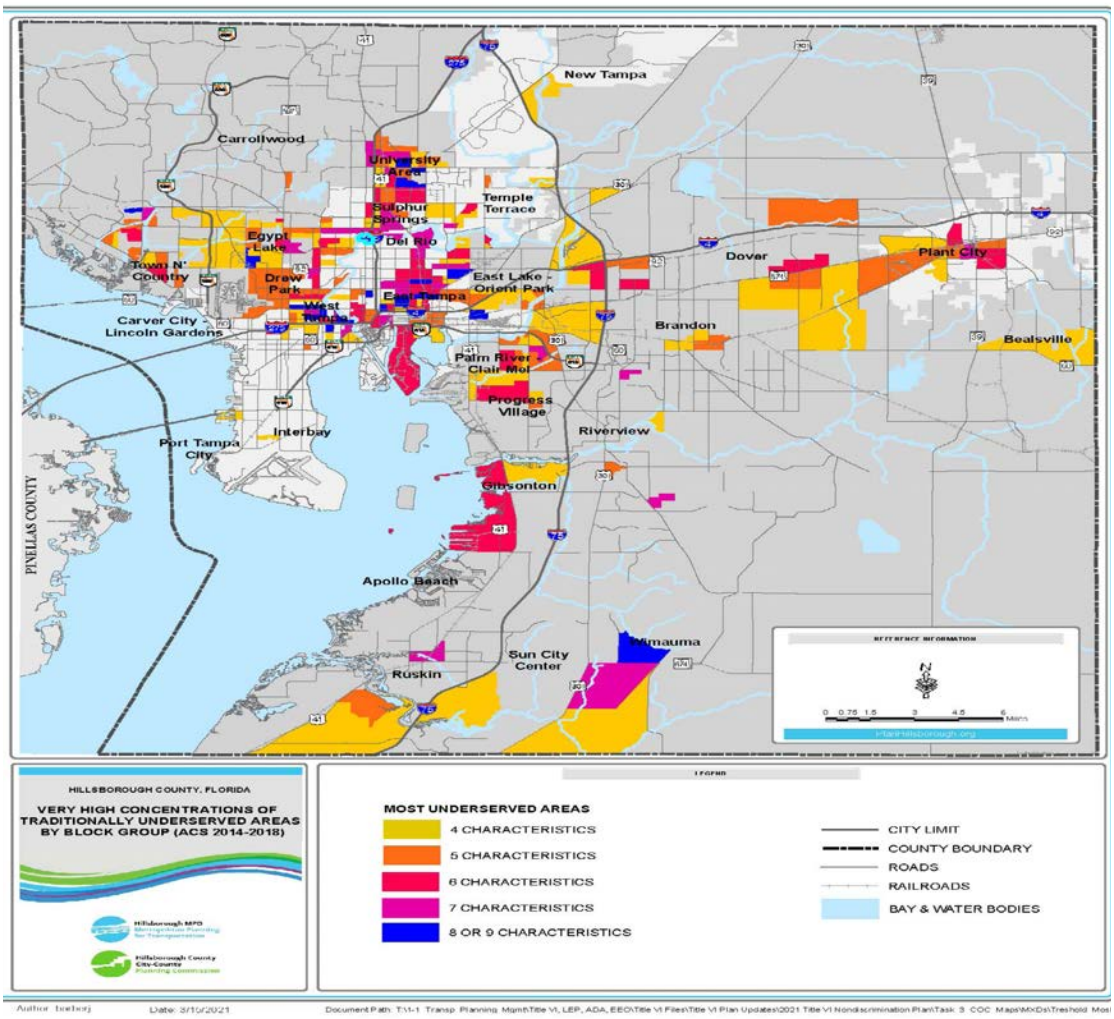

Figure 5: Underserved Communities in Hillsborough County, Florida. Source: https://planhillsborough.org/wp-content/uploads/2021/08/August2021_Nondiscrimination_Equity_Plan.pdf

effects on low-income and minority communities. Major transportation plans/projects that go through the NEPA process with EIS preparation would only have to include analyses of the plan/project impact on low-income, minority, and occasionally LEP persons in their environmental justice chapters. As previously mentioned, environmental justice analysis is process-based and focused on avoiding disproportionately burdening vulnerable populations. However, equitable transportation planning practices demand more forethought and must be more inclusive by considering the mobility needs of a large share of underrepresented populations.

In the case studies mentioned in this article, the MPOs not only expanded their environmental justice-based analysis beyond low-income and minority populations, they also broadened their understanding of the location of the demographic groups with different mobility needs (Twaddell, et al., 2019). Some agencies also rethought and renamed their nomenclature and definitions of underrepresented communities.

For example, prior to 2020, both the MTC and Hillsborough TPOused the term Communities of Concern for their vulnerable populations. In 2020, both agencies changed their definition and methodology to reflect society's increased awareness of language and rhetoric. MTC's board decided to adopt Equity Focus Communities (Tupase, 2021) , while the Hillsborough TPO went with Underserved Communities (Plan Hillsborough nondiscrimination & equity plan, 2021). CMAP used the environmental justice model to identify concentrations of minority and low-income populations in its programs and plans prior to its On To 2050 Comprehensive Plan effort. In 2018, when CMAP created On To 2050, the agency also adopted a new methodology to identify "geographies not currently well connected to regional economic progress" in economically disconnected and disinvested areas (Economically disconnected areas, n.d.). By broadening and renaming equity metrics, transportation planners are increasing the inclusivity in the transportation planning process, acknowledging the power of language in shaping a negative perception towards disadvantaged populations in the past, and aiming to reshape transportation policies in a more equitable, forward-looking future.

Transportation planners and transportation planning agencies should go beyond what is required by law to increase the inclusivity of their agency's plans, programs, and projects. In deciding on the nomenclature and determining which indicators to feature, planners should think critically about and analyze the demographics and specific needs of the communities they serve.

About the Author

June Lai

June Lai is a transportation planner at HDR with experience in policy and plan development in relation to transportation equity, environmental justice, data analysis and visualization. Prior to joining HDR, June worked for the County of San Luis Obispo and Motivate on the expansion of Bay Area Bike Share to the East Bay. She holds a dual master's in City & Regional Planning and Engineering from Cal Poly SLO, and a bachelor's degree in Urban Studies from UC Berkeley.

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Cover photo: Adults traversing an accessible pedestrian bridge (Unsplash)

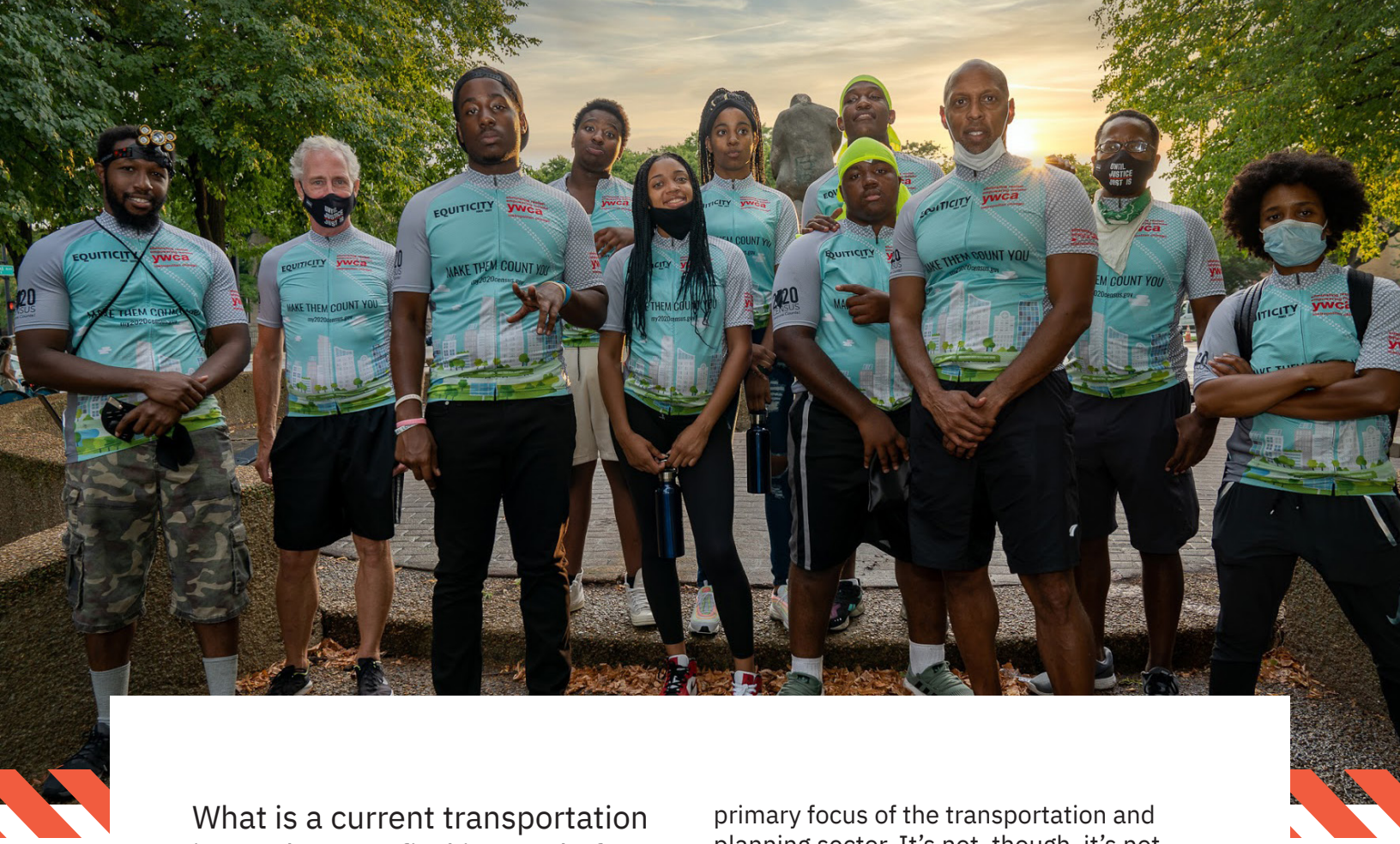
SPECIAL FEATURE

A CRITICAL QUESTION

WITH OLATUNJI OBOI REED

Olatunji Oboi Reed

Founding President & CEO of Equiticity



What is a current transportation issue that you find in need of a radical rethinking?

All of them. All of them. Transportation and planning in this country has deep, deep roots in structural racism and white supremacy. Your sector built monuments to racism for future generations to adore. Today we call those monuments highways, and they ravaged our neighborhoods here in Chicago and cities across the country. Your sector is more concerned about white lives than Black lives. Your sector is more concerned about bike lanes than young Black and Brown children. There is structural racism in this sector and the most important work your sector must do is the active dismantling of structural racism that is inherent within how you all operate. And next is putting the tactical strategies in place to ensure Black and Brown people are connecting to the services and the infrastructure that your sector provides in a way that improves life outcomes and reduces transportation inequities and related inequities. That should be the primary focus of the transportation and planning sector. It's not, though, it's not.

People in your sector still need convincing that we [Black, Brown, and Indigenous people of color] are being harmed by how you all operate. I'll give you a quick example. Here in Chicago, the three way intersection of 79th and Stony Island and South Chicago is one of the most dangerous intersections in the state of Illinois, and it's been that way for many generations. It was that dangerous when my grandfather was coming up in this city. And to date, there's been no wholesale re-engineering of that intersection. Yet your sector comes to us and says the solution to traffic violence is policing. **There's something fundamentally flawed, irreparably broken with a sector that takes that approach.**

So, naturally, there needs to be a dismantling of structural racism within your sector to ensure an active move away from enforcement to reduce traffic violence. Your sector is the root cause of traffic violence in our neighborhoods. It's your sector that did that and you're going to the police to ask

them to fix a problem that you created. So we need to move away from enforcement and move toward re-engineering our streets.

We need to fix transit in this country. We need to restore operational and infrastructural funding at the federal level for transit. We need to financially support alternative models of mobility service delivery that includes mobility hubs that should be funded at the federal level. We need to support the community-based organizations that are organizing around the socialization of mobility with, for example, community bicycle rides, neighborhood walking tours, group scooter rolls, public transit excursions, open street festivals, and related mobility events. There should be government dollars coming to community-based organizations to execute this work.

We are doing this work with limited resources and little government support. When the truth is that these socialization activities - at Equiticity we call them Community Mobility Rituals (Figure 1) - they are transformative in our neighborhoods and they have the potential of helping to reduce violence in our communities. That's the number one concern Black and Brown people have who live in major cities like Chicago. So when I think about the priorities of the planning sector, that's what I think about.

Expanded Content

Continue the conversation with Oboi in our "Critical Conversations: The State of Transportation Planning in 2022" podcast series, available at planning.org/podcast or wherever you get your podcasts.

https://planning.org/podcast/

Cover photo: Equiticity Census Team (Photo by Norvell Tolbert Photography)

Olatunji Oboi Reed

Olatunji Oboi Reed serves as the founding President & CEO of Equiticity, a racial equity movement, operationalizing for racial equity, increased mobility, and racial justice to improve the lives of Black and Brown people across the United States. In 2015, Oboi was awarded The White House Transportation Champion of Change award. He serves as Co-Chair of the Transportation Equity Network, and Steering Committee Member of PolicyLink's Transportation Equity Caucus. Oboi is a frequent speaker, panelist, and facilitator at conferences around the world.

Figure 1: Image of a Go Hub Friday Night Ride Series, one of Equiticity's Mobility Rituals

BUS STOPS & PERCEIVED SAFETY THROUGH A GENDER LENS

Daytime vs. Nighttime Differences in Feelings of Safety Along MBTA Bus Route 1

Grecia White

Figure 1: Survey recruitment poster hung at a bus stop along Massachusetts Ave in Boston

Bus Stops and Perceived Safety Through a Gender Lens takes a microscale approach and focuses on bus stops along a single route in Boston to better understand safety perceptions at different times of day through a gender lens.

A survey was conducted using an SMS platform, SlickText, to conduct the perceived safety audit. I hung up large posters with the project and survey details at 33 out of the 46 bus stops along the route (Figure 1). Participants were asked how safe they felt waiting for the bus at a specific bus stop during the daytime vs nighttime and whether they identified as a woman or a man. The 118 survey responses were cleaned and analyzed using Excel and R, a free programming software (Figure 2).

As shown in Figure 3, the perceived safety scores were coupled with Massachusetts Bay Transportation Authority (MBTA) amenities data to identify any patterns between the amenities available at each stop and the safety scores given by people.

Since publication, I have met with a Cambridge, Massachusetts planner interested in learning more about the project and findings. This person also proposed the idea of pairing the survey data with land use data. After publication, I was also invited to speak at the 2021 Modernizing Rail conference, where I presented to transit advocates and enthusiasts. Here the topic of land use was again mentioned as another possible factor influencing safety perceptions. Most recently, I've been invited to present at a Boston Region MPO Transit Working Group meeting.

All this leads me to think there is interest in adding a gender lens to transit research, in order to better understand the experience of different riders.

Future work could include analyzing land use data and evaluating its influence on safety perceptions versus the influence of amenities at bus stops. At the same time I was conducting this research, I was also working on a personal project, a documentary focused on women who bike

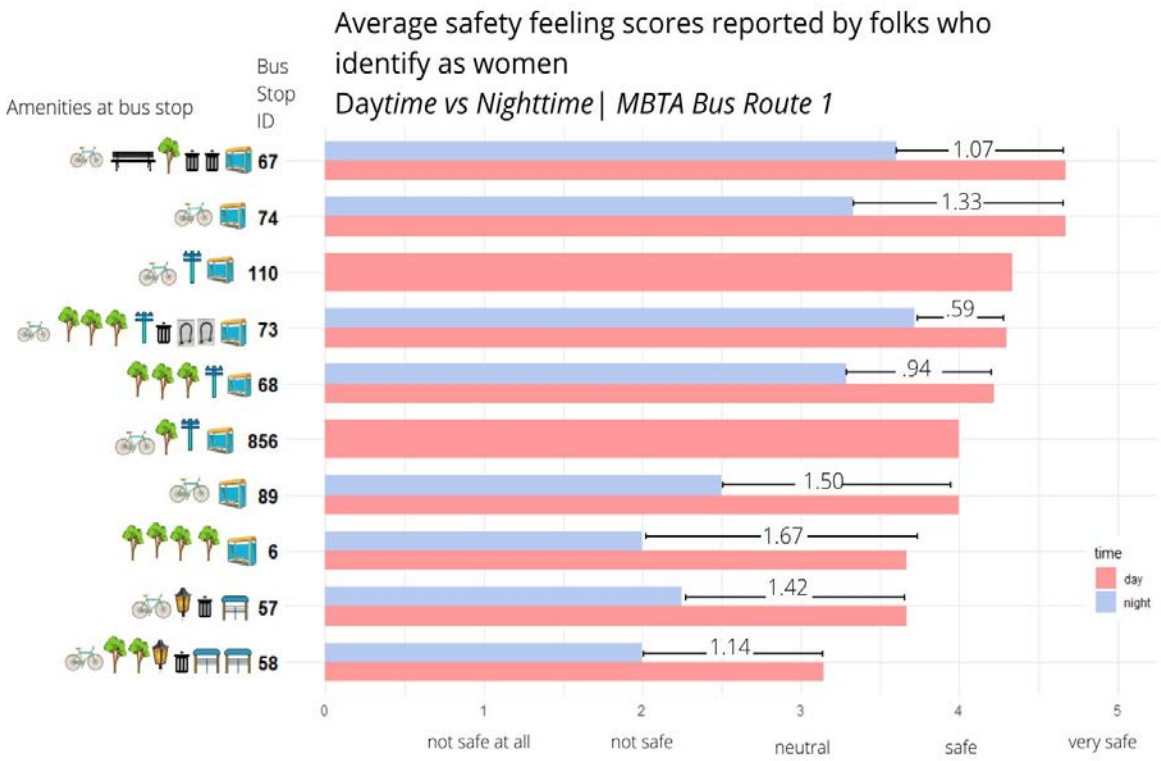


Figure 2: Safety Feeling Score Scale -- Only includes data from bus stops that received 3 or more responses for daytime or 3 or more responses for nighttime from folks who identify as a woman.

at night. As part of this effort, I met and interviewed people about their experiences. This led to patterns emerging that would have otherwise not been brought to my attention had I only sent out a survey.

Future studies aimed at improving the transit experiences of various groups of people, including women, could include the collection of qualitative data, such as interviews, to complement quantitative data.

Insights from interviews could lead to a more complex, but fuller and clearer understanding of people's struggles and joys as they move through their cities.

Explore for yourself!

See what physical amenities are present at each stop along MBTA bus route 1 in the northbound direction as well as the daytime and nighttime safety scores for folks who identified as women (Figure 2).

Visit to the full interactive map at https://bit.ly/bus_stops_perceived_safety_map to access the southbound stops, southbound amenities and the safety scores for non women identifying folks.

Visit https://bit.ly/bus_stops_perceived_safety_report to see the author's completed report, created using ArcGIS Story Maps.

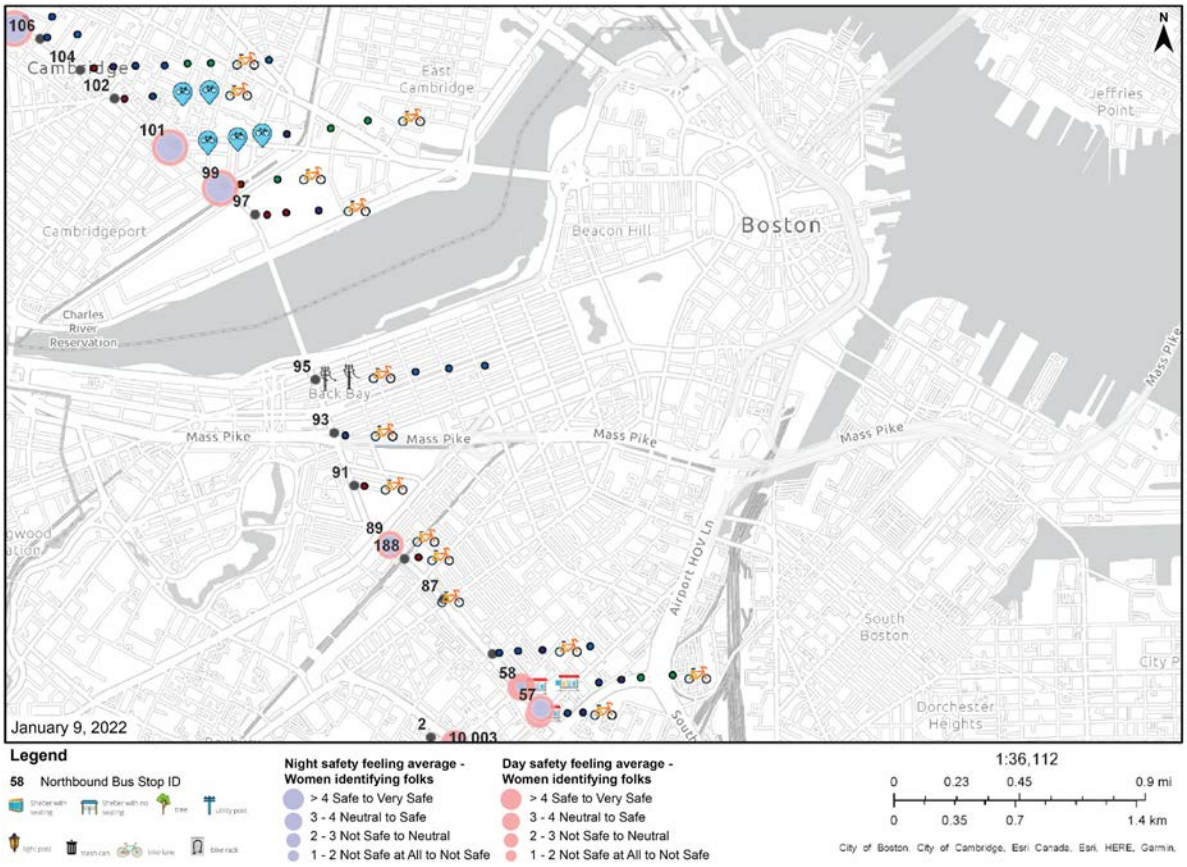


Figure 3: MBTA Route 1 bus stops, PATI amenities and average daytime and nighttime perceived safety scores. Sources: City of Boston, City of Cambridge, Massachusetts Bay Transportation Authority, Esri Canada, Esri, HERE, Garmin

About the Author

Grecia White

Grecia White is interested in using data + media to improve the delivery of government services in order to better serve the needs of all citizens and foster trust and engagement. She considers herself to be a transportation scholar activist and hopes to bring visibility to the issues women and minorities face as they move around their cities. Grecia completed her Master's degree in Urban Informatics in August 2021 from Northeastern University.

WHERE THE SIDEWALK ENDS

The State Of Municipal ADA Transition Planning for the Public Right-of-Way in the Chicago Region

Yochai Eisenberg
Audrey Wennink
Jeremy Glover

Figure 1: The lack of sidewalks at this bus stop in Homewood, IL prevents any kind of meaningful access for people with disabilities. Image courtesy Metropolitan Planning Council.

Nearly every person will experience disability at some point in their lifetime, either personally or in a caregiving role. In fact, nearly one-quarter (23.5%) of Americans over the age of 65 experience a mobility-limiting disability (Brumbaugh, S., 2018). In the Chicago region, the population is getting older. According to the Chicago Metropolitan Agency for Planning (CMAP), a large increase in the number of people over 85 will increase the average age of the region's residents from 35.7 in 2010 to 39.4 by 2050 (On to 2050, n.d.). In 2019, there were 828,419 people in the six-county Chicago region who identified as a person with a disability, about 10 percent of the population. That's an increase of 11.6% since 2010. During that same period the region's overall population actually fell by half a percent.[1]

When sidewalks, crosswalks, and transit stations are universally accessible, people of all abilities and ages can stay mobile and actively participate in their communities (Figure 1). Not only is that important for general health and well-being but it enables residents to age in place without fear of becoming disconnected or homebound should they experience a disability. Community planning should pay more attention to creating inclusive and livable communities for people of all ages and abilities because this issue affects everyone. However, municipal capacity may be limiting progress in developing such plans as well as the quality of those plans. This is especially concerning for communities with a higher disability population that are also typically low-income and low-resource communities. This Chicago-area research showed these communities more often had lower quality ADA transition plans.

In 2020, the US celebrated the 30-year anniversary of the Americans with Disabilities Act (ADA), the landmark civil rights legislation that prohibits discrimination against people with disabilities in all areas of public life. The ADA was the first of its kind, a model for

1 American Community Survey 1-year estimates for 2010 and 2019. The six-county Chicago region includes Cook, DuPage, Kane, Lake, McHenry, and Will Counties.

other nations around the world. Now is an opportune time to reflect on the progress made in three decades, and also to take stock of how much work remains to create a just and equitable society for people with disabilities.

The unfortunate reality is that many requirements of the ADA implementing regulations, especially at the local level, have not been fully implemented. This is largely due to insufficient education and enforcement by the federal government. Nowhere is this truer than on our sidewalks, crosswalks, and other pedestrian infrastructure.

Pedestrian infrastructure matters. Pathways for walking and wheeling are critical for people of all abilities to get to the places they want and need to go, including jobs, school, healthcare, recreation, and social activities. The ADA implementing regulations require that all pathways in the public right-of-way, such as sidewalks, be accessible to all people. Due to a lack of coordinated planning, there is often a patchwork of accessible and inaccessible infrastructure creating discontinuous routes.

This situation has always been serious, but it has taken on an even greater urgency since the COVID-19 pandemic. This public health crisis has profound implications for the disability community, so it's more important than ever that local governments renew their commitment to fulfilling the requirements of the ADA. Many people are using pedestrian infrastructure more than ever before for basic transportation and recreation. When barriers to accessible mobility exist, quarantine can become confinement.

The United State Access Board, a federal agency focusing on accessible design, has guidelines to help local governments build pedestrian facilities that are compliant with the ADA (Guide to the ADA Accessibility Standards, n.d.). Existing sidewalks must be wide, flat, and barrier-free. Ramps must connect sidewalks to the street at intersections. These qualities of pedestrian infrastructure may escape the attention of an able-bodied person but can restrict mobility and limit access for a person with a disability, and this inequitable access is a critical civil rights issue (Figures 2, 3, and 4).

The first step to ensuring equitable access in the public right-of-way is to identify existing barriers. Careful planning is necessary as streetscape infrastructure investments are costly and remain in place for many years; although it is worth noting building sidewalks is a fraction of the cost and sidewalks tend to outlive their car-dominating streetscapes. That's why Title II of the ADA requires any unit of government with more than 50 employees to create an **ADA transition plan** that identifies barriers to access in the public right-of-way, and develop a plan for addressing those barriers.[2]

The intention of this research was to determine how many municipalities in the Chicago region have ADA transition plans and to assess the quality of those plans. Even if local governments did create a transition plan at some point since the ADA was passed, revised ADA guidelines finalized in 2010 necessitated plan updates. While transition plans are also required to address barriers to access in public buildings, we focused only on the public right-of-way (i.e. streets and sidewalks). To conduct this research, the Metropolitan Planning Council (MPC) partnered with the Great Lakes ADA Center at the University of Illinois at Chicago to conduct a regional assessment.

2 The ADA also requires that transition plans address barriers to accessing public facilities. However, this report is only focusing on barriers in the public right-of-way.

Figure 2: This incomplete sidewalk in Harvey, IL makes passage difficult or impossible for people with disabilities. Image courtesy Metropolitan Planning Council.

This study grew out of MPC's 2019 report titled Toward Universal Mobility: Charting a Path to Improve Transportation Accessibility. The report outlined 32 recommendations to improve transportation and mobility for people with disabilities in the greater Chicago region. Many of the recommendations stem directly from the requirements of the ADA, especially as they pertain to physical infrastructure and transit service. One such recommendation is to create a technical assistance program to help local governments develop ADA transition plans. This report provides baseline data that could inform such a program.

WHAT IS AN ADA TRANSITION PLAN, AND WHY IS IT IMPORTANT?

The ADA is divided into five titles that provide for equal access in areas including employment, education, transportation, and public space. The ADA National Network has detailed information on each of the Act's titles. Title II of the ADA explains that ADA Transition plans must include:

1. A designation of the official(s) responsible for the implementation of the transition plan
2. An inventory of barriers (i.e., identification of physical obstacles to access)
3. A prioritized schedule of when barriers will be eliminated and deficiencies corrected
4. A description of the methods that will be used to make facilities accessible
5. Provision of an opportunity to interested persons, including individuals with disabilities or organizations representing individuals with disabilities, to participate in the development of the transition plan by submitting comments

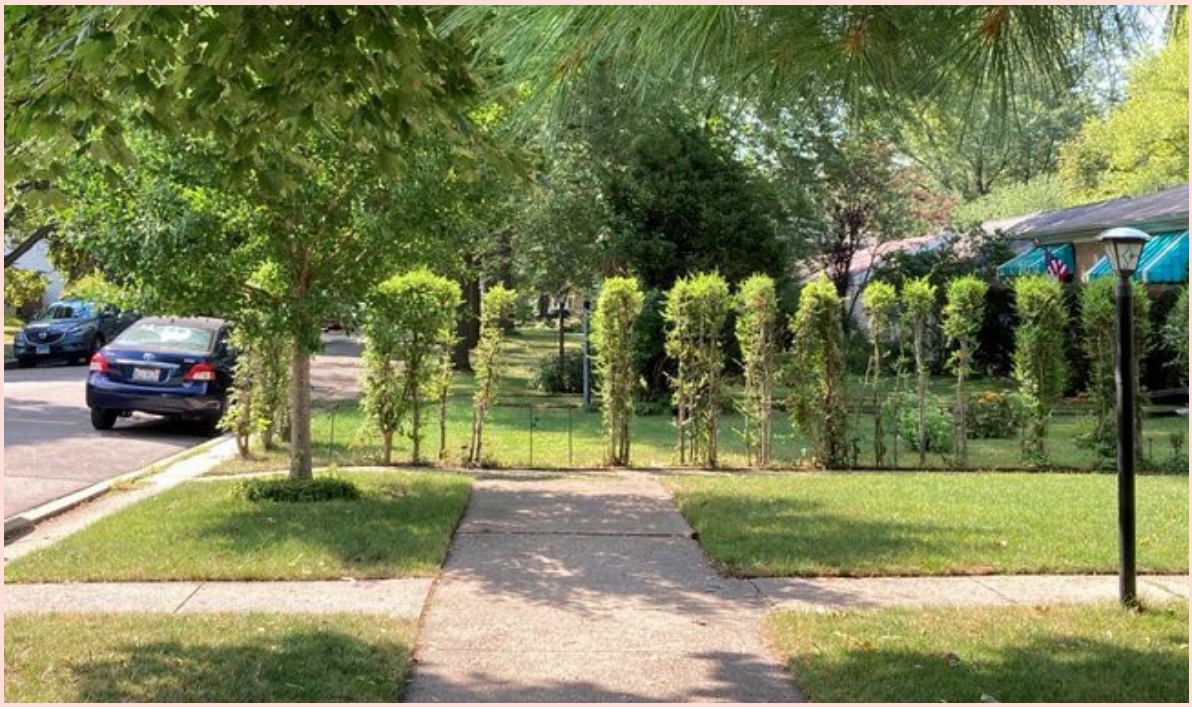


Figure 3: An all-too-common situation is when a sidewalk comes to an abrupt end, forcing pedestrians into the street such as this case in Evanston, IL. Photo courtesy Victoria Barrett.

Figure 4: Access Living is a disability-rights advocacy group in Chicago. Their new headquarters building is rated LEED-NC Gold and features advanced universal-design solutions to accommodate its staff and clients. An additional curb cut from the loading zone allows clients to roll out of vehicles parked curbside. The storm drain provides a high-contrast “stripe” visual cue guiding visually impaired people to the front door. Courtesy of Access Living.

REQUIREMENTS VERSUS BEST PRACTICES

Transition plans vary widely in detail, quality, and comprehensibility. In addition to the requirements discussed above, experts have identified 35 best practices for transition plans to make them more representative of their communities' needs and more likely to be implemented, which are summarized in broad categories below (Eisenberg, Heider, Gould, & Jones, 2020):

- **Meaningful public engagement.** Local governments are required to provide an opportunity for interested parties to view transition plans and submit comments. This is a very low bar for public engagement. Moving beyond the requirement means authentically involving people with disabilities and other stakeholders to gain from their vast knowledge on accessibility barriers in their communities. Meaningful engagement with the disability community will strengthen the quality of a plan, build support for implementation, and potentially mitigate the risk of legal challenges.
- **Transparent inventory methods and results.** One of the first steps in the transition planning process is to conduct a self-assessment to create an inventory of all accessibility barriers in the public right-of-way. Communities use various kinds of inventory methods including physical audits, GIS mapping, and aerial imagery analysis. A thorough inventory with a well-defined methodology creates trust in the process and ensures that all barriers are documented. Although communities may be afraid to report barriers because of concerns it opens them up to potential litigation, reporting barriers is a transparent approach to sharing the information gathered so that internal and external stakeholders have a comprehensive understanding of the existing conditions.
- **Detailed and actionable implementation plans.** Identifying barriers to access is a useful exercise by itself, but the real purpose of an ADA transition plan is to transition to a state of universal accessibility in the public realm. High-quality transition plans, therefore, provide a detailed schedule for barrier removal and explicitly define the methods that will be used. Since local governments have scarce resources, high-quality plans will also detail how barrier removal will be funded and how the work will be phased and prioritized. All plans are required to specify a responsible public official, but local governments who are serious about implementation will designate a senior official who is accountable to the public.
- **Planning for the future.** Although not required by the ADA, high-quality plans will establish a system to monitor progress and make periodic updates. ADA transition plans should also describe how they align with other local or regional planning processes. Cross-jurisdictional collaboration is especially important for transition planning. Responsibility for accessibility improvements changes depending on who has jurisdiction over a road. This distinction is of little importance to pedestrians, who are likely unaware when crossing arbitrary municipal boundaries, but can have a major impact on access and safety. Prioritizing the removal of barriers to

access should be embedded in every transportation planning effort in the region.

Non-compliance is a gamble.

More than 30 years after the passing of the ADA, people with disabilities continue to face barriers in the pedestrian environment. While the federal government has mostly taken a hands-off approach to enforcement, non-compliant entities are at risk of being sued by local groups in federal court. In most cases, a settlement agreement will force the local government into compliance, with potentially serious financial consequences. This has already happened on numerous occasions in Illinois.

In 2007, the City of Chicago entered a settlement where it was required to dedicate $50 million in new funding to curb ramp repair and installation annually for a five-year period. In 2015, Champaign County, IL reached a settlement agreement on a wide range of ADA issues, including the requirement to bring the public right-of-way into full compliance within three years. The town of Pekin, IL in Tazewell County is currently being sued by a group of residents for failure to provide accessible sidewalks and curb ramps. Additional litigation is very likely in the future.

One municipal ADA coordinator we talked to explains: "Threats of lawsuits or losing federal funding – that's a pretty big hammer. And if you want grants for your community, then you better get on it. And unfortunately, that speaks to more people than doing the right thing…because everyone should have equal access to neighborhoods [and] businesses, to be able to live their lives" (Eisenberg, Heider, Stokes, & Deitrick, 2020).

Local governments that don't act risk losing out on future funding opportunities, or worse: losing control of their own capital improvement plans. Additionally, plans that are decades old likely do not satisfy the requirements of Title II. In published guidance (Civil Rights Americans with Disabilities Act Transition Plans, 2012) to local governments, the FHWA calls transition plans "living" documents that must be updated as often as necessary to assure that they remain relevant and inclusive of all outstanding accessibility barriers. Not making enough progress was at the heart of a recent legal settlement with the City of New Orleans, as plaintiffs successfully argued that a plan completed in 2011 wasn't being implemented but rather was "collecting dust on the shelf" (Eisenberg, Heider, Stokes, Deitrick, 2020).

BENEFITS TO COMMUNITIES

Going through the ADA transition planning process can increase the capacity of a community to support mobility and participation for people with disabilities. Local governments interested in doing the minimum can simply fill out a template and post it online. But going through the ADA transition planning process with purpose and intention can be a way to **infuse inclusion into a municipal government's culture.** An ADA coordinator explained, "It's not just a block on a checklist, right? That's not what the intent of the ADA is in my opinion. It's a complete philosophy change in the way that we look at and treat other people. It's a sense of awareness that someone who might have a disability still has the same rights and accessibility to everything that we provide as a city."

If done well, the transition planning process facilitates cultural change as people within the local government and in the larger community better understand their individual role in a system of removing barriers to "universal mobility" and start to identify new opportunities for

making programs, facilities, and services more accessible.

It is standard practice to build new infrastructure following the most recent accessibility design guidelines and to bring streets and sidewalks into compliance with the ADA whenever a major reconstruction happens. One could argue, then, that transition planning is an unnecessary and expensive step that leads to the same eventual outcome. However, transition plans allow local governments to identify and address accessibility issues in a systematic fashion, ensuring that barriers do not remain in the pedestrian network that reduce the usefulness of all the other accessibility investments made. Transition plans enable more informed decision-making and more efficient use of scarce public resources.

Additional benefits emerge from this planning process. Because many communities do not have a comprehensive database on the infrastructure in their right-of-way, the self-assessment required to create an inventory of accessibility barriers is an excellent opportunity to collect data that can be used for many planning efforts affecting pedestrians and transit users more broadly. Further, data on pedestrian infrastructure quality can be used for developing navigation apps that provide users with disabilities with a customized route that meets their mobility needs.

STATE OF TRANSITION PLANNING IN THE CHICAGO REGION

Despite the federal requirement, transition plans are an underused tool. A national study of 401 government entities found that only 13% had transition plans readily available (Eisenberg, Heider, Gould, & Jones, 2020).

So what's the state of transition planning in greater Chicago? The first step to answering this question was tracking down all the transition plans in the region. These plans are legally required to be available to the public, so one might expect locating them to be relatively easy, but it was not. We worked with a group of students from the University of Illinois-Chicago College of Urban Planning and Public Administration to contact and review the websites of each of the 200 municipalities in the region with at least 50 employees. **Of the 83 municipalities that responded, only 22 had a transition plan. That's just 11%. Of those 22, all but one had completed the plan since 2010** (Figure 5).

It's important to recognize that this inventory is just a snapshot in time. It's possible that we missed a few, and some may be in the works currently. But that would likely only move the needle by a few percentage points, and this figure is in line with the national study that found a 13% compliance rate. Of the plans that we were able to verify, they had a pretty wide distribution with no clear geographic pattern.

The students also assessed the quality of the plans by checking to see how many of the five required elements each plan satisfied. As you can see in Table 1 on the next page, none of the required elements was satisfied universally by all 22 plans. The most essential task of a transition plan, completing an inventory of access barriers, was done for all but one plan, and nearly all plans specified a responsible public official. The most common public officials designated as ADA coordinator were human resources director, public works or engineering director or village administrator.

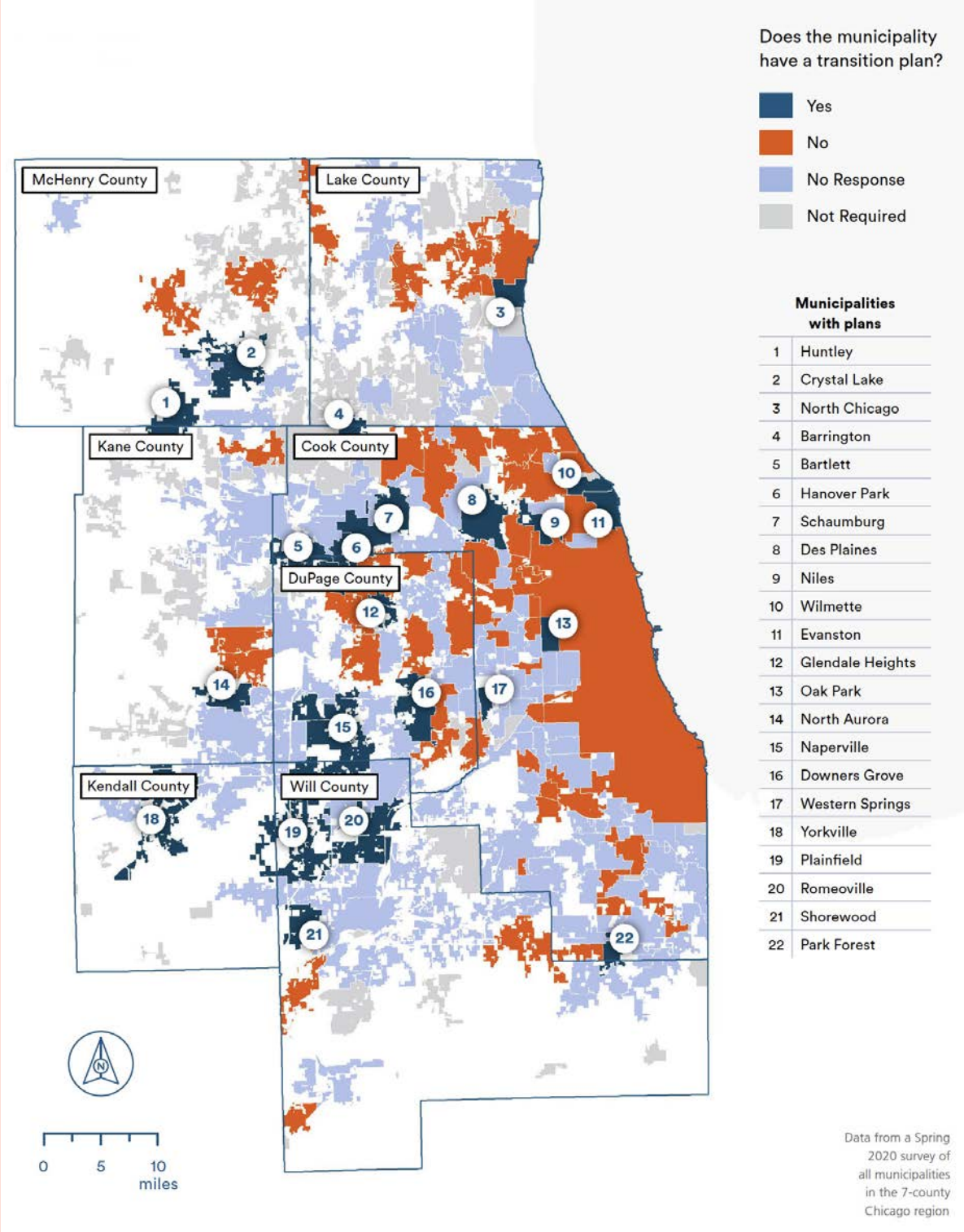


Figure 5: Transition Plan Status for Municipalities in the Chicago Region

Table 1. Assessment of how many of the five required elements each plan satisfied

Required Element	Count	%
Complete an inventory of barriers in public rights of way	21	95
Identification of a public official responsible for plan implementation	20	91
Describe the methods that will be used to remove barriers and make facilities accessible	18	82
Include a prioritized schedule for barrier removal	11	50
Provide an opportunity for interested persons to participate in the development of the plan	11	50

COMMUNITY CHARACTERISTIC

Creating an ADA transition plan takes time, money, and expertise. These resources are not evenly spread across communities in the Chicago region and these inequities have an impact on a municipality's ability to create a high-quality transition plan. To investigate this idea, we looked for a relationship between municipal transition plan status (whether they had a plan) and certain demographic and community characteristics such as income, race, number of municipal staff, and prevalence of disability among residents. For municipalities with plans, we also investigated if those same characteristics might correlate with the quality of their plans. We found that:

- Larger municipalities and municipalities with higher median incomes were more likely to have ADA transition plans.
- Municipalities with a higher percentage of people with disabilities were less likely to have a transition plan than those with a low percentage of people with disabilities.
- Among municipalities that did have plans, higher rates of disability were associated with lower plan quality, meaning that they satisfied fewer required elements and adhered to less of the expert-identified best practices. This may be related to the capacity of communities, given the median income of residents.
- Municipalities with higher median incomes tended to have higher quality plans.
- The municipalities with the highest percentage of Black residents and people of color had completed significantly fewer required elements and best practices in their plans.

MOVING FORWARD

Like the nation at large, the Chicago region hasn't made enough progress in creating and implementing ADA transition plans. That doesn't mean that local governments haven't been working hard to make their communities accessible, but they haven't done it in a systematic, transparent, and community-driven way. Among the municipalities that did complete a plan, most had very cursory public outreach, and a surprising number had no obvious means for public comment at all. It's also unclear how seriously officials took the process beyond satisfying the minimum requirements. There is very little information about implementation and future updates. Additionally, as with all other areas of planning, there are clear equity issues. Lower-capacity communities are struggling to make these plans impactful, or just make them at all.

Fortunately, for the nearly 90% of eligible municipalities in the Chicago region that don't have an ADA transition plan, and the estimated 87% of all eligible units of government nationwide, there's a lot of great information on how to get started.

About the Authors

Yochai Eisenberg, PhD

Yochai Eisenberg's research seeks to improve community mobility and access for people with disabilities. He leads research efforts to better understand the status of implementation of ADA transition plans for the public rights of way and currently serves on a technical committee for the Metropolitan Planning Council for their Universal Mobility Initiative.

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Jeremy Glover was formerly a Transportation Associate at MPC where he contributed to reports, including Transit Means Business, Toward Universal Mobility, and Where the Sidewalk Ends.

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Audrey Wennink directs MPC's transportation efforts and coordinates transportation initiatives with other facets of planning including affordable housing, land use, equity and the environment. She leads transportation research and advocacy efforts including pursuing sustainable funding for transportation in Illinois, integration of performance-based planning methods into transportation practice, and developing efforts to boost transportation equity.

Resources

This article is adapted from a report released in March 2021 by the Metropolitan Planning Council and the Great Lakes ADA Center. You can read the full report, which contains much additional detail on the regional transition plan assessment, here.

There are many resources available to local governments to help with the ADA transition plan development process. The New England ADA Center has a very comprehensive website to help local governments learn about the requirements of Title II of the ADA: Title II Action Guide for State and Local Governments.

The Minnesota Department of Transportation has compiled several transition plan templates, examples, and educational resources specific to rights-of-way: State Aid for Local Transportation - ADA.

The Ohio Department of Transportation similarly has provided templates and examples of ADA transition plans: ADA Transition Plan Resources for Local Agencies.

The National Cooperative Highway Research Program developed a very detailed guide on best practices for ADA transition planning. The report is written for state departments of transportation, but is relevant for local governments as well: NCHRP Project Number 20-7 (232) - ADA Transition Plans: A Guide to Best Management Practices.

The Great Plains ADA Center has developed a national certification program for people who have been designated as an ADA coordinator by their local government. This is a great way to learn about the role and to learn strategies that will help you complete and implement a good transition plan: ADA Coordinator Training Certification Program (ACTCP).

Advocacy Makes a Difference

Since originally releasing these findings in February 2021, we've seen exciting developments in the Chicago region. Our report caught the attention of the Federal Highway Administration's Chicago urban satellite office, which took special interest in improving access in the public right-of-way. Representatives from FHWA engaged the Illinois DOT and the region's metropolitan planning organization (MPO) to discuss different ways to tackle this problem. As of January 2022, the MPO is in the process of hiring a full-time regional ADA coordinator to assist municipalities with Title II compliance, with a special focus on ADA transition plans. Sometimes all an issue needs is a little extra visibility to get the wheels rolling.

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SPECIAL FEATURE

A CRITICAL QUESTION

WITH JUDY SHANLEY & CLAIRE STANLEY

Judy Shanley

Project Director

National Office of Easterseals

Claire Stanley

Public Policy Analyst

National Disability Rights Network

Where do you find the biggest gap between how transportation planners view the world and how non-planners perceive mobility and accessibility in their everyday lives?

***Claire Stanley*:** The orientation and mobility, training, that I went through when I was younger, it's now not enough, because there are different new designs that cause you to scratch your head and go – okay what new training do we need that is going to be effective enough, because some of these new designs are just so outside of the box. For example, a specific example that comes to mind are floating bus stops and the new way cities are setting bus systems to interact with bike lanes. With your traditional four-way intersection, there are different little islands that you crossover and a lot of times what's in between them is a bike lane. Instead of just crossing the street, I'm on the other corner and might have to cross a bike lane crossover to some kind of floating island. However, that bike lane between the islands makes it really hard for people with all kinds of disabilities, and I am speaking here specifically for the blind community, of which I am a member.

Depending on the orientation and mobility training, design features like these make it really hard for us to navigate and interact with our communities. And so, when planners are trying to create really new fancy things that I'm sure are all about interacting with pedestrians and cyclists - and I think they have really good intentions - they're actually making it so much more complicated for blind individuals in particular.

I think the city planners had this great intention behind these new plans, but they often forget people with disabilities. We're kind of an afterthought.

Judy Shanley: I agree with you wholeheartedly. One of the things that I think is different between transportation planners and people that have to utilize the service, particularly individuals with disabilities, is planners think about

efficiency. They think about getting from point A to point B and what you've talked about in terms of floating bus stops is similar to flag stops. Agencies put in flag stops, where the person on the side of the road has to motion to a bus or a fixed route service to stop or train. For the transit planner, sure, it's efficient to keep that vehicle running but for an individual with a disability, how do you access that ride when you can't see the vehicle coming? I think that planners think about efficiency, whereas riders may think about the quality of service and the implications of that service and their impact on accessing opportunities like a doctor's appointment or going to school.

Transportation planners are very analytical and quantitative, and I think the riding public is thinking about the quality of the service and the implications on an individual's life when that transportation service is challenged. I agree with what Claire said about the new mobility and new innovation and design, that it's added in without thinking about the implications for various riders. I think that's the difference in the way transportation planners and non-planners perceive mobility and accessibility in their everyday lives.

***Claire Stanley*:** That's so interesting, too, because I always wonder - not just in city planning, but all kinds of different areas of design - for people who are going to school, whether you're an architect or urban developer, I often hear from people in these programs that they're not getting classes and education on how to make things ADA compliant or user friendly. And that boggles my mind. I'm like, we're in 2022 and this isn't part of the curriculum? Because it would make such a big impact on making things accessible.

Judy Shanley: Exactly – I just finished a study under my FTA-funded project, the National Center for Mobility Management, where I queried university programs for planners to ask them what they are teaching. In their curriculum, very few indicated that there was any coursework that future professionals had in their programs about ADA accessibility and mobility management. And that's what ultimately hurts the discipline. On another note, public agencies like the Metropolitan Planning Council in Chicago have developed a report on universal mobility in which they have highlighted that educating transportation planners whether in school or in the profession about universal mobility can help create a lot of awareness as well as opportunity.

Cover image: Wider aisles on passenger rail mean people using wheelchairs can move freely instead of essentially being stuck in one spot (National Disability Rights Network)

Expanded Content

Continue the conversation with Claire and Judy in our “Critical Conversations: The State of Transportation Planning in 2022” podcast series, available at planning.org/podcast or wherever you get your podcasts.

https://planning.org/podcast/

Judy Shanley

Judy Shanley is a Project Director with the National Office of Easterseals in Chicago. She manages projects funded by the Federal Transit Administration (FTA), the National Science Foundation, and the Federal Highway Administration. The focus of this work is on mobility management, coordinated transportation systems, health, and human service transit partnerships.

Claire Stanley

Claire Stanley is a Public Policy Analyst at the National Disability Rights Network (NDRN). Prior to her position with NDRN, Claire worked as an advocate with the American Council of the Blind where she advocated for the rights of blind and visually impaired persons, both on a direct level as well as on Capitol Hill. As a person with a disability, Ms. Stanley believes strongly in the rights of all persons with disabilities.

TOOLS OF THE TRADE

An Equity Toolkit for Planners and the Community

Tia Boyd
Kristine M. Williams

INTRODUCTION

Transportation equity is a representation of fairness in the distribution of benefits and burdens. It differs from equality. A system of equality treats everyone the same, regardless of their abilities and needs, whereas equity provides specific support and resources based on a population's needs and abilities (Litman, 2021; Martinson, 2018). An equitable approach to transportation planning requires an understanding of each population group, their needs, and tailored strategies to address these needs.

This paper presents a set of tools and resources to advance transportation investments for underserved communities and populations. It describes the Transportation Equity Toolkit, which provides a framework for a transportation equity needs assessment and an equity-based project identification and prioritization process. The toolkit is a resource for metropolitan planning organizations (MPOs), local governments, and community organizations as they work with traditionally underserved communities on equitable plans and investments.

THE CONSEQUENCES OF TRANSPORTATION DECISIONS AND INVESTMENTS

Equity in transportation decision-making and investments promotes 1) equal access to safe, affordable, and reliable transportation, 2) improved access to opportunity, and 3) a fair share of transportation benefits and not just burdens. To accomplish equity goals, MPOs and local governments are evaluating transportation plans and projects from an equity perspective. However, needs identification frequently focuses on system deficiencies and can overlook the needs of specific populations. Furthermore, approaches used to identify and prioritize projects of benefit to disadvantaged populations vary in scope and effectiveness (Williams et al., 2019). These gaps in current practice may contribute to inequities in the transportation system for traditionally underserved communities.

Failure to emphasize equity and the needs of underserved communities in transportation decisions and investments has serious consequences. It can increase exposure to crashes and emissions, reduce physical activity and access to healthy foods, and impede access to essential services, jobs, and educational opportunities. Transportation inequity is often evidenced by underinvestment in needed infrastructure improvements, services, and amenities in low-income communities. It is also conflated with the consequences of conventional planning practice, such as:

- A focus on roadway expansion at the expense of transit, bicycle, and pedestrian needs;
- Urban sprawl, housing segregation, and a growing disconnect between affordable housing and jobs or services; and
- Displacement of underserved populations in areas with a rich array of affordable transportation options.

AN EMPHASIS ON TRADITIONALLY UNDERSERVED COMMUNITIES

To ensure a focus on equity, the toolkit emphasizes early identification of the needs and location of underserved communities in the planning process. Underserved communities are "populations sharing a particular characteristic, as well as geographic communities, who have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life" (Exec. Order No. 13985, 2021). In transportation, traditionally underserved communities are those whose needs are typically forgotten or ignored in the transportation planning process.

These populations may include low-income and:

- Minority
- Older adults
- Young persons
- Women
- Persons with disabilities
- Single-parent households
- Zero-vehicle households
- Limited English Proficiency (LEP)
- LGBTQ+
- Other underserved or disadvantaged populations groups

Note: Individuals may belong to more than one population group, and as a result face intersecting barriers. Source: Exec. Order No. 13985, 2021.

Underserved communities can be supported through transportation decisions and investments that acknowledge and address the historical and cumulative disproportionate impacts faced by disadvantaged populations. Frameworks and tools that emphasize an equity approach provide the foundational support for transportation planning to advance equity in underserved communities. The transportation equity toolkit was developed for this purpose and is a helpful tool in the planner's toolkit.

FRAMEWORKS AND TOOLS TO EMPHASIZE AN EQUITY APPROACH

The Transportation Equity Toolkit provides the framework for a transportation equity needs assessment of identified underserved populations and an equity-based project screening and prioritization process.

A variety of tools and methods are provided for these frameworks, including two tools developed specifically for the toolkit:

- **Transportation Equity Audit Tool (Audit Tool)**: a survey-based tool designed for use by agency staff, community organizers, and community members in identifying community transportation needs from an equity perspective; and
- **Transportation Equity Scorecard Tool (Scorecard)**: a spreadsheet tool to assist staff of MPOs and other transportation planning agencies in prioritizing projects that advance equity.

Six interrelated dimensions of transportation equity are addressed in the toolkit: 1) mobility, 2) accessibility, 3) affordability, 4) health, 5) safety, and 6) environment. The presence or absence of each of these dimensions determines how the transportation system impacts affected populations. The dimensions and their definitions are as follows:

- **Mobility**: people's ability to move from origins to destinations (home to work, work to grocery store, etc.)
- **Accessibility**: how easily people can travel between locations (travel time, number of amenities and services that are reachable within a given amount of time, etc.)
- **Affordability**: cost of travel to destinations as a percentage of income (Housing + Transportation index)
- **Health**: the ability to participate in active transportation, access green spaces, and meet daily needs. This also relates to safety and the environment (risk of injury or fatality, risk of exposure to pollution and disease, stress, etc.).
- **Safety**: the risk of injury or fatality associated with the transportation system (speed, crash rate, etc.). This includes both perceived and observed safety concerns.
- **Physical and Social Environment**: the level of pollution (air quality, noise levels, resulting illness, etc.) and the social and psychological effects of transportation (stress, social relationships, community cohesion, etc.)

These dimensions are emphasized in the needs assessment and project screening and prioritization processes. Methods for weighting are also suggested when using the Audit Tool and Scorecard. For example, the Scorecard Tool provides an option to weight scores based on the magnitude of their anticipated benefit. Each of these dimensions, their applicability in the equity-based needs assessment and project screening and prioritization process, and the assessment processes suggested for each framework and accompanying tool are explained in the following sections.

IDENTIFYING COMMUNITY NEEDS

A transportation equity needs assessment is a comprehensive process to identify the specific transportation needs of traditionally underserved communities. Data collected during the assessment can be used to develop targeted improvements for addressing identified needs and improving the quality of life for communities with the greatest needs.

To have a lasting impact on the communities they serve, agency staff must understand how people use the transportation system. Although the definition of transportation equity centers on understanding the needs of all transportation users (Federal Highway

Administration, 2019; Wennink & Krapp, 2020), the specific needs of traditionally underserved communities are often not adequately addressed. The transportation equity needs assessment provides agencies with methods and tools focused on identifying the specific needs of underserved populations with an emphasis on the six dimensions of equity.

Reasons for conducting an equity assessment might include the following (Williams et al., 2021):

- Learn about the specific needs of target populations
- Identify priority needs
- Get a clear description of needs and their underlying causes
- Ensure that actions taken align with community needs as identified by community members
- Increase public engagement and build public trust
- Secure community support for projects and future actions
- Provide the public with a sense of ownership in activities carried out in their communities
- Increase agency accountability

The process to conduct the needs assessment and use the Transportation Equity Audit Tool includes several interrelated steps. These steps generally involve 1) locating and profiling communities of concern and 2) creating an inventory and assessing mobility needs.

The inventory and assessment address the equity dimensions (mobility, accessibility, affordability, health, and the physical and social environment) and include the following steps, which are described in this section:

1. Involve the community
2. Review and prepare to use the Equity Audit Tool
3. Use the Audit Tool to collect information about the community's transportation needs
4. Compile, analyze, and share information collected during the audit

The first set of steps for conducting the needs assessment is shown in Figure 2. This involves locating and mapping underserved communities (referred to as communities of concern (COCs) on the map) by collecting socioeconomic and demographic statistics.

After the maps are complete, an inventory can be performed to begin to assess mobility needs. The inventory is a high-level assessment of transportation deficiencies and should be further supplemented with field studies. An example inventory map assessing safety needs is shown in Figure 1. The following steps were used to develop the safety inventory map:

1. Use census, state, regional, and/or local data to summarize travel patterns and modes used.
2. Review existing plans and studies impacting the study area to identify current and proposed transportation projects and services.
3. Use GIS to build inventory maps.
4. Overlay the inventory maps onto the COC maps.
5. Conduct targeted field studies and summarize findings.

The map in Figure 2 shows fatalities, injuries, and property damage for bicyclists and pedestrians. Additionally, the map provides information on the bicycle and pedestrian network, for transit stops

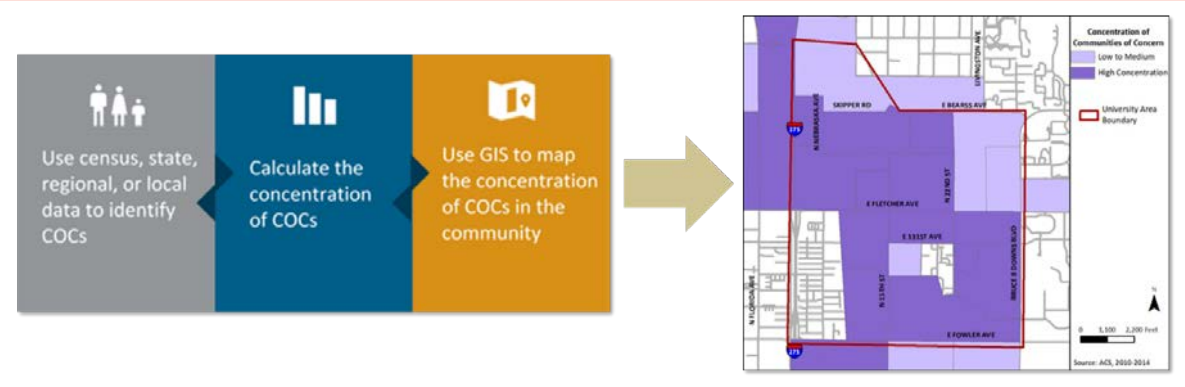

Figure 1:Defining and mapping underserved communities. Source: Williams et al., 2021

Example threshold-based method

The threshold-based method is commonly used to identify the relative concentration of communities of concern in a study area. The steps are as follows:

- Identify the relative concentration of COCs at the census tract, block group, or traffic analysis zone (TAZ) level for a set of selected socio-economic variables;
- Identify the regional average for that variable (or the average based on agency or jurisdictional boundaries);
- Identify and visually represent areas with larger concentrations (e.g., greater than one or two standard deviations above the average) of one or more groups of COCs.

For more information, see the Scorecard User Guide and Evaluating the Distributional Effects of Regional Transportation Plans and Projects, Williams et al., 2017.

and routes, and essential destinations for community members (aggregate of employment, educational facilities, shopping, etc.). The information in the map is used to identify high crash areas and deficiencies in the bicycle and pedestrian networks that affect mobility within an area.

The findings from the inventory and field studies are most valuable when supplemented with community input, using the toolkit resources and Audit Tool.

THE TRANSPORTATION EQUITY AUDIT TOOL

The Audit Tool is designed to guide transportation agency staff, community organizers, and community members through the transportation needs assessment process. The tool is divided into eight sections, building on the dimensions of equity. These sections are as follows:

- Community Characteristics
- Access to Opportunity
- Environment
- Safety
- Active Transportation
- Public Transportation
- Investments and Burdens
- Overall Ratings

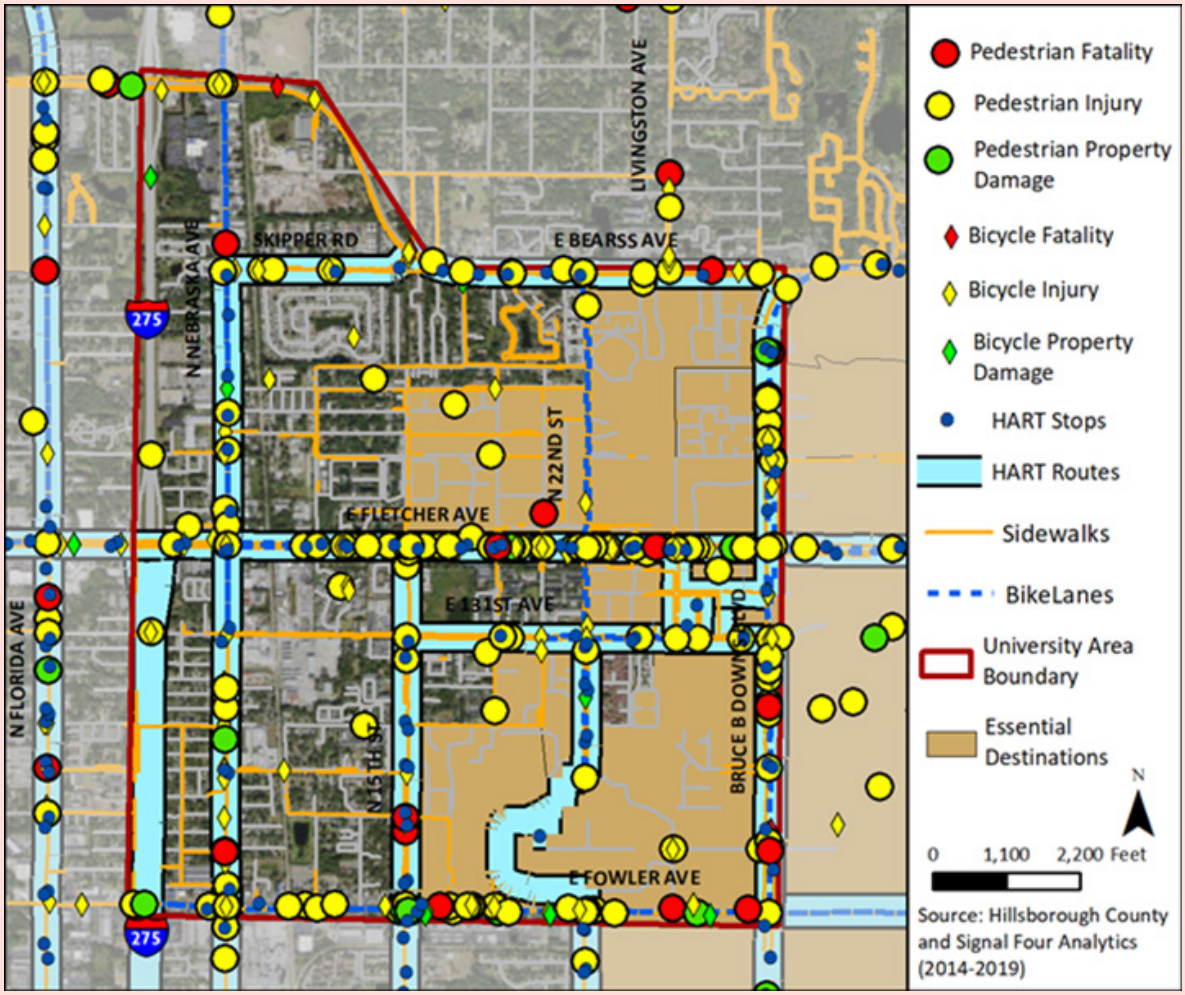

Figure 2: Example inventory map assessing safety needs. Source: Williams et al., 2021.

A goal of the audit is to promote collaboration between agency staff and community stakeholders in the planning process and to empower community members to become advocates for their needs. Community members can complete the audit tool with agency staff or community organizers. This is achieved through more focused discussions about individualized community needs to ensure that targeted improvements for transportation are implemented. Deliberate efforts to engage community members must be made throughout the planning process. Identifying and involving people from the community early in the needs assessment helps to focus the analysis effort and ensures more accurate evaluations.

The community can be involved using various techniques. Agency staff or community organizers can hold a community meeting and/or walk-audit with community members. Alternatively, community members can be interviewed in person, by phone, mail, or using an online survey (email, social media, agency website, etc.). The techniques provided in the toolkit are not prescriptive. Agency staff and community members should

use a variety of techniques targeted to the population characteristics to engage community members during the audit.

Once the audit is complete, results are evaluated using a three-step process. First, prioritize needs by organizing the needs categories from highest to lowest using the average ratings provided for the Overall Ratings section of the audit tool. For a more refined analysis, rank individual needs in each category (environment, safety, active transportation, public transportation, investments and burdens) from highest to lowest using the average number of responses for each prompt.

The process for prioritizing needs should consider the sociodemographic data collected in the Community Characteristics section of the audit and be consistent with travel mode preferences relative to each category. For example, in communities with a significant number of zero-vehicle households, special attention should be given to needs in the active transportation and public transportation categories (Williams et al., 2021, p. 17). Further analysis can be conducted using techniques such as a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to identify needs that may not be immediately evident during the audit.

Next, use strategies, such as a root cause analysis or cause and consequence analysis, to uncover the underlying causes of problems faced by underserved populations. Understanding these causes can lead to more robust problem-solving strategies. Finally, review, synthesize, and document evaluation results in a needs assessment report and share with the community and other key stakeholders. Use results from the evaluation to characterize high priority needs and inform targeted strategies to address those needs.

The audit and evaluation results can also inform a community action plan to ensure that investments target identified needs. For example, in 2020, the University Area Community Development Corporation (UACDC) and the Hillsborough County Government conducted a Pedestrian/Bicycle Safety Study for Harvest Hope Park (a park within the University Area Community shown in Figure 2). The area surrounding the park was identified as a high-crash area. As a result, the UACDC and Hillsborough County are in the process of developing and implementing various safety interventions focused on these targeted safety needs (ABC Action News, 2020).

THE TRANSPORTATION EQUITY SCORECARD TOOL

Overcoming transportation inequities involves more equitably allocating transportation investments based on community needs (Wennink & Krapp, 2020). The Toolkit informs this practice with the Transportation Equity Scorecard Tool and accompanying guidance. The tool and guidance provide a framework using adaptations of the six dimensions of equity (mobility, accessibility, affordability, health, and the physical and social environment). This framework aims to advance transportation projects for funding based on the extent to which they directly advance the needs of underserved populations in terms of these equity dimensions.

The Transportation Equity Scorecard Tool is a spreadsheet-based tool for use by local and regional transportation planning agencies to screen and prioritize transportation projects with an equity lens with input from community members. Table 1 shows several example uses for the scorecard.

The dimensions of equity and relevant factors applied in the Scorecard Tool are as follows:

- **Access to Opportunity**: employment, education, and community services (including parks and recreational facilities).
- **Health and Environment**: health care, healthy food, and environmental challenges (e.g. environmental impacts such as noise or emissions caused by heavy traffic, lack of trees or streetscaping, etc.).
- **Safety and Emergency Evacuation**: safety and emergency evacuation.
- **Affordability**: housing, transportation, and housing and transportation costs.
- **Mobility**: active transportation, transit access and service, and Americans with Disabilities Act (ADA) considerations.
- **Burdens**: the adverse impacts of proposed projects (e.g. cumulative, disproportionate, or other major adverse impacts such as barrier effects, increased noise or emissions, displacement of residents, businesses, or public amenities, etc.)

The equity evaluation for the tool involves the four steps shown in Figure 3. Each step requires careful consideration of community needs and regional goals, as well as stakeholder and public outreach. Step-by-step instructions to use the scorecard and examples are included in the Scorecard User Guide.

As with the Audit Tool, the first step in the prioritization process is to locate underserved communities (also referred to as communities of concern (COCs)) using GIS. Second, select the scoring system. The equity scorecard tool scores each project against the factors/criteria based on the concentration of COCs impacted (see Table 2). A weighting system allows agencies to assign a weight to each score based on the magnitude of the anticipated impact on equity.

Table 1. Example Uses for the Scorecard. Source: Williams et al., 2021.

EXAMPLE USES FOR THE SCORECARD
Moving projects from a needs list to a cost affordable list when preparing a metropolitan transportation plan
Selecting projects for funding in the transportation improvement program (TIP)
Selecting projects as part of a specific agency plan, program, or initiative (e.g., Transportation Disadvantaged plan, bicycle and pedestrian plan, Transportation Alternatives Program, Vision Zero plan, Complete Streets program, etc.)
Selecting projects that best advance an equity plan or policy
Selecting project alternatives that best advance equity

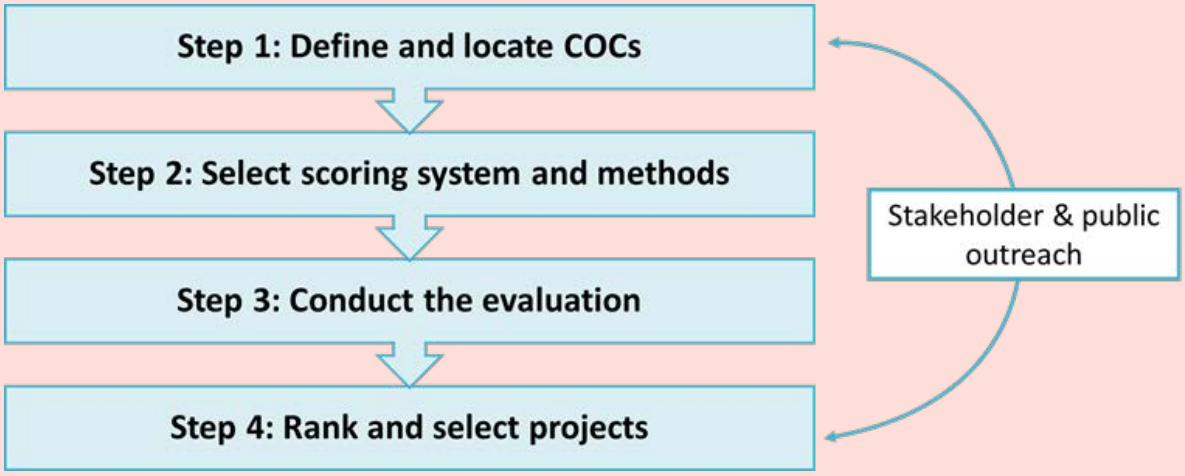

Figure 3: Equity project screening and prioritization process. Source: Williams et al., 2021.

Conducting the evaluation begins with collecting and assembling the data. After data are collected and assembled, the project type, project location or coverage, and location of COCs in relation to the project are identified.

After evaluating projects and entering the responses for each criterion into the tool, the results are summed to generate scores for each category and the total equity score (Figure 4). The total scores are used to rank projects and identify those that promote equity or specific dimensions of equity. These findings may then be presented to community members for discussion and refinement.

The selection process and results should be clearly communicated to stakeholders and the public. Projects selected without engaging underserved communities in the prioritization exercise could have limited benefits for those communities regardless of level, depth, or type of evaluation. Public involvement can validate scorecard results and confirm that selected projects:

- Enhance the transportation experience of those communities,
- Improve access to opportunity and healthy, safe, and affordable connections to all destinations, and
- Do not cause adverse impacts or create barriers.

Score		Weight	
Points (COCs)	Max Points	COCs*Impact	Max Points
-10, 0, +1, or +2	2	(-10, 0, +1, or +2)*(2)	4

Table 2. Equity Scorecard Scoring System. Source: Williams et al., 2021.

Project ID	
Category	**Factor**
Access to Opportunity	Employment
	Education
	Community Services and Shopping
Health and Environment	Health Care
	Healthy Food
Mobility	Transit Access and Service
	Americans with Disabilities Act (ADA)
Burdens	Adverse Impacts
	Total Score

Project ID
Access to Opportunity
Health and Environment
Safety and Emergency Evacuation
Affordability
Mobility
Burdens
Total

Figure 4: Scorecard results page.
Source: Williams et al., 2021.

CONCLUSION

The growing focus of federal, state, and local agencies on advancing equity and the needs of underserved communities illuminates a shift in thinking regarding how identifying and prioritizing transportation projects should be addressed. The Transportation Equity Toolkit can serve as one of the contemporary transportation planner's tools of the trade. It is comprehensive in its approach, applying methods for equity-based analysis that address several dimensions of equity. Through these methods, planners can identify and prioritize the needs of disadvantaged populations, empower underserved communities to more effectively engage in identifying and addressing their needs, and support agencies as they work to advance equity in the transportation planning process.

About the Authors

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Tia Boyd is a Research Associate at the Center for Urban Transportation Research (CUTR) at USF. Her research focuses on transportation decision-making, with an emphasis on equity in transportation planning. She serves in leading roles for several projects developing methods and tools to advance equity in transportation planning processes and generating curricula and other educational resources for transportation planning. She also serves in supporting roles for projects on MPO policy, planning, and programming.

Kristine M. Williams

Kristine M. Williams, AICP, is Program Director of Planning and Corridor Management at CUTR with more than 20 years of experience in advancing the state of the practice in access management in the U.S. and abroad. She is also a multimodal planning specialist and has developed tools and methods for improving social equity in transportation planning. Kristine is an Emeritus Member of the TRB Access Management Committee.

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Cover photo: Examples of the many types of scenarios transportation equity can address (CTEDD Transportation Equity Tooklit)

EVACUATIONS AND EQUITY

Emerging Multidisciplinary Approaches, Strategies, and Perspectives

Stephen D. Wong

In the summer of 2013, I had the unique opportunity to run home repair mission trip camps for high school and middle school students. One of the camps took me to Keansburg, New Jersey, which had been hit hard by Hurricane Sandy in 2012. As I witnessed the resulting devastation firsthand, I saw strong personal connections that resulted in the incredible resilience of a community. Often when we think about resilience in transportation engineering and planning, we think first of the infrastructure, systems, or operations. However, human connection to others, places, and institutions – what is broadly considered social capital – has been equally important (if not more) in helping communities prepare for, respond to, and recover from disasters (Aldrich, 2012; Murphy, 2007).

This understanding comes at a pivotal moment: research continues to show that disadvantaged populations are most adversely affected by climate change and natural disasters (Islam & Winkel, 2017; Sanchez & Brenman, 2008). For the transportation industry, evacuations from major disasters have shown the acute barriers and challenges that disadvantaged people face. In 2005, during Hurricane Katrina, estimates of 127,000 to 300,000 people in the metropolitan area of New Orleans did not have reliable access to transportation, contributing to the devastating loss of 1,833 lives (Boyd et al., 2009; Wolshon, 2002). In California, during the 2018 Camp Fire in Paradise, over 60% of the 86 people killed were older adults aged 65 or more (Newberry, 2019). Within this challenging context, the transportation profession requires new data, tools, strategies, and perspectives – especially those that consider social and behavioral implications – to improve equitable outcomes. This brief piece explores emerging ideas and multidisciplinary perspectives that connect social science, engineering, and planning with the goal of increasing equitable outcomes in evacuations. Evacuation planning can no longer be an afterthought, and resilient transportation systems are crucial in supporting thriving and prepared communities.

DATA NEEDS

Building human-centered transportation resilience requires a reframing of data needs. While efforts continue to collect survey data following disasters (Wong, Pel, Shaheen & Chorus, 2020; Kuligowski et al., 2022) data suffer from three key issues: 1) a lack of standardized survey questions and data from multiple disasters; 2) unrepresentative and small samples; and 3) undersampling of underserved populations. Alongside these survey data challenges, the collection of vital and official evacuation statistics, such as how many people evacuate and who evacuates, remains elusive. Altogether, this leads to research, lessons learned, and strategies that often fail to address either generalized needs (regardless of context, hazard, or geography) or misses the needs of underserved populations who need resources the most.

Despite these challenges, actions can be taken to construct more equitable and informed evacuation plans for a variety of communities. First, government agencies and research funders must recognize the essential need for post-disaster data. This is especially important for behavioral data which must be collected quickly to ensure evacuees can recall exact choices and perceptions. Second, recognition should coexist with additional rapid funding and staffing to collect data, conduct analyses, and develop implementable lessons learned for other similar communities. Third, other human-centered data collection methods such as focus groups and interviews of the affected community should be conducted as they have proven effective for gathering information from underserved populations, including indigenous populations (Wong, Broader & Shaheen, 2020; McGee et al., 2021). Finally, researchers must work directly with impacted communities to co-create the research and collect data. For example, researchers and communities can collectively design and administer focus groups that address key challenges within that community and for its unique population. Together, these steps can bolster both the quality and quantity of data to inform resilient infrastructure planning, transportation responses, and equity-based evacuation strategies.

MULTI-MODALITY AND A SHARING APPROACH

Alongside changing data needs, emerging and multidisciplinary strategies for evacuation planning could equitably expand resource opportunities. While not new, transit-based evacuation plans have garnered renewed interest in recent years, particularly from major cities with high hazard risk (e.g., New Orleans) (City of New Orleans, 2021). Smaller jurisdictions can also benefit from these plans, though implementation remains a long way off. Despite work on multi-modal simulations in engineering (Murray-Tuite & Wolshon, 2013), actionable guidance remains largely missing from the transit-based evacuation literature. Other forms of transportation other than automobiles, such as rail, air, and bicycles, could meet the needs of diverse populations, though research and case studies remain largely absent.

Modes within the sharing economy also present an intriguing opportunity during evacuations. New technology connections have enabled easier sharing of transportation and shelter resources, whether through a company (e.g., Uber, Lyft, Airbnb) or through peers and neighbors. New research has indicated that sharing resources could help certain vulnerable groups in evacuations and that communities with high levels of trust and compassion (i.e., elements of social capital) would have high levels of sharing

willingness (Wong, Broader & Shaheen, 2020; Wong, Walker & Shaheen, 2020). Neighborhood and community-driven plans that leverage social capital could produce more equitable evacuations. It should also be noted that lower-tech strategies, such as sirens or phone (or contact) trees, are also essential to reduce disparities related to the digital divide and smartphone access. Social networks, which have been found to affect evacuation behavior (Sadri et al., 2017)], could also be bolstered to expand mobility options. While the integration of shared resources into a multi-modal strategy may not be imminent, a mobility-for-all perspective can help guide these emerging opportunities.

PERSPECTIVES FOR THE FUTURE

Recent research has found that just 13 out of America's 50 largest cities describe, in detail, evacuating carless and vulnerable populations in their evacuation plans (Renne & Mayorga, 2018). This research does not even account for the hundreds of municipalities and communities across North America that do not have publicly available or even internal evacuation plans for any disaster. The challenge is not uniquely urban or suburban – rural areas will continue to be affected by increasing disaster risks, while also contending with typically lower funding and staffing resources for emergency preparedness efforts. More positively, examples of more equitable evacuation plans are beginning to emerge, such as the transit-based evacuation process in New Orleans (City of New Orleans, 2021).

A renewed urgency for wildfire evacuation plans in California is also offering a roadmap for preparedness in both small and large jurisdictions. Moving forward, several new perspectives can help guide more equitable outcomes specifically in evacuations and the planning process:

- Disasters are increasing in size, scope, and impact, and more people are living in high-risk areas, necessitating more evacuations across diverse communities in North America.
- Evacuation planning should be undertaken more broadly across all communities with clear details on how to evacuate underserved populations in need of extra assistance.
- Research can help identify mechanisms (e.g., transit-based, shared mobility) and other transportation response strategies best suited for specific communities and hazards.
- Increases in funding and resources for all communities can help in equitable disaster planning and preparedness, lowering the costs of response and recovery.
- Strategies should advance evidence from a variety of fields and multidisciplinary perspectives, such as how social science can inform engineering design and resilient transportation.

My experience witnessing the resilience of people in Keansburg, New Jersey did not occur by accident. Resilient communities require cultivation, guidance, and support, without which have led to deadly consequences in disasters, especially for those without the ability or resources to find safety. While research plays a pivotal role, the communication of this research to practitioners and stakeholders requires extensive effort. Co-creation of research is a good first step to exchange knowledge and disseminate implementable strategies during and after the research analysis. Ultimately, the benefits of both effective research and communication can be immense: evidence-based and long-term planning by governments and transportation agencies can inform safe, highly effective, and equitable evacuations for all communities and people.

About the Author

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Dr. Stephen Wong is an Assistant Professor in the Department of Civil and Environmental Engineering and leader of the Resilient and Sustainable Mobility and Evacuation (RESUME) Group at the University of Alberta in Edmonton, Canada.

Dr. Wong's multidisciplinary research focuses on the effects of travel behavior during disasters and everyday conditions, aiming to improve safety and resilience, reduce environmental impacts, and promote a more just society. He holds several committee positions at the Transportation Research Board and received his Ph.D. from the University of California, Berkeley in 2020.

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Cover photo: Evacuation during Hurricane Matthew (US Department of Agriculture)

SPECIAL FEATURE

A CRITICAL QUESTION

WITH TAMIKA BUTLER

Tamika Butler

Principal and Founder of
Tamika L. Butler Consulting

The theme for the 2022 report is “Intersections + Identities: A Radical Rethinking of Our Transportation Experiences” - what is a current transportation issue that you find is most in need of a “radical rethinking”?

Something I always talk about is that in our planning world you can be an engineer, you can be a planner, you can also be a landscape architect. So I think it’s hard to just talk about our profession, but I think broadly in this industry, one of the things I personally feel is that folks do this work because we care. We want to do the right thing, we want to connect people, we want to bring people together, we want to create inviting spaces – some of us do that through engineering and some of us do it through design or planning.

I think something we radically need to rethink is that equity is solely an external process or can only manifest externally. I think what we have to realize is just because in your heart you want to do equity, you might not be ready, like you may need to read. You may need to figure out why when you look around at your team everybody looks like you, everybody has very similar experiences to you. And in the consulting world, this is something you see all the time. We see RFP’s coming out that say, ”We want to do this, this, and this with equity, equity, equity,” and you’ll see these firms apply for these projects and you’re thinking you don’t even have women or person of color on your team. You have no projects where you’ve shown a history of doing equitable work. What is your skillset to be able to do this?” So, while I think it is important for us to focus on external-facing equity: how can our projects and outcomes be more equitable, I don’t think that should be at the expense of doing the internal work.

And I think that’s something that comes up when I do equity trainings for people and organizations. Sometimes I get feedback such as, “We were hoping you would take us through a process to evaluate projects

in a more equitable way, but instead we're talking about our personal experiences with racism, we're reading and talking about the tenants of white supremacy culture in a workplace." And so what I always tell people is, You have to rethink this idea that equity is just something you do out in the world. It's something that's a deeply personal journey and an organizational journey and a cultural journey, and if you can't do that right, then you can be an organization that does your external equity work and recruits a bunch of folks of color to come work for you, but if you haven't done the work internally, then what will those folks' experiences be? You can do the external work to make sure your outreach and engagement process is more equitable, but if you haven't done the work and the folks on your staff who are being sent out to these communities still don't get it, then that's not going to be a good experience for those communities.

Personally, when I talk about equity I'm always centering race. That doesn't mean you can't have equity work for projects that centers on older adults or trans people or undocumented folks. It is more important that the community you are working with and where you are trying to bring about change has a shared vision of what equity looks like. You have to come to that definition of equity together. Beyond that, as the "experts" we have to learn how to step back, respect the wisdom of those we are there to help, and let them self-determine what equity means, looks like, and feels like for themselves.

Expanded Content

Continue the conversation with Tamika in our "Critical Conversations: The State of Transportation Planning in 2022" podcast series, available at planning.org/podcast or wherever you get your podcasts.

https://planning.org/podcast/

Cover photo: Tamika cycling in downtown Los Angeles (Courtesy of the author)

Tamika Butler

Tamika is the Principal and Founder of Tamika L. Butler Consulting, where she focuses on shining a light on inequality, inequity, and social justice-related issues. With a diverse background in law, community organizing, and nonprofit leadership, she is a national expert on issues related to public policy, the built environment, equity, anti-racism, diversity and inclusion, organizational behavior, and change management. She is also a doctoral student in Urban Planning at UCLA's Institute for Transportation Studies in the Luskin School of Public Affairs.

3

TECHNOLOGY

BUILDING FOR THE FUTURE

FROM CURBS TO CODES

Digital infrastructure and data-driven planning for smarter mobility

Veronica Siranosian
Laynee Jones

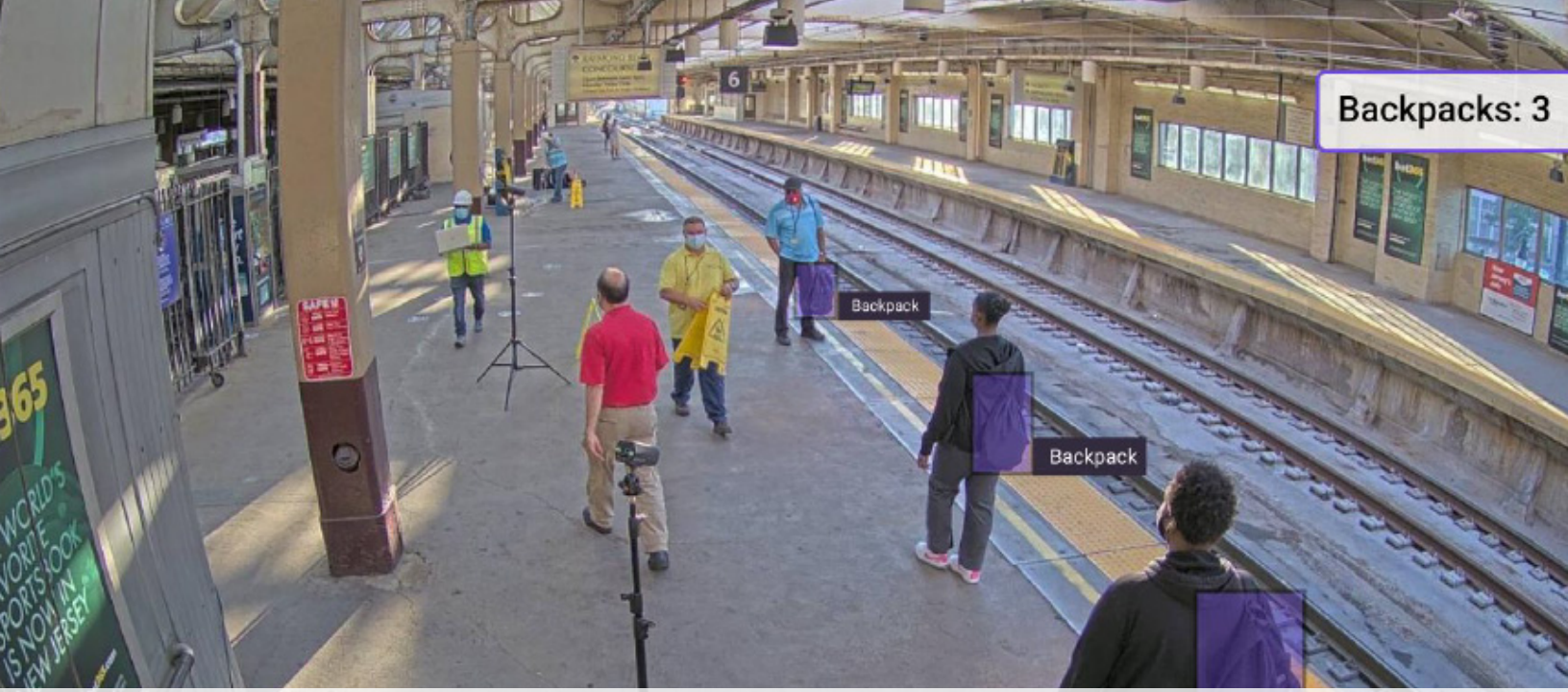


Figure 1: Example of cameras with AI software sesigned to identify crowding, determine train capacity, and capture and count passengers boarding, exiting, and awaiting trains at specific station platforms and routes

The increasing digitization of our everyday lives has created opportunities for planners to leverage digital solutions for more accurate, transparent, and collaborative transportation planning that supports a more equitable and sustainable future. As of April 2021, 85% of Americans owned smartphones, generating rich data on our locations and travel patterns (Pew Research Center, 2021). These smartphones connect us to transportation services and related information anytime, anywhere. Transportation networks and the communities they serve are also becoming increasingly digitized and connected, enabling more data-driven and informed planning. In 2020 there were 143 planned and operational connected vehicle deployments across the US with over 23,600 vehicle-based devices and 12,300 infrastructure deployments (USDOT, 2020). Transit vehicles (buses, light rail, and streetcar) are increasingly equipped with real-time location tracking devices, and the USDOT has supported connected technology pilots that integrate data from vehicles, transit, infrastructure, and personal devices (USDOT, 2022). Together with solutions like artificial intelligence and machine learning, these data can transform the way planning projects are designed and delivered to leverage digital transformation for smarter and more equitable mobility (Figure 1).

DISPARATE AND DAUNTING TO DYNAMIC DATA AND INSIGHTS

Transportation planning projects often rely on multiple sources of data to understand travel patterns and behaviors, develop alternative solutions, and test the ability of those alternatives to meet travelers' needs and their environmental impacts. This data is often historic in nature, aggregated, and presented in static tables or charts, making it difficult for communities and decision-makers to understand the connections between data and transportation solutions. Data presented as averages can also hide unique needs and impacts related to gender, race, and socioeconomic status. Historic data, while fundamentally important to understand long-term past trends, may not reflect more recent

changes (for example the dramatic changes brought on by the pandemic).

Dynamic data dashboards enable planners to more transparently present data and associated analyses. As part of the Bay Area Transit recovery vision, AECOM partnered with the nonprofit Seamless Bay Area to explore how post-pandemic transit network and investment scenarios could serve Communities of Concern, including persons with limited English proficiency, zero-vehicle households, seniors, persons with one or more disability, single-parent families, and renters paying over half their income for housing (AECOM and Seamless Bay Area, 2020). Using Microsoft's PowerBI tool and AECOM's Mobilitics™ scenario planning tool (Figure 2), scenario factors can be toggled on and off or adjusted to see how accessibility changes for these specific communities (AECOM, n.d.).

Technologies like artificial intelligence (AI, which translates massive amounts of data using algorithms and computer-based instructions into actionable information) also provide opportunities to capture and use new sources of real-time data to inform transit decisions. In New Jersey, NJ TRANSIT conducted a pilot program with AECOM to configure existing cameras with AI software to identify crowding, determine train capacity, and capture and count passengers boarding, exiting, and awaiting trains at specific station platforms and routes (Chong, J, 2021). Combining existing transportation camera and sensor infrastructure with digital solutions like artificial intelligence and machine learning opens up new use cases to better understand near-term needs and conditions, and convert data into meaningful and actionable insights.

Planners are already adept at gathering, analyzing, and interpreting multiple data sources to inform planning decisions. New and emerging digital approaches such as these demonstrate that we can do more with the data we already have- by disaggregating it to focus on

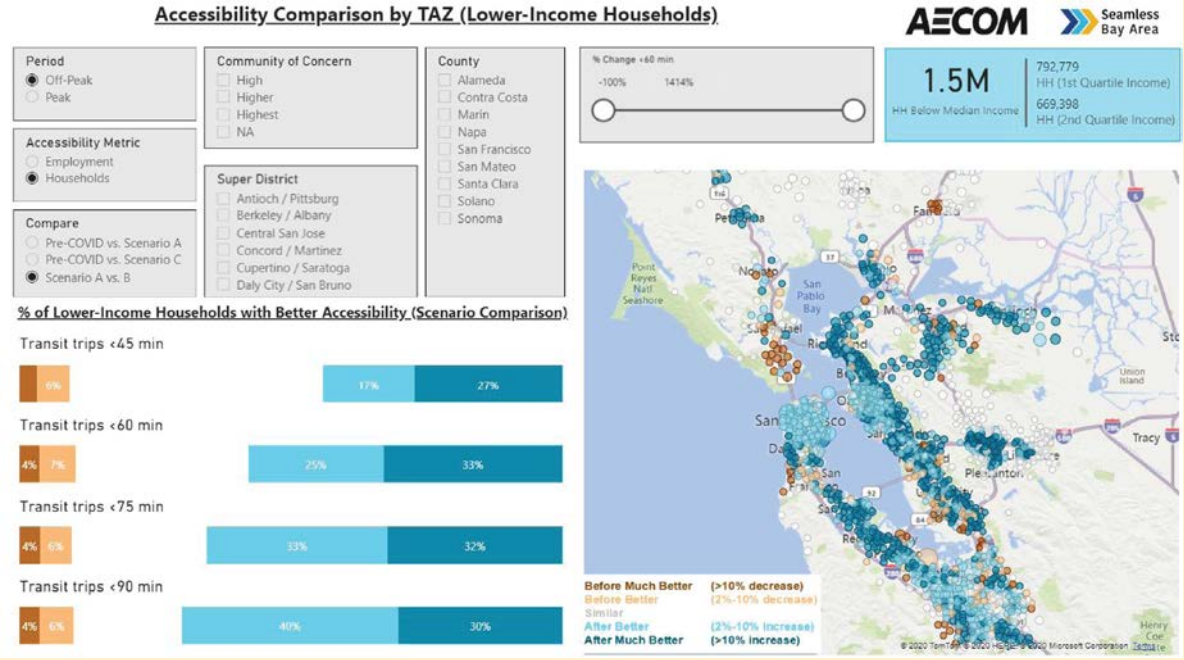


Figure 2: Screenshot of Microsoft's PowerBI tool and AECOM's Mobilitics™ scenario planning tool.

often overlooked issues related to race, gender, socioeconomics, or geography and making those analyses more accessible and transparent using dynamic data dashboards, and by using digital solutions like artificial intelligence and machine learning to better distill trends and statistics from Big Data to inform service planning decisions today and forecasts for the future.

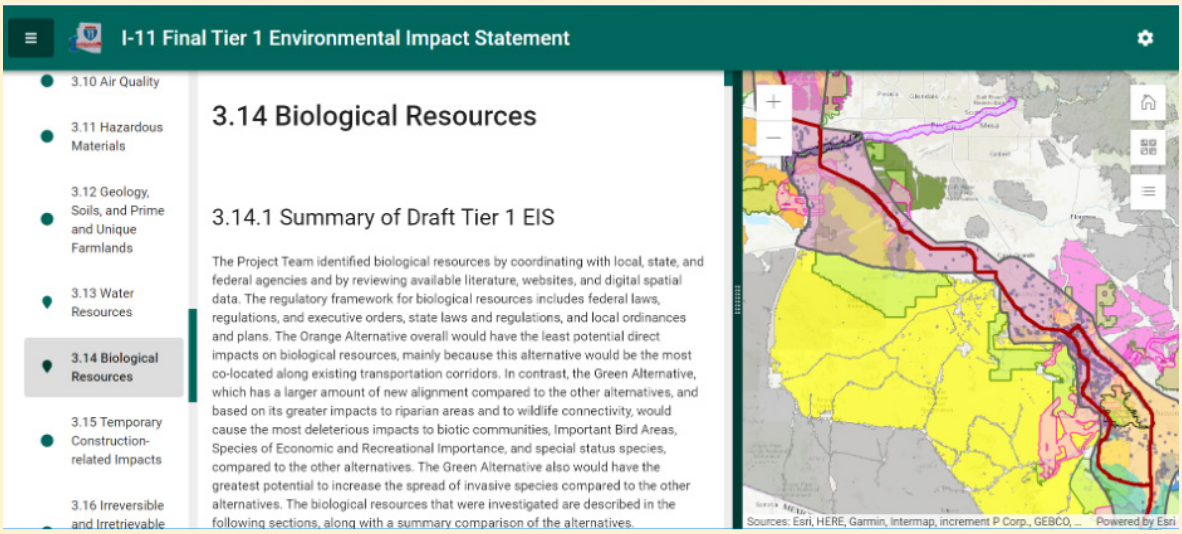
BEYOND COMMUNICATION TO ENGAGEMENT

A critical step in the transportation planning process is the ability for communities to review and comment on project alternatives and potential environmental impacts. To date, this process has mainly involved volumes of hard copy documents being placed in public places for review, with digital copies consisting of static PDFs available on project websites. When trying to understand how a project may impact or benefit them, community members are often confronted with reams of paper or long lists of PDFs that can be difficult to navigate, let alone interact with. Digital solutions can transform this one-way communication to two-way engagement.

In July 2021, The Federal Highway Administration and Arizona Department of Transportation published the nation's first fully digital, interactive Environmental Impact Statement on a transportation project. The Final National Environmental Policy Act (NEPA) Tier 1 Environmental Impact Statement (EIS) for the Interstate 11 Corridor project used AECOM's interactive PlanEngage tool, which transforms the way planning documents are communicated, offering greater accessibility and transparency for project stakeholders, agencies, and the public (Figure 3). The tool is interactive, mobile phone friendly, and compatible with third-party language translation. The official document is entirely interactive, allowing readers to zoom in and out of maps and click through layers of information. Readers can comment on any part of the text, geographic area, or transportation alternative as they are reading the document. Steven Olmsted, ADOT Program Delivery Manager, noted some early benefits realized from the use of this digital solution. "The FEIS has been out for just 75 days and we are at over 3,000 views. We are very pleased with where it's at already. We received a lot of responses on the tool, especially how pleased partnering agencies were with the availability of shapefiles and map layers."

In addition to presenting information in a more engaging and accessible way to communities, PlanEngage enables project teams to create, edit, and publish project information into a single interactive platform, streamlining document production, enhancing efficiency, and improving quality. This includes photos, visualizations, sound demonstrations, videos, project dashboards, models, and narrative. Geospatial information is all in one place, improving quality, reducing errors, saving review time, and eliminating the need to transfer large documents.

Prior to the I-11 Final EIS, NEPA documents were moving in the direction of brochures and shortened, graphical PDF (static) documents, resulting in easier to digest content, but losing much of the document specificity and detail stakeholders care about. The I-11 project demonstrates that a digital and interactive approach can deliver both increased accessibility and maintained specificity and detail. Publishing online, interactive content with graphics, videos, and zoomable maps allows readers, including community stakeholders and responsible and trustee public agencies, to drill down into details where needed and truly understand planning projects.



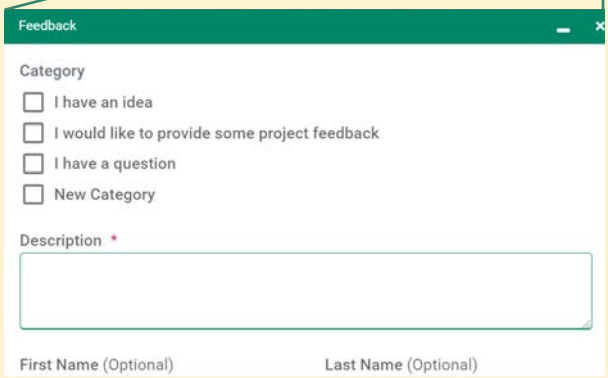


Figure 3: Selection of screenshots from AECOM's interactive PlanEngage tool

A critical consideration when deploying digital solutions for planning project engagement is to use these tools to expand access and complement other approaches, rather than inadvertently reinforce inequities. The PlanEngage platform is fully compliant with Web Content Accessibility Guidelines, which make Internet content more accessible for people with disabilities and traditional PDF and hard copies of the document were also made available on the project website and public libraries.

CONNECTING THE PHYSICAL TO THE DIGITAL FOR SMARTER MOBILITY

Digital planning, design, and engineering help planners, decision-makers, and community members to understand complex and interrelated mobility challenges, and to use digital replicas or "twins" to plan, forecast, deliver, and operate transportation systems. Digital twins combine virtual models with real-time data from a built asset to support more sophisticated simulations and adaptive (and autonomous) interventions. This approach has been used on numerous projects globally, including the Thames Tideway Tunnel, High Speed2 as well as numerous Highways England schemes in the UK (Colclough, J. 2020).

Implementation of digital twins to improve transportation planning requires taking a "digital first" approach for new projects, as well as digitizing existing physical assets which may have incomplete or limited accompanying digital data. A comprehensive digital strategy is critical to best leverage the benefits of digital twins. In the U.S., public agencies are taking the lead to transition to digitally-enabled design that can support future digital twins. The Utah Department of Transportation's (UDOT) Digital Delivery compiles data "digitally from each stage in the lifecycle of the project, reducing the need for paper, capturing as-built information, and aiding decision making by downstream users" (UDOT, 2022).

The data generated from digital twins can support a variety of beneficial use cases for transportation projects, including improved service planning, proactive and predictive maintenance and asset management, and safety, resilience, and sustainability operational improvements.

A fully connected, automated, and digitized future is on the horizon. As practitioners with a primary obligation to serve the public interest, planners have a responsibility and opportunity to channel digital tools to achieve more equitable outcomes. Careful consideration should be taken to ensure that digital approaches complement traditional ones where needed so as not to reinforce inequities related to the digital divide. Digital solutions can be used to harness more dynamic and real-time data that better represents and makes transparent the diversity of communities, translate static and one-way communication to more accessible and interactive engagement and connect the physical to the digital for more informed transportation system management, delivery, and maintenance. By embracing, developing, and using digital approaches planners can expand the toolbox of solutions available to create sustainable and equitable mobility solutions for our communities.

Key Takeaways

1. Be Accessible and Transparent: While digital solutions can help to translate disparate and daunting information into dynamic data insights, the results will hold more value if stakeholders can engage with them in meaningful ways. Be transparent about data sources, digital tools used, and limitations to avoid extrapolating inaccurate conclusions from limited

datasets or creating a “black box” that confuses the planning process.

2. Expand Engagement and Equity: Use digital solutions and data analysis to better understand differentiated travel needs and patterns (by race, gender, income, geography). Look for who might not be represented in the data or who may not have access to digital tools. Use these insights to develop bespoke combinations of digital and traditional solutions to maximize access and engagement with the planning process.

Digital is a Tool: Digital solutions aren’t an end in and of themselves. Ask questions based on community needs and priorities. Digital solutions and data science can be used as tools to help understand what is most important to the community and ultimately deliver more equitable solutions that meet the community’s needs.

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Veronica Siranosian, AICP is Vice President, Digital Solutions Director at AECOM, where she advances digital delivery and innovation in infrastructure planning, design and delivery. Born in Mexico of Armenian ancestry and raised in the US, she is acutely aware of the impacts of place on opportunity and works to leverage innovation in infrastructure and planning to connect people to opportunities and advance equity. She combines her experience in the public, private, and nonprofit sectors to serve clients globally as a technical subject matter expert for digital and innovative infrastructure projects, with a focus on urban and transportation planning.

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GIVING CURB VISIBILITY TO DELIVERY DRIVERS

Giacomo Dalla Chiara
Anne Goodchild

INTRODUCTION

At the time we are writing this article, hundreds of thousands of delivery vehicles are getting ready to hit the road and travel across U.S. cities to meet the highest peak of demand for e-commerce deliveries during Thanksgiving, Black Friday, and the Christmas holiday season. This mammoth fleet will not only add vehicle miles travelled through urban centers but also increase parking congestion, battling with other vehicles for available curb space.

While the integration of road traffic data with modern navigation systems has seen huge developments in the past decade, drastically changing the way we, and delivery vehicles, navigate through cities, not as much can be said when it comes to parking. The task of finding and securing parking is still left to drivers, and largely unsupported by real-time information or app-based solutions. Delivery vehicle drivers are affected by curb parking congestion even more than any other driver because delivery drivers have to re-park their vehicles not once or twice, but 10, 20, or even more times during a delivery route.

Our work, discussed in this article, focuses on improving delivery drivers' life when it comes to finding available curb space, improving the delivery system, and reducing some of the externalities generated in the process. We first describe what types of parking behaviors delivery drivers adopt when facing a lack of available curb parking, then we will quantify the cost of lack of available parking, estimating how much time delivery drivers spent circling the block and searching for parking. We then discuss how we can improve on that by creating the first curb availability information system – OpenPark.

A DAY IN AN URBAN DELIVERY DRIVER'S LIFE

An urban delivery vehicle is generally considered any van or truck that performs deliveries and pick-ups in an urban area. Typically, a driver starts his journey from a depot, often located outside the city center, and is provided with a list of delivery addresses located across the city – often

referred to as delivery manifest. The driver then loads the vehicle and starts the delivery route. The delivery addresses are sometimes ordered in a sequence to reflect priorities, time windows, and such that some objective function, which could be total vehicle miles travelled or total travel time is minimized. More advanced vehicle routing software also takes into consideration road traffic information, routing the vehicle to avoid peak hour traffic.

Unless a delivery location hosts a private loading/unloading bay – a parking area dedicated for the loading/unloading of commercial vehicles – drivers do not park at that address, but rather on the curb, possibly in the vicinity of the destination. Most buildings in urban cores are not even equipped with off-street loading/unloading bays. For instance, in downtown Seattle, only 20 percent of the blocks host at least one off-street loading/unloading bay, with 80 percent of the blocks relying solely on curb spaces (Urban Freight Lab, 2020). Therefore, delivery drivers compete daily with other curb users – private cars, ride-hailing vehicles, public transit vehicles, other commercial vehicles, pedestrians, and bikers – for available space to park and unload the vehicle. Moreover, no available routing software considers curb availability information when generating a manifest, simply because no city in the world actively collects this information. As a consequence, delivery drivers have to use their knowledge of the area and previous experience to decide where to park the vehicle, and for each parking location, how many delivery addresses to walk and deliver to. In a way, parking is an art, and currently, no existing software or routing algorithm can tell you where and how to park.

In part because of that, it is also the most expensive component of the last mile. On average, urban delivery drivers spend 80 percent of their working time outside their vehicles, loading and unloading goods and walking to delivery destinations, while only 20 percent of their time is spent driving between parking locations and to/from the depot (Dalla Chiara et al., 2021). Therefore, if we can use parking information to better route the vehicle to available parking spaces, we might be able to reduce total delivery time and perhaps emissions and delivery costs.

Let's take a step back, and ask ourselves, what do drivers do when they are not able to find available parking? After performing ride alongs with different carriers, we have identified four types of parking behaviors.

- **Double-parking**. While it is commonly assumed that urban delivery drivers always choose to double-park, i.e. parking on the travel lane, from empirical data collection (see Dalla Chiara et al., 2021) we observed that double-parking takes place less than 5 percent of the times drivers park. However, this does not mean that drivers always park in the dedicated commercial vehicle load zones (CVLZ). In fact, in our studies, CVLZ parking took place approximately 50 percent of the time. Therefore, while drivers do not always strive to park in curb zones dedicated to commercial vehicles, they still prefer to park on the curb lane (even in curb spaces not designated for commercial vehicles) and not on the travel lane.
- **Cruising for parking**. When a driver reaches the vicinity of a destination and no curb space is readily available in front of the delivery address, he/she might choose to circle the block in search of available curb space, which is often referred to as cruising for parking.

- **Re-routing**. If, after spending some time searching for parking, still no available curb space can be found, a driver might choose to “give up” and drive to the next destination, coming back later in the day. We defined this parking behavior as “re-routing”. Figure 1 shows GPS traces from a vehicle that performed re-routing

- **Queueing**. Vehicle drivers that are not able to find an available space might choose to temporarily park in an alternative location and wait until the desired space becomes available, hence creating an “invisible” queue of vehicles waiting to access a given space.

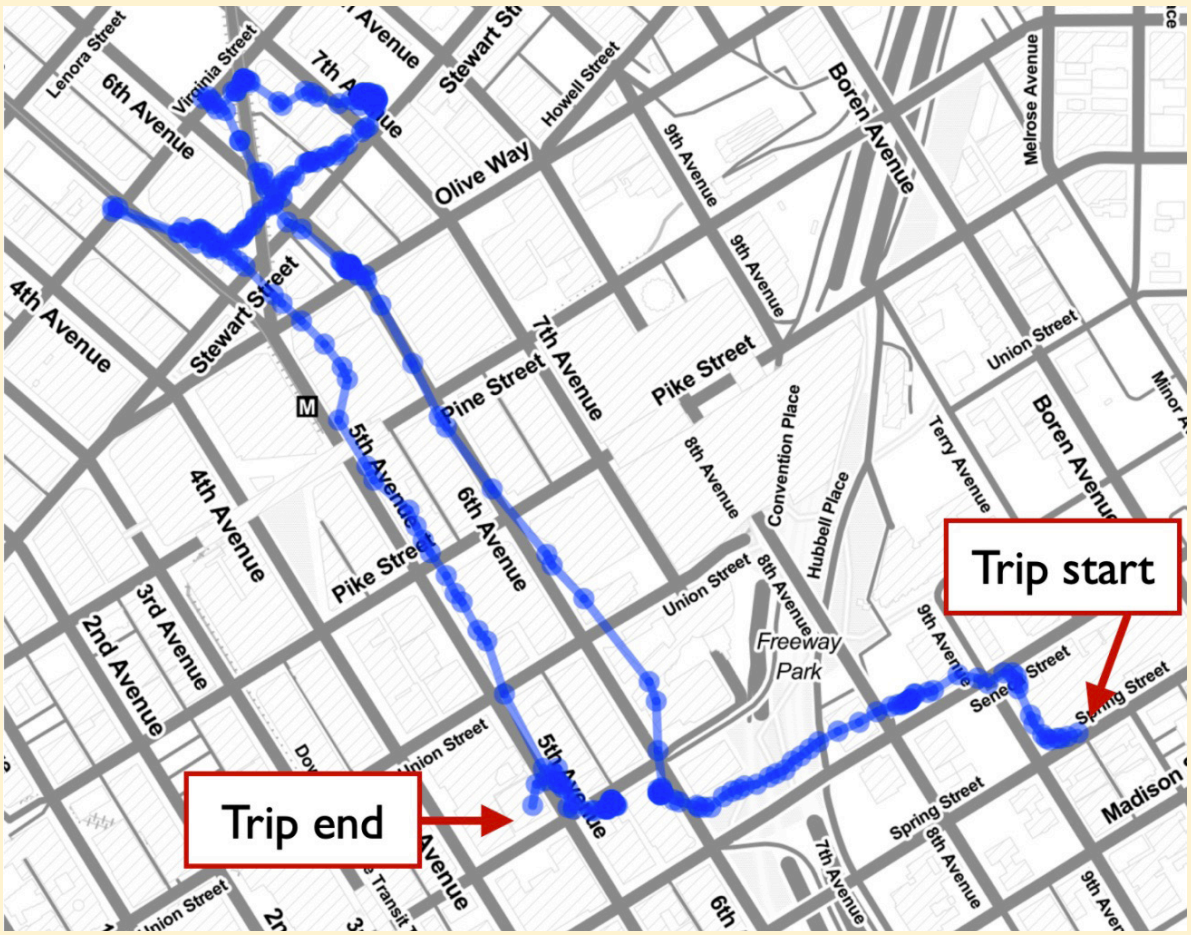

Figure 1: GPS traces from a delivery vehicle that re-routed due to unavailable curb parking

THE COST OF PARKING FOR DELIVERY VEHICLES

What is the cost of a lack of available curb parking for commercial vehicles? Often, the scientific literature points to the number of dollars spent on parking tickets, which for large carriers amounts to millions (e.g. see Kawamura et al., 2014). However, there is another, potentially larger source of cost, which is the time drivers spend searching for parking – the sum of the time spent cruising for parking, re-routing, and queueing.

While identifying the presence of cruising for parking is relatively easy (e.g. through surveys or ride alongs), quantifying it is not. As Donald Shoup wrote, "cruising is invisible" (Shoup, 2006), as cruising vehicles are mixed with other vehicles that are not searching for parking, and even when knowing which vehicle is attempting to park, it is impossible, for each driver, when parking seeking begins.

In a recent paper (Dalla Chiara and Goodchild, 2020), we designed a method to estimate the time that commercial vehicles spent searching for parking. Consider that a delivery vehicle took five minutes to drive from curb space to curb space between two delivery destinations. This time might comprise not only the driving activity but also the time spent searching for parking, circling the block, and visually checking block faces farther away from the desired destination. If the driver would have known in advance the exact location of the nearest available curb space, he/she would have directly routed the vehicle to that space. Let's say that the time to reach the available curb space directly (without searching for it) is 4 minutes. Therefore, the difference between the original trip time (5 minutes) and the optimal path assuming perfect information (4 minutes) is 1 minute, which we assume is a good estimate of the time spent searching for parking.

We implemented this method using GPS data from two different carriers performing deliveries in Downtown Seattle: carrier A is a parcel delivery company that used delivery vans; carrier B is a heavy-goods delivery carrier that used larger trucks. For each observed vehicle trip time between any two destinations, we subtracted its respective travel time (which assumes knowledge of where available parking is), which we estimated from the Google Maps Distance Matrix API (Google Maps, 2021). We then obtained the empirical distribution of searching for parking times (also referred to as trip time deviations) displayed in Figure 2. The median time spent searching for parking is 2.1 and 3.3 minutes, for carriers A and B respectively. Multiplying each number for the average number of stops per trip performed by each carrier, we obtain that a delivery driver from company A spends on average 50 minutes a day searching for parking, while a delivery driver from carrier B spends 30 minutes a day.

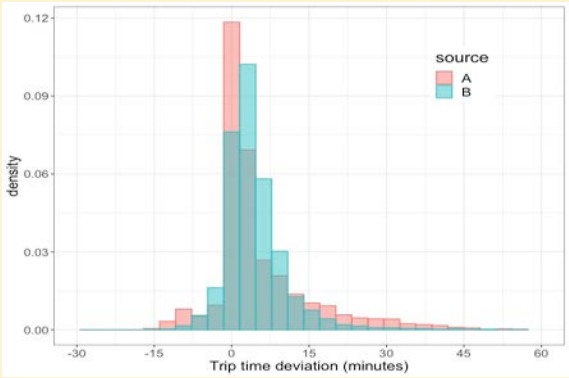

Figure 2: Empirical distribution of time spent searching for parking for delivery vehicles from two delivery carriers: carrier A is a parcel delivery company, carrier B is a heavy-goods delivery company

HARVESTING CURB PARKING AVAILABILITY DATA

Can the delivery driver avoid the 30 minutes to 1 hour per day spent searching for parking if they have curb availability information? To answer that, we first have to find a way to collect curb parking availability information.

When it comes to choosing the best type of sensor to detect vehicle occupancy in curb spaces, many alternative technology options are available. The two main technologies used are video-based and magnetic-based sensors. The latter detects magnetic fields generated by vehicles and is deployed on (or in) the curb, while the first one uses video cameras with image recognition technology, and is deployed on poles or other elevated areas with a clear view of the parking spaces being monitored.

In the implementation described here, magnetic-based sensors were chosen. Each sensor covers a circular area of 10 feet in diameter. Since curb zones can be longer than 10 feet, multiple sensors were installed. The study area consisted of 10 blocks, located in the Belltown neighborhood of Seattle, WA, from 1st to 3rd Avenue and from Battery to Stewart Street. Figure 3 depicts the study area and the location of curb parking availability sensors. A total of 274 sensors were deployed on commercial vehicle load zones (CVLZs) and passenger load zones (PLZs). Figure 4 shows the deployment of sensors on two consecutive PLZ and CVLZ spaces. Each sensor harvests parking availability data and it is triggered every time a vehicle is in the vicinity of the sensor. Each sensor communicates this information in real-time to our servers through gateways, one of which is shown in Figure 5.

Before using the deployed infrastructure, we tested the accuracy of the information received by taking video recordings and comparing real parking events with what the sensors captured. Out of 74 parking events recorded by the videos (hence 74 vehicles observed entering a curb space and leaving after some time) 72 of them were captured by at least one sensor being triggered. Therefore, 97 percent of the real parking events were reflected in the data generated by the sensors, with only two events being missed.

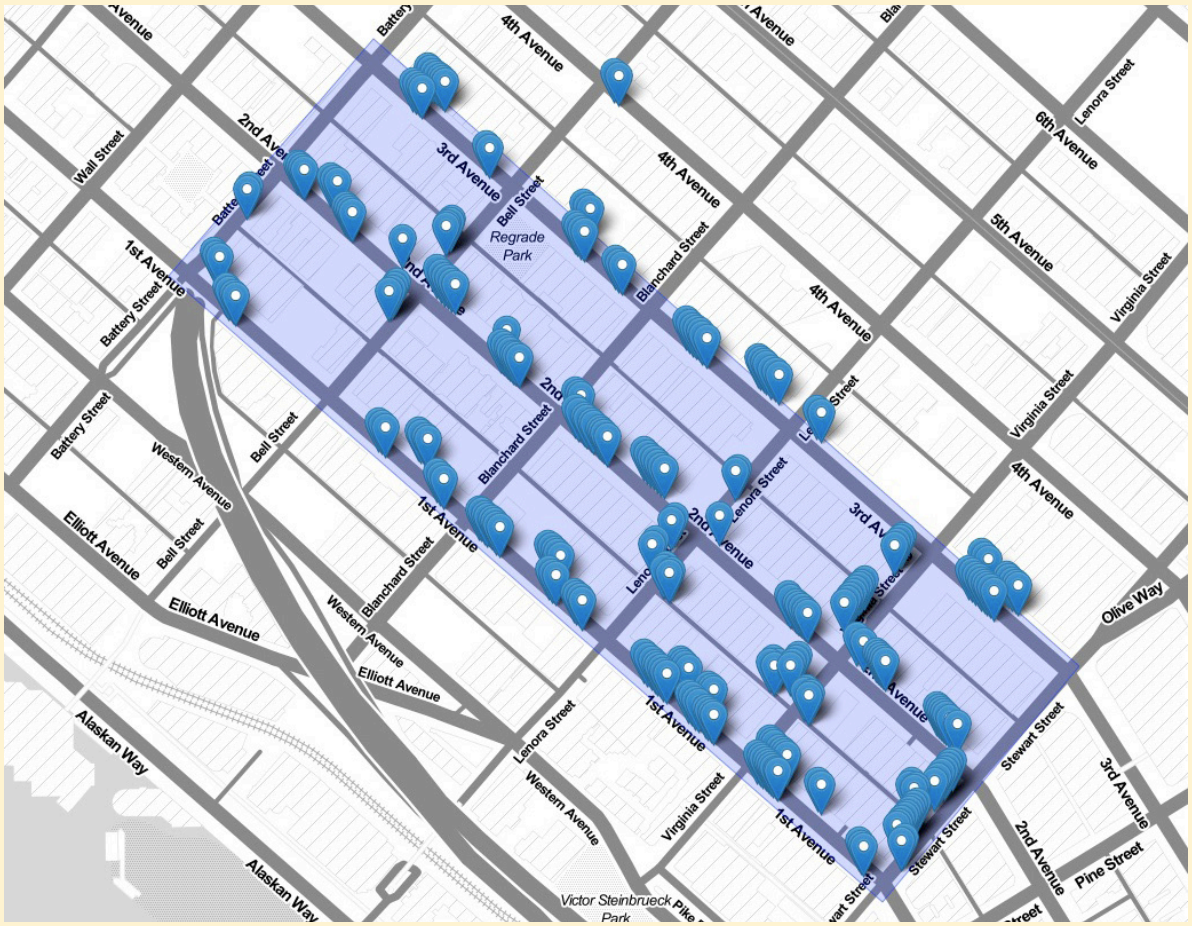

Figure 3: Study area in Seattle, WA, where 274 curb parking availability sensors were installed on commercial vehicle load zones and passenger load zones

Figure 4: Deployment of curb availability sensors on a passenger load zone and commercial vehicle load zone in Seattle, WA274 curb parking availability sensors were installed on commercial vehicle load zones and passenger load zones

Figure 5: A gateway receiving curb availability information from curb availability sensors and broadcasting this information to the cloud274 curb parking availability sensors were installed on commercial vehicle load zones and passenger load zones

GIVING CURB PARKING VISIBILITY

In collaboration with the Pacific Northwest National Laboratory, we developed an open web application called OpenPark that displays in real-time the curb availability data collected by the sensor infrastructure. A screenshot of the app is shown in Figure 6. Each commercial vehicle load zone and passenger load zone is displayed on a map as a segment, the length of which is proportional to the length of the space. A driver using the app is first asked to select the length of space needed to park the vehicle—longer vehicles clearly will require more curb space. Then the curb spaces hosting active sensors are then color-coded: green spaces are available right now, red spaces are occupied, and yellow spaces are available but their length is shorter than the specific desired length of curb space.

While the sensors provide real-time information, a driver is usually interested in knowing where available curb spaces are before reaching the destination. Hence, they are interested in a prediction of future curb availability. By storing historical occupancy data for each curb space, we developed machine learning models to estimate curb occupancy 5, 15, and 30 minutes in the future.

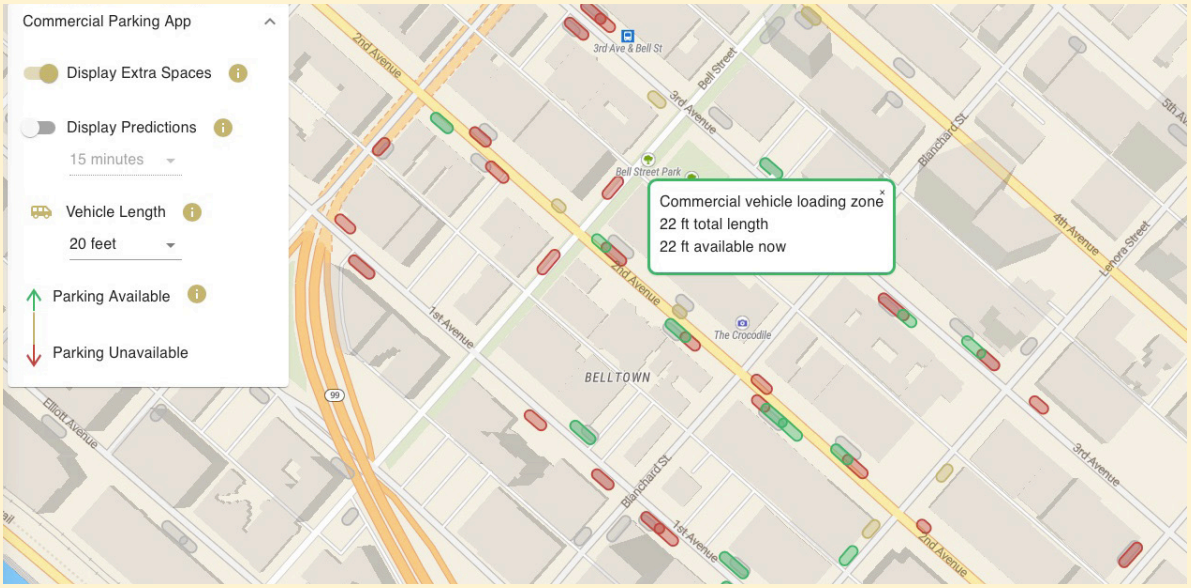

Figure 6: OpenPark web-app displaying real-time and future curb availabilities in the Belltown study area in Seattle, WA

THE FUTURE OF CURB PARKING AVAILABILITY INFORMATION FOR DELIVERY VEHICLES

Once OpenPark was deployed, drivers reported a striking change in behavior in approaching a delivery manifest. Drivers reported that the app allowed them to make better-informed decisions, not only regarding parking but also regarding routing, therefore changing the sequence in which they visit delivery addresses accounting for parking availability. The drivers were able to route their vehicles directly to a specific curb space or block face, while previously the driver would drive near the block where the delivery address is and then search for parking. Drivers were particularly emphatic about the reduced decision-making load, reduced stress levels, and improved sense of confidence and safety with which they were able to go about their work.

Drivers would like to see full integration of curb availability information into existing intelligent transportation systems. In the current study, drivers were not required to provide any information regarding their route, other than the length of curb space they need. In other words, the system is "passive" as it broadcasts curb availability information through OpenPark, but it does not interact with a driver's route. If more information is available, then a future system could either provide a parking recommendation, hence suggesting the best curb space to park, or even provide a better route, avoiding peak hour parking congestion.

The tools and technologies are available to monitor, provide visibility to, and manage curb space. We are certain that these tools and technologies will continue to be tested and developed, and will be part of curb infrastructure management in the future as these tools provide an opportunity to improve the efficiency of delivery vehicles, reducing their impact on traffic and emissions, and make more space for other users.

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Dr. Giacomo Dalla Chiara is a Postdoctoral Scholar at the University of Washington. Previously, he was a research fellow at the Singapore University of Technology and Design in 2018 and a visiting scholar at the Massachusetts Institute of Technology in 2017. He holds a Ph.D. in Engineering Systems Design from the Singapore University of Technology and Design (Singapore) and a M.Sc. in Statistics from ETH Zurich (Switzerland). His research focuses on statistical methods applied to urban mobility problems. In his work, he develops models and simulations to study and develop new sustainable urban logistics practices.

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Cover photo: Parcel delivery drivers parking and walking to delivery destinations

PREPARING FOR THE NEW MOBILITIES

Smart Planning for Emerging Transportation Technologies and Services

Todd Litman

Many new transportation technologies and services, such as those listed in the box below, are currently under development and becoming commercially available. They have tantalizing potential. They may allow people to scoot, ride, and fly like never before. However, they can also impose large costs on users and communities, and create unexpected problems. How should communities prepare?

Proponents predict that within a few years, autonomous taxis, flying cars and pneumatic tube transport will replace most personal vehicle travel and virtually eliminate traffic congestion, crash risks and pollution problems. However, there are good reasons to be skeptical of overly-optimistic predictions; new travel modes and services are often less reliable, affordable and beneficial than initially predicted, and they frequently create new problems. How should communities prepare?

This is an important and timely issue - communities face countless decisions on how to incorporate new mobilities. To help guide those decisions, planners must apply comprehensive analysis. Planners need unbiased information on their total benefits and costs, the distribution of those impacts, and the degree that they support or contradict strategic community goals.

There are likely to be unintended consequences. For example, with current policies, electric and autonomous cars, telework, air taxis, pneumatic tube transport are likely to induce more vehicle travel and sprawl, increasing associated costs. To maximize benefits, they may require policies that encourage travelers to choose the most efficient option for each trip.

To reduce pollution, many jurisdictions have ambitious vehicle electrification targets. These rely on substantial public subsidies to purchase electric vehicles and build recharging networks, and electric vehicle users don't pay the road user taxes applied to fossil fuels. Together these represent hundreds of dollars in subsidies per vehicle-year. This results in relatively high costs per ton of emission reduced,

and since electric vehicles are purchased by relatively affluent households, these subsidies are regressive, favoring wealthy people. Are there more cost-effective and equitable ways to reduce pollution?

Many of the projected benefits of autonomous vehicles, such as reduced congestion, crashes and pollution, depend on them having dedicated lanes that allow platooning, in which several vehicles drive close together at relatively high speeds. At what point should governments dedicate scarce highway lanes to these expensive vehicles? How much should users pay?

Consider another issue. If urban roads are unpriced, it will often be cheaper for autonomous vehicles to drive in circles to avoid paying for parking, although that will increase traffic congestion, traffic risk and pollution. Should communities regulate or price city streets to prevent these problems?

Similarly, should governments build flying car terminals and allow drone deliveries in residential neighborhoods, and if so, what regulations, fees and enforcement practices should apply? Which new mobilities should be mandated, encouraged, regulated, restricted, or forbidden in a particular situation? To answer these questions, decision makers need comprehensive information on their impacts, as discussed in the next section.

Examples of New Mobilities (Litman, 2021a)

1. **Active Travel and Micromobilities**. Walking, bicycling, and variations, including small, lower-speed motorized vehicles such as e-scooters, e-bikes, and cargo bikes.
2. **Vehicle Sharing**. Convenient and affordable bicycle, scooter, and automobile rental services.
3. **Ridehailing and Microtransit**. Mobility services that transport individuals and small groups.
4. **Electric Vehicles**. Battery-powered scooters, bikes, cars, trucks, and buses.
5. **Autonomous Vehicles**. Vehicles that can operate without a human driver.
6. **Public Transport Innovations**. Improved transit convenience, comfort, safety, and speed.
7. **Mobility as a Service (MaaS)**. Navigation and transport payment apps that integrate multiple modes.
8. **Telework**. Telecommunications that substitutes for physical travel.
9. **Tunnel Roads and Pneumatic Tube Transport**. New high-speed transport networks.
10. **Aviation Innovation**. Air taxis, drones, and supersonic jets.
11. **Mobility Prioritization**. Pricing systems and incentives that favor higher-value trips and more efficient modes.
12. **Logistics Management**. Integrated freight delivery services.

COMPREHENSIVE ANALYSIS OF NEW MOBILITY IMPACTS

Below are impacts to consider when evaluating new mobilities.

User experience

New mobilities vary in their convenience and comfort. Some that seem glamorous may actually be unpleasant to use for most riders. For example, autonomous taxi passengers may sometimes find garbage and odors left by previous occupants, and pneumatic tube transport confines passengers into windowless capsules that accelerate and decelerate with nausea-inducing forces. Even telework, the use of telecommunications to substitute for physical travel for work, school, commerce and healthcare, can be frustrating, isolating and unfair to people that lack high quality telecommunications services or private home offices. On the other hand, improving active, micromodes (e-scooters and e-bikes), and transit services can make local travel more convenient and enjoyable.

Travel speeds and time costs

Some new mobilities, such as flying cars and pneumatic tube transport, increase travel speeds, while others, such as public transit service improvements and autonomous vehicles, make travel more convenient and comfortable, which reduces travel time unit costs (dollars per hour of travel). Some only increase speeds for a portion of the trips, so their actual door-to-door time savings are modest. For example, supersonic jets may reduce London-to-New York flight times from seven to four hours, which sounds impressive, but considering the time required to access airports, clear security, check in, clear customs and reach destinations, it typically reduces door-to-door travel times from eleven to eight hours, a modest savings that is only cost effective for people whose time is valued at thousands of dollars an hour.

Affordability and social equity

Some new mobilities, such as active, micromodes and public transit improvements, have low costs and serve disadvantaged users. Some, such as ride hailing and (Mobility as a Service (MaaS), have high costs per mile but help support an affordable multimodal lifestyle and are centered on convenience. Some modes, such as personal autonomous vehicles, air taxis and tunnel roads, are inherently expensive (Fulton, Compostella & Kothawala, 2020).

Public infrastructure costs

Some new mobilities require public investments. For example, to achieve their potential, active and micromodes require new but relatively low cost facilities and programs. Vehicle sharing services and MaaS may require start-up funding, although they can become self-supporting in the future. Electric vehicles currently receive large subsidies for purchases and recharging networks. Autonomous vehicles may require large investments to create their navigation systems and dedicated lanes. Tunnel roads, pneumatic tube transport and aviation innovations also require costly new infrastructure; communities will need to decide whether to make these investments and how much to charge for their use.

Travel impacts

A key question in the analysis of new mobilities is how they increase or reduce total vehicle traffic and therefore problems such as congestion, safety, and pollution emission. For example, because they have lower operating costs and reduce driver stress, electric autonomous vehicles are likely to be driven 10-30% more annually,

including many deadhead (travel with no passenger) miles when traveling to pick up or after dropping off passengers. Similarly, although telework may reduce commute trips, it can encourage workers to choose more sprawled home locations, causing their total vehicle travel and associated costs to increase.

Public health (physical activity and contagion risks)

Because they encourage physical activity and are unenclosed, active modes tend to provide the greatest health benefits and the least contagion risk. Since most transit trips include walking and bicycling links, public and microtransit innovations also tend to increase fitness and overall health benefits. Autonomous vehicles, air taxis, tunnel roads and pneumatic tube transport passengers are sedentary and enclosed for long periods, so are least healthy.

Effects on strategic planning goals

Many jurisdictions have strategic goals to create more compact, multimodal communities, increase active travel, reduce private automobile travel, and achieve social equity. Affordable and resource-efficient modes, and those that reduce total vehicle travel, tend to support these goals. These include active travel and micromodes, public transit innovations, MaaS, vehicle sharing, mobility prioritization and logistics management. Because they tend to increase total vehicle travel and sprawl, and displace resource-efficient modes, electric and autonomous vehicles, telework, tunnel roads, pneumatic tube transport, and aviation innovations tend to contradict strategic goals unless implemented with strong TDM incentives and Smart Growth development policies.

To evaluate multiple and diverse impacts, planners can apply multi-criteria analysis, which uses various rating systems to rank and prioritize effects. This exercise evaluates the twelve new mobilities according to the eight goals listed above at right, using a seven-point rating system from 3 (best) to -3 (worst).

Eight Community Goals

1. Speed and travel time savings
2. User financial savings and affordability (savings to lower-income households)
3. Infrastructure and congestion cost reductions
4. Social equity goals (inclusivity, affordability, reducing external costs, etc.)
5. Public health and safety
6. Minimizing contagion risks
7. Resource efficiency and emission reductions
8. Support for strategic goals such as more compact development

Figure 1 illustrates the results.

This analysis indicates that active and public transport improvements and micromodes provide the greatest variety of benefits, because they are affordable, healthy and resource-efficient. Vehicle sharing, Mobility as a Service, mobility prioritization and logistics management also provide multiple benefits because they encourage travelers to choose resource-efficient modes. As a result, they tend to support strategic goals to reduce automobile dependency and create more compact, multi-modal communities.

In contrast, higher-speed modes, including electric and autonomous vehicles, tunnel roads, pneumatic tube transport, and aviation innovations, provide fewer benefits, because they are expensive and resource-intensive, and tend to impose

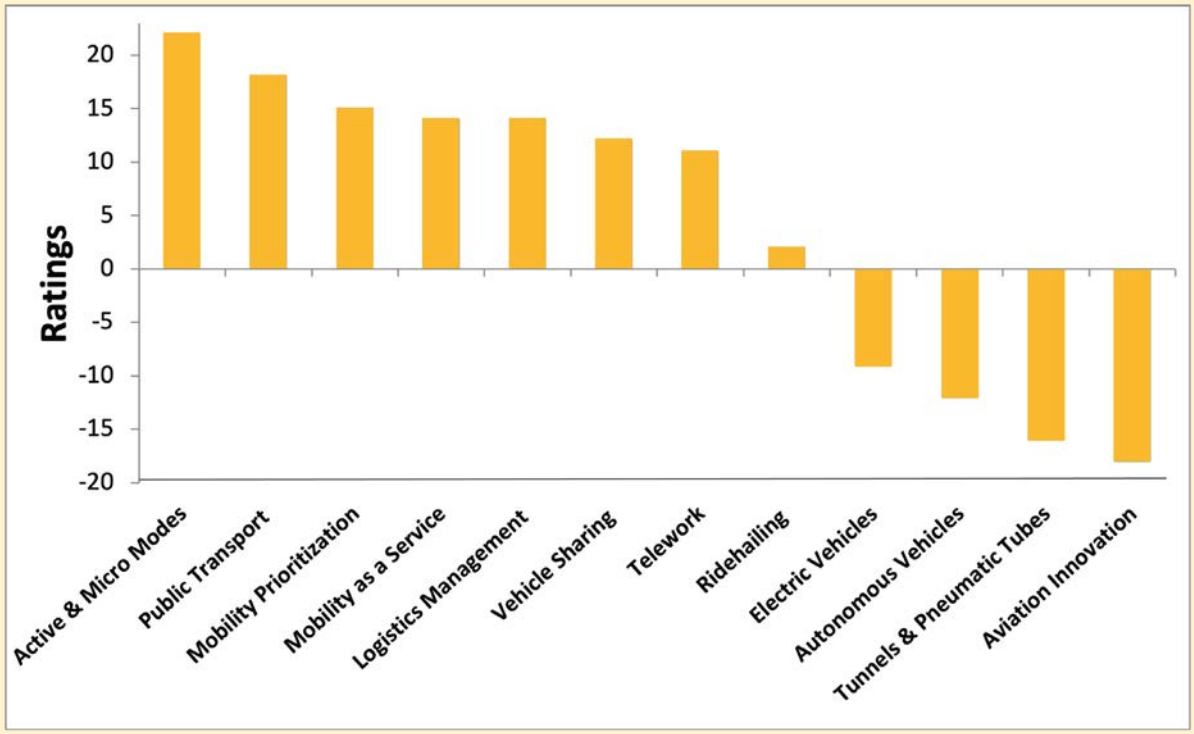

Figure 1: Multi-Criteria Ratings of New Mobilities (Litman 2021)

significant external costs. Because they increase travel speeds, these modes tend to rate well under the old planning paradigm, but less well under the new paradigm which considers a greater variety of community goals.

These impacts can vary depending on conditions and policies. For example, with current policies, electric and autonomous vehicles are likely to increase total vehicle travel and sprawl, and therefore external costs, so their net benefits increase if they are implemented with TDM incentives and Smart Growth policies. Some impacts may change over time. Electric and autonomous vehicles, pneumatic tube transport and air taxis may become more affordable and efficient in the future, which could increase their net benefits.

These ratings are somewhat subjective. It is possible to use different assumptions and methods. For example, this analysis applies equal weight to each of the eight goals; a planning process might consider some more important than others, or rate some modes higher or lower with regard to some goals. However, such adjustments are unlikely to substantially change the results. For example, increasing the weight given travel time savings cannot offset the fact that higher-speed modes, such as electric and autonomous vehicles, pneumatic tube transport, and supersonic jets, are expensive and resource-intensive, require little physical activity, and with current policies are likely to increase total vehicle travel and external costs. Even with different assumptions, affordable and resource-efficient modes would probably outrank expensive, resource-intensive modes in terms of many community goals.

These results do not mean that lower-rated modes are bad and should be forbidden, but this analysis does indicate that new mobilities vary significantly in their net

benefits (benefits minus costs). It indicates which modes provide the greatest overall benefits, and so deserve the most public support. It also indicates that some modes, those that are likely to increase total vehicle travel, should be implemented with TDM incentives and Smart Growth policies to prevent them from increasing external costs. In particular, it suggests that communities will need to implement efficient transportation pricing and incentives to use shared modes, in order to recover public infrastructure costs, prevent traffic problems and discourage more sprawl.

Questions to Ask About New Mobilities (Goldsmith 2019)

- Is it affordable?
- Can physically, economically and socially disadvantaged groups use it?
- How will it affect non-users, particularly disadvantaged groups?
- What infrastructure will it require, who should pay, and what regulations should apply?
- How will it affect public health and safety? What risks does it impose on non-users?
- How will it affect community livability, environmental quality, and resource consumption?
- Will it increase or reduce total vehicle travel? Will it increase or reduce sprawl?

WHAT ARE PLANNERS DOING?

Many experts and organizations offer guidance for implementing new mobilities (Henaghan 2018). These vary in perspective and scope. For example, The National Association of City Transportation Official's Guidelines for Regulating Shared Micromobility (NACTO, 2016) recognizes the potential benefits of scooter, bike and e-bike sharing services, but also various costs and risks they can impose and so recommends policies to ensure their safety and fairness. Their Blueprint for Autonomous Urbanism (NACTO, 2019) provides guidance for transformative policies and planning practices to create a people-focused autonomous future that reduces total vehicle travel, and offers mobility and opportunity to everyone, not just those in cars.

The Greenline Institute's Autonomous Vehicle Heaven or Hell? Creating a Transportation Revolution that Benefits All (Creger, Espino & Sanchez, 2019) concludes that "If left up to the free market without adequate regulation, we can expect a 'hell' scenario dominated by personally-owned autonomous vehicles that are only accessible to those who can afford them, while further congesting our streets and polluting our air, leaving others to cope with worse traffic, longer commutes and under-resourced public transit." Similarly, Tom Cohen and Clémence Cavoli's article (2019), Automated Vehicles: Exploring Possible Consequences of Government (non)intervention for Congestion and Accessibility argues that laissez-faire free-market policies will cause autonomous vehicles to increase traffic congestion and reduce accessibility for non-drivers, resulting in undesirable outcomes.

The Shared Mobility Principles for Livable Cities provides guidance toward the best outcomes for new mobility options. It recommends that governments use regulations and pricing to favor shared modes, limit vehicle traffic and more efficiently manage curb space, particular in cities. Historian David Zipper's article (2021), When Cities Say No to New Transportation Technology, describes why

and how cities have limited new modes for the common good.

Some jurisdictions are starting to develop strategic planning programs to prepare for emerging transportation technologies and services. Below are three examples.

- The City of Seattle's New Mobility Playbook (Seattle 2017) offers guidelines for implementing a broad variety of emerging technologies, including vehicle sharing, ridehailing, MaaS, and electric and autonomous vehicles. It identifies strategic goals that should be considered with evaluating specific policies, including safety, connectivity, vibrancy, affordability, and innovation. It critically examines how new mobilities can support or contradict those goals, defines new mobility principles, and identifies specific near-term policies that the city should implement to ensure that new mobilities support the city's goals.
- The Los Angeles Department of Transportation's Transportation Technology Action Plan (LADOT 2020), recognizes that "code is the new concrete," and asks, "How do we focus on Transportation Happiness and Universal Basic Mobility with the same intensity as we have traditionally focused on moving cars and people faster?" It discusses the types of digital infrastructure that will be needed to support transportation innovations, and discusses issues such as data sharing, privacy, community outreach, and culture change.
- The Denver region's 2030 Mobility Choice Blueprint (2019) discusses potential benefits that can be achieved by taking a proactive approach to planning new transportation technologies. It defines various planning objectives (regional collaboration, system optimization, shared mobility, data security and sharing, mobility electrification, driverless vehicle preparation, and new transportation funding), describes how various regional organizations can collaborate to support these objectives, and identifies specific tactical actions to support this process.

CONCLUSIONS

Numerous new transportation technologies and services are currently under development. Policy makers and practitioners face countless decisions concerning how new mobilities will be incorporated into their communities.

We can learn from past mistakes. Previous transportation innovations provided large benefits but also imposed large costs on users and communities, and often exacerbated inequities. New mobilities have diverse benefits and costs, and so require comprehensive analysis of their impacts, including often overlooked effects on affordability, social equity, public health and environmental quality. To maximize the benefits and minimize the costs, communities must decide which new mobilities should be mandated, encouraged, regulated, restricted, or forbidden in a particular situation.

Predictions that autonomous taxis and flying cars will soon be cheap and ubiquitous, and displace most private vehicle travel, are made primarily by people with financial interests in these industries. Vehicle innovations tend to be implemented more slowly than other technological innovations due to high costs, strict safety requirements, and slow fleet turnover. Automobiles typically cost fifty times as much and last ten times as long as personal computers and mobile phones.

Consumers seldom purchase new vehicles simply to obtain a new technology. Most vehicle innovations are initially costly and imperfect. It usually takes decades before they are common in the fleet.

This analysis indicates that slower but affordable, inclusive, healthy and resource-efficient modes, such as active, micromodes and public transit improvements tend to provide the greatest variety of benefits. Vehicle sharing, MaaS, and telework are somewhat more costly and resource intensive, but can still play important roles in an efficient and equitable transportation system. The most glamorous new mobilities, the modes that tend to generate the most popular excitement, such as autonomous cars, air taxis and pneumatic tube transport, may be costly and provide limited benefits. They may be appropriate for some trips, but their use should be constrained to prevent increases in external costs and inequities. For example, air taxis and drones may be useful for occasional urgent trips to isolated areas, but they impose large external costs, so their use should be regulated and priced for efficiency and fairness. Most residents probably don't want their neighborhood sky filled with flying cars carrying commuters each morning, or drones delivering pizza and beer to their neighbor's late-night parties.

The benefits of new mobility are contingent; they depend on public policies. With current policies, electric and autonomous cars, telework, air taxis, pneumatic tube transport are likely to increase total vehicle travel and sprawl, and associated costs. Their overall benefits increase if they are implemented with TDM incentives that encourage travelers to choose the most efficient mode for each trip, which will often require limiting the use of glamorous but costly and resource-intensive new modes.

Planners will need to take the lead. To prepare for the future we must frighten, reassure, and analyze. We need to inform decision-makers about the potential risks of new mobilities. We also need to reassure them that excellent solutions are available. We must identify the specific policies and programs needed to maximize their benefits and minimize their costs.

New mobilities are no panacea. No magic thinking please! Communities must be discerning; we must be willing to say "no" when necessary to ensure that emerging transportation technologies and services truly benefit everyone.

About the Author

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Todd Litman is founder and executive director of the Victoria Transport Policy Institute, an independent research organization dedicated to developing innovative solutions to transport problems. His work helps expand the range of impacts and options considered in transportation decision-making, improve evaluation methods, and make specialized technical concepts accessible to a larger audience. His research is used worldwide in transport planning and policy analysis. He is active in the Transportation Research Board and the Institute of Transportation Engineers. Much of the information in this article is extracted from his book, *New Mobilities: Smart Planning for Emerging Transportation Technologies* (Island Press, 2021).

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Cover photo: Los Angeles Department of Transportation's Transportation Technology Action Plan

INNOVATIONS IN RURAL PUBLIC TRANSPORTATION

Data Standards Undergird Equity

Jana Lynott

Adapted from a keynote address the author gave at the National Rural and Intercity Bus Transportation Conference, October 2021

Those of us living in America's largest cities can now connect to myriad transportation services through the palm of our hand. Google maps and any number of trip-planning apps readily dish up information about the next bus or train, let one see whether the bus is wheelchair accessible, and even tell us how crowded a particular bus is. Rural public transportation, on the other hand, remains largely opaque and highly disconnected. But it doesn't need to remain that way. The same technological advances that are ushering in a new travel paradigm in our cities are available to help rural systems modernize their services.

I hail from Iowa, where I grew up riding Greyhound down highway 30 between my parents' homes. After a fun-filled weekend with my dad, he'd put me and my sister on the bus, much preferring to leave the driving Sunday afternoons to a professional. I now live in the city, where I can take advantage of Metrobus service operating on 15-minute headways right outside my door, connecting me within 10 minutes to the DC metro system. From there, I can get to my office, shopping, restaurants, and any major city along the East Coast through intermodal connections to Amtrak and a host of bus companies.

I think because of my early experience riding Greyhound and the local CyRide bus in Ames, I've always believed that the ability to live life fully without a car is something that should be available to everyone—not only people living in big cities, but people living in rural America as well.

There is a lot of really exciting innovation happening in our industry right now and it gives me hope that my vision for seamless travel by public transportation will be realized.

EMBRACE UNIVERSAL MOBILITY AS A SERVICE

This is actually now a widely shared vision and the industry has a new name for it—Mobility as a Service, whereby our private transportation (i.e. our private cars) is replaced by a system where we can meet our transportation needs by summoning any variety of transportation services. And

there are some heavy hitters investing to make this happen. For instance, Uber is creating Uber as a Service, where the company's customers can use the Uber App to hail an Uber, rent one of their bikes or scooters, and even compare those options with the cost and schedule of public transportation. Ford and Toyota are making similar investments, and any number of public transportation agencies now define themselves not solely as bus and train operators, but as mobility managers, helping customers navigate the multiple ways to get around their communities.

I coined the term Universal Mobility as a Service (Figure 1) to emphasize the need to ensure that these new systems serve everyone, regardless of ability, age, income, or geography.

How we go about creating these seamless networks of transportation services will determine the cost of travel and ultimately how equitable our transportation system will be. With so much rapid change happening right now in the transportation sector, we have a window of opportunity to address current inequities of our transportation system.

DATA STANDARDS: SOUNDS WONKY, BUT FOUNDATIONAL

Data standards are the underlying technology that enable seamless travel and support more equitable access.

Data standards are nothing more than a standardized way to present information about a trip to facilitate data sharing

Figure 1: Key tenets of Universal Mobility as a Service, Source: AARP Public Policy Institute

and coordination among providers. Data standards define:

- the fields of data,
- how the information in each field is to be formatted, and
- the order of operations in terms of the system taking those fields of data and doing something with them in a certain order.

There are two primary types of data to be shared in a public transportation environment (Figure 2):

- Discovery Data
- Transactional Data

more than 500 transit agencies in the US that put their route and schedule information into this GTFS format and that give permission to Google Maps or other 3rd party app developers to offer this service information to transit riders. That in and of itself is really important, as lack of knowledge leads to lost customers. The Rural Transit Assistance Program is helping rural transit providers format their route and schedule data consistent with the GTFS so that their services become known to a wider audience and make travel easier to navigate.

North American Bus Service providers are creating the National Intercity Bus Atlas

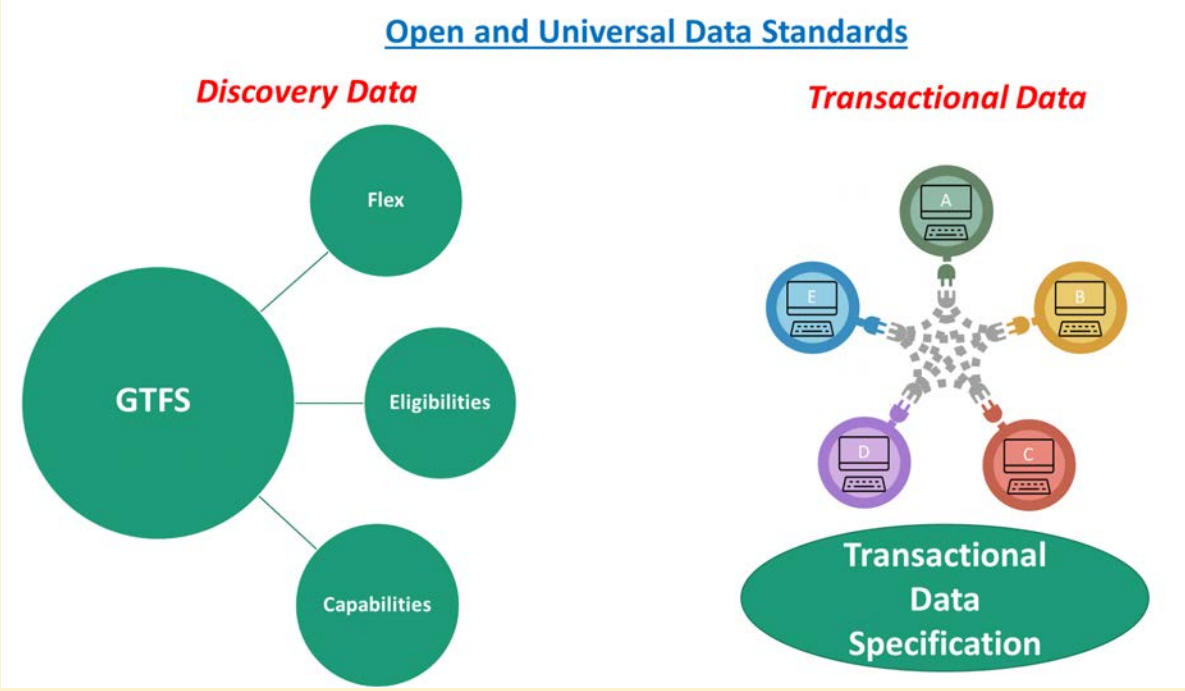

Figure 2: Discovery vs. transactional data, Source: AARP Public Policy Institute

DISCOVERY DATA

The General Transit Feed Specification, or GTFS is the underlying data standard for discovery data. Discovery data allow customers to find information about available travel options. There are now

shown here with GTFS data. The lines and dots on this map represent scheduled intercity routes and stations, a system that logged 68.5 million trips in 2017 according to the National Household Transportation Survey. Joining route fragments onto a single map provides context. All of

a sudden, seemingly unrelated parts, when rendered as a whole, provide an understanding of the complete system and show how our nation benefits from intercity bus services.

But as good as the GTFS is, it's just Phase I of information sharing. The GTFS describes fixed routes with fixed schedules. That's a problem when half of America's transit service is delivered through demand-responsive transportation. We need a system that can describe more specialized services such as those common in rural America and those tailored to meet the needs of older adults and people with disabilities.

The GTFS-Flex extension begins to do just that. It allows customers to view their demand-responsive transportation options. It also describes route deviated services, continuous stops (board anywhere), flag stops, point deviation, and point-to-zone services. It provides customers with a flexible itinerary that reflects service areas and service hours and with a description of the unique rules of the service.

The Vermont Agency for Transportation was the first to develop a statewide GTFS-Flex trip planning tool using the OpenTripPlanner web app (Figure 3). Other transit agencies have followed suit.

Why is this cool? Well, it allows community transportation to compete with other flexible shared-ride services. Uber and Lyft can afford to buy ads in Google Maps and appear as first/last mile connections. Small companies and public agencies cannot but should still be discoverable by their potential customers. The GTFS-Flex enables this to happen.

TRANSACTIONAL DATA

On the other side of the equation are transactional data, which allow a transportation provider and customer to make a transaction—be it to schedule a trip or to make a payment.

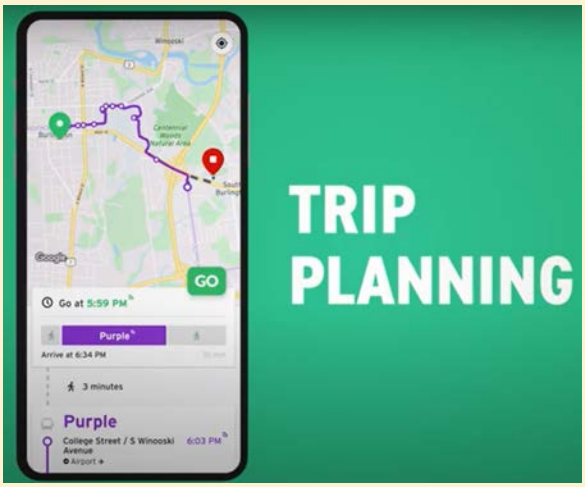

Figure 3: Vermont Trip Planner Generic, Source: Vermont Agency of Transportation

For many rural services, it's not enough to inform customers about the service. For them to take advantage of the service, the trip needs to be scheduled, a vehicle and driver dispatched, a fare paid, a subsidy reflected, a report made for the grant funder. This is what makes rural public transportation more complex than urban fixed-route services.

For this there is a new data standard under development that is tailored to the unique needs of demand-responsive transportation. It's called the Transactional Data Specification, published by the Transportation Research Board in 2020.

The TDS allows the reservation systems of multiple community transportation providers to share customers and trip data among one another and as appropriate with brokerages. If one provider doesn't have a vehicle or driver available when a customer requests a ride, that provider can post that trip in the system and another provider in the network can pick it up and provide the ride. That means fewer trip denials, fewer empty seats, and lower costs per passenger.

Other benefits include:

- less staff time dedicated to manually coordinating and scheduling trips,
- accurate billing-related data for trips, and, most important, better service for customers, such as same day rides and more reliable and punctual transportation.

Unlike Uber's Application Programming Interface, or API, the GTFS and TDS are all open and universal data standards, created through industry consensus and owned by no one and everyone.

The TDS is modeled upon a data standard that has been in operation in Scandinavia for two decades and most prominently used in Denmark, where the scheduling systems of more than 550 private sector transportation providers interoperate with a publicly owned transit company to create a nationwide DRT system. This high quality service caters to the needs of people with disabilities and those traveling to medical appointments, but is open to the general public as well. Imagine a coordinated system in the United States that weaves together rural public transportation, ADA paratransit, and Medicaid non-emergency medical transportation.

AARP funded the first proof-of-concept of the TDS. RideSheet was created by Full Path Transit Technology to address the needs of very small nonprofit transportation providers—those who operate fewer than a dozen vehicles. RideSheet puts scheduling in the Cloud using Google Suite of software (e.g., Google Sheets). And It integrates the TDS so that two or more providers can share trip data.

The Minnesota DOT is integrating both GTFS and transactional data standards into its Greater Minnesota Mobility as a Service Platform. The project aims to integrate transit planning and ticketing with taxis, TNCs, van pool, and other modes. The pilot will bring together seven transit systems plus private providers in Southern Minnesota, including Jefferson Lines.

Via mobility services for seniors (Photo courtesy of the author)

THE FUTURE OF TRANSPORTATION

Universal Mobility as a Service can and must be the future of transportation. MaaS is coming, but rural and intercity public transportation could be left behind unless we are proactive. Without open and universal data standards, such as the GTFS and TDS, rural residents may not ever discover the service available in their community and could continue to confront fragmented services.

If we commit to open and universal data standards we create a more competitive and equitable market where no single operator or software vendor owns the entire customer interaction, and where all riders see all options, including the best ones for them. We create a system where service doesn't stop at the county border or require onerous paperwork to qualify a person, simply because we haven't put in place the technology that can closely track trips for appropriate cost-allocation and billing.

Many smart and committed people have already done tremendous work to lay out these systems. But it will take all of us to implement them, starting by demanding that software vendors use them.

But if we make the effort, we will see the payoff in the form of a seamless, intermodal, interstate transportation system, one that is affordable and accessible to everyone.

This is the Future of Transportation.

Recommended Resources

AARP Public Policy Resources on the Future of Transportation

- Modernizing Demand-Responsive Transportation for the Age of New Mobility (a primer on the transactional data standard for demand-responsive transportation, including a section of the model FlexDanmark transportation system)
- FlexDanmark video series
- Universal Mobility as a Service
- Mobility Managers

Rural Transit Assistance Program GTFS Builder

MobilityData (the organization that convenes GTFS stakeholders and hosts OpenMobilityData, a worldwide repository of GTFS datasets)

TRB Research Report 210: Development of Transactional Data Specifications for Demand-Responsive Transportation

National Intercity Bus Atlas

Cover photo: Greyhound bus service in a rural area

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Jana Lynott is a Senior Strategic Policy Advisor with AARP Public Policy Institute's Livable Communities team. As a researcher, writer, videographer, and keynote speaker, Jana brings to her work a passion for the role community design and transportation service play in the health and quality of life of people of all ages, abilities, and incomes. Her current research explores how "disruptive" technologies may influence the form and delivery of transportation services of the future.

IDENTIFYING ROADBLOCKS

to the

SUCCESSFUL IMPLEMENTATION OF MAAS AND MICRO MOBILITY

As Part of Multi-Modal Transportation

Priyadharshini Balan

Figure 1: Image showing people using bikes and e-scooters during the pandemic. Source: Expatica, 2021.

INTRODUCTION

The pandemic brought all modes of transportation to a brief halt, and for a while, the prediction of our future transportation usage seemed ambiguous. To people, cars have so far been the only preferred means of transportation and still are, due to the comfort it offers and the fact that the infrastructure is predominantly designed for automobiles. The co-existence of cars and other transportation alternatives is not as easy as it seems to be, because of many reasons, including but not limited to, increased demand for road space, congestion, safety, aging infrastructure, and our existing local, state/federal government laws. Enhancing services to access diverse transportation modes like biking, walking, scooting (e-scooters), and ridesharing, etc. are crucial to enable people to change the way they commute. Targeted analysis to expand transit facilities for multiple modes would help improve equity in transportation, giving people the opportunity to switch to sustainable commuting, allowing transportation professionals to efficiently manage demand, and ease congestion.

Public transportation's ridership numbers dropped significantly in 2020 and 2021 as more and more people became skeptical about using public transit due to concerns of the coronavirus (Figure 1). This forced the transit agencies to alter transit routes/stops or cut down services, which directly affected the population that was solely dependent on these services. The pandemic also highlighted the need to be proactive in addressing the inequity in the services provided, and improve amenities to serve people of all ages, races, communities, and economic backgrounds. Urban mobility needs to adapt to emerging technologies and become more resilient to existing challenges. Micro-mobility and Mobility-as-a-Service were initially perceived to address many of the issues pertaining to sustainability, affordability, last-mile transportation, and equity. However, these services themselves are facing various challenges to thrive and expand, which was exacerbated by the pandemic. The report discusses the status quo of shared mobility and mobility as a service and ways to utilize those services to their full potential.

According to SAE International, shared micro-mobility is defined as "the shared use of a bicycle, scooter, moped, or other low-speed vehicle or device that provides travelers with short-term access on an as-needed basis" (SAE International, 2018). Mobility-as-a-service integrates various forms of transport services into a single mobility service accessible on demand. MaaS Alliance defines mobility-as-a-service as "A MaaS operator facilitates a diverse menu of transport options to meet customer's requests, be they public transport, ride-sharing, car-sharing or bike-sharing, taxi, or car rental/lease or a combination thereof. For the user, MaaS can offer added value by using a single application to provide access to mobility with a single payment channel instead of multiple ticketing and payment options" (MaaS Alliance, n.d.). MAASiFiE gives a precise definition for MaaS, as "multimodal and sustainable mobility services addressing customers' transportation needs by integrating planning and payment on a one-stop-shop principle" (MAASiFiE, n.d.).

NEED FOR MULTI-MODALITY

Multi-modality in transportation is the planning and development that evaluates the incorporation of various modes, like walking, using bikes, e-scooters, public transit, paratransit, shared transportation services, and automobiles, etc., to travel and connect between these various modes (Figure 2). As we have become accustomed to car-centric cities, the concept of multi-modal transportation may seem like a new effort to try and integrate alternative

Figure 2: E-scooter devices lined up on a sidewalk in Austin. Source: Swiftmile, December 2020

transportation modes into the existing automobile-oriented transportation system. However, multimodal transportation services were something that long existed before cars took over. Major investments and developments that took place in the last several decades focused on roads and enormous parking infrastructures which facilitated faster commutes for people who owned private vehicles.

Factors like climate change and congestion have prompted city planners and developers to include diverse transportation modes and facilities in recent years. Long-range plans and strategic transportation plans are now focusing on building infrastructures like complete streets, expansion of transit services, adequate sidewalks, bike lanes, pedestrian-friendly streets, and redesigning roads to accommodate shared mobility, public transit along with cars, and freight vehicles (Figure 3).

The connectivity between riders' origin and destination of a trip could not always be completed without relying on a car, except for a few cases. Even though public transportation is available, a large number of people do not have reliable first-mile/last-mile connectivity and that has also held back vulnerable populations from having access to basic services and opportunities. As each of the different modes of transportations have their own app, people are required to use and toggle between multiple apps when they use multiple transportation modes. For example, a rider might use the bus to get fromone location to another, and might use a shared bicycle to cover the last-mile of

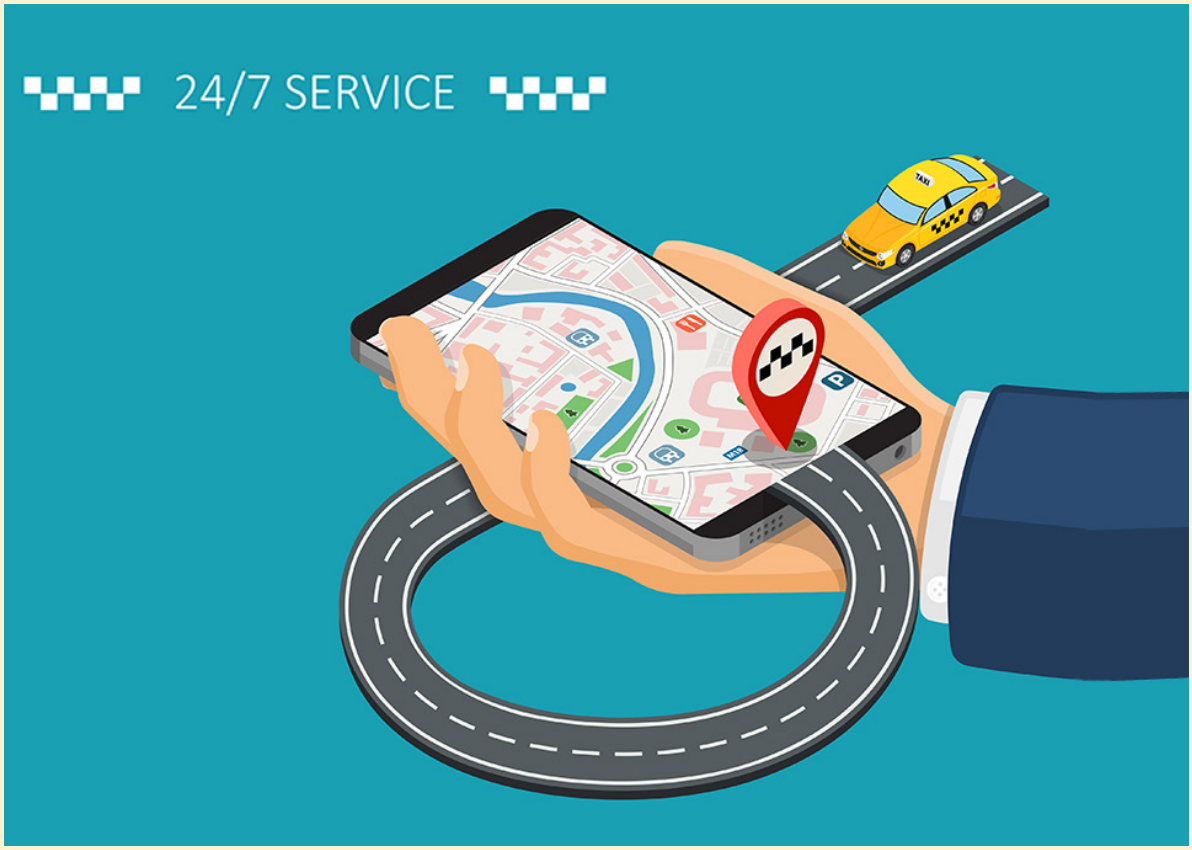

Figure 3: Illustration of Mobility-as-a-Service. Source: IEEE Innovation at work, n.d.

the commute. In this case, to buy tickets for the bus the rider would have to use one app, and to use the shared bicycle the rider would have to use another app (like Lime, Citi Bike etc.). This experience to use multiple modes of transportation can be made more seamless and better through Mobility-as-a-Service. Mobility-as-a-service and micro-mobility if well-implemented, we can enable travel behavior changes among people and encourage sustainable commute options.

MICRO-MOBILITY AND MOBILITY-AS-A-SERVICE

Micro Mobility and Mobility-as-a-Service were considered ambitious innovations that would transform the landscape of public transportation usage and shared mobility. The obstacles that emerged to implement, operate, and increaseridership, especially when the competition was against automobiles were unforeseen. Starting to use micro-mobility or shared mobility does not simply mean shifting the priority away from cars. It involves more than just allocating road space and scaling up services.

MICRO-MOBILITY AND ITS PERFORMANCE DURING THE PANDEMIC:

Shared micro-mobility mode of transportation was a huge step in addressing the first-mile/last-mile connectivity, as people find it difficult to access public transits like buses or trains, most of which are over a quarter-mile of walking distance from the trip origin/destination (People usually consider quarter mile as the reasonable and acceptable walking distance before opting to drive). The full-fledged operation of micro-mobility was not until 2017. Even though e-scooters tried to make their debut in the previous years they didn't make

Figure 4: Micro-mobility's presence indicated by e-scooters and e-bikes. Source: Austin American Statesman, 2019.

the cut mainly due to affordability and the technology was still in the early stages (Figure 4).

As cities focused on developing bicycle infrastructure, dockless micro-mobility started taking over the sidewalks and streets of various cities like San Francisco, Santa Monica, Washington D.C., and Atlanta among many others. In some cities, the operation of micro-mobility services was short-lived due to safety concerns; safety was one of the major obstacles that impeded the rapid expansion of shared micro-mobility in several cities. Several injuries were recorded due to the E-scooters' incompatibility with irregular surfaces, minor obstructions on the ground, collision with cars, and failed breaks. People not wearing helmets also led to some serious head injuries, escalating the seriousness of safety concerns pertaining to e-scooter usage. Due to continued collaboration with micro-mobility service providers and policy developments from studying the rider behaviors and patterns, cities are able to regulate and systematically guide

E-scooters' performance. As we expect more users, there is a rising need to develop comprehensive policies to enforce responsible riding, parking, and regulate safety.

Micro-mobility usage displayed a sharp decline beginning the month of March in 2020, after the country was hard-hit by the spread of the coronavirus, as depicted in Figure 6. The trip data statistics show the micro-mobility usage at the City of Austin, beginning January of 2020 until January 2021. We can see the drop in the number of trips from 13,556 on March 14, 2020, to just 283 trips on March 21, 2020. Until May, the statistics of daily trips remained below 1000, and there was a gradual increase from June showing people's choice to use micro-mobility during the pandemic. Figures 6 and 7 also indicate how the number of trips shows a steady increase from 2020 to 2021 and especially when the pandemic cases shot up in June, July, August of 2020, and briefly again in December of 2020, and January, February of 2021.

The images show the heat map of micro-mobility usage in the Austin area. The dark colored routes denote the most traveled routes and the lighter colored ones denote least traveled by e-bikes and e-scooters. The information on the left shoes the type of data, type of vehicles (which include e-bikes, sit down e-scooters, and stand up e-scooters), data period for which the heat map is shown, and shows the total count of the trips taken for the mentioned period.

Though the heat map doesn't drastically show any differences in the routes taken, the total trips taken each data period shows how the rider behavior has changed throughout different times of the pandemic. In figure 6, the total number of trips taken were 320,952 and this was during when the pandemic started. Figure 7, shows the heat map for data period July to October 2020, and we can observe the increase in the total trips taken (574,108). This could be due to people's concern about taking public transportation and using bicycles and micro-mobility to commute. As we see in figure 8 and figure 9, we can see how the total trips taken have shown an

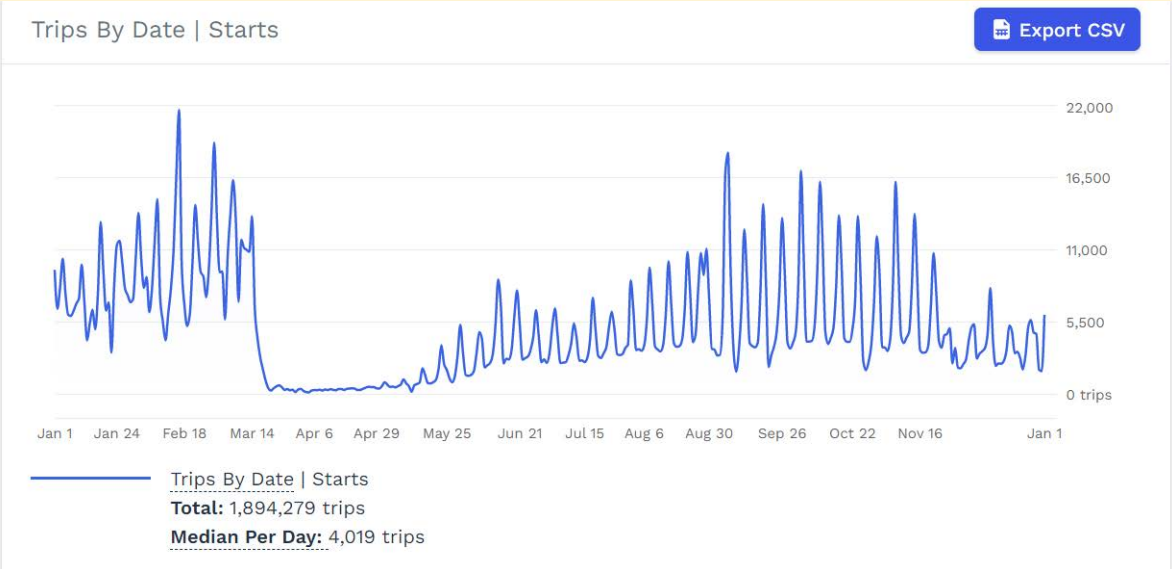

Figure 5: Micro-mobility trip data statistics showing a dip in the usage in the City of Austin, after the surge of coronavirus cases, as shown by the RideReport. Source: RideReport, Austin

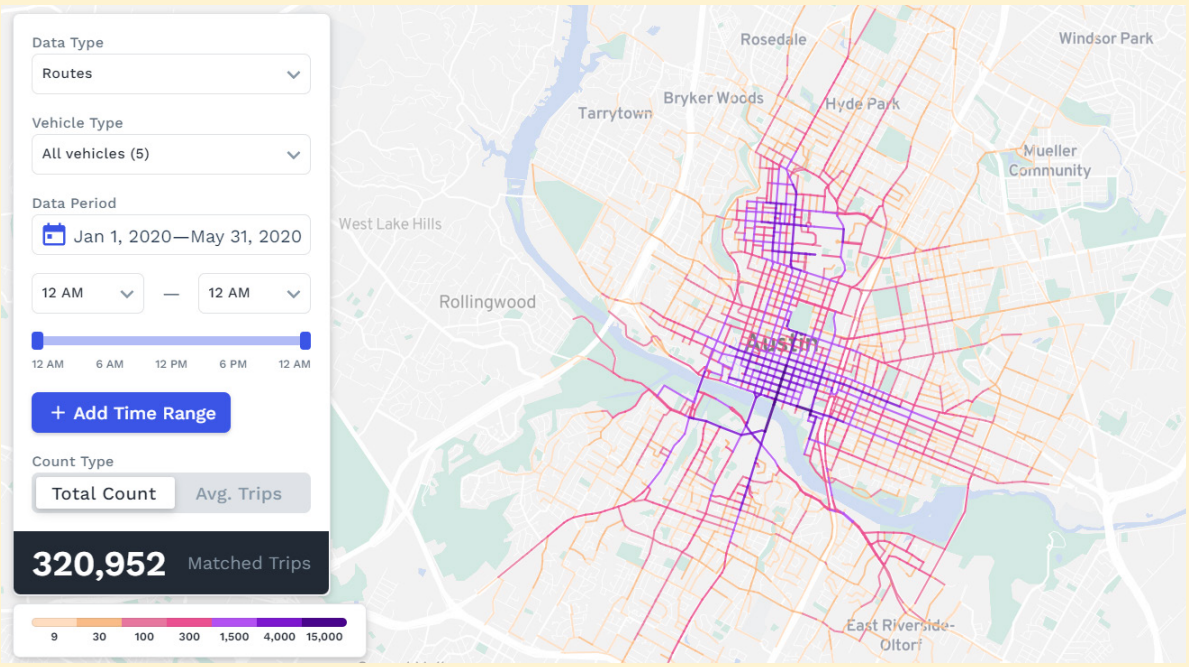

Figure 6: Austin's micro-mobility trip route heat map for the period January 2020 - May 2020 obtained from RideReport. The total number of trips is 320,952. Source: RideReport, Austin

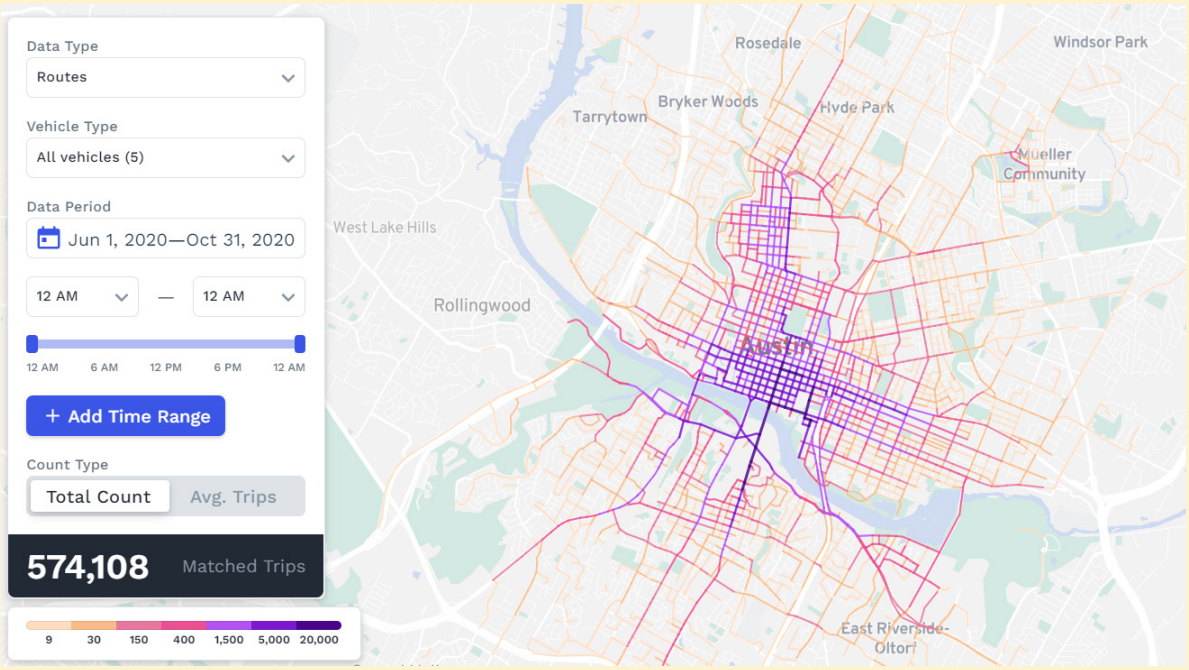

Figure 7: Austin's micro-mobility trip route heat map for the period June 2020 - October 2020 obtained from RideReport. The total number of trips is 574,108 showing a significant increase (close to double) from the previous months of the pandemic. This represents the user's preference for micro-mobility mode during the pandemic. Source: RideReport, Austin

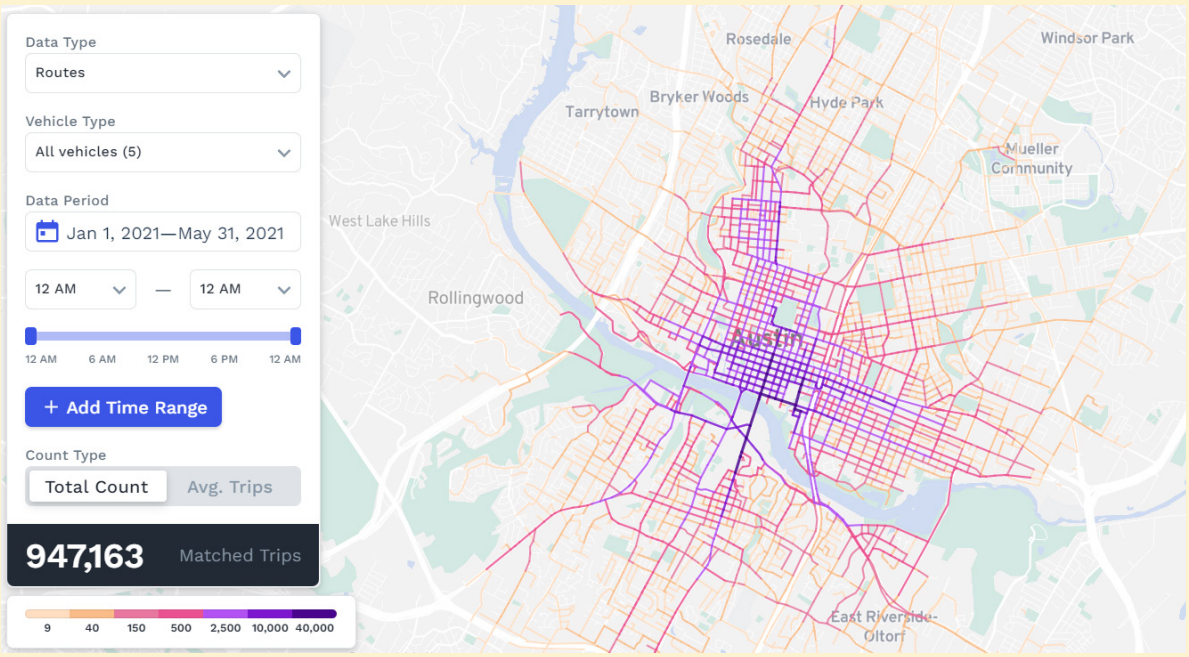

Figure 8: Austin's micro-mobility trip route heat map for the period January 2021 - May 2021 obtained from RideReport. The total number of trips is 947,163 (almost triple the trip numbers compared to 2020 trip data for the same time period). Source: RideReport, Austin

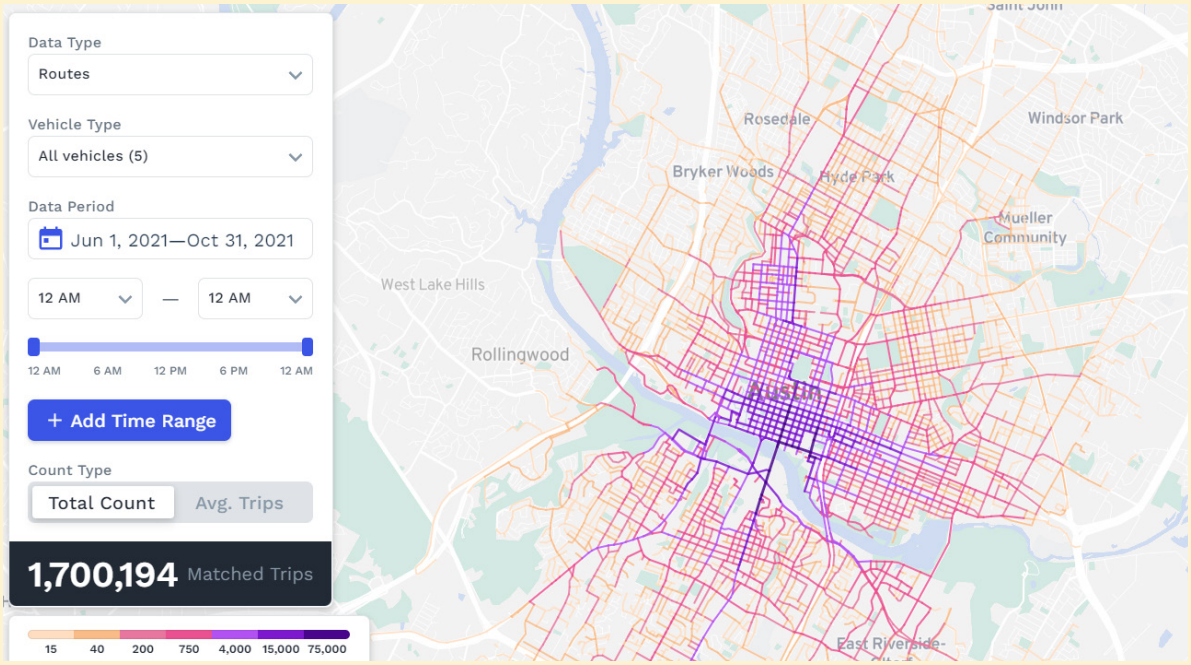

Figure 9: Austin's micro-mobility trip route heat map for the period June 2021 - October 2021 obtained from RideReport. The total number of trips is 1,700,194. Source: RideReport, Austin.

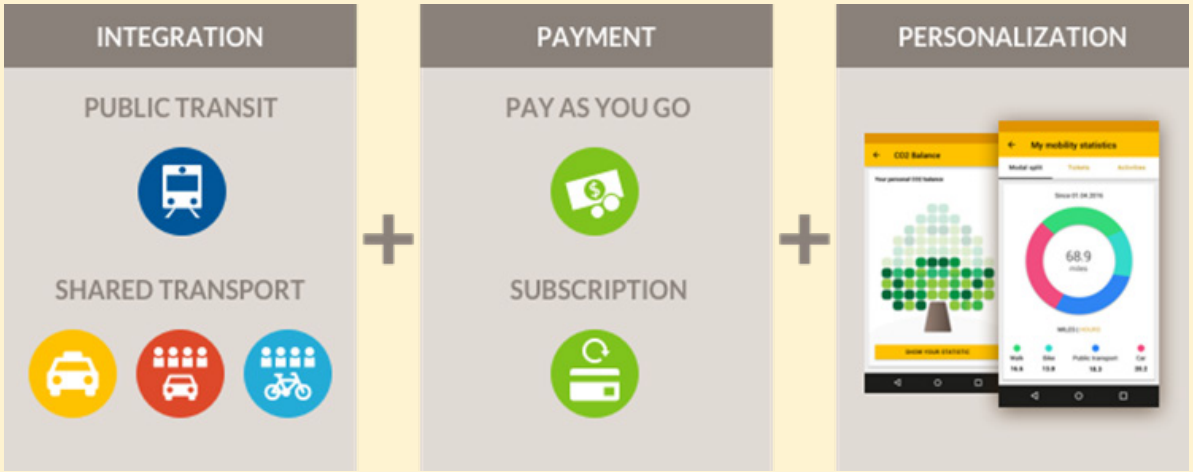

Figure 10: The concept of Mobility-as-a-Service

upward trajectory even though concerns surrounding the spread of the coronavirus was not completely gone.

As we see, despite concerns about the spread of the virus and people looking to switch to safer modes and socially distanced means of travel, micro-mobility emerged as a reliable travel alternative. Apart from the fact that shared micro-mobility was convenient to travel in a safe way, they are also sustainable, climate-friendly, and do not cause congestion. It also appropriately integrates with public transportation offering multi-modal alternatives to people who are reliant on public transit, essential, and front-line workers, etc. This characteristic of micro-mobility addresses some equity issues and has a lot of potential to continue to take equal space in the urban mobility realm, and would eventually aid in supporting the other sustainable transportation modes.

MOBILITY-AS-A-SERVICE AND THE PANDEMIC'S EFFECT ON MAAS:

Increased availability of different transportation modes and a parallel increase in private automobiles have led to more and more congestion. The concept "Mobility-as-a-Service '' targets making the usage and transition between different mobility services for the users, a more seamless process through a connected digital platform. With MaaS planning, travel can be effortless as users can choose their preferred mode while being able to pay for different services (public & private) in an integrated application on smartphones. This way, MaaS is able to offer personalized transit services to users and thereby slowly shifting people away from using personal vehicles. Mobility-as-a-Service also works well when there is a healthy partnership between Public agencies and Private Transportation Network Companies. Such collaboration would pave the way to improve public transportation ridership along with the help of private TNC's. However, there is also the risk of private TNC's offering enticing discounts and offers, that could attract more riders than public transportation, which could mean returning to increased traffic and congestion (Figure 10).

MaaS includes public transportation, shared mobility, ride-hailing, and sustainable transportation modes integrated with transportation apps. Mobility-as-a-Service enables users to visualize data acquired from the service providers' application

interface that interpret and comprehend the service-providing applications. MaaS was an up and coming Europe back in 2015, when MAASiFiE, a project financed by the CEDR Transnational Road Research Programme 2014 on Mobility & ITS. The project duration was between 2015 and 2017 and the where the focus was to mainly to analyze the state-of-the-art and future trends of MaaS, which also includes multimodal traveler information services, ticketing/payment systems and sharing concepts. The objectives also include developing businesses and operator models, analyzing technological requirements, performing socio-economic and environmental impact assessments (MAASiFiE, n.d.).

In July 2021, Pittsburgh launched its first comprehensive "mobility-as-a-service" app under Move PGH pilot program. The residents will be able to pay for buses, rent out micro-mobility devices like electric bikes, mopeds, scooters, and also find carpooling services (Wilson, 2021). Although MaaS is still evolving, the pandemic has enabled cities to adapt to new technologies, improve infrastructure to aid safe ways of traveling, and try new pilots to learn the viability of emerging mobility options. This has also opened doors for MaaS to grow and steadily integrate into the current transportation system. As the stay-at-home orders were put in place after COVID-19 cases surged, the drive-alone rates and the Vehicle Miles Traveled (VMT) dramatically reduced. Many businesses and companies opted to allow their employees work-from-home and continued the flexible work policy indefinitely. It's not only the commute trips, but in certain cities, even grocery and basic necessities shopping were done online, significantly reducing shopping, leisure, and recreation trips taken by people. It was also noted that bicycle purchases skyrocketed, indicating that people were switching to biking and many cities expanded their bicycle infrastructure by adding more bike lanes. According to StreetlightData analysis, the bike miles traveled increased by a substantial amount in May 2020 compared to May 2019. With all these transfigurations around rider behavior and patterns as a result of the pandemic, MaaS has resurfaced as the development that could aid people in gradually shifting to alternative modes of transportation and moving away from using private vehicles and cars.

ROADBLOCKS TO SUCCESSFUL IMPLEMENTATION OF MULTI-MODAL TRANSPORTATION AND RECOMMENDATIONS

As much as shared micro-mobility and Mobility-as-a-Service are making a gradual and steady foundation in the recent transportation ecosystem, their implementation and successful operation have not been uniform across the country. Different cities experience different challenges of their own and each location needs to be analyzed and studied to outline policies to efficiently operate and serve the riders in an equitable way.

Challenges associated with micro-mobility or Mobility-as-a-Service's successful implementation and operation are mentioned below.

Challenge:

Infrastructure

Dedicated infrastructure for shared mobility and micro-mobility is still something various cities are working on. During the pandemic, the country experienced a biking boom and this forced many cities to build dedicated bike lanes to enable the riders to have a smooth and safe riding experience (Figure 11).

Recommendation:

Building reliable infrastructure for these urban mobility options will enable smooth functioning and also encourage more people to switch to sustainable modes of transportation. Cities have already expanded their existing bike lanes and are planning to build more. Offering incentives to buy e-bikes could encourage more people to switch to sustainable transportation options. For example, Austin Energy, the City of Austin's electric power utility department, offers rebates and incentives for purchasing electric vehicles. Residents who receive electricity from Austin Energy are eligible to buy electric vehicles at a discounted price. By fulfilling certain eligibility criteria, the users will be able to get incentives ranging from $50-$400 (Austin Energy, n.d.).

Challenge:

Safety

Riding bikes and e-scooters very close to traffic lanes with high-speed limit needs has long been a topic of safety concern. Safety regulations for e-scooters and other micro-mobility are also still in the early stages of development. Wearing helmets is not mandatory and because riders generally ignore safety precautions, there have been serious injury reports due to collisions and incompatible infrastructure, like uneven surfaces (Figure 12).

Recommendation:

As more bike lanes are built and more in city limits where high-speed vehicle traffic exists, it is important to develop improved infrastructure that keeps the vehicular traffic away from bicycles and e-scooter traffic. Delineators marking the bike lanes or regulated speed near the bike lanes could enable added safety to the shared/micro-mobility users. Educational outreach and increasing awareness among riders to use helmets should be a constant effort from both government agencies as well as mobility operators. Mobility operators could also provide their users with promotional offers or discounts to purchase helmets, and continued efforts will persuade people to take safety precautions.

Due to the pandemic, the mobility operators are responsible for maintaining sanitized devices to curb the spread of coronavirus, and it is important to be transparent about the cleanliness practice they follow to reassure people of the safety efforts they make.

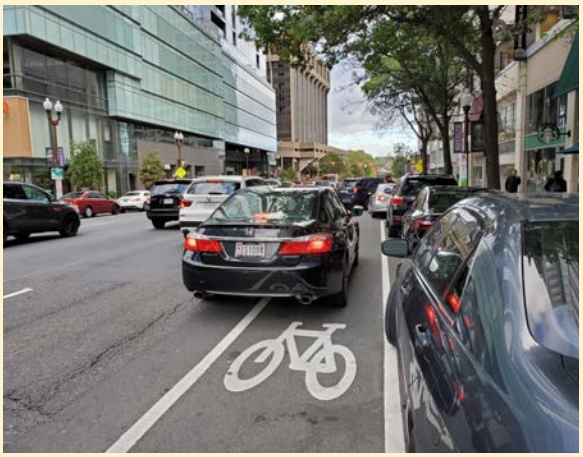

Figure 11: Car riding/parking on a bicycle lane in Arlington, Washington. Source: Greater Greater Washington, 2019

Figure 12: Bicycle lane located very close to vehicular traffic. Source: LADOT Livable Streets, 2020

Challenge:

Equity

Usually, the mobility operators start their services by introducing the devices in the downtown or the city core, as they are more visible, attract more riders, especially workers in the downtown and tourists visiting the city. Depending on performance and ridership numbers, the operators plan to expand their operation to other parts of the city. Often, the low-income and underserved communities are left out, and this shows the inequity in the services provided (Figure 13).

Recommendation:

NACTO Shared micro-mobility Guidelines describes very well how cities and operators have similar goals, but how those goals don't align. Cities want the micro-mobility services to be provided in all neighborhoods and want the providers to focus on transit stations. However, micro-mobility providers focus on maximizing revenues and the locations chosen for deployment are mostly central business districts, downtowns, and entertainment areas. NACTO recommends cities to require operators to rebalance vehicles within permitted service areas and that cities should reserve the right to suspend operating permits when the operators don't comply with the rebalancing requirements (NACTO, 2019). If Mobility-as-a-Service and shared mobility are developed to become stable, reliable transportation modes, this could enable people from low-income communities, people not having private vehicles, job seekers, and even the elderly population to have the freedom to commute in a more affordable way. Targeted analysis and a better understanding of which locations need micro-mobility and multi-modal services would offer more people who don't own cars, the opportunity to use public transit and micro-mobility services on a regular

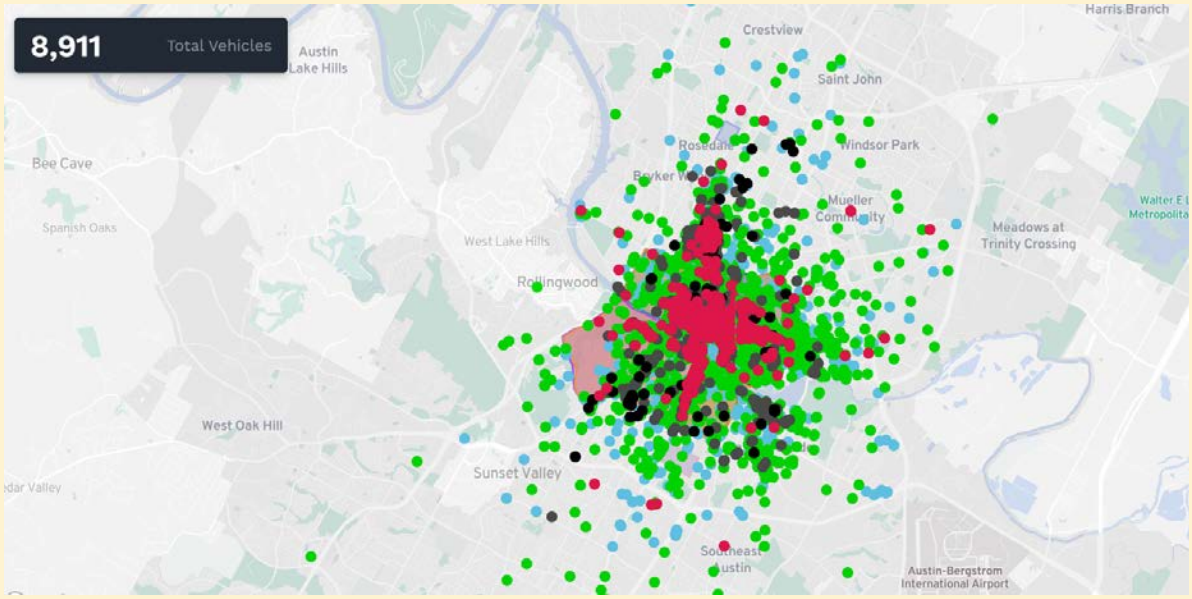

Figure 13: Map showing the total available shared-mobility vehicles present in the City of Austin (The different colors shown denote different micro-mobility providers, which are Link, Lime, Wheels, and Bird) The polygon denotes the Downtown Austin Projects Coordination Zone. This image also shows the concentration of devices in the downtown and areas close to downtown, indicating inequity in the services provided in other parts of the city. Source: RideReport, Austin.

basis. It is important to consider the populations that do not have smartphones to be more inclusive and one step closer to achieving equity. A single card that would be linked to an account that could be refilled at different locations local grocery stores, has the potential to reach a wider population (like non-white populations, low-income, and immigrant populations). This single card would be used to pay for various transit modes, like buses, light rails, shared bicycles, shared micro-mobility, and ride-sharing services (Goffman, 2020).

Challenge:

Parking and Deployment

Micro-mobility operation is predominantly dockless and the parking and deployment aspects have often been scrutinized. The sidewalk clutter poses a major hazard and causes interference with accessible pathways for people with disabilities especially when devices are knocked down close to ADA access ramps. Los Angeles Department of Transportation's audit identified in 2020 that about 7% of e-scooters were blocking disability access ramps (Sanders, 2021). It also causes obstructions to pedestrians using sidewalks and visual pollution as well. It becomes complicated as the dockless parking does not help much to address the sidewalk clutters since the devices could be knocked down easily.

The deployment of dockless bikes and e-scooters is also problematic. Since there are more and more micro-mobility operators entering the market, operators are competitive of their fleet size andlook for opportunities to roll out more devices to increase their ridership or address their ridership demand. This often leads to oversaturation of devices in a given particular location, which could either cause issues like blocking sidewalks, sidewalk clutters, and taking over parking spaces for other devices (Figure 14).

Figure 14: E-scooter clutter due to unregulated parking. Source: Kxan, Austin, 2019.

Recommendation:

Cities and mobility operators could collaborate to identify effective deployment locations. This could be more dynamic as each and every location would have its own character and rider behavior pattern. Analyzing data and carefully deciding deployment locations with all the involved mobility operators would avoid oversaturation and reduce visual pollution associated with micro-mobility. Permanent or makeshift parking corrals for micro-mobility is the first step to address unorganized dockless mobility parking. Next, would be to make these parking areas more visible by erecting stand-up signs that give clear instructions to park micro-mobility devices in that space. Parking stickers or painted boxes that indicate micro-mobility parking specifically would navigate people to park in designated spaces. NACTO's discusses best practices that cities could follow to regulate parking. Cities should require operators to develop a deployment plan or parking operations plan for routine street maintenance and special events (NACTO, 2019).

Challenge:

Vehicle Miles Traveled

Regular deployment and rebalancing of the devices require mobility operators to constantly move around in a separate automobile to deploy devices in designated spots and also to address clutters, oversaturation, or retrieving devices from no-park zones or other undesignated locations where the devices are dropped off by the users. This means as the vans and trucks are more frequently moving around to take care of the deployment and rebalancing, this increases Vehicle Miles Traveled (VMT) contributing to congestion and pollution, which is mostly overlooked (Figure 15).

Recommendation:

This is one of the more complicated issues to address, as the operational logistics of the micro-mobility industry are still developing and evolving. Though it's too early to come up with any solution as the dynamics could change, it is still important to keep this issue in mind. Since one of the main purposes of micro-mobility is to offer a sustainable commute option and help in reducing pollution from automobiles, this, in an indirect way, contradicts the purpose. More studies and analysis is required to keep understanding how the VMT is actually changing and if they are still in the acceptable range as compared to drive-alone rates.

Challenge:

Regulation

Cities are still learning to identify ways to address issues relating to micro-mobility and shared mobility's safe riding, parking, infrastructure, and logistics associated with it. Designating and maintaining parking spaces for shared mobility devices are tricky as riders tend to look out for the location that is convenient and closer to their origin/destination, which means they mostly do not take the effort to park the devices in designated parking spaces even if there are designated parking boxes. Regulations pertaining to Mobility-as-a-Service involve more negotiations between government transit agencies and private transportation network companies. As both the parties are looking to improve their services, it is possible that, while making efforts to act in the best interest of their respective organizations and their goals, it might become difficult to reach a middle ground to partner and work together (Figure 16).

Figure 15: E-scooters being loaded in a truck to be rebalanced. Source: Greenbiz, 2019.

Figure 16: Micro-mobility Corral in Austin, a parking regulation to enable organized parking and deployment. Source: Austin Transportation Department, 2019.

Recommendation:

In the case of Mobility-as-a-service, it is always important to remember that the goal is to reduce congestion, dependency on private vehicles and aid sustainable mobility before partnering with transit providers. As various entities partner to implement MaaS, it also involves aspects like data-sharing, varying business prototypes, and support from users. Therefore, regulating MaaS goes beyond just partnerships, and careful planning is required to deal with data privacy, data sharing between transit agencies, and also the payment logistics coordination between transit agencies. Lyft's Biketown and Portland Department of Transportation's partnership is one of the best examples of well-executed collaboration. Biketown offers $1 to the riders for returning the bikes locked away from a station, or bringing bikes to a station low on bikes (Rousculp, 2020). Such incentives would possibly change the parking behavior and would encourage riders to park in designated parking corrals.

Challenge:

Rapid expansion

With the rise in ridership and operational expansion in many places, the mobility operators are rapidly expanding and more new operators are coming up as well. This means the cities will need to be aware of this fast growth and be prepared accordingly to make informed decisions about how this mobility option can co-exist with other transportation modes while

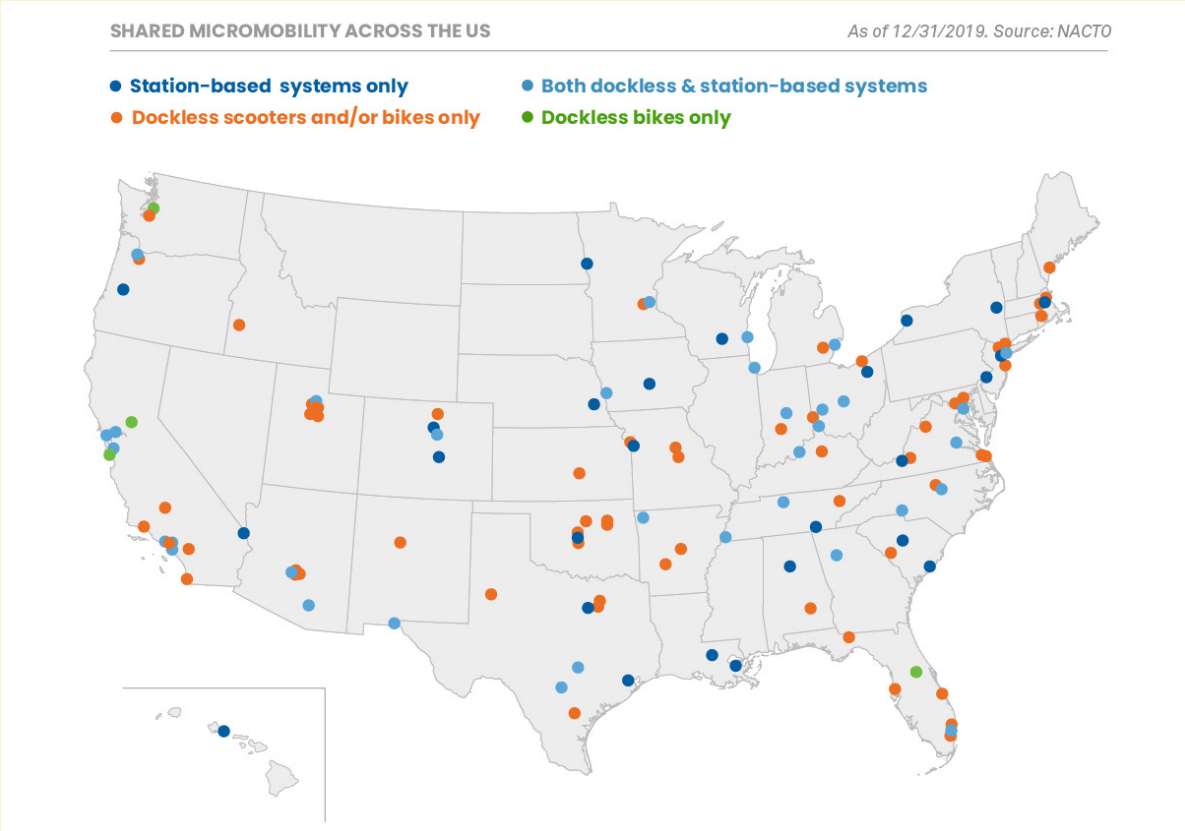

Figure 17: A map depicted by NACTO showing the presence of shared micro-mobility across the US as of 2019. Source: Shared micro-mobility in the US:2019, NACTO.

making accommodations for their efficient operations.

Recommendations:

As more and more competitors flood the city, there needs to be adequate infrastructure to accommodate increasing mobility devices and parking spaces for the same. It is also important to understand and determine the threshold of the expansion and how much development is ideal to meet the demand, support the transit system, and offer equitable service.

CONCLUSION

The pandemic has definitely highlighted the need to take serious steps in creating a more diverse transportation infrastructure to address several issues, especially since our current infrastructure has been built to accommodate transportation growth only up to the foreseeable future. As the cities work to create a safe environment to fit in all types of mobility alternatives, there is a lot of research and data-driven analysis required to comprehend Mobility-as-a-Service and micro-mobility implementation. The challenges associated with shared mobility and multi-modal transportation are not static and it is more evolving as the services keep expanding. Policy interventions and partnerships with private stakeholders are going to be an extensive part of addressing the obstacles associated with efficient multimodal mobility performance. With dockless mobility beginning to make significant impacts addressing first-mile/last-mile connectivity, sustainable mobility, reducing drive-alone rates, promoting healthy commute choices, and helping alleviate congestion, it is crucial to make it more equitable as well, so that it serves every one of all age, race, income level, and gender. Micro-mobility and multi-modal transportation decision-making processes are not just dependent on one particular party, they involve government agencies, shared-mobility providers, other stakeholders, the general public, and most of the decisions eventually are made over long observation periods and rider behaviors. The successful implementation of micro-mobility and Mobility-as-a-service will directly affect the ridership numbers and the ridership numbers directly affect the successful continuation of the mobility programs.

About the Author

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Priyadharshini Balan is a Transportation Specialist at Commute Seattle, a nonprofit Transportation Management Association. She works on the Commute Trip Reduction program, which focuses on supporting employers and businesses in Seattle to reduce their drive alone rates and encourage sustainable transportation options. Previously, Priyadharshini was a Project Coordinator for the City of Austin's transportation department, focusing on shared-mobility demand management, parking enforcement, and curb-space management.

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Figure 14: E-scooter clutter due to unregulated parking. Source: Kxan, Austin, 2019. https://www.kxan.com/news/local/austin/why-there-were-big-piles-of-scooters-in-downtown-austin-during-sxsw/ .

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AUTOMATED BRT: A NEW MODE FOR HIGH-QUALITY, HIGH-CAPACITY TRANSIT

Richard Mudge
Jerome Lutin

Figure 1: LRT - Newark, NJ Source: J. Lutin

INTRODUCTION

This paper describes a new approach to high-capacity transit, Automated Bus Rapid Transit (ABRT). ABRT builds on technologies developed to support autonomous vehicles. While autonomous vehicles get most of the attention in the media, buses can use these individual technologies to help solve specific public transit problems. These range from ways to enhance conventional Bus Rapid Transit (BRT) so that it is more comparable to light rail transit, (LRT) to opportunities to improve the quality of traditional bus transit.

This paper highlights the advantages of an Automated BRT system for cities that are planning transit infrastructure investments in anticipation of growth or to serve unmet transport needs. ABRT may also fit in cities that have begun to prepare for the deployment of self-driving technology.

COMPARING CURRENT MODES OF TRANSIT

FTA defines Light Rail as a transit mode that typically is an electric railway with a light volume traffic capacity compared to heavy rail (Figure 1). It is characterized by:

- Passenger rail cars operating singly (or in short, usually two-car, trains) on fixed rails in shared or exclusive right-of-way (ROW);
- Low or high platform loading; and
- Vehicle power drawn from an overhead electric line via a trolley pole or a pantograph (Glossary, n.d.).

The FTA defines Bus Rapid Transit as fixed-route bus systems that operate at least 50 percent of the service on fixed guideway. These systems also have defined passenger stations, traffic signal priority or preemption, and short headway bidirectional services for a substantial part of weekdays and weekend days (Glossary, n.d.). A growing number of BRT lines operate on arterials and may not have dedicated guideway.

Most LRT and conventional BRT vehicles now have low floors throughout most of the vehicle which eases boarding and alighting (Figure 2). Some BRT systems also have level boarding and are compliant with the Americans with Disabilities Act.

Most LRT vehicle operators are located away from boarding areas. This makes on-board fare collection impractical. Although bus drivers for conventional BRT vehicles can collect fares, most systems are trending toward off-board fare collection or electronic fare collection which allows passengers to use all doors on the bus. This is particularly useful to help avoid COVID-19.

In many ways, LRT and conventional BRT are similar, but each has distinct advantages and disadvantages. LRT has greater passenger capacity potential with a single operator, but the need to construct track, signals, electric power systems, and specialized maintenance facilities means that infrastructure costs will be substantially more than BRT.

Conventional BRT has less passenger capacity potential per operator than LRT, but significantly lower infrastructure costs and greater flexibility in terms of ease of route and service level modifications, since BRT buses can use lanes on existing streets as part of the permanent route or temporarily, as part of construction phasing. Automated BRT has the potential to improve BRT performance to equal rail capacity and service levels in most respects, but with lower capital costs, and greater flexibility to adapt with changing technology.

On LRT systems, expensive trackwork and signals may be needed at terminals and junctions. BRT can use conventional traffic signals, roundabouts, and intersections at such locations (Figure 3).

AUTOMATED BRT – THE TECHNOLOGY

Levels of Automation

There has been a lot of hype associated with automated vehicles, resulting in growing skepticism about the speed with which fully autonomous vehicles will be deployed. In the transit bus industry, however, real progress is being made based on sound scientific and engineering work.

Adding the Right Technology

Buses have been retrofitted with automated driving technology in demonstrations over the past two decades, and bus original equipment manufacturers (OEMs) plan to incorporate various automated driver

Figure 2: BRT Articulated Bus - Cleveland, OH Source: J. Lutin

Figure 3: Landscaped BRT Station - Los Angeles, CA Source: Google Earth

assistance systems into future production models. Existing buses can be retrofitted with proven technology. For example:

- Drive-by-wire systems – Throttle, braking, and steering systems are modified to allow electromechanical activation.
- Imaging sensors – Cameras, radar, and lidar (light detection and ranging) sensors are placed on the vehicle to generate a virtual model of the operating environment in real time. Each type of sensor has its own advantages in terms of the type of objects that it can identify and the distance over which it operates. In recent years the cost of these technologies has dropped dramatically, and performance has increased.
- Locating devices – GPS and inertial measurement units (IMU's) that incorporate gyroscopes and accelerometers to measure position, speed, and changes in motion. Other methods track distances from objects (buildings, signs, trees etc.) along the right of way.
- Stored high-definition maps and landmark databases - to guide the vehicle from origin to destination and ensure it stays within a geographically defined operating area – sometimes called a "geofenced" area.
- Autonomy systems – computing devices that accept inputs from sensors, maps, and localizing devices; fuse the data; and use artificial intelligence to provide directions to the vehicle by activating functions through the drive-by-wire system.
- Data recorders and analyzers – to collect and mine the data to evaluate vehicle and system performance.
- V2X communications (between vehicles and roadside sensors) allow vehicles to communicate wirelessly with roadside units to exchange data, and with each other to enable them to operate collaboratively. An example is traffic signal priority in which Automated BRT buses can communicate with traffic signals to gain extra green time in order to avoid delays, or to slow down in advance of a red light.

Using Automation to Assist, not Replace, Drivers

In 2018, the Federal Transit Administration published the Strategic Transit Automation Research (STAR) Plan that includes an automated BRT use case (Machek et al., 2018). The authors describe it as follows: "The automated Bus Rapid Transit technology package uses a full-size or articulated bus to provide BRT service without a driver on board the vehicle". ... "Fully-automated BRT could be of interest to cities that are considering cost-effective alternatives to light rail transit or other high-capacity transit systems."

The goal of Automated BRT as defined in this paper is not to remove the driver but rather to provide technology that will enable transit authorities to transport more passengers safer, more comfortably, and with greater accessibility for the mobility impaired. The driver may be able to spend more time assisting passengers rather than focusing on maneuvering in traffic. Therefore, the definition of ABRT used in this whitepaper can include fully autonomous operation but does not require it.

Much of the automated functionality needed for ABRT to match LRT can be achieved with lower levels of automation, most of which has already been

demonstrated on autos, trucks, and buses Automated capabilities described here include:

- Automated Precision Docking
- Automated Collision Avoidance and Emergency Braking
- Automated Lane Keeping
- Automated Bus Platooning
- Smooth Acceleration and Deceleration

ADVANTAGES OF AUTOMATED BRT TECHNOLOGY

Precision Docking

Disabled riders often need lifts or ramps deployed when boarding and alighting from buses (Figure 4). In addition to the inconvenience this creates for the disabled user, they often report feeling stigmatized by the delay created for other riders. The operational inefficiencies encountered by lack of access to BRT by disabled individuals are reflected by a vast difference in operating expenses. FTA data for 2019 shows that nationwide, the average conventional BRT trip cost is $3.43 per trip while the cost for accessible service (demand-responsive paratransit) is $39.51 per trip (NTD National Transit Database 2018 National Transit Summaries and Trends, 2019).

Figure 4: Level Boarding in Wheelchair - Kansas City, MO Source: KCATA

To provide ADA-compliant level boarding for all riders without using lifts or ramps, bus door openings must be no more than three inches (8 cm) away from the platform. Larger gaps can lead to passenger accidents and injuries, and smaller gaps can lead to bus and platform damage.

Consistently achieving that gap is challenging for drivers. This can be particularly difficult to achieve for rear doors, especially for articulated buses.

Automated systems that can aid the driver in precision docking were successfully demonstrated first at Lane Transit District in Eugene, Oregon from 2013 to 2015 (Gregg & Pessaro, 2016).

Additional testing of precision docking is being included in two FTA-funded demonstrations: one by Connecticut Department of Transportation (CTDOT) on the CTfastrak Hartford – New Britain BRT line and the other by the Kansas City Area Transportation Authority to test precision docking technologies on the Prospect MAX BRT system (Connecticut Department of Transportation, 2020; Kansas City Transportation Authority, 2020). Robotic Research provides technology for both projects using New Flyer buses in Connecticut and Gillig buses in Kansas City.

Automated Lane Keeping

Automated lane keeping has been successfully tested by the Minnesota Valley Transit Authority (MVTA) in 2010-2011 (Pessaro, 2013). MVTA operates express buses on freeway shoulders in the Twin Cities area. Automated lane keeping helped drivers keep buses centered on the narrow shoulders, improving safety, and reducing

driver stress (Figure 5). In addition to facilitating the use of freeway shoulders, for Automated BRT, this functionality can reduce lane widths resulting in narrower rights of way, less paving, and lower infrastructure costs. This technology is particularly important for BRT systems that operate on narrow city streets.

Automated Bus Platooning

Sometimes called "leader-follower" operation can use connected vehicle communications (CV2X) to form trains or "platoons" of buses. Leader-follower operation has been successfully implemented by Robotic Research on full-size trucks for the US Army under rigorous combat conditions. Related deployment is underway for commercial trucks by several firms.

The Port Authority of New York and New Jersey (PANYNJ) plans to demonstrate bus platoons to increase capacity and reliability on the Exclusive Bus Lane (XBL), a contra-flow lane that carries 1,850 buses into the Lincoln Tunnel during the four-hour morning peak period each weekday (Figure 6; Port Authority of New York and New Jersey, 2019).

This technology will also ensure that the buses stay within the narrow lane used for the XBL and avoid knocking down lane delimiters that help keep oncoming traffic in adjacent lanes from entering the bus-only lane. The CTDOT project will also deploy bus platoons along the CTfastrak

For Automated BRT, bus platooning enable a driver in the lead bus to control one or more following buses, providing additional capacity and reducing the distance between buses to improve speed and flow. This increases the potential number of passengers per driver.

Leader follower systems also provide management with the flexibility to use

Figure 5: Automated Bus on Shoulder - Minneapolis, MN Source: FTA Lane Assist Technology Report 2003

Figure 6: Exclusive Bus Lane (XBL) – Weehawken, NJ Source: PANYNJ

buses as part of a bus platoon during rush hours and then as individual buses for passenger pickup and drop off on either ends of the BRT section. Another option would use the leader-follower platoon during peak hour traffic and use buses individually during off-peak periods when less capacity is needed. The train-like capabilities offered by platooning result in a mode of transit that offers the capacity potential of LRT, but with the flexibility to manage peak vs. non-peak needs, reach of service, and population growth changes.

Figure 7: Bus Collision Avoidance Testing Source: Virginia Tech Transportation Institute

Automated Collision Avoidance and Emergency Braking

In 2019 US bus transit agencies reported 6,228 collisions, 16,594 injuries, 95 fatalities, and $770 million in casualty and liability expenses (National Transit Database, Safety and Security Time Series Data, n.d.; 2019 annual database operating expenses, n.d.). 74 percent of high value bus insurance claims (more than $100,000) have been attributed to collisions (Lutin et al., 2016).

Automated collision avoidance and emergency braking (AEB) systems to prevent forward collisions with vehicles and collisions with vulnerable road users (such as pedestrians and cyclists) are now common options for passenger cars and are increasingly used by commercial vehicles. Adapting these systems for buses is currently under way in several FTA-sponsored projects and bus OEMs (Figure 7). Research shows that AEB systems could yield a significant return on investment in terms of reducing collision related insurance claims for the transit industry. Much of the technology needed for AEB, including sensors, drive-by-wire kits, and computers can be shared with other automated functions as an integral part of Automated BRT. This technology could also monitor other blind spots such as the rear door area.

SMOOTH ACCELERATION AND DECELERATION

The ability to control acceleration and deceleration in a coordinated fashion will improve rider comfort while also reducing the prospect of passenger slip and fall incidents. The ability to smooth bus movement supports other automated controls including lane keeping and platoons. In addition, CV2X technology can allow the bus to anticipate traffic signal changes which can also reduce fuel use. The same infrastructure that enables vehicle-to-infrastructure communications between automated transit buses and traffic signals could be utilized by connected vehicles, as they become more common. This dual-use infrastructure is another example of how Automated BRT allows transit agencies to scale their transit solution as technology advances.

BUS YARD AUTOMATION

ABRT technology can help make bus yards more cost effective. Buses can be parked and retrieved without a driver (this is a special exception to the rule mentioned above about always having a driver on an automated bus). The automated bus will also reduce bus hits and related damage as buses are parked near each other and then retrieved. The potential savings may help recover the costs of adding yard automation technology to the buses.

AUTOMATED BRT – A SUMMARY

While the value of an integrated ABRT system is likely greater than the sum of its parts, Table 1 summarizes the benefits of its individual components.

Table 1. The Value of Automated Bus Rapid Transit

Automated Collision Avoidance and Emergency Braking	• Save lives • Fewer collisions • Fewer injuries • Reduce insurance claims • Reduce collision damage repairs • Reduce spare bus ratios
Automated Lane-Keeping	• Narrower busways • Support turning lanes • Fewer sideswipe collisions • Fewer mirror replacements • Less ROW acquisition and infrastructure cost • Use of shoulders for buses
Automated Precision Docking	• Level boarding at all doors • ADA-compliant access for mobility impaired users • Improved service to disabled community at lower cost to agency • Fewer boarding and alighting accidents • Reduce damage to buses and platforms from manual docking
Automated Smooth Acceleration, Deceleration and Speed Control	• Better ride quality • Greater comfort for passengers • Fewer slip and fall incidents • Increased fuel savings
Automated Bus Platooning and Automated Leader-Follower Capability	• Increased passenger capacity on high volume routes • Increased flexibility to adjust passenger capacity by time of day • Increased passenger spacing with social distancing • Improve passenger to driver ratio

Together, the above benefits combine to enhance Bus Rapid Transit into a mode of high-quality, high-capacity transit that compares with LRT while reducing infrastructure costs and increasing flexibility to meet changing demand over time.

WHERE DO WE GO FROM HERE?

While Automated BRT can be described as a new transit mode, the underlying technologies are proven. The transit industry is under pressure to find cost-effective ways to improve service for their customers. ABRT (as well as its individual components) offer a promising solution. Indeed, they may open the door to public private partnerships for applications such as yard automation.

Industry Developments – In March 2021 New Flyer Industries of America, Inc., the largest manufacturer of transit buses in North America, in collaboration with Robotic Research LLC, rolled out the Xcelsior Charge AV, a prototype battery electric 40-foot bus which incorporates many of the automated use cases discussed in this paper (Figure 8). Gillig LLC, another large transit bus manufacturer in North America, also has agreed to develop automated buses in partnership with Robotic Research.

Figure 8: New Flyer Xcelsior Charge AV – Source - New Flyer Industries of America, Inc.

New Flyer is building three Level 4 automated buses for the CTfastrak project mentioned above based on the Xcelsior Charge AV prototype (New Flyer, 2020). This deployment, which is funded by the FTA and CTDOT, will be the first Automated BRT deployed in revenue service in the US.

Additional manufacturers have announced automated bus pilots in China, Germany, and Scotland, although it is unclear if these are intended to operate as BRT. Over the next few years, it is expected that some bus manufacturers will add ADAS equipped buses to their standard commercial lines.

An association of transit and transportation agencies has formed the Automated Bus Consortium, a collaboration designed to investigate the feasibility of implementing automated bus projects across the United States. The Consortium aims to accelerate the development of automated transit technologies (Automated Bus Consortium, n.d.).

Federal policy – FTA includes an automated BRT use case with level 4 automation as an integrated demonstration in the STAR plan's five-year strategic transit automation research roadmap, starting in year four, Federal Fiscal Year 2021. The CTDOT project may meet the goals for that integrated demonstration. Although the STAR plan does not include future funding targets, there is clear interest in providing continued technical support for the various use-cases including ABRT.

Incorporating ABRT into the Planning Process – One purpose of this paper is to lay the groundwork for including Automated BRT in the planning process.

Planning for high-capacity transit corridors involves a multi-year process, especially if Federal funds are used. Most Federally funded capital grants are discretionary or competitive, require local matching funds, and are evaluated for funding based

on a number of criteria (Capital Grants Program, n.d.). Among the steps involved, prospective grantees must show that alternatives have been considered and evaluated for aspects such as mobility, cost-effectiveness, and environmental impacts. It is in this part of the planning process that an ABRT alternative can be developed and considered as a viable alternative.

It is hoped that this white paper will stimulate thinking about the potential offered by Automated BRT. While no integrated ABRT system is yet in operation, this paper provides the basis for planners to engage with OEMs, autonomy firms, and experts to collaborate on planning and engineering needed to deploy for ABRT corridor deployments.

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REALIZING THE POTENTIAL OF EMERGING TRANSPORTATION TECHNOLOGIES

A Revision of Transportation Planning

Brian Waterman
David Gross

Figure 1: NYC 5th Avenue 1900 (automobile circled in red) vs 1913 (horse and buggy circled in red) (Ecosphere+, 2017)

INTRODUCTION

What is old, is new again. In the year 2022, we are facing similar challenges as transportation planners did in the early 1900s. Then, motorized transportation was introduced, which radically changed how we planned, designed, and operated the urban transportation system (UTS). Previously, the UTS was limited to human and animal capabilities with an emphasis on accessibility since not everyone owned or maintained horses with trolleys and interurbans providing a degree of separation between employment and housing (Figure 1).

Motorized transportation, however, changed the paradigm. This led to a greater influence on mobility with infrastructure, regulations, and performance measures, designed to quickly move vehicles from one point to another, which conflicts with how people and freight access their desired destinations. This focus on mobility over accessibility significantly affected how the UTS influenced the development of cities, travel behaviors, and how people interact with their environment over the subsequent years.

Today, we are at the precipice of another major change in planning. Autonomous, connected, electric, and shared vehicles (ACES) will change the purpose, funding, and operation of the UTS. The problem, however, is how we currently plan and design the network is not sufficient to take advantage of benefits associated with this emerging technology, leading to missed opportunities to improve the network to equally achieve both accessibility and mobility.

Currently, transportation professionals often evaluate and propose new infrastructure, routes, or network solutions in stovepiped, mode-specific manner where each mode (automobile, bicycle, pedestrian, and transit) has its own set of experts. We are compartmentalized but planning for ACES needs collaboration to realize the improved efficiencies and better ways of moving people or goods across an urban environment. Furthermore, since the changes to the UTS that were

needed to realize the benefits of motorized transportation led to unintended negative consequences, such as urban sprawl, and divided neighborhoods - it is possible that similar negative consequences could result unless we change how we plan to realize the benefits of ACES.

HOW WE PLAN

In 2022, we are still trying to balance two opposing approaches (accessibility and mobility), with us historically favoring mobility measures by focusing on improving capacity. The mobility approach is inherent to transportation planning with an emphasis on how transportation improvements affect the level of service (an A – F ranking based on volume to capacity ratios) to the network (Merlin et al., 2018). As a result, we created a hierarchical process to evaluate interactions between decision-makers and users with the focus on providing additional transportation infrastructure and facilities to influence the users' travel choices (Di et al., 2018). However, there is a recent movement towards accessibility-based transportation planning. This shift is based on the argument that the purpose of the transportation network is to provide users access to their desired destinations (Martens, 2015). The challenge with shifting to an accessibility-based approach under current methodologies is the reliance on the surrounding land uses and changing urban form to support modifications to the transportation network (Merlin et al., 2018).

Accessibility, the ease of reaching services and activities, essentially looks at the number of people, jobs, and/or other services within a defined distance or time to use a transportation mode. Mobility, on the other hand, is defined as the ease of moving and focuses on measuring UTS average travel speed or time (Boisjoly & El-Geneidy, 2017).

In addition, the development of innovative urban mobility solutions often encounters several barriers. For example, Sochor et al. recognized that the environment where urban mobility management operates is often fragmented and lacks a "holistic approach by which synergies could be achieved between different modes of transport" (Sochor et al., 2015). Solutions proposed to address transportation problems are typically mode-specific, such as reconfiguring intersections to improve flow or constructing multi-use paths without factoring in impacts to transportation behavior.

While changes to federal transportation law require transit agencies to have a seat on Metropolitan Planning Organization (MPO) boards and participate in the transportation planning process, some agencies that do participate, however, report that "participation tangibly benefits transit systems by enhancing consideration of transit needs in corridor studies or accelerating transit project delivery" (Sciara, 2017). Additionally, funding for transportation projects could sometimes represent more the desires of local or state officials rather than the needs of the transportation network. This results in some of the decisions being largely based on public perception and may not consider "interfaces with the private sector and what contribution it could make to the achievement of urban mobility goals" (Sochor et al., 2015). This results in some urban areas being challenged to deliver comprehensive UTS investment plans which are comprised of diverse users with different requirements that must be funded through continually decreasing budgets (Sciara, 2017).

As a result, we have created a transportation network that favors the private automobile (Ionescu, 2022) with performance measures focused on

network speed and convenience. While there is a national focus on highway safety and reducing conflicts between transportation modes, it is these mobility-based network design approaches that focus on maximizing the distances people can travel within their time and money budgets, i.e., capacity-based performance measures. However, ACES and the creation of the "information everywhere" world have created new opportunities to make the transportation network more efficient and customizable. As a result, the transportation network can become "much more tailored to precisely what users want, when they want it, and how they want it, through increased consumption choices and convenience" (Goodall & Dovey, 2017). ACES can create a UTS with increased access, decreased travel times, and opportunities for more flexible and personalized means of transportation (Bahamonde-Birke et al., 2018).

Embracing ACES in network design could make it possible to achieve both accessibility and mobility-based goals without having to make a choice between the two by including the following characteristics:

- Multimodal transportation,
- Planning objectives built around access and societal improvements along with congestion, parking, and road savings,
- Analysis of economic, social, and environmental impacts,
- Multimodal level of service and accessibility modeling performance measures,
- Improved transportation options, and
- Integrating and strategic planning.

Therefore, changing how we plan beyond the year 2022 requires a diverse range of actors working together: "mobility management players, telcos [sic], payment processors, public and private transportation providers, and local authorities with responsibility for transportation and city planning" (Goodall & Dovey, 2017). However, are we ready to change to integrate the new technology?

SURVEY METHODOLOGY & RESULTS

To answer this question and show concurrence from industry professionals that the current approach is not sufficient to embrace the benefits of ACES, a survey was prepared and distributed to transportation engineers, planners, and other professionals through alumni networks, industry colleagues, professional organizations, and social media in Spring 2021. In addition to questions on what position the respondent holds and years of experience, the survey consisted of a mixture of multiple-choice, ranking, and open-ended questions designed to understand the state of the industry and whether the current techniques are sufficient to take advantage of the benefit of ACES on the transportation network. There were 104 total responses to the survey with 82 percent completing the survey. Figure 2 provides the breakdown of respondents by career and level of experience. Most of the transportation planners have less than 10 years of experience and most of the engineers have more than 16 years of experience.

The questions were designed to compare the practices of today with what is needed for "tomorrow" (twenty years from now) to help assess whether the industry is prepared to integrate the benefits of ACES and where (if any) changes are needed. This survey validates the findings from the literature review and provides direction on where the industry needs to go.

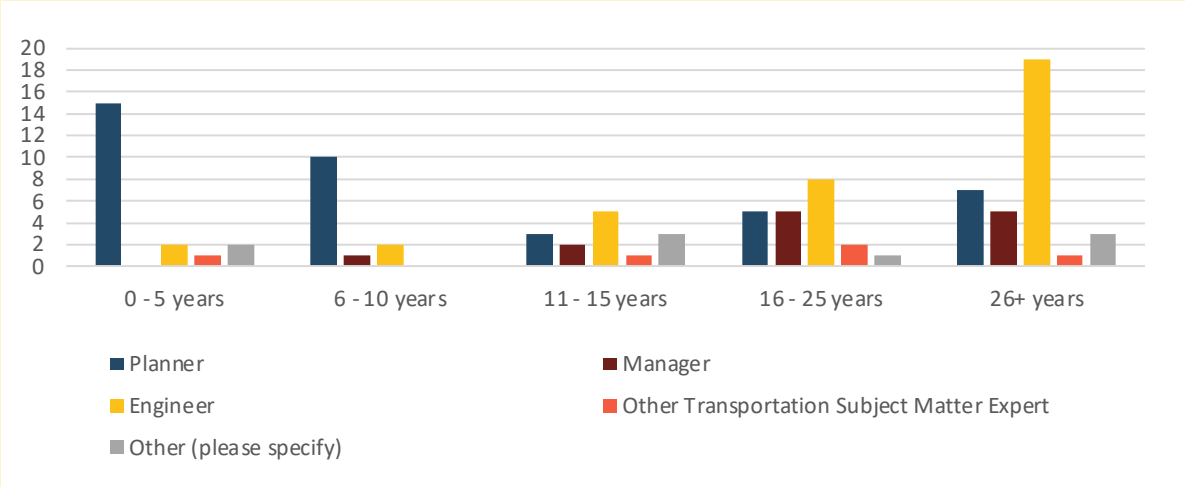

Figure 2: Respondent Career & Experience

For example, Figure 3 and Figure 4 provide the results from the respondents as they "Prioritize the focus of today's transportation system" and "Prioritize the focus of tomorrow's transportation system," respectively for all responses and then stratified based on the transportation profession. In both questions, infrastructure sustainment is ranked as the top choice for all respondents and is a statistically significant response ($p \leq 0.05$). This is followed by maintaining capacity for mass transit. This prioritization, however, is inconsistent with the benefits of ACES, where research is projecting an increase in capacity. The importance of capacity expansion for mass transit in both questions would be consistent with current research since ACES is expected to change the operation of public transportation with potentially more frequency and personalization of the system.

When these questions are looked at across the different positions, the disconnect in the purpose of the transportation network is illustrated, echoing a unimodal shortcoming in how we currently plan. In Figure 3, engineers and managers placed capacity for the personal automobile higher than the other modes with planners placing a greater importance on public transportation. While the prominence of personal automobiles decreases in Figure 4, planners and decision makers are more balanced in the rankings with a slight preference for policy development in the planner.

The engineers maintain their focus on infrastructure with infrastructure sustainment, capacity for ACES, and capacity for mass transit taking the top priorities.

As for the benefits of ACES, Figure 5 shows what transportation engineers, managers, and planners think to be the greatest benefit of ACES. The identified benefits came from the literature review, with the integration with public transportation systems and mobility benefits for mobility impaired individuals being identified as the greatest among all respondents. Integration with public transportation is the top choice for transportation engineers and managers. Planners place decreased car ownership as the top benefit, followed by mobility benefits.

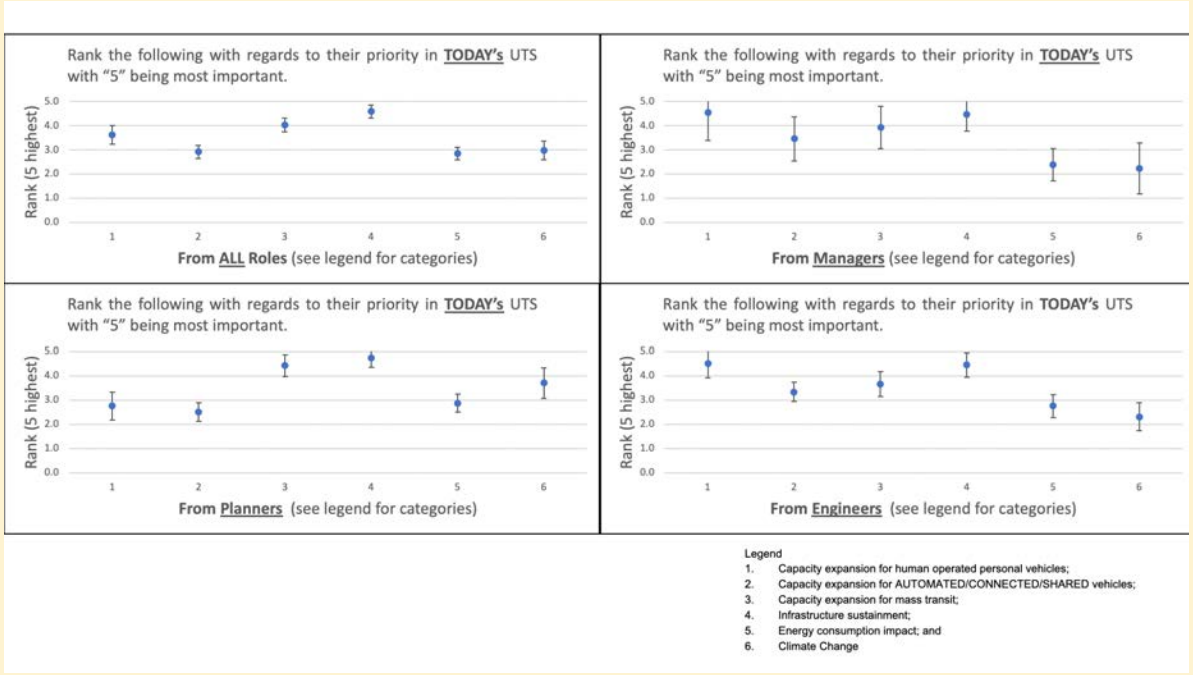

Figure 3: Prioritization of Today's UTS

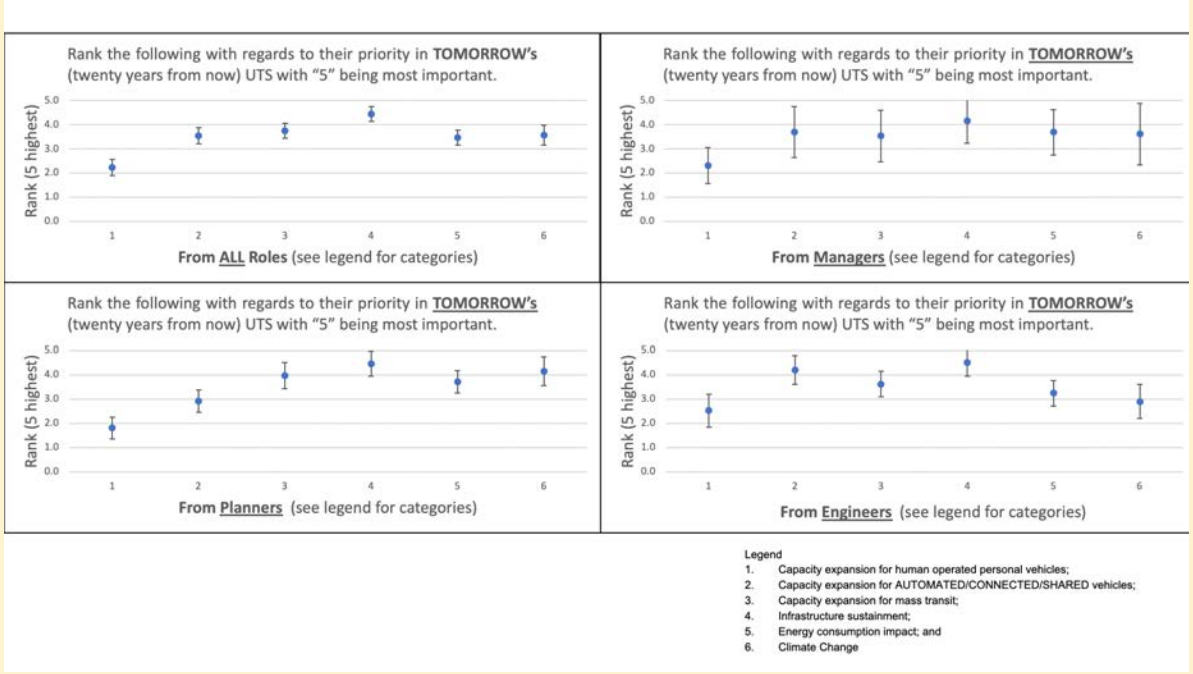

Figure 4: Prioritization of Tomorrow's UTS

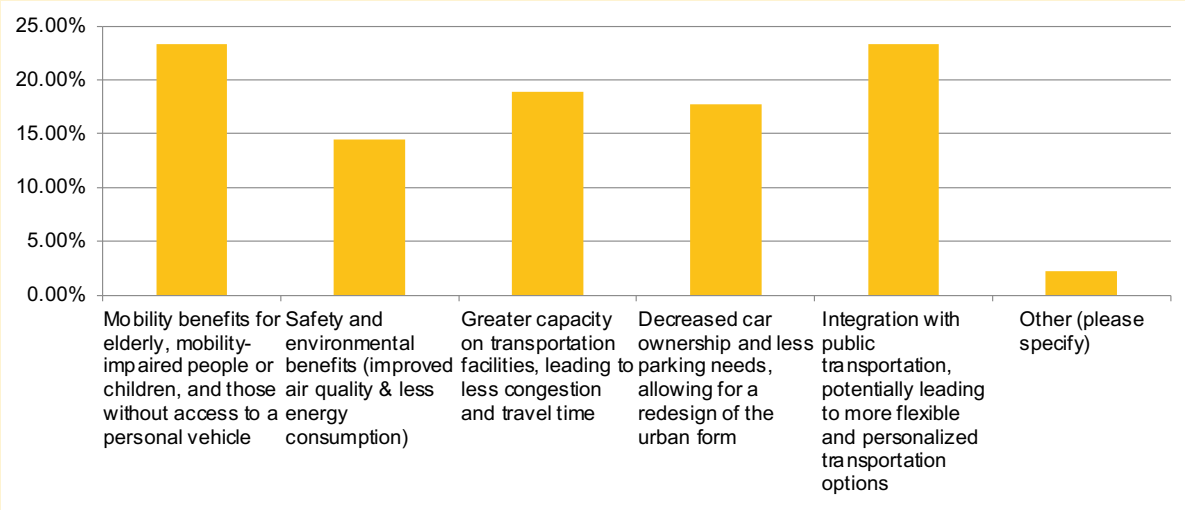

Figure 5: Greatest Benefits of ACES

While there are expected to be benefits to the UTS due to ACES, there will also be significant disruptions. The respondents were asked to rank the level of disruption in terms of:

- Governance – how the UTS is regulated;
- Safety – how ACES interacts with the UTS and affects crash/fatality rates;
- Personal rights –how individuals utilize the UTS;
- Commercialization – how businesses utilize the UTS;
- Market adoption rates – how ACES interacts with existing technology and how this interaction affects UTS design;
- Point to Point Transportation – how people travel a short distance (<2 miles) from their home/origin; and
- Hub to Hub Transportation – how people travel a long distance (>=2 miles) from their home/origin.

Figure 6 provides the results and stratifies it across the different transportation occupations. The results are flipped where the most important disruption has the highest value. For all groups, disruption to safety is the highest ranked choice followed by governance. This illustrates that integrating ACES into the UTS requires a change in the regulatory environment. This is illustrated by the responses to another question where a majority (51%) of all respondents called for the provision of a regulatory environment for ACES, with market forces guiding its adoption and implementation.

This choice is consistent across all professions; however, a plurality of planners does call for government ownership of ACES. When it comes to how to mitigate against these disruptions, responses range from there will always be disruption to the need for additional funding. The most common response or theme is the need for education about ACES and UTS to better understand its impacts on a larger society and to prepare the public for what is coming.

Since it is known that ACES will disrupt the UTS as well as provide benefits, the question remains as to whether current transportation planning practices are sufficient. The respondents were then asked how well they agree or disagree

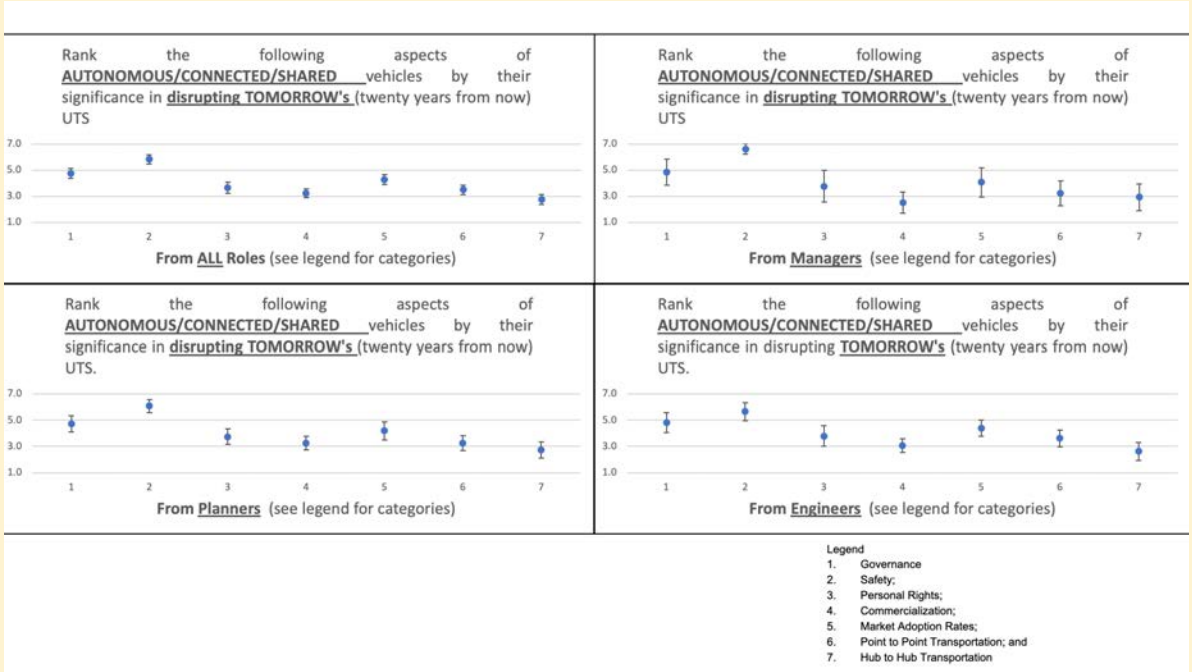

Figure 6: Ranking Disruption to the UTS by ACES

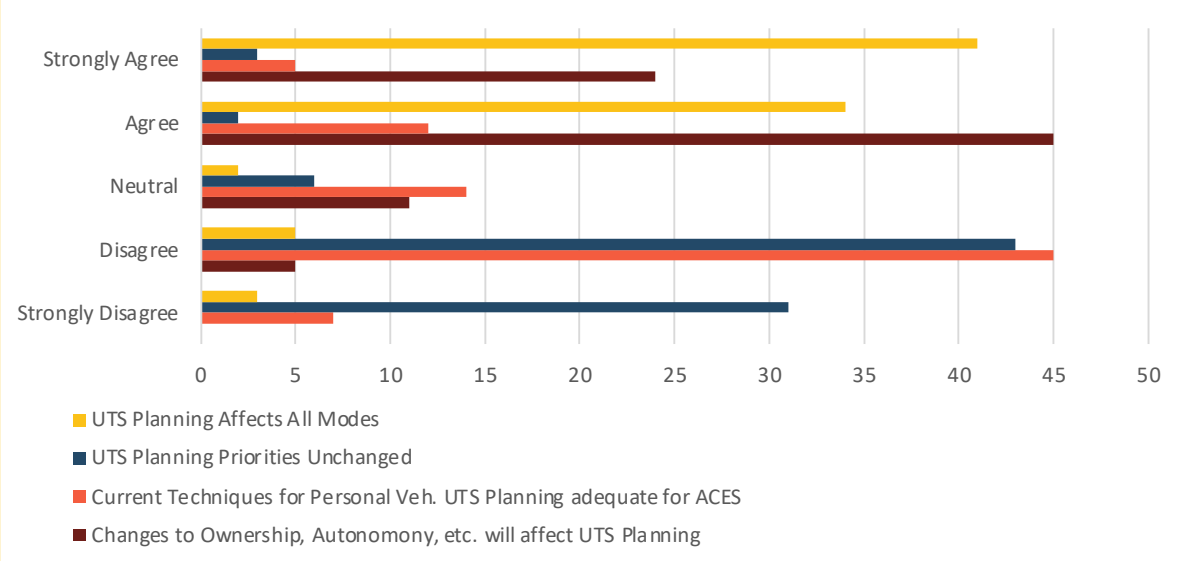

Figure 7: Questions 14 & 15 Results

with statements associated with the transportation planning practice. The results for all respondents are presented in Figure 7.

Over 88 percent of all respondents recognize the value of UTS planning and its impacts to the different transportation modes. However, a similar percentage (87 percent) believe the priorities for transportation planning need to change to incorporate ACES into the UTS. The major challenge identified by this survey is that how the priorities or techniques change are not consistent across the different

professions. Most of the transportation engineers either strongly agree, agree, or are neutral to the statement "Techniques optimizing urban surface transportation planning for PERSONAL vehicles are adequate for AUTONOMOUS/CONNECTED/SHARED vehicles," whereas planners and managers recognize the deficiency of the current techniques.

It is this disconnect between planners, managers, and engineers as it relates to transportation planning techniques and the different priorities of the future network (Figure 4) that verify the shortcomings in our current planning efforts. That is, how we currently plan transportation networks is not sufficient for the integration of ACES. So how should the practice respond and what changes should be made to take advantage of the benefits of ACES? The answer lies in adopting a more holistic approach to UTS planning, focusing less on the individual modes, and more on the effectiveness of the entire UTS in the movement of people and freight.

CONCLUSION

The State of Transportation Planning in 2022 is one that is at a crossroads as it faces the retirement of the current approach to planning and the rise of a new paradigm to support ACES, which has the potential to transform the very notion of accessibility and mobility. The problem, however, is that the current approach is built around these competing concepts - accessibility and mobility, not the operation of the entire system. If the profession is going to take advantage of the benefits of ACES, a change should be made to include both concepts and look holistically at how the transportation network is meeting the desired requirements.

If transportation professionals are going to change and plan for a new, transformative, transportation network, they need to adopt a more holistic approach. We need to collaborate with each other and look fully at the interfaces and interactions between the different transportation modes within the transportation network to create a more integrated, dynamic system. This approach is more iterative, collaborative, and cooperative in that it could promote a more multimodal network fully integrating ACES. As a result, a better transportation network could be created that achieves both accessibility and mobility goals.

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Brian Waterman is a Senior Planner with HDR and has more than 20 years' experience in transportation planning, transit operations, , research, and working with a broad range of internal and external stakeholders and community partners to address transportation issues. His passion is for improving transit efficiency, meeting customer needs, and developing transportation policy. He is currently pursuing his PhD at Florida State University studying potential changes to the transportation network to incorporate emerging mobility options.

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Dr. David C. Gross delivers deep expertise and experience in system architecture, modeling & simulation (M&S), and human computer interfaces creating $1 billion of technical innovation and $3 billion of business opportunities. He has more than fifty technical publications and two patents. He holds a PhD from the University of Central Florida and is a Technical Fellow of the two largest Aerospace Companies in the world (Boeing and Lockheed Martin), and as a NASA Faculty Fellow.

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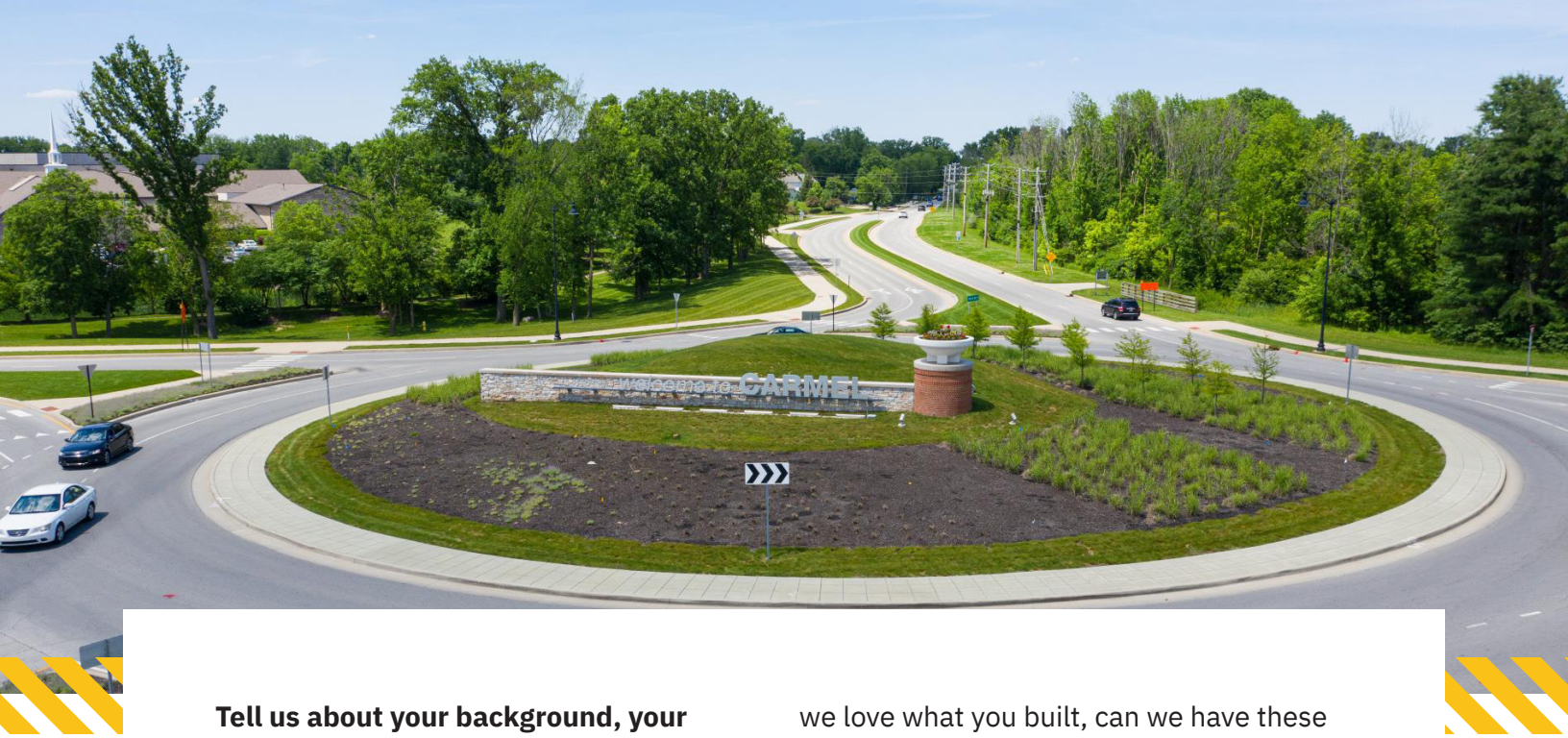
SPECIAL FEATURE

A FIRESIDE CHAT

WITH TIFFANY CHU

Tiffany Chu

Chief of Staff to the City of Boston's
Mayor Michelle Wu



Tell us about your background, your journey, and how you came to your role as SVP at Remix by Via?

I have my roots in design architecture and urban planning, and I studied architecture and planning at MIT and that was probably one of the most important influences on what I do in my day-to-day. I would say my background starts as a child of immigrants: my parents emigrated from Taiwan to Flushing in Queens in New York City in the 80s and then we moved to suburban New Jersey in Somerset County in Bridgewater when I was young.

So both of those experiences shaped me a lot in terms of how I think about the world, what makes for access in terms of people getting around, and the importance of transportation.

Remix, in particular, emerged from a side project when my co-founders and I were fellows at Code for America, a nonprofit based in San Francisco. And it was originally a hackathon project to help residents of San Francisco suggest better transit routes to the City. It snowballed and went viral on the Internet and became this fun prototype that armchair planners and professional planners were starting to design their own fantasy transit systems. That's when we got about 200 emails in our inbox saying, "Hey we love what you built, can we have these 10 features soon, because I'm using it for my real job as a transportation planner in xyz city."

So fast forward about seven years to when we started Remix as an official company. We got funding for it, went through a couple of accelerators, and eventually signed up about 400 cities and agencies around the world. So now, not only do we help cities and agencies plan better transit networks, but we also help design safer streets and help different stakeholders collaborate across the same platform with transportation data.

The theme for the 2022 report is "Intersections + Identities: A Radical Rethinking of Our Transportation Experiences" - what is a current transportation issue that you find is most in need of a "radical rethinking"?

I'll share two of the biggest transportation issues - one at the macro level and one at the micro-level one.

The macro-level is around straight-up funding and the amount of funding that goes to highways versus local transportation needs at the street level. If there is anything that I would want to see radically rethought, it would be the allocation of funding to be less towards

highways and State DOT's and more towards local municipalities.

At a micro level, I think the biggest issue that requires a radical rethinking is around the allocation of space in our right of way. So much of our space is just purely dedicated to the moving and storage of private single-occupancy vehicles, whereas our right-of-way could be made much more efficient if we allocated more for public transit and sustainable active transportation modes.

On the topic of intersections, how do you think the intersection of transit and technology impacted and advanced the state of transportation planning?

I think planning is happening faster today than any time before in history. Because of the pandemic and because of technology, there are much faster iterations and changes happening on our city streets and on our transit network. Transit agencies have had to cut back service by a significant amount due to COVID, there are not enough operators, there is low ridership, and this continues to be kind of a chicken and egg issue. Every month or every quarter there's probably a new set of transit schedules and services being rolled out and different bus lines to accommodate for social distancing and new quick build projects, so I think planning has become more iterative with technology.

Where do you find the biggest gap between how transportation planners view the world and how non-planners perceive mobility and accessibility in their everyday lives?

Taking my planning hat off for a second, I think the most difficult part of the conversation, especially when it comes to public outreach, is for people to understand how their personal behaviors impact others in the community. We see this play out a lot in terms of the conversation around density. I think transportation planners specifically understand at a fundamental level that transportation is a geometry issue. And that is attributed to Jarrett Walker and his work – where the goal of transportation is to move the most amount of people in the least amount of space, most efficiently. The closer that things are together, the easier it is to deliver on that service.

I think the biggest gap is when planners understand that and they know that they cannot provide good quality, high-frequency transit service to places that are extremely sprawling and have very low-density land use. There's a big gap between that understanding and the general public's understanding of density – where they just see density as people crammed together in little amounts of space when it's really about the type of urban form that allows the best quality services to proliferate and be sustainable.

What advice would you give to planning students and early career professionals as they advance their careers and contribute to their communities?

I think it's really important for planning students and early career folks to get on the ground and have a very grassroots understanding of what communities they're serving. What that means is to get involved in your local community, whether it's attending public meetings or joining a local advocacy group. The more in touch you are with the nature of where the profession is heading - and the greater the grasp of the concerns of the community you have - the better equipped you'll be to foster and influence meaningful change.

What, according to you, is the State of Transportation Planning in America today?

The State of Transportation Planning in America is in flux today with lots of highs and lots of lows.

The highs include the passage of a massive infrastructure bill that, if implemented well, could really jumpstart a ton of exciting projects. But if implemented poorly or too slowly, it will cause our profession to maybe even take a step back from where we have been due to COVID.

I think there are a lot of opportunities. There's some really amazing work happening in small- to medium-sized cities. I'll call one out – Carmel, Indiana has been a huge beacon of excitement for folks in terms of all the new roundabouts that the city has implemented (as pictured on page 81). That's a very tactical but extremely impactful design-oriented change that could make a big difference in other cities.

There are many similar examples and anecdotes where different communities across America are making small but meaningful changes, something as small as to allow for restaurants to use parking during COVID for outdoor dining. That is, in my opinion, an example of a small but meaningful change to the trajectory of transportation planning in our country.

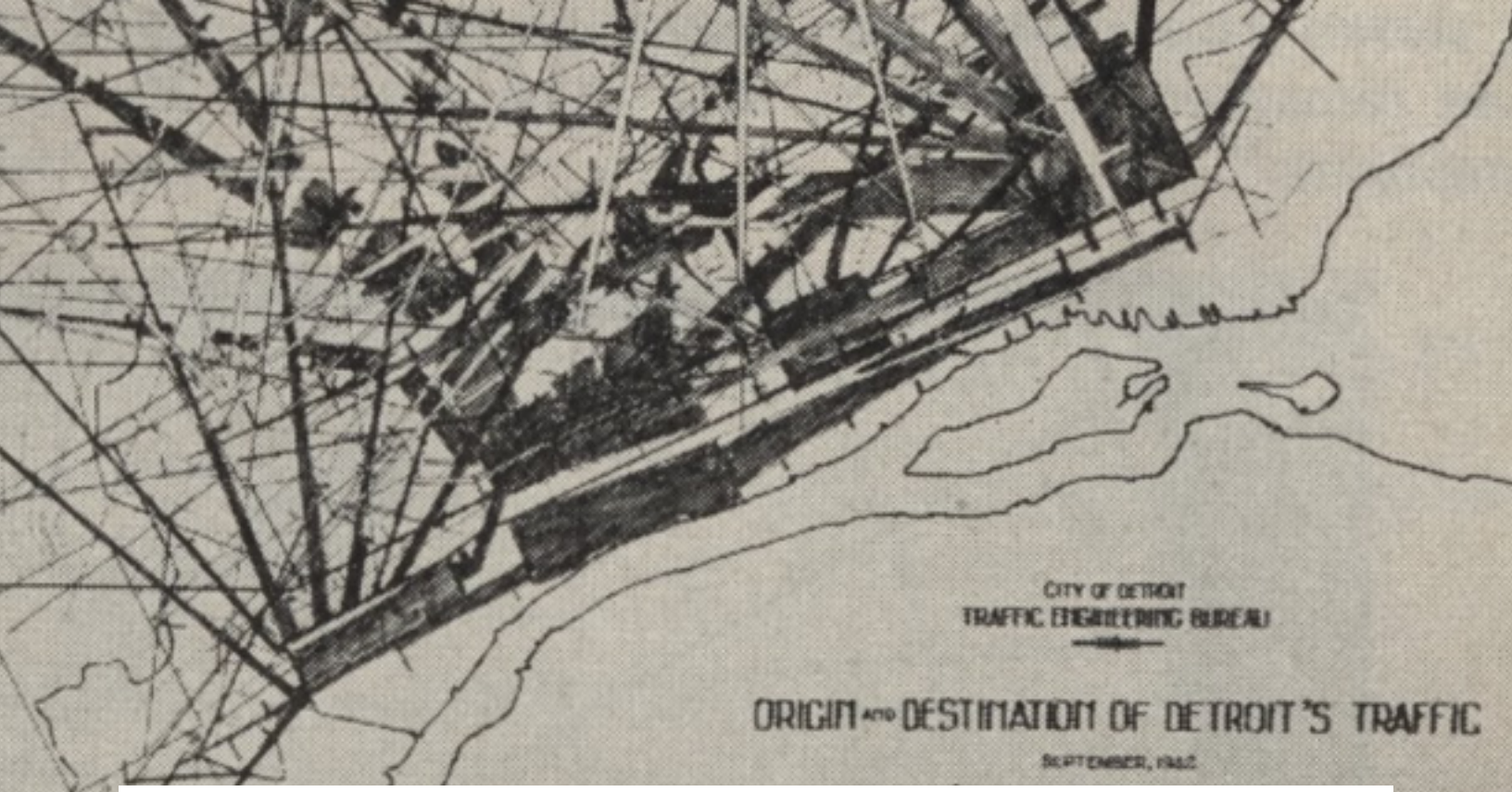
Tiffany Chu

Tiffany Chu is the former CEO & Co-founder of Remix, the leading collaborative software platform for transportation planning for 500+ cities, which was acquired by Via in March 2021. Currently, she serves as the Chief of Staff to the City of Boston's Mayor Michelle Wu.

Note: this interview was conducted while Tiffany was still in her role at Via.

MODELS AND THE QUESTIONS WE ASK

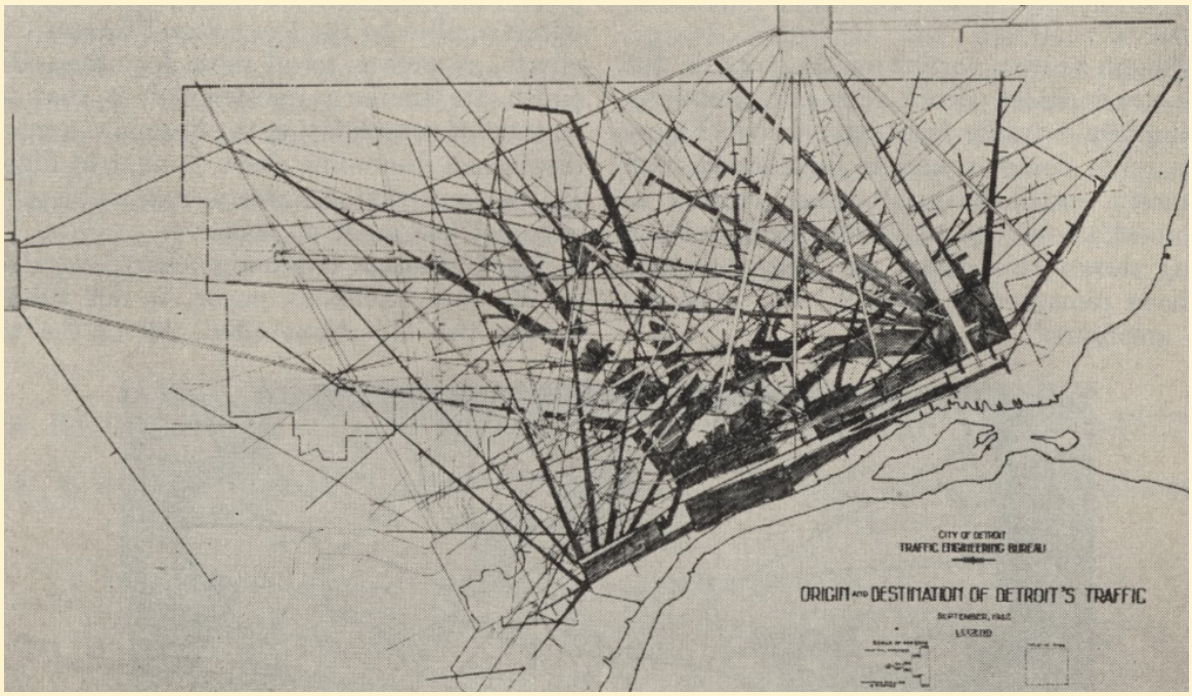
David Wasserman
Cheryl Croshere
Karel Martens



Travel demand modeling has been used as a tool by transportation professionals for defining travel behavior processes and procedures for close to seventy years. With origins tied to the construction of the interstate highway system, our pursuit to understand the connections between human behavior and infrastructure is an under-examined part of transportation planning's history. Many of the underlying assumptions in modeling practice influence transportation legislation, development review procedures, impact fee schedules, parking regulations, and environmental impact statements, to name a few. However, as transportation investments are expected to address new goals such as economic development, environmental justice, improving public health, or mitigating/adapting to climate change, the travel demand modeling practice needs to evolve. Our focus on travel demand as a technical exercise carries implicit assumptions and values that should be scrutinized if we wish to avoid reinforcing the perceived disparities of the past. With new challenges, we need new questions centered around who benefits from investments, the role of transport in increasing access to opportunity, transport costs and location affordability, and how the systems and processes of planning can change to meet more multifaceted goals.

THE ORIGINS OF TRAVEL DEMAND MODELING

Travel demand models were developed to answer the question: where should interstate highways be routed through urban areas? Before travel demand models, there were desire line maps depicting trip origins and destinations. It's perhaps not surprising that the first of these desire line maps were developed by engineers in Detroit, the birthplace of so many of America's automobiles. They were trying to solve the problem of traffic congestion on urban roads by designing new highway routes. In 1942, Detroit traffic engineers surveyed workers in ten industrial areas and the central business district about their trip-making habits to and from work. Using a grid of analysis zones layered onto a map of the city, their desire-line maps connected the workers' origin zones with destination zones, as shown in Figure 1.



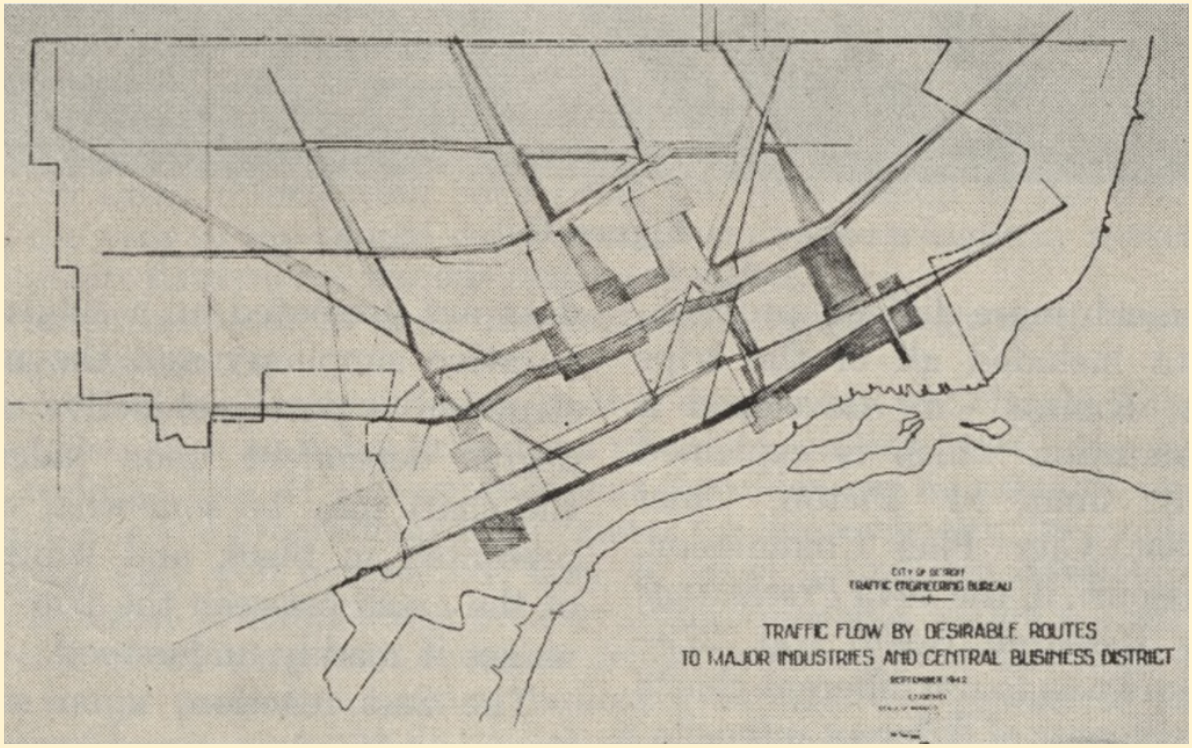


Figure 2: Traffic flow by desirable routes to major industries and central business district
(printed in McLachlan & Lynch, 1950, p.365)

These desire lines did not discern the length of workers' current trips or distinguish how travel behavior may have varied by time of day. They simply connected workers' homes to their workplaces. The engineers' next step was to widen the connecting desire lines according to the magnitude of trips between zones, creating "desirable routes," as shown in Figure 2. These desirable routes became the basis for planning interstate highways through the city (McLachlan & Lynch, 1950).

Soon after, engineers began conducting more comprehensive origin-destination surveys by home interview. This method - adopted in 149 US cities by 1963 - allowed for more nuanced attention to the socioeconomic motivations for travel, including car ownership, shopping and work habits, race, gender, family size, and employment; the how and why trips are made, which became the basis of the four-step model (i.e., trip generation, trip distribution, mode choice, and trip assignment). These surveys and mapping exercises grew into comprehensive urban transportation planning and travel demand modeling, which were synonymous at the time.

The first city to forecast travel in relation to land use generators was San Juan, Puerto Rico in the early 1950s (Weiner, 2009). Many large metropolitan cities followed with their own metropolitan transportation studies. These studies included massive data collection efforts, the use of early computers, and innovation in statistical methods. They were trying to understand travel behavior as a rational problem that could be solved through engineering.

A manual from 1956 entitled "Better Transportation in Your City" introduced politicians and engineers untrained in transportation to the basics of research then being carried out (National Committee, 1956). This included questions such as: Why do people travel? Why do they go to the places they do, and why do they choose the modes of transportation and the routes that they do? How can current travel patterns be simulated and future patterns forecasted? Transportation studies sought not only to understand but predict and plan for urban residents' travel.

The answers derived from these studies were fairly predictable: highways. Later, in the 1960s and 1970s, commuter transit systems - such as the Washington D.C. Metro and Bay Area Regional Transportation (BART) were also developed using travel demand modeling and offered diversification into other motorized travel modes.

The 1962 Federal-Aid Highway Act made funding for highway and transit projects in metropolitan areas contingent on continuing, comprehensive, and coordinated (3C) planning - a way of describing metropolitan transportation studies that came to be known as the four-step method of travel demand forecasting (i.e., trip generation, trip distribution, mode choice, and trip assignment).The Act set a deadline of 1965 for such studies to be complete. And with that, experimentation in travel forecasting methods came to a near halt, as cities scrambled to meet the deadline for funding. As one study for the San Francisco Bay Area Transportation Study Commission concluded, "Time cannot be squandered on experimentation. Thus, all experimental work to be done will be back-stopped by established methodology which has proved to be effective, if not conceptually ideal" (1964).

Since then, the four-step model has been used widely in the US and elsewhere. The main purpose of these models has roughly stayed the same over the past fifty years: forecasting future travel patterns and predicting the impact of proposed

interventions. The models have improved over time, but the changes in their use are more significant. Where originally used to assess the impacts of road projects, travel demand models are now also used to forecast possible impacts of more modest infrastructure investments like BRT corridors or new subway stations, as well as 'soft' measures like zero-emission zones and congestion pricing.

Despite their use for a broader set of policy questions, the fundamentals of travel demand models have not changed. Hence, their assumptions of travel demand models and the role they play in decision-making is still being criticized on numerous grounds. We discuss some of these critiques and subsequently show how the models can be used as a powerful tool to answer an even broader set of questions.

CRITIQUE #1: MODELS REFLECT CONSTRAINTS AS MUCH AS PREFERENCES

The origins of travel demand models are important in context to their contemporary critiques. Transportation demand models have been criticized on numerous grounds. This includes that the forecasts they produce overestimate use and underestimate costs, for example, and are susceptible to manipulation for preconceived political ends (Wachs, 1987, 1990; Flyvberg, 2007; Flyvberg & Molley, 2011; Gordon, 2020). Perhaps one of the most convincing critiques relates to the implicit assumption underlying travel models. This is that travel patterns are a result of choice and, thus, reflect preferences (Sheppard, 1995). When this assumption is accepted, observed travel patterns can be used to forecast future preferred travel patterns using transport models and, subsequently, to identify improvements in the transport system to serve those desired trips.

This typical approach is problematic, once it is understood that travel patterns are as much a result of constraint as of preference (Anciaes et al, 2016). This clearly holds for poorer households and people without access to a private motorized vehicle. The former group is likely to restrict their overall travel as well as their use of specific modes to limit the financial burden on the household. This is reflected in the 2017 U.S. National Household Travel Survey (NHTS) data when we look at low-income households. For example, even though households making less than $25,000 make up 23% of the sampled population, they travel 13% of the nation's vehicle miles traveled (VMT) (USDOT, 2017).

It is important to realize that the above is a critique of the assumptions underlying the way in which models are used. They do not disvalue the models themselves. Once it is realized that the outputs generated by travel models may reflect constraints as much as preferences, it becomes possible to use these models to answer entirely different questions than those traditionally asked within the context of transportation planning, as we will show below.

CRITIQUE #2: LEGACY OF COMMUNITY SEVERANCE

Connected to the under-examination of constraints is the role of new infrastructure in forming different types of barriers to active modes of travel across communities (Anciaes et al, 2016). The potential barrier effects of new and expanded facilities have inspired entire methodologies to understand the level of comfort of cyclists and pedestrians at the segment and intersection level, some of which are routinely used in practice today (Levinson et al, 2020). However, beyond how transportation professionals conceive these barrier effects on active modes, other disciplines have noted a wider range

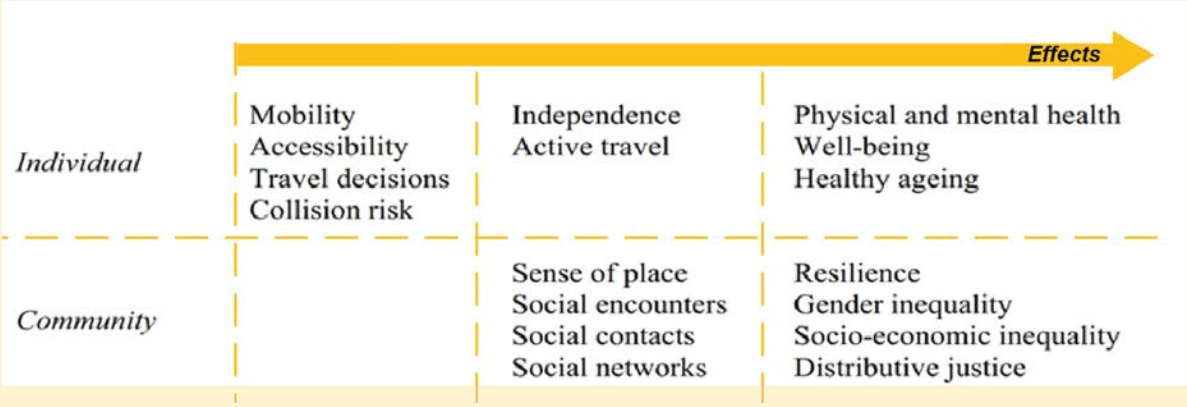


Figure 3: What are the effects of community severance? (Anciaes et al, 2016)

of impacts on sense of place, resilience, social cohesion, and physical and mental health (Anciaes et al, 2016). They start with potential changes in people's options and choices, and cascade into wider implications for individual and community well-being as illustrated in Figure 3. These impacts on communities are rarely reported alongside the volumes, segment level delays, origin-destination matrices, or other statistics that accompany a travel demand model's output (TRB, 2021).

The network suitability methodologies such as bicycle and pedestrian level of traffic stress have been increasingly acknowledged by Departments of Transportation as ways to understand barrier effects as they relate to active transportation (ODOT, 2020). These methods provide a familiar starting place for transportation professionals to expand their traditional focus on (motorized) travel demand to a more cross-disciplinary lens required to address tradeoffs associated with community severance (Anciaes et al, 2016).

CRITIQUE #3: WHO BENEFITS FROM ADDRESSING CONGESTION?

Additionally, much of modeling's intellectual framing is oriented around when and how the choice to travel influences congestion (Beimborn, 2006; Castiglione et al, 2015). With so much focus given to peak travel demand in models, understanding who that timeframe benefits is important to understanding the equity implications of modeling practice. Research examining the equity implications of congestion pricing provides an indication that it tends to benefit those with more resources rather than less. For example, as shown in Figure 4, when looking at commuting patterns in Portland, Oregon the rates of driving during the peak period for commuters earning 400% of the poverty line were nearly twice that of those who earned below 200% of the poverty line (FHWA, 2009). Similar findings are reported in surveys on regarding low-income users' preferences for taxes versus tolls in King County, WA where low-income users vastly preferred tolls to higher income users (FHWA, 2009).

CRITIQUE #4: SHIFTING GOALS & UNCHANGING LENS

Transportation investments are increasingly expected to address a diversity of community goals, such as improved accessibility, economic development, equity and environmental justice, supporting recreation and healthy habits,

Commuting Pattern by Income Group in Portland, OR, area			
	Less Than Poverty Guideline	100%-200% of Poverty Guideline	More Than 400% of Poverty Guideline
Not Employed	58.70%	43.20%	16.70%
SOV-Peak	17.10%	14.60%	35.40%
SOV-Off-Peak	4.30%	13.40%	19.20%
Carpool-Peak	5.70%	7.20%	9.80%
Carpool-Off-Peak	5.70%	2.30%	2.20%
All Other Modes	8.50%	19.20%	16.60%
Total	100.00%	100.00%	100.00%
Number of Cases	109	229	575.00%
Missing Cases*	(21)	(21)	(63)

*Missing data concerning mode of travel were allocated proportionately across five commuter categories.
SOV = single-occupancy vehicle

Figure 4: This table presents commuting patterns by income group in the Portland, OR, area. It illustrates the degree to which different income groups commute during peak periods. (FHWA, 2009).

mitigating climate change, and investing in resilient transportation systems (Brookings, 2020; NAS, 2021; Levinson et al, 2020; Martens and Golub, 2021). Our traditional focus in transportation planning often frames added capacity either around accommodating new growth, enabling high traffic speeds, or mitigating congestion (Beimborn, 2006, TRB, 2021). While models can be used to inform other goals, their typical application on a micro or macro scale is focused on a narrow set of goals (Brookings, 2020). This was publicly excoriated in an article titled "The Broken Algorithm That Poisoned American Transportation" (Gordon, 2020). While much of the article discusses how models have traditionally been applied, some of its critiques target the underlying analytical frames models have inherited. The questions surrounding models and the values they embody has as much to do with their construction as with their application. If models are perceived solely to be "sales tools" for highways, it is a direct challenge to their legitimacy, and we will be left with only politics rather than insight (Gordon, 2020; NAS, 2020).

ILLUSTRATING NEW QUESTIONS

Once we think about the goal of transportation policy as not merely serving expected peak demand, but as a way to shape that very demand, it becomes possible to use transportation models to answer entirely new questions. This could potentially include the following.

New Question #1: Which potential projects improve access to opportunities?

The intent of this question is examining how the transportation system connects people

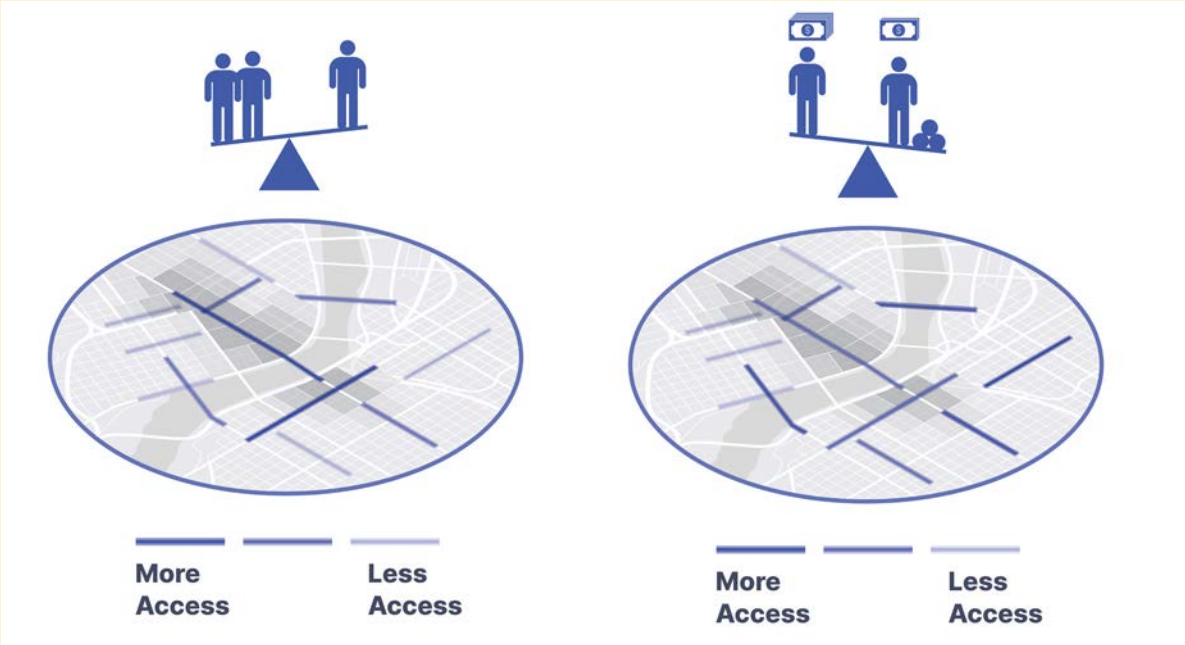


Figure 5: Examining the accessibility gain of projects provides us the opportunity to use weighted averages and other descriptive statistics to understand who benefits from enhanced connectivity. The projects that might rise to the top may differ depending on who we are trying to serve, with this illustration contrasting how the benefit of a project might accrue to the general population vs. to low-income populations. Conceptual illustration by Elizabeth Bisegna.

to opportunity. Accessibility is increasingly being considered as an emerging metric of success in transportation planning because of its integrated consideration of land use and transportation as connected systems. For example, access to opportunities can be improved not only through improving mobility by adding highway lanes or bus lines, but through changes in land use as well, creating destinations that are closer than they were previously. The value of access is often reflected in the premiums individuals may pay for land, the affordability of their transportation options, and their quality of life (Levinson et al, 2020). Additionally, as a metric measuring the benefit of transportation facilities, it can also help us understand who benefits from improvements through the stratification of different demographic groups relative to accessibility gains associated with a project (Levinson et al., 2020; Martens et al. 2021).

This ability to understand the relative benefit of improvements is incredibly important to understanding the equity implications of planning decisions (Levinson et al., 2020). To that end, states and MPOs are increasingly using accessibility measures to evaluate and prioritize projects. One such example is the Salt Lake City MPO the Wasatch Front Regional Council (WFRC), and their work leveraging travel demand modeling to map automobile and transit accessibility through their Access to Opportunity database (WFRC, 2017). This use of the travel demand model to examine changes to access through time sets is an example of how we can leverage models to move us closer to metrics that promote equity of opportunity as well as livability and can help frame conversations surrounding transportation justice.

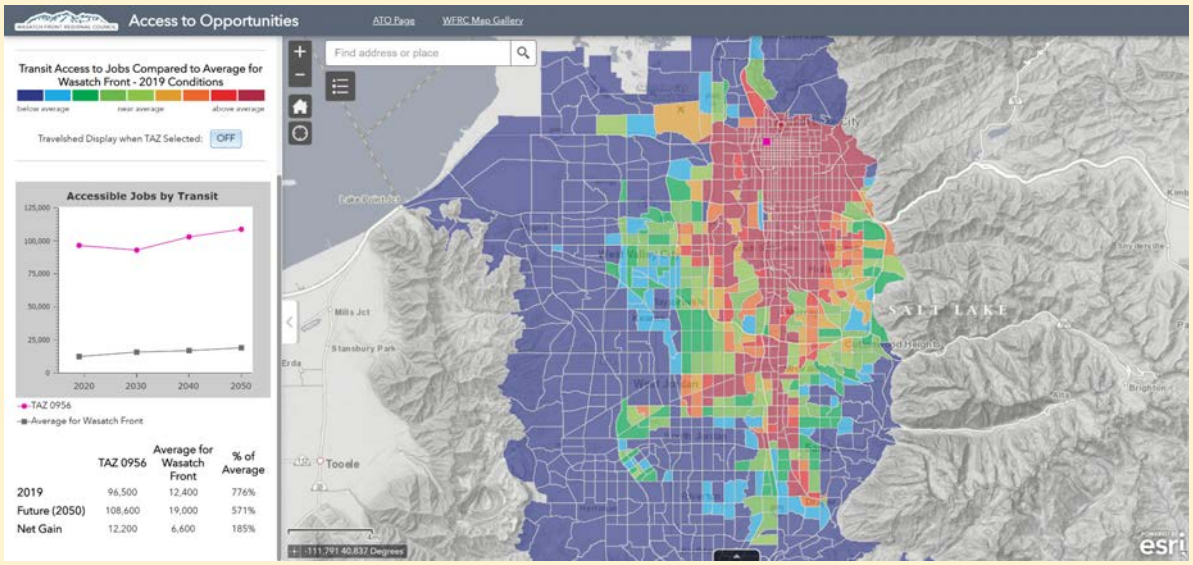


Figure 6: WFRC maintains a web-based dashboard that enables the public to understand the current degrees of access to jobs via driving or using public transit, but also how that access may change in the future given expected changes in land use and transportation infrastructure.

New Question #2: What do the travel patterns of low-income groups tell us about their mobility needs?

The focus on addressing congestion is also heavily focused on the needs of commuters, but with the advent of Activity Based Models (ABMs) there are more opportunities to broaden the application of models to mobility needs beyond the commute trip (Castiglione et al, 2015). One of the most promising aspects of their advancement is the ability to understand the activity patterns of different demographic groups across multiple trip purposes. This ability to stratify trips by income, for example, enables planners to explore the potential travel needs of disadvantaged communities more deeply (Castiglione et al, 2015). This can often mean expanding beyond understanding what important destinations are in these communities but using models to understand the (lack) of transportation options and characteristics of those options such as their affordability and reliability (Castiglione et al, 2015).

This type of analysis is often complex to manage in practice, but new software platforms are enabling the accessible inspection of ABM outputs. These models increasingly rely on big data obtained from mobile location tracking, which provide more detail on trip patterns than traditional travel behavior surveys (even if short trips, such as those made by foot, bicycle or other forms of micro-mobility, may be more difficult to capture). In combination with Census demographic data and land use data, such new models can provide a rich understanding of activity patterns, both at the aggregate level and for specific population groups.

One example of such a software is Replica, which can represent travel patterns of different income groups so that the geography of disadvantage can be better understood (Figures 7 and 8). Where trip patterns of low-income groups

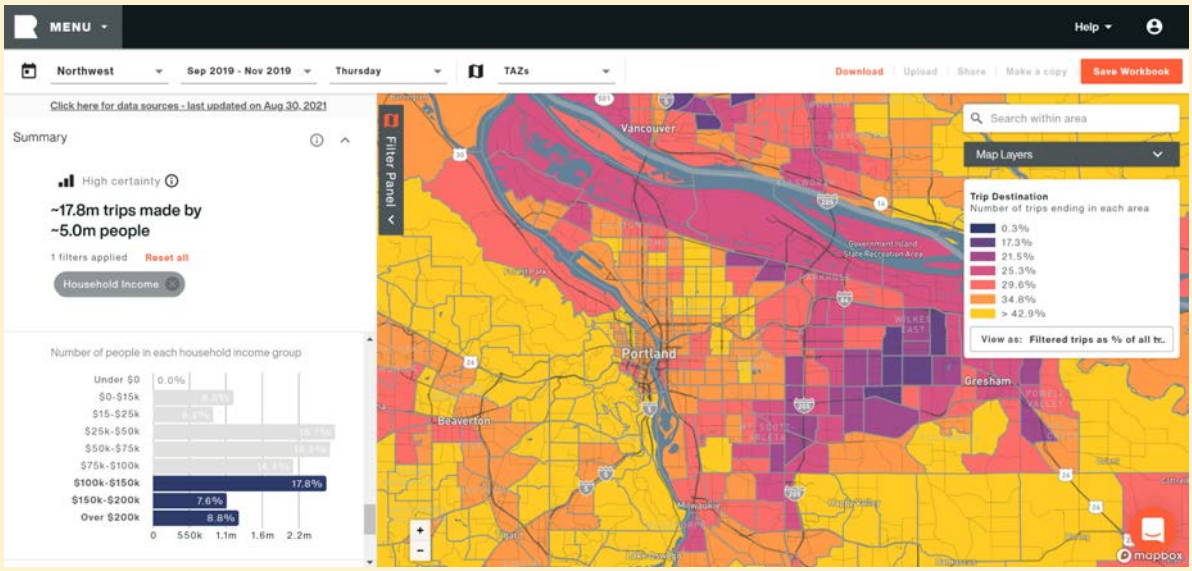


Figure 7: Snapshot from Replica's Place's platform, which provides insights from a nationwide activity-based model with a few clicks. This map from the Replica Platform shows the distribution of trip destinations of people with a household income of over $100,000 in Portland, Oregon.

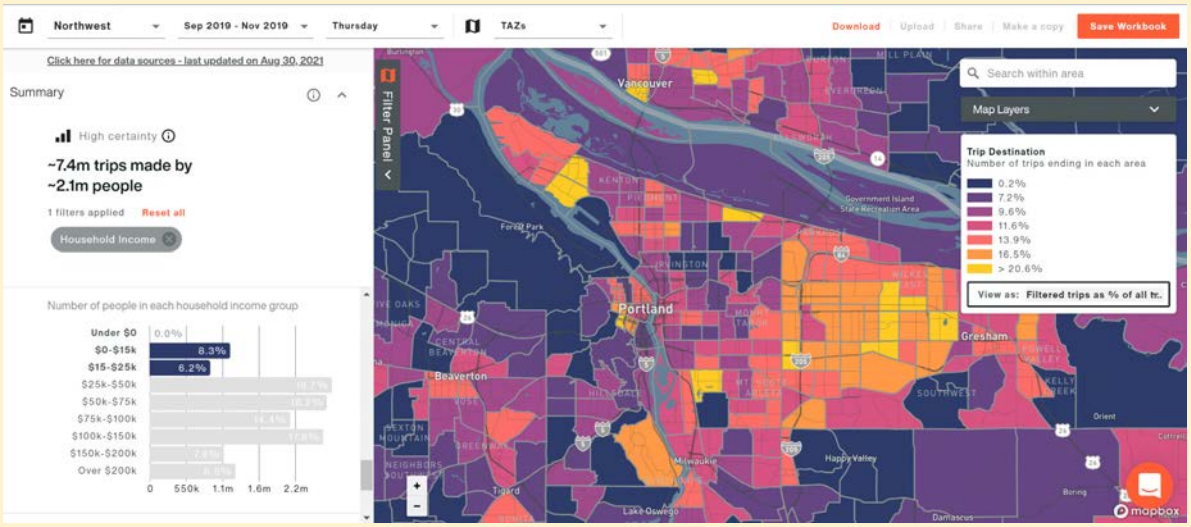


Figure 8: This map from the Replica Platform shows the distribution of trip destinations of people with an annual household income of under $25,000 in Portland, Oregon. Note the large differences in spatial distribution of trips in comparison to the high-income groups.

typically remain invisible in the aggregate outputs of travel demand models due to their modest share in overall trips, ABM models can make these distinctly different patterns visible because of their abilities to disaggregate for distinct groups.

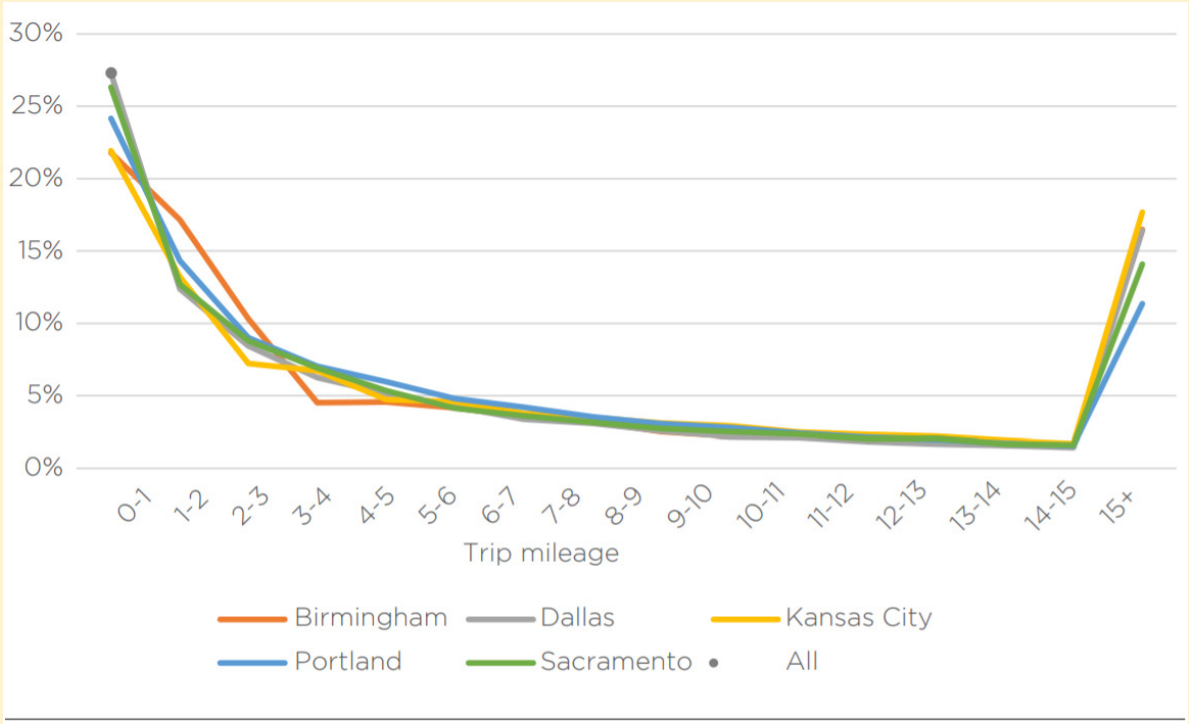
New Question #3: Can we reframe results to inform where potential for mode shift exists?

Beyond leveraging models to understand the trip patterns and demand of different demographic groups, models can help identify short trips that have the

potential to be shifted to other modes of transportation. Mixed-use, compact, and human-scale neighborhood designs lead to shorter distance trips (Guthrie et al, 2015; Brookings, 2020). This can include neighborhoods closer to the historic urban core that are designed with shorter blocks and more intersections per acre, which tend to produce more trips under 3 miles (Brookings, 2020).

A Brookings Institute study looked at the trip lengths across several metropolitan regions. They found that over 50% of all trips in Chicago, Dallas, Portland, and Sacramento fall under 4 miles; in Kansas City, 49% of trips fall below that threshold. Millions of trips don't even stretch a mile, ranging from 22% of trips in Kansas City to 30% in Chicago (Figure 9).

These insights can also be made geographically specific to understand which locations and links can benefit from better active travel connections. One application example is provided when Alta Planning + Design (Alta) assisted the Orange County Transportation Authority (OCTA) with developing a long-range, comprehensive multimodal approach to address South Orange County's wider mobility needs and how strategic investments in mobility hubs and network improvements can help meet them. The outputs of the OCTA Model were analyzed using an interactive origin-destination visualization tool, providing insight into short, total, and non-motorized trips in the region. These trip estimates were then used to inform where active travel investments could increase active trips. This possible modal shift was then fed



Source: Brookings analysis of Replica data

Figure 9: Brooking's analysis illustrating the share of all trips by trip mileage, for five metropolitan areas. It illustrates that short trips make up a significant proportion of total travel. Travel demand models can help examine the intersection of transportation and land use that can make these insights valuable for planning (Brookings, 2020).

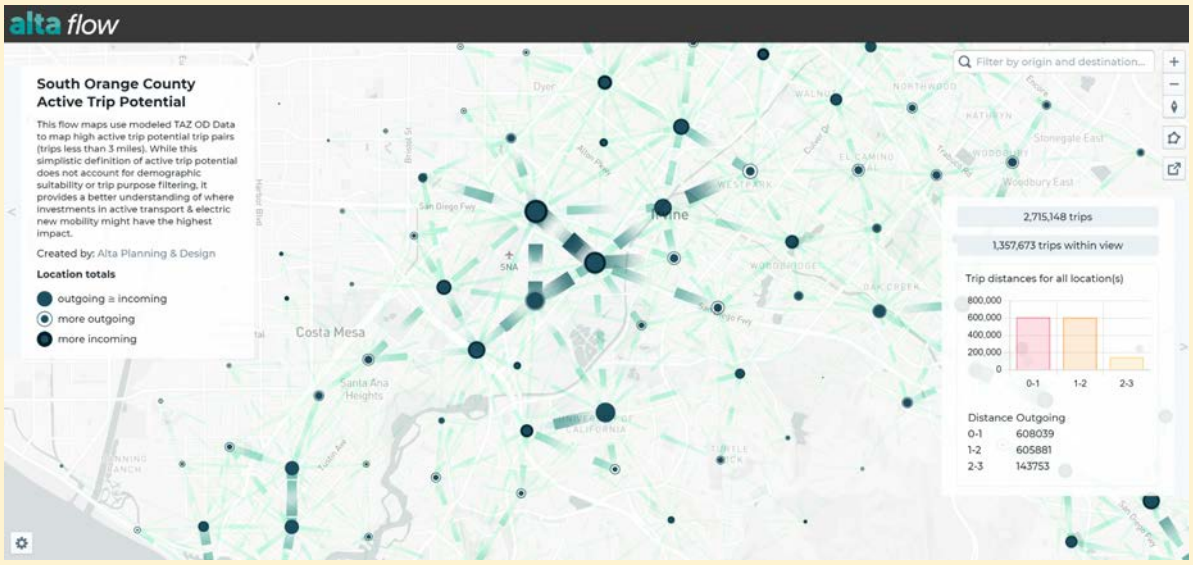


Figure 10: Alta Planning + Design has developed custom interactive visualizations of trips less than 3 miles in South Orange County and other jurisdictions to serve as a tool for understanding where active trip potential (i.e., bicycle and pedestrian activities) indicates potential desire lines for new supportive infrastructure.

back into the model to understand larger potential changes in VMT and other key metrics of interest to OCTA.

Since this analysis, Alta has been using data similar to the Brookings analysis to estimate bicycle and pedestrian trips and understand the gap between potential trips of this nature and existing mode share. This example shows how models, if used in novel ways, can help facilitate more multimodal planning.

New Question #4: Can being more open about models and their results help us reach across the table to other disciplines to find new tools and questions?

Like any other profession, transportation professionals by the nature of their training or experience often engage with challenges and issues with a lens that frames the problems in certain ways. This framing can create blind spots and reinforce a sense of rigidity to our approaches and guide our understanding of the solutions, designs, or plans for civic problems we wish to address. One way to address this is to enable other disciplines to create actionable insights if we can make their methods and results more accessible. MPOs vary in the degree to which they are transparent with the results from modeling activities. The sharing of model data is noteworthy enough, that a federal study looking at the historical forecast accuracy noted that "[a]cknowledging the uncertainty inherent in forecasting and reporting a range is a way for the forecasting agency to protect its own credibility. The agencies that shared data for this study are a model of transparency and should be celebrated for their efforts to learn from past forecasts and engage in a process of continued improvement (NAS, 2020)."

While more MPOs, such as the Puget Sound Regional Council (PSRC) and San Diego Regional Planning Agency (SANDAG), are starting to use open-source architectures

such as ActivitySim for the basis of their models, the San Francisco Bay Area Metropolitan Transportation Commission (MTC) goes one step further by hosting the results from different model runs in the open. These results are available for anyone to download to use as part of research or projects in the region.

While the model data can be complicated to understand or analyze, it is an important step to being more transparent and enabling other disciplines to bring their own insights to model outputs. For example, when transportation professionals think about active mode splits, we typically are looking to understand the proportion of trips met by active modes, but an epidemiologist might be more interested in the question of whether modeled active travel matches daily recommended physical activity (Anciaes et al, 2016). This simple reframing enables a model to inform questions related to public health that might not have occurred if the fear of how model results were interpreted in public forums continues to compel us to silo them.

CONCLUSIONS

The regionalist and moralist Lewis Mumford was incredibly concerned about the role of human values in how society applied new technologies. He heavily critiqued the values and methods (political and technical) used to justify megaprojects of the 20th century, often pursued at the expense of vulnerable communities' quality of life (Mumford, 1970; Critchley, 2012). Now that the goals of transportation policy are both broadening and shifting, it is time to reconsider how we can apply our models to support these developments. This is particularly challenging in this era as defined by social, technological, and climatic change.

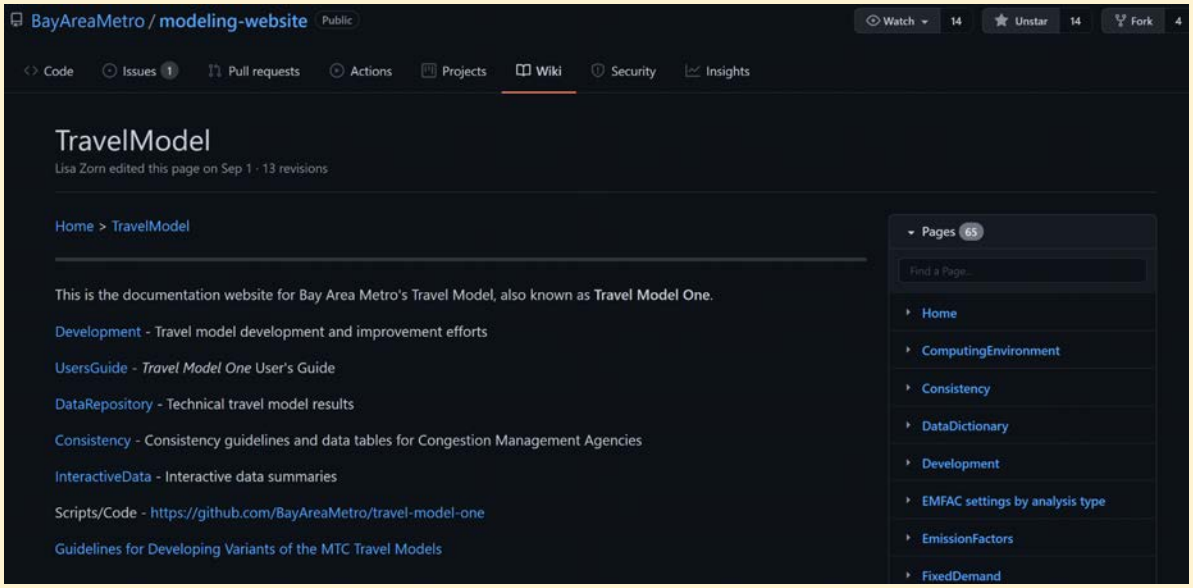


Figure 11: The San Francisco Bay Area MTC has open-sourced both their model and key model results for use by planners, researchers, and the public at large. Opening up models and their results enables other disciplines to leverage models for new questions.

The examples of how we can reframe models around new questions are intended to identify how we can meet those challenges. Asking new questions requires transportation planners and engineers to critically examine the analytical frames they bring to problems. This means looking for more opportunities to engage with cross-disciplinary research and thinking about what other disciplines can tell us about our framing of questions (Guthrie et al, 2015; Beimborn, 2006). Being more transparent and open about the methods and outputs of travel demand models can be part of that process.

The investments we make in transportation are intergenerational vehicles of change, and the lens we bring to how we model our common futures needs to change.

About the Authors

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David Wasserman is the Data Science Practice Leader at Alta Planning & Design. His work lies at the intersection of urban informatics, 3-D visualization, geospatial analytics, and visual storytelling. His current areas of focus are enabling data-informed scenario planning, incorporating civic data science into planning projects with web-delivery and computer vision derived datasets, and generating accessibility metrics that can identify the possible benefits of projects and who they go to.

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Cover image: Detail of Figure 1.

TRANSPORTATION ENERGY BEYOND FOSSIL FUELS

Improving Vehicle Efficiency

Kimberly Burton

TRANSPORTATION ENERGY INTRODUCTION

Energy Consumption Patterns

In 2020, 26 percent of the total U.S. energy consumption came from the transportation sector – transporting people and goods, as shown in Figure 1. This percentage has remained similar over the past decade; in 2011, 28 percent of the total U.S. energy consumption came from the transportation sector.

Petroleum continues to be the main source of energy for transportation (Figure 2). In 2020, petroleum fueled about 90 percent of the transportation sector's energy needs. Most of the remaining percentages came from biofuels, natural gas, and electricity, which have steadily increased over the years until recently. It is important to note that this most recent data does come from a time when travel patterns were different due to COVID-19. With a decrease in traffic, there was a corresponding decrease in transportation energy consumption, but immediately

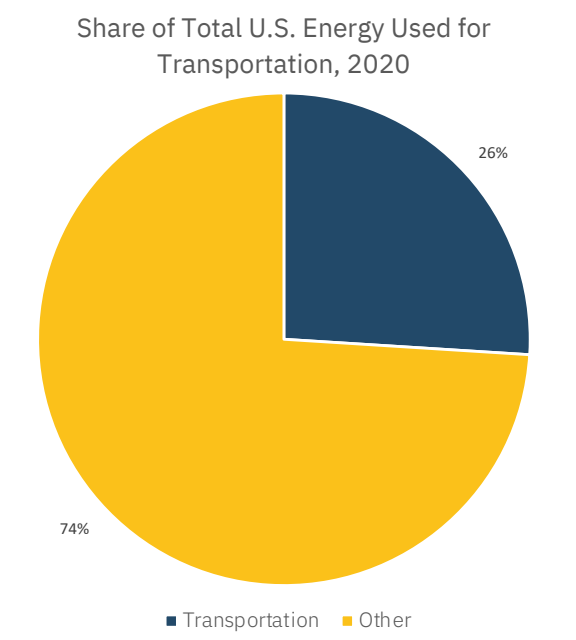


Figure 1: Share of Total U.S. Energy Used for Transportation in 2020, Source: U.S. EIA, https://www.eia.gov/energyexplained/use-of-energy/transportation.php

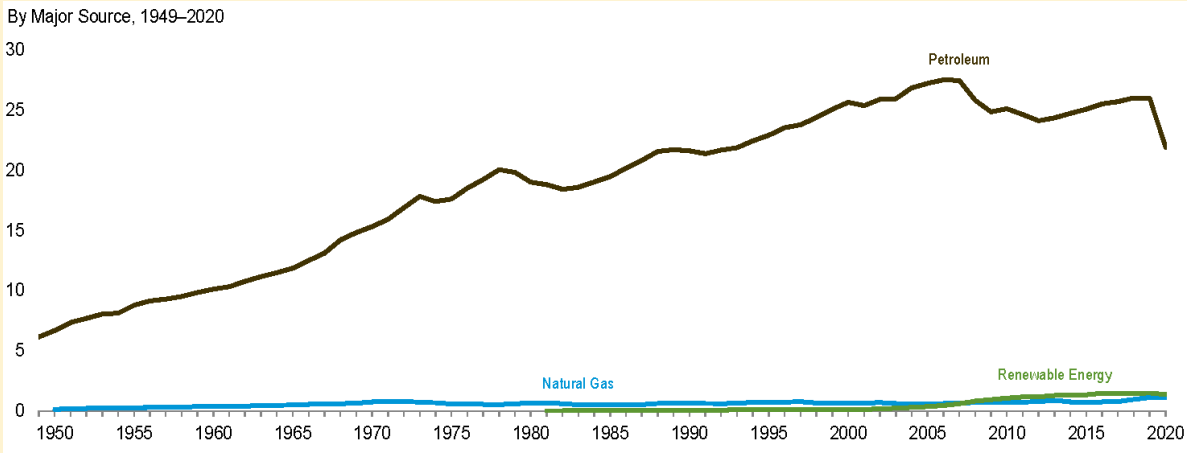


Figure 2: U.S. Transportation Energy Sources in 1949-2020, Source: U.S. EIA, Monthly Energy Review, November 2021, https://www.eia.gov/totalenergy/data/monthly/#consumption

prior to COVID-19, transportation energy use had been increasing since the sharp drop during the 2008/2009 recession.

Energy Consumption Projections

Although transportation energy use took a sharp dip in 2019/2020 due to COVID-19, the U.S. Energy Information Administration projects transportation energy use will rebound and continue increasing through 2050 (Figures 3a and 3b). In addition, the trends show that although alternative fuels use is increasing, petroleum-based fuels will remain the dominant source of energy for the transportation sector with a similar proportion of the usage as compared to other fuels through 2050 (Annual energy outlook 2021, 2021).

TRANSPORTATION ENERGY ISSUES

The three main issues with our current energy consumption patterns center around:

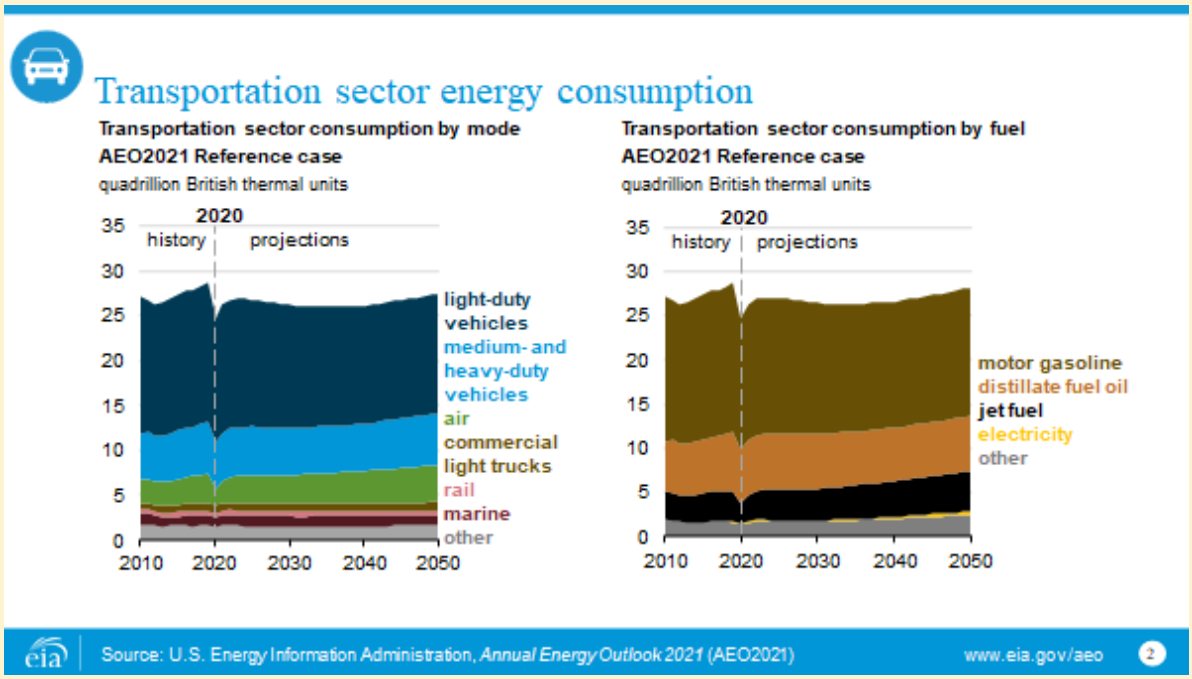
1. Environmental Damage - climate change, air pollution & extraction
2. Nonrenewable Supplies – supply limitations & price fluctuations
3. Nondomestic Supplies – security & dependability concerns

Environmental Damage

Transportation energy relies almost solely on petroleum-based energy sources. These energy sources release greenhouse gasses, air toxins, and particulate matter into the air when used. Greenhouse gasses contribute to climate change, and air toxins and particulate matter cause health problems. In addition, extraction of petroleum products can cause irreparable damage to the environment through disturbance during extraction and leakage during extraction and transport.

Nonrenewable Supplies

Petroleum is a nonrenewable energy source, which means there is a limited amount available to extract. Projections show that the world has enough petroleum supply to meet demand through 2050, but after that, there is substantial uncertainty about the remaining supply and demand (Frequently asked questions: Does the world have enough oil to meet our future needs?, 2021). As the supply dwindles, prices will fluctuate. As a result, the transportation sector will have to find other sources to rely on soon.



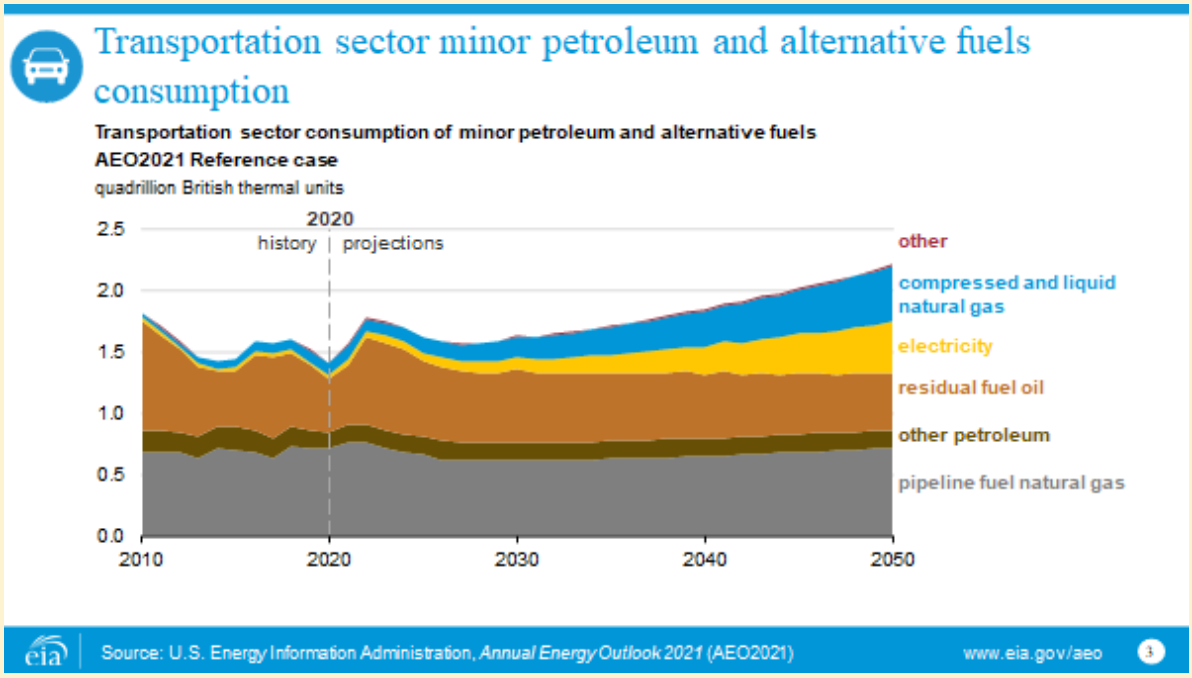


Figure 3a/b: Transportation Sector Energy Consumption, 2010-2050, Source: U.S. EIA 2021 Transportation Energy Outlook Report, https://www.eia.gov/outlooks/aeo/pdf/05%20AEO2021%20Transportation.pdf

Nondomestic Supplies

Although the U.S. does produce petroleum, most of the world's remaining petroleum supply is not located in the U.S., so the U.S. is dependent on foreign sources of energy outside its control. This situation creates security and dependability concerns, and can also result in price fluctuations.

TRANSPORTATION ENERGY SOLUTIONS

There are three key solutions to help us address the problems associated with transportation energy use:

- Improve vehicle energy efficiency
- Use low-carbon fuels
- Reduce vehicle miles traveled

Vehicle energy efficiency is the use of technology to reduce the amount of energy needed to perform the same functions as before (Use of energy explained: energy efficiency and conservation, 2020). Low-carbon fuels are types of fuels with lower carbon content as compared to conventional petroleum fuels. Vehicle miles traveled is the total amount of miles that vehicles have traveled within a specific area over a defined time period, typically annually.

In this edition of the SoTP, we will focus on how to **improve vehicle energy efficiency**. To learn more about using low-carbon fuels, please see the "Transportation Energy Beyond Fossil Fuels" article in the 2018 SoTP, and to learn more about reducing vehicle miles traveled, please see the article in the 2020 SoTP.

VEHICLE EFFICIENCY BENEFITS

Increasing vehicle efficiency results in a variety of benefits.

- GHG emissions – there will be a decrease in the amount of fossil fuels that are burned for transportation energy, thus reducing those emissions that contribute to climate change and air pollution.
- Energy security – there will be less reliance on foreign sources of nonrenewable energy.
- Fuel costs – people will need less gasoline so they will be able to spend less money refilling their vehicles.
- Air quality – there will be fewer air toxins and particulate matter in the air due to decreased emissions.
- Public health – the improved air quality will also result in public health benefits related to having cleaning air.
- Natural environment – there will be less disruption and pollution due to decreased fossil fuel extraction needs.

For example, as can been seen in Figure 4, vehicle efficiency has a direct and immediate effect on CO2 emissions. For the years that fuel economy increased, CO2 emissions decreased, and for the years that vehicle efficiency decreased, CO2 emissions increased.

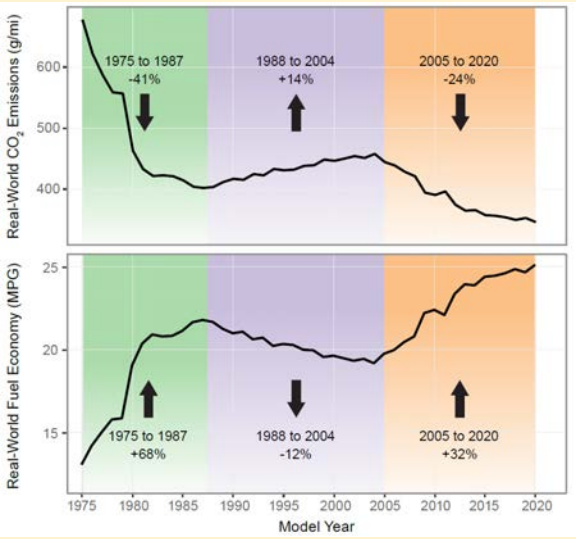


Figure 4: Trends in Fuel Economy and CO2 Emissions Since Model Year 1975, Source: U.S. EPA 2021 Automotive Trends Report, November 2021, Figure 2:2, p. 6, https://www.epa.gov/system/files/documents/2021-11/420r21023.pdf

VEHICLE EFFICIENCY CHALLENGES

In spite of the many benefits, there are still some challenges to improving vehicle efficiency that need to be acknowledged and addressed. Some challenges are broad, while others are more specific, including:

- **Alternative fuel vehicle (AFV) cost** – AFVs are typically more expensive than conventional vehicles (Alternative Fuels Data Center: Electric Vehicle Benefits and Considerations, n.d.). On the low end, a hybrid version of a conventional vehicle may only cost $2,000 to $5,000 more, but on the high end, there are also alternative fuel vehicles that can cost over $100,000.
- **Information/education** – people need to know more about vehicle efficiency - AFV options, AFV benefits and challenges, fueling station locations, behavior changes, and vehicle maintenance needs. In addition, people need to know more about translating the upfront cost of a fuel-efficient vehicle into long-term savings on gasoline.
- **Policy implementation** – changing federal and state political priorities affect standards. Vehicle efficiency standards can be a political issue. The federal vehicle efficiency standards have been increasing over time, but when federal administrations change, the standards may be strengthened or weakened.
- **Public Perception of Safety** – lighter cars can be perceived as less safe.
- **EV charging time** – EVs vehicles can take many hours to fully charge the battery.
- **BEV range** – BEVs do not have the same range as conventional vehicles.
- **Rebound effect** – people may drive more if their vehicles are more fuel efficient. Research studies have shown that driving can increase by about 19 percent (Stapleton, Sorrell, & Schwanen, 2016; Su, 2015; Su, 2012).

VEHICLE EFFICIENCY METHODS

To improve vehicle efficiency, the amount of energy consumed by a vehicle during its operation must be reduced. Ways to improve vehicle efficiency include:

- Behavior change
- Vehicle maintenance
- Vehicle design

Behavior change

According to the U.S. Department of Energy, there are several strategies that can help drivers reduce the amount of gas they use through modified behaviors (Gas mileage tip, n.d.). Reduced speeding and less rapid acceleration are simple actions that can lower gas mileage by 15 to 30 percent on highways and 10 to 40 percent on local roads. Driver feedback devices that record and display fuel consumption can also help improve fuel economy by about three percent. In addition, it helps to avoid hauling cargo on a vehicle's roof and heavy items inside the vehicle; avoid excess idling and AC use; and use the cruise control (Driving more efficiently, n.d.).

Another strategy is to combine trips. Combining errands into one trip saves time and fuel. In addition, for commuting, try to avoid rush hour, drive your most fuel-efficient vehicles, and consider telecommuting, carpooling, and taking transit on some days (Planning and combining trips, n.d.). The last tip is to choose a fuel-efficient vehicle to drive. This choice is the most important thing you can do to improve fuel efficiency, and types of

Figure 5: Aerodynamic Design Example - Shanghai Transit, Source: Tim Adams 2014, Shanghai Maglev, https://flic.kr/p/m5CzY9

Figure 6: Lightweighting Example - BMW Carbon Fiber Honeycomb Structure, Source: s.yuki 2013, 2013 IAA BMW i3 Honeycomb structure, https://flic.kr/p/g3R9eS

fuel-efficient vehicles are discussed in the next section (Choosing a more efficient vehicle, n.d.).

Vehicle Maintenance

Another way to improve vehicle efficiency is to keep vehicles properly maintained. Keep engines tuned up, make sure tires are properly inflated, use the recommended grade of motor oil for vehicles, and replace clogged air filters. These routine maintenance items together can improve vehicle efficiency by five to nine percent (Keeping your vehicle in shape, n.d.).

Vehicle Design

There are several ways that vehicles can be designed to be more efficient. The first group includes designing vehicles to reduce "parasitic losses." That means reducing friction and recovering waste heat for use in vehicles. Reducing friction and other energy losses can include a variety of areas in a vehicle: aerodynamics (see Figure 5); friction and wear on the engine; operation of air conditioning, heaters, and refrigeration; braking; and engine idling. These energy losses can be significant. For example, according to the U.S. DOE, "non-engine losses such as wind resistance and drag, braking, and rolling resistance can account for up to a 45 percent decrease in efficiency for heavy-duty vehicles" (Parasitic loss reduction research and development, n.d.).

The second group of vehicle design solutions includes "lightweighting." Lightweighting involves reducing the weight of vehicle materials (see Figure 6). According to the U.S. DOE, "replacing heavy steel components with materials such as high-strength steel, aluminum, or glass fiber-reinforced polymer composites can decrease component weight by 10 - 60 percent" (Short-term lightweight materials research, n.d.).

Lightweighting is an especially important approach because vehicles have been steadily increasing in weight since the 1980s. As shown in the Figure 7 below, the data from the U.S. EPA not only show an

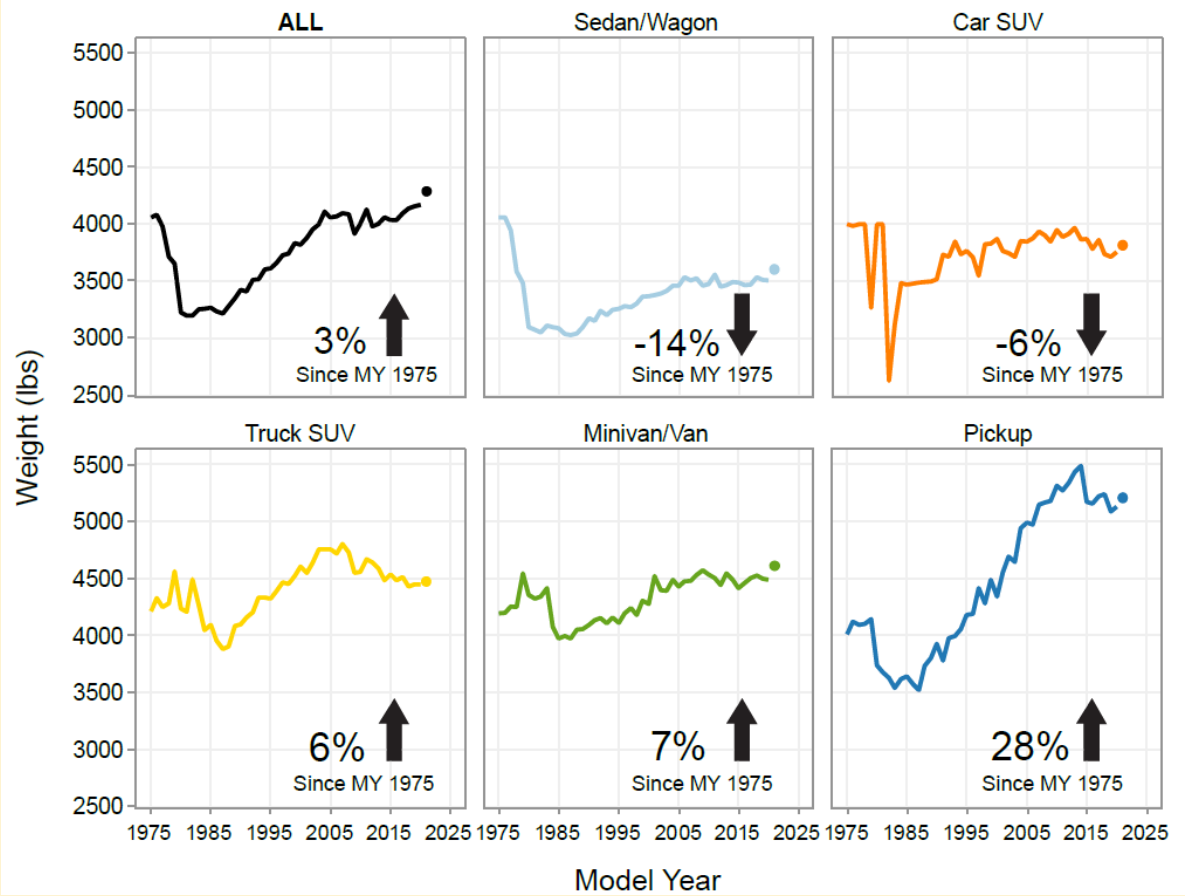


Figure 7: Average New Vehicle Weight by Vehicle Type, 1975 - 2025, Source: U.S. EPA 2021 Automotive Trends Report, November 2021, Figure 3:5, p. 20, https://www.epa.gov/system/files/documents/2021-11/420r21023.pdf and https://www.epa.gov/automotive-trends/explore-automotive-trends-data

increase in vehicle weight over time, but vehicles are even heavier now than back in the 1970s (The 2021 EPA automotive trends report, 2021).

The third group of vehicle design solutions include improving the efficiency of conventional gasoline-powered internal combustion engines in addition to increasing the development of alternative fuel vehicles that can use lower-carbon fuels, such as partially or fully electric-powered vehicles and vehicles powered by other alternative fuel sources, such as biofuels, hydrogen, compressed natural gas, and propane. (Please note that alternative fuel sources are discussed more in-depth in the 2018 State of Transportation Planning Report).

There are many alternative fuel vehicle options available today; the main types that are highlighted in Table 1 include:

- Flex Fuel Vehicles (FFV)
- Hybrid Electric Vehicles (HEV)
- Plug-In Hybrid Electric Vehicles (PHEV)
- Battery Electric Vehicles (BEV)
- Fuel Cell Electric Vehicles (FCEV)
- Natural Gas Vehicles (NGV) & Propane Vehicles
- Zero-Emission Vehicles (ZEV)

Table 1. Alternative Fuel Vehicle Types

Flex Fuel Vehicles (FFV)	FFVs have an internal combustion engine that can run on gasoline or ethanol (biofuel) blends, and the engines are capable of operating on gasoline-ethanol blends up to 83 percent. E85 is a gasoline-ethanol blend containing 51 to 83 percent ethanol (Flexible fuel vehicles, n.d.). FFVs also have diesel options that use specific biodiesel blend fuels.
Hybrid Electric Vehicles (HEV)	HEVs have a gasoline engine like conventional vehicles but also have an electric motor that works with the gasoline engine. HEVs can include a variety of technologies, such as recapturing energy lost during braking via regenerative braking, using an electric motor at low speeds, assisting the gasoline engine during acceleration or climbing, and turning off the engine temporarily when the vehicle is stopped (How hybrids work, n.d.). These hybrids cannot be plugged in and charged, but they can be very fuel efficient.
Plug-In Hybrid Electric Vehicles (PHEV)	PHEVs are HEVs with a gasoline engine and a high-capacity battery that can plug into an outlet or charging station to recharge. There are two basic types – (1) series/extended range PHEVs where the gasoline engine is only used to generate electricity for the battery when needed and (2) parallel/blended PHEVs that function more like HEVs and electric-only operation usually only occurs at low speeds (Plug-in hybrids, n.d.). Since HEVs and PHEVs have internal combustion engines, the engines can be adapted to use flex fuels (FFV) as well as conventional gasoline.
Battery Electric Vehicles (BEV)	BEVs run solely on a high-capacity battery pack and are propelled by only an electric motor. They plug into an outlet or charging station to recharge. Their driving range is shorter than a vehicle with an engine, and it takes more time to recharge batteries than to fill up a tank with gasoline, but BEVs are more energy efficient, environmentally-friendly, quiet, and easily maintained (All-electric vehicles, n.d.).
Fuel Cell Electric Vehicles (FCEV)	FCEVs convert hydrogen fuel to electricity with zero emissions using fuel cells. These types of vehicles are not common due to high costs, technology limitations, and lack of widespread retail fueling stations, but there is potential to see more of them in the future as the technology is refined (Hydrogen, n.d.).
Natural Gas Vehicles (NGV) & Propane Vehicles	Natural gas needs to be compressed (CNG) or liquified (LNG) for vehicle use. According to the U.S. DOE, NGVs can be light-, medium-, and heavy-duty vehicles. CNG vehicles are best for high-mileage, centrally-fueled fleets, such as public transit buses. LNG vehicles, due to the higher density of LNG, are better for long distance vehicles, such as semi-trucks (Natural gas, n.d.). Similar to NGVs, propane vehicles are also typically used in fleets, such as school buses, shuttles, taxis, and police vehicles. Using these fuels can offer many benefits for fleets, such as improved fuel economy and performance, lower maintenance costs, less environmental pollution, and fewer cold-start issues (as compared to diesel) (Propane, n.d.).
Zero-Emission Vehicles (ZEV)	One other type of alternative fuel vehicle worth noting is a “ZEV”, or zero-emission vehicle. ZEVs are a group of alternative fuel vehicles, including BEVs and FCEVs, since both types of vehicles do not directly produce carbon emissions. FFVs, HEV, PHEVs, NGVs, and propane vehicles have varying levels of emissions because they all directly burn a fuel source – albeit lower emissions than conventional gasoline.

VEHICLE EFFICIENCY TRENDS

There are two important indicators related to vehicle efficiency that show how vehicle efficiency has been increasing over time – the federal fuel efficiency standards and the types of available AFVs on the market.

CAFE Standards

The National Highway Traffic Safety Administration (NHTSA) establishes the Corporate Average Fuel Economy (CAFE) Standards and regulates how far passenger cars and trucks must travel on a gallon of fuel. When they were established in the 1970s, the CAFE standards mandated doubling the average 1974 fuel efficiency to 27.5 mpg by 1985. Since that time, the CAFE Standards have been increasing. For example, in 2012, the CAFE standards were increased to 54.5 mpg by 2025. As shown in Figure 8 below, the CAFE standards have increased over time, and vehicle efficiency has increased as a result.

In the present-day, the NHTSA is working to update the CAFE standards for vehicle model years 2024-2026. According to the NHTSA's press release on August 5, 2021, "The new standards would increase fuel efficiency 8% annually for model years 2024-2026 and increase the estimated fleetwide average by 12 miles per gallon for model year 2026, relative to model year 2021" (U.S. Department of Transportation, National Highway Traffic Safety Administration, 2021).

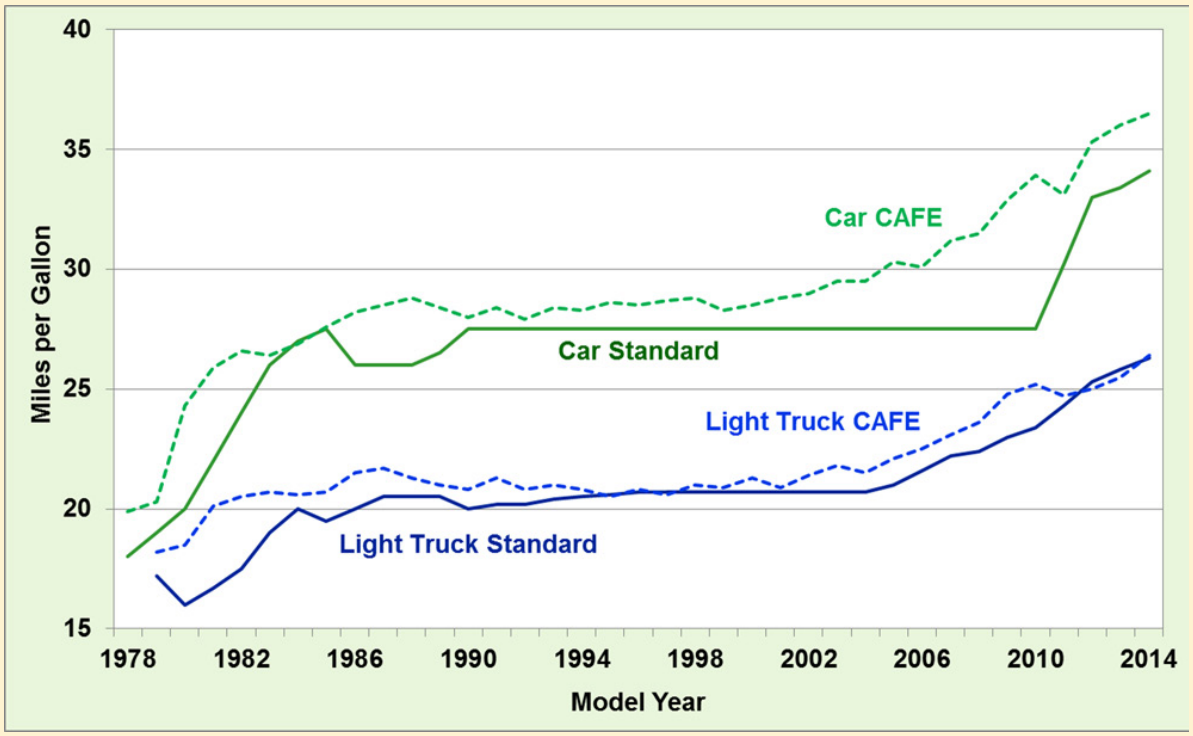


Figure 8: CAFE and CAFE Standards for Cars and Light Truck, Model Year 1978-2014, Source: U.S. DOE, Vehicle Technologies Office, https://www.energy.gov/eere/vehicles/fact-870-april-27-2015-corporate-average-fuel-economy-progress-1978-2014

AFV Fuel and Model Types

The U.S. Department of Energy's Alternative Fuels Data Center tracks AFV data over time, which offers an informed snapshot of AFV-related trends (currently 1991 – 2019), including AFV fuel types, AFV model types, and fleet fuel types. AFV models grew steadily from 1991 to 2002 as FFVs gained popularity and then dropped from 2002 to 2006 as manufacturers reduced the variety of FFV models available (see Figure 9). In 2007, sales surged due to federal and state tax incentives and rebates. AFV models then grew 250 percent from 2010 to 2014 as the U.S. emerged from the 2008/2009 recession. Technology improvements, cost reduction, increasing model choice, maturing charging infrastructure, and economic recovery have continued to influence and support increased sales. The number of AFV models were at an all-time high of 220 models in 2019. It is also interesting to note that from 2003 to 2017, FFVs (E85) had the most vehicle models available, largely because the technology is relatively easy and inexpensive to adapt to conventional vehicles, but in 2017, the number of electric vehicle models available overtook FFVs (Maps and data, n.d.).

Looking more closely at AFV model types (see Figure 10), for the HEV models, the Toyota RAV4 was the top-selling HEV in 2019, followed by the Ford Fusion and the Toyota Prius. The Toyota Prius had been in the lead for many years. For BEVs and PHEVs, the Chevrolet Volt had been on the market the longest and had the most overall sales, but the model was discontinued in 2019. In 2018, the newly introduced Tesla Model 3 rapidly increased vehicle sales and became the best-selling plug-in electric vehicle with nearly 50 percent of the market share (Maps and data, n.d.).

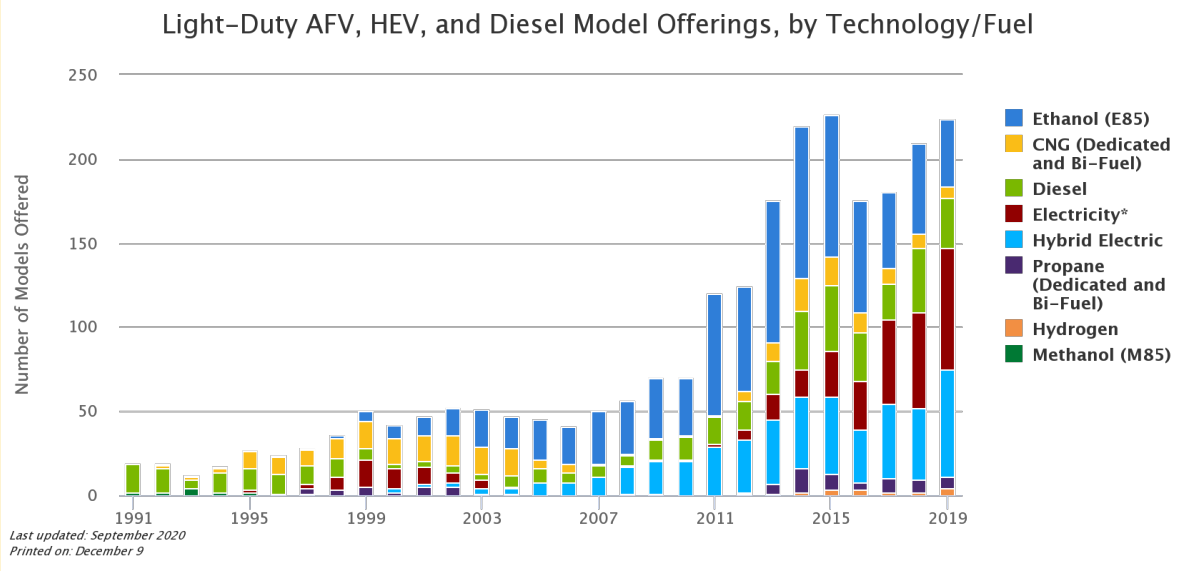


Figure 9: Alternative Fuel Vehicles by Fuel Type (1991-2019), Source: Alternative Fuels Data Center, afdc.energy.gov; fueleconomy.gov and http://www.afdc.energy.gov/data/

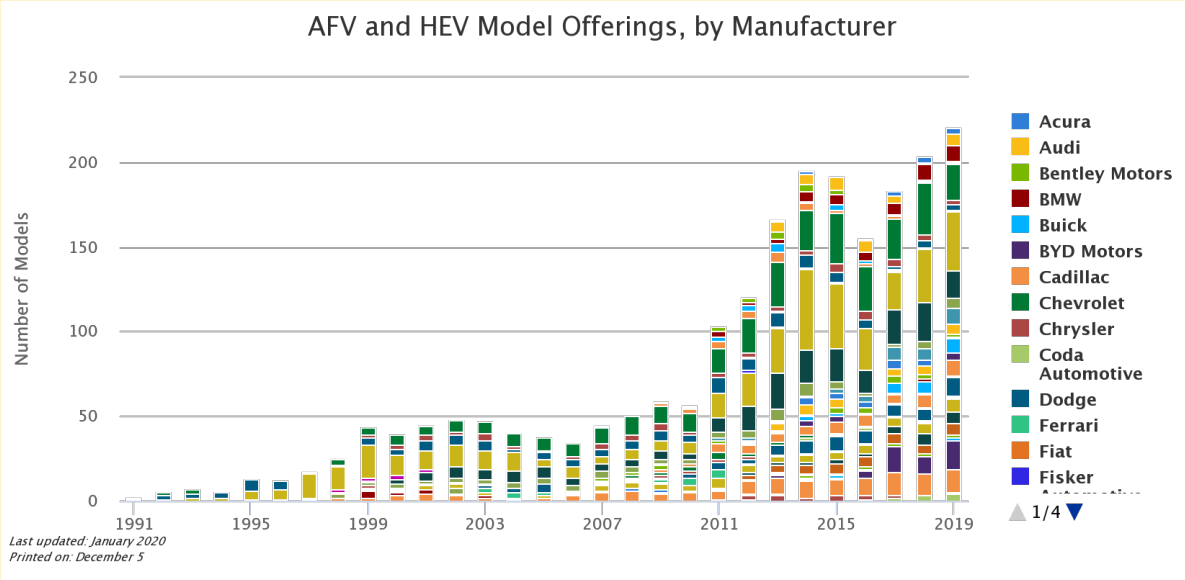


Figure 10: Alternative Fuel Vehicles by Model Type (1991-2019), Source: AFDC Light Duty Vehicle Search, circa 01/30/20, http://www.afdc.energy.gov/data/

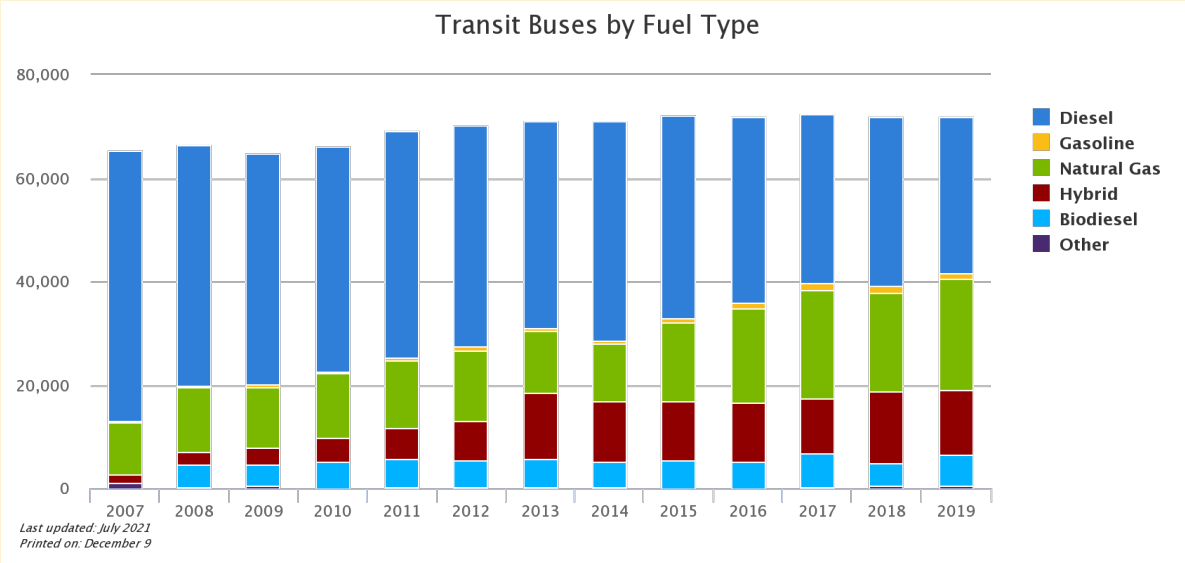


Figure 11: Transit Bus Fuel Types (2007-2019), Source: Derived from Tables 21 and 34 in Appendix A of the 2020 Public Transportation Fact Book from the American Public Transportation Association, http://www.afdc.energy.gov/data/

Fleet vehicles are groups of vehicles owned or leased by organizations, included rental cars, taxis, service trucks, school buses, transit buses, and police cruisers. When focusing on fleet vehicle types, FFVs have consistently been the most acquired type of fleet vehicle, likely because they can run on flex fuels or gasoline, manufacturers offer fleet FFV models, and there is little to no cost difference in the purchase price of FFVs when compared to conventional vehicles. The pattern is different with transit buses – from 2007 to 2019, diesel buses represent the largest portion of total buses, with natural gas buses coming in second (see Figure 11). Hybrid buses are the fastest growing category as they have increased more than eight times from 2007 to 2019. The increase in both natural gas and hybrid buses is largely a result of favorable economics and clean air benefits in the transit bus application (Maps and data, n.d.).

NEXT STEPS IN VEHICLE EFFICIENCY

In summary, to move towards more sustainable energy patterns for transportation, we need to improve vehicle efficiency by:

- Reducing/eliminating the use of nonrenewable fossil fuels to power our vehicles.
- Switching to more energy efficient vehicles.
- Implementing more programs, grants, and policies that encourage vehicle energy efficiency research, technology, and practices.

As planners, there are ways we can help improve vehicle efficiency:

1. **Fleets**: At all organizations, planners can assist with fleet purchasing for their jurisdiction (general vehicles, safety vehicles, school buses, and transit buses), so planners can direct fleet vehicle purchases to more fuel-efficient vehicles.
2. **Education**: A key role for planners is to engage and educate the public, so we can create educational materials and share tools with the public on vehicle efficiency (see tool examples below).
3. **Economic Development**: Planners who work in or assist with economic development can focus their economic development programs and funds on recruiting and supporting businesses that are involved in vehicle efficiency technologies.
4. **Workforce Development**: Planners can also assist businesses that are involved in vehicle efficiency technologies by connecting them and their employee's educational needs to local institutions that provide adult training programs.
5. **AFV Infrastructure**: Planners can facilitate the installation AFV charging/fueling stations and update zoning and building codes to require new development to include them too.
6. **Federal/State**: Planners at the state and federal levels can help prioritize grant funding, research, and policies, including federal CAFE standards, to increase vehicle efficiency.

Here are some useful tools and resources that you can use (and share) to help improve vehicle efficiency:

- Compare cars and calculate GHG gas emissions - https://www.fueleconomy.gov/
- Alternative fueling station locator - https://afdc.energy.gov/stations/#/find/nearest
- EV Explorer - https://gis.its.ucdavis.edu/evexplorer/#!/locations/start
- APA Policy Guide on Energy: https://www.planning.org/policy/guides/adopted/energy.htm
- APA Surface Transportation Policy Guide: https://www.planning.org/publications/document/9178049/
- International Energy Agency - https://www.iea.org/fuels-and-technologies/fuel-economy
- Environmental and Energy Study Institute: https://www.eesi.org/
- U.S. Energy Information Administration: https://www.eia.gov/

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Cover photo: Detail of Figure 5

4

MOBILITY

THE FUTURE IS MULTIMODAL

MD 193 (University Boulevard)

AMHERST AVE TO ARCOLA AVE:

Multi-Modal Shared Streets Pilot Project

Joseph Moges
Urooj Zafar
Derek L. Gunn
Claudine Myers
Winstina Hughes

THE CHALLENGE

The demand for access to outdoor recreational amenities increased amid COVID-19 pandemic restrictions. In response, the Maryland Department of Transportation State Highway Administration (MDOT SHA) pursued non-traditional means to serve increased pedestrian and bicyclist traffic in an effort to support our most vulnerable users. The MD 193 (University Boulevard) Multimodal Shared Streets Pilot Project (the Pilot) studied how a public transportation agency could meet this demand while simultaneously balancing mobility, access, and safety for cyclists, drivers, and pedestrians.

THE ROADWAY

MD 193 is classified as an urban principal arterial along this 1.35-mile corridor segment in Montgomery County, Maryland. Located in an urbanized area, the segment has several multimodal traffic generators from housing and commercial developments, mass transit, parks, recreational facilities, and hiker-biker trails.

The existing typical section consists of six travel lanes, no shoulders, and continuous sidewalks (Figure 1). The posted speed limit is 35 MPH and the Average Annual Daily Traffic (AADT) volume is approximately 27,900 vehicles. [MDOT SHA Data Services Division, 2020 Montgomery County Highway Location Reference, pg 87]

The eastbound and westbound lanes of MD 193 are separated by curbed medians, with directional access restricted to median breaks. The roadway features five signalized intersections and five unsignalized intersections as well as several driveway access points.

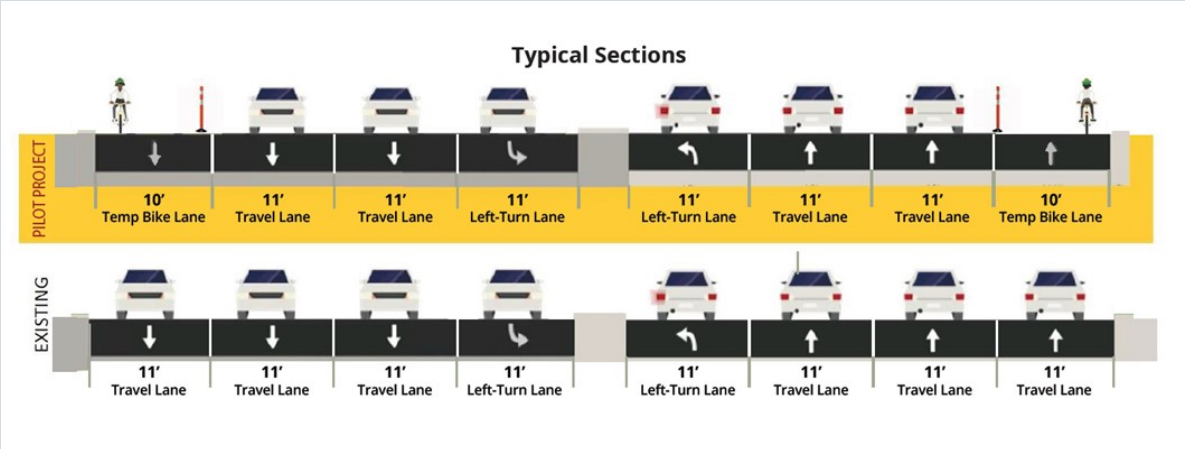

Figure 1: MD 193 Typical Section - Existing & Proposed. (No source. Image generated by MDOT Staff)

Figure 2: Achieving a Balanced Road Design rendering (top) and implemented improvements at the MD 193/ Sligo Creek Parkway intersection (top). Images by MDOT.

THE IMPROVEMENT

The Pilot implemented a road diet on MD 193 between Amherst Avenue and Arcola Avenue, in which part of the roadway used for vehicular travel were temporarily repurposed into dedicated bike lanes for cyclists, adjacent to curbs along westbound and eastbound MD 193 (Figure 2).

MDOT SHA staff accounted for points of conflict and sources of congestion that create challenges when retrofitting improvements. They studied driver access and navigation, mapped public transit stops, highlighted recreational facilities, and identified commercial and residential zones. Staff considered:

- How cyclists were integrated into the existing roadway network;
- The pavement condition, including uneven pavement joints and potholes;
- The importance of a continuous sidewalk with a path free of obstructions; and
- The presence of clear signing and visible markings to support pedestrian crossings within the corridor.

PROJECT PARTNERS

Collaboration was key for the successful implementation of the Pilot. MDOT SHA engaged Montgomery County Department of Transportation (MCDOT), Washington Metropolitan Area Transit Authority (WMATA), Montgomery County Ride On, Maryland National Capital of Parks and Planning Commission (M-NCPPC), Montgomery County Police, Washington Area Bicyclist Association (WABA), local elected officials and local residents. These stakeholders had intimate knowledge of the corridor not easily discerned from traffic counts and site visits.

Both WMATA and Montgomery County Ride On each supplied a bus and drivers familiar with the corridor to perform bus navigation tests. Cones were placed along the curb lanes to simulate a road diet. Bus drivers approached their stops under normal traffic conditions and merged in and out of delineated spaces. Cones were adjusted based on input from drivers.

Exhibit A: Project partners

Safety protocols, in the form of driver education and training, were in place to avoid potential conflicts with cyclists. Bus drivers regularly provided feedback through the duration of the Pilot project and modifications were made by MDOT SHA Maintenance forces.

THE DESIGN

MDOT SHA pursued a design to accommodate a single directional bike lane in both the eastbound and westbound direction of the corridor segment. Flex posts were used to separate the motorized travel lanes from the repurposed curb lanes (Figure 3). White paint was used for lane shifts and bike symbols and green paint was used to highlight bike crossings. White reflective thermoplastic markings were used for yield bars on the approach to bus stops. On side streets signs were installed to alert motorists to “BIKE LANES AHEAD”

Figure 3: WMATA Transit Bus departing from repurposed curb lane. Image by MDOT.

and construction barrels were placed to channelize traffic at spot locations.

The result of the bus navigation test established appropriate taper and tangent lengths for the final roadway design (Figure 4). A roadway design length of 165 feet was utilized for an average 40-foot transit bus and 210 feet for a 60-foot articulated bus.

Designed as a pilot project, the entire application is removable: hydro-blasting and/or grinding removes lane markings; a skid steer loader detaches flex posts installed with adhesive tape; temporary signs and barrels can all be recycled in Maintenance stockyards for use on other projects.

TRAFFIC AND DATA ANALYSIS

- An assessment of crash history, types, patterns and trends identified spot and section improvement needs and revealed that the Pilot provided a multimodal safety benefit for all roadway users: motorists, bicyclists, and pedestrians.
- The repurposed lanes resulted in reduced motorist speed. Notably, the road diet resulted in minimal delays, with motorists spending an average of an additional 15 seconds traveling through this segment of MD 193 on a typical weekday compared to preexisting conditions.

- A level of comfort or stress was performed to understand existing demand. The results established a baseline to understand the high volume of continuous data generated from the Pilot. Data collected will be assessed during final review. It will be a critical detail in understanding the efficacy of the Pilot.

FINANCING

The Pilot was financed through a Federal Highway Administration (FHWA) State Planning and Research, Subpart B (SPR-B) program grant. The funding covered traffic analysis, engineering, design, and construction. MDOT SHA procured design consultant Mead & Hunt to prepare renderings for community outreach meetings; assist in data collection pre- and post-implementation; as well as draft and compile information for the final reporting effort.

Since the scope of work did not propose permanent geometric changes, our maintenance staff was able to install the flex post and lane markings needed to repurpose the curb lanes. To ensure timely implementation, only materials from the MDOT SHA's Qualified Producers and Products List (QPPL) were selected. These vendors have established relationships with the state and were instrumental in supplying materials on short notice.

Efficient use of funding was paramount to the success of the project.

COMMUNITY OUTREACH

MDOT SHA pivoted from in person meetings to virtual meetings due to the pandemic (Figure 5). All discussions with stakeholders were held via conference calls and through video conferencing software, resulting in greater stakeholder participation. Anecdotally, this could be due to these applications allowing the public to join meetings from any location.

Figure 4: MD 193/Reedie Drive intersection Shared Street design. Image by MDOT.

Local bicycle advocacy groups were instrumental in the launch of the Pilot project. Initial meetings with this subset of stakeholders focused on corridor selection and accommodations of safety features, such as the use of positive barriers and increased signage. It was also important for MDOT SHA to get the word out so the public could experience the temporary bike lane.

Prior to implementation, a public pre-construction meeting was held using Microsoft Teams. At this meeting MDOT SHA was supported by local agency partners and elected officials. Renderings of the proposed improvements were presented, and participants asked questions concerning safety, traffic operations and project duration.

Through the duration of the project, MDOT SHA maintained an interactive website

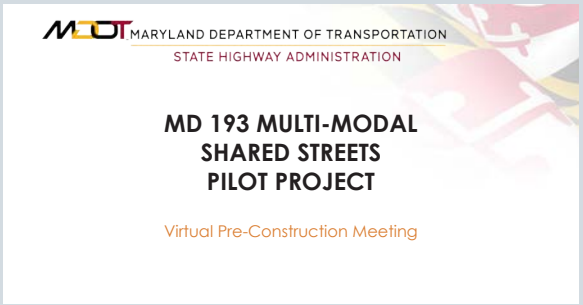

Figure 5: Screenshot of a virtual meeting slide.

Figure 6: Eco-Counter MD 193/Sligo Creek Parkway. Image by MDOT. Source: source: https://www.eco-counter.com

in which stakeholders could submit their observations, ask questions, and express their overall feeling of the project. Community engagement through the website enabled the design team to make real-time changes. Adjustments were made to signal timings and Maintenance staff deployed to remove accumulated trash in the repurposed lanes. Variable Message Signs (VMS) displayed electronic messages that alerted travelers to changes in traffic patterns and flyers and e-mail blasts were sent to keep stakeholders informed of project milestones.

PREPARATION FOR BIKE LANES

Approximately one month before bike lanes were installed, a continuous multimodal tracking device was installed to collect data associated with “ridership generated” and “ridership sustained.” The device was placed adjacent to the sidewalk (Figure 6). The counter location was ADA compliant, and object markers were placed alongside the counter for pedestrian visibility.

VMS was installed at each of the two main line approaches to give advance notice to the public of the forthcoming traffic changes, as well as encourage bicycle ridership. All signing connected with the repurposed lanes were installed in advance and remained covered until the bike lanes were opened to cyclists.

SIMPLICITY IN INSTALLATION

The deployment of the new bike lanes was simple. MDOT SHA staff designated installation teams and divided the task in two phases, eastbound and westbound.

For efficiency, the installation sequence began with the striping team, then the flex post installation team, and lastly the thermoplastic pavement marking installation team. The logic is based on the establishment of lane striping followed by reinforcement with flex posts.

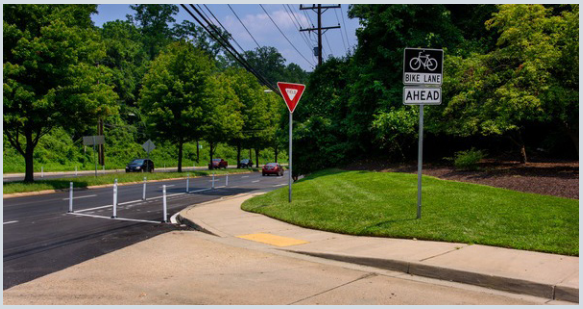

Figure 7: Images of Temporary project signing. Image by MDOT.

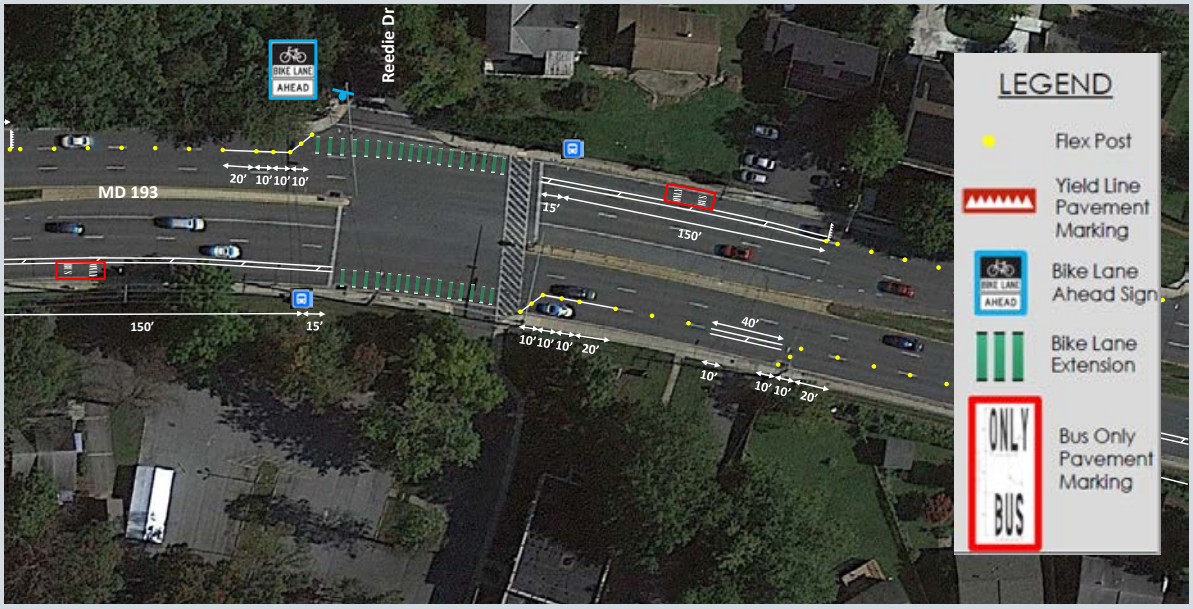

Figure 8: MD 193/Reedie Drive Intersection Design Revisions

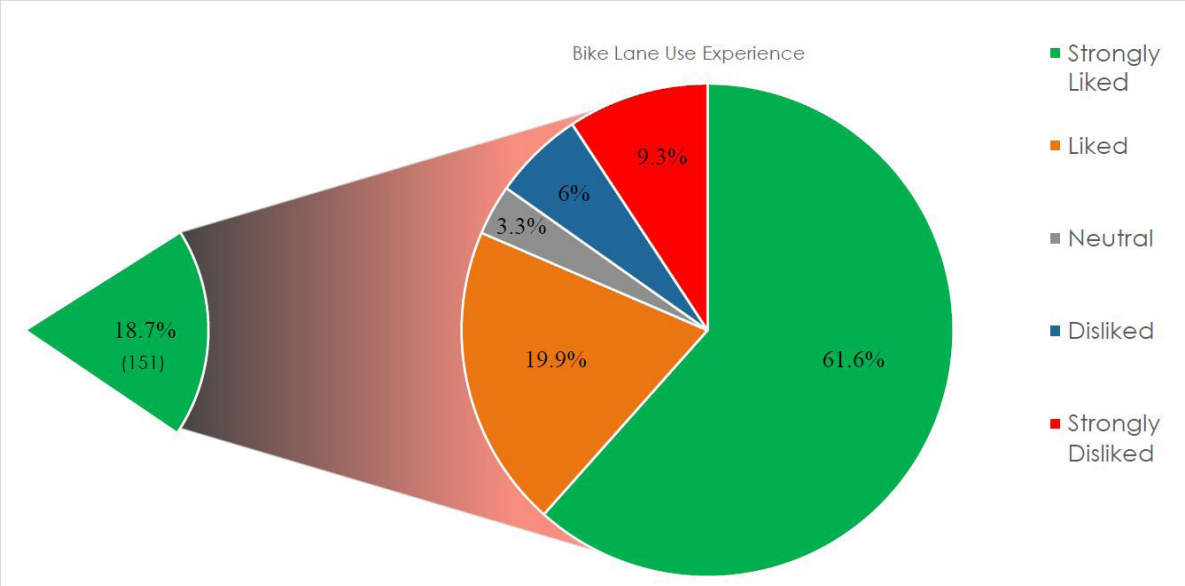

Figure 9: Bike Lane User Experience

DESIGN MODIFICATIONS AND ADJUSTMENTS

There were two unforeseen challenges with the design improvements that needed to be addressed in a reactive fashion. Incremental improvements were executed to address them. The first challenge required an adjustment to signing. Motorists were observed entering the bike lane and executing a late merge into the appropriate lane. Supplemental signing was added to better demarcate the temporary bike lane (Figure 7). Signing was also added to remind motorists that turning traffic must yield to pedestrians and bicyclists.

The second required roadway design modifications (Figure 8). During field visits motorists were observed traveling in the repurposed curb lanes designated for cyclists. The following changes were made:

- Supplemental signing was installed along the eastbound approach to the temporary bike lane because the existing signing was not sufficient.
- Additional flex posts were installed to further delineate the temporary bike lanes and block access by motorists
- "Bus Only" pavement markings (Figure 8) were installed in the merge areas at all the transit stops to clearly identify the break in flex posts were to be used by transit vehicles only. This proved to be an effective solution.
- Green colored bike lane extension line pavement markings were installed at all signalized intersections within the project limits to delineate the bike lanes through the intersections and to maximize visibility of cyclists.

CONCLUSION

The Pilot Project was successful in meeting the multimodal demand of the area and improving the comfort level of cyclists and pedestrians traveling within the project limits. According to the data collected, local residents and motorists experienced minimal commuting delays and cyclists had a favorable experience while utilizing the repurposed curb lanes (Figure 9).

The process outlined for this Pilot, including the implemented roadway improvements; the design process; types of partner relationships established; traffic analysis and data collected can assist other public transportation agencies with assessing the appropriate tools and treatments needed to provide safe and efficient multimodal accommodations in an otherwise vehicle-centric road network. As the Shared Street Pilot completed its final stage, the MDOT Secretary was asked by Montgomery County elected officials during a public meeting if the pilot could remain in place indefinitely. The endorsement by a majority of elected officials reflects the overwhelming success of the pilot.

Cover photo: Detail of Figure 2

About the Authors

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Joseph Moges is a Consultant Project Manager for MDOT SHA's District 3 Traffic Office. In his capacity, Joseph is responsible for managing the Purple Line project with respect to traffic design, construction management, and public outreach. In this role, close coordination is required between state, local governments, transit agencies, advocacy groups, and elected officials. Joseph also manages other special projects including both of the District's Shared Streets projects for outdoor dining and multimodal improvements.

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Urooj Zafar is the Montgomery County Team Leader for the Engineering Systems Team at MDOT SHA. In this role she is responsible for assuring the engineering completeness of complex highway design projects and developing the District's System Preservation program. Urooj served as design project manager for the MD 193 Multimodal Shared Streets Project. She holds a bachelor's in science for Civil Engineering from the University of Engineering & Technology in Lahore, Pakistan.

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Derek Gunn is the Deputy District Engineer for the MDOT SHA District 3 Office. As Deputy, he shares leadership responsibilities for operations within the District. He has over twenty years of experience in transportation planning and engineering. His areas of focus include travel demand forecasting and analysis, and multi-modal traffic safety. He currently serves as co-chair for the state's Pedestrian-Bicycle Emphasis Area Team.

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Claudine Myers is the Assistant District Engineer of Project Development with MDOT SHA's District 3 Office. In this capacity she oversees the development of the District's Crash Prevention, Safety & Spot, and Congestion Relief Programs; including the permitting and relocation of utilities with state rights of way. Claudine holds a bachelor's degree in Civil Engineering from Morgan State University and has over twenty years of experience in the field of transportation.

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Winstina Hughes is an Assistant Regional Planner with MDOT SHA. Currently, she manages community and government customer relations for Prince George's County in the District 3 Office. Winstina earned her Masters in City and Regional Planning from the Edward J. Bloustein School at Rutgers University. Additionally, she has over 10 years of experience building community through Open Source contribution and Community Development work.

THE UNREALIZED BENEFITS of PAID PARKING

Jane Wilberding
Evan Kindler

People do not often talk about parking; people complain about parking. When parking is easy, it is an afterthought. When parking is difficult, it is infuriating. And more often than not, we hear about the seemingly unending struggle to find a spot, quickly followed by the grievance that there isn't enough parking. Yet, when you look at land use distribution in American cities, this claim loses validity. Five percent of urban land in the US is covered by surface parking, with an estimated three to eight spaces for every registered car (Herriges, 2019).

So why does it feel like there is never an open spot? By and large, this can be attributed to how parking is priced: many central business districts (CBDs) provide on-street parking free of charge to incentivize visitors. But since these are the most desirable places to park and they're free, employees, visitors, and customers park and stay in these spaces for long periods of time. This leads incoming customers to complain that there is not enough parking and declare that more parking needs to be built. The more cars in a CBD, the more public space is ceded to car dominance, and the more parking we will continue to need. This in turn requires taxpayer dollars to be spent to build it, while edging out transit, bike, and pedestrian infrastructure in the process. Nearly our entire transportation network is built to accommodate cars, yet parking is a headache, especially in the areas people most want to be.

But there is a way to reverse this dismal cycle. In order to do so, we must better manage our current parking stock while funding infrastructure improvements that make car-free transportation safe, convenient, and enjoyable. A parking benefit district (PBD) is a tool for cities to do just that. As parking reform pioneer Donald Shoup describes it, a PBD is an area where the local governing body "spend[s] meter revenue for public services in the metered area. These cities offer each neighborhood a package that includes both priced parking and better public services. Everyone who lives, works, visits, or owns property in a Parking Benefit District can then see their meter money at work"

(Shoup, 2018)." An on-street parking space is a limited commodity and should be managed using the economic principles of supply and demand. When parking fees are absent—or nominal, parking demand is unmanageably high; when parking fees are too costly, they can discourage customers

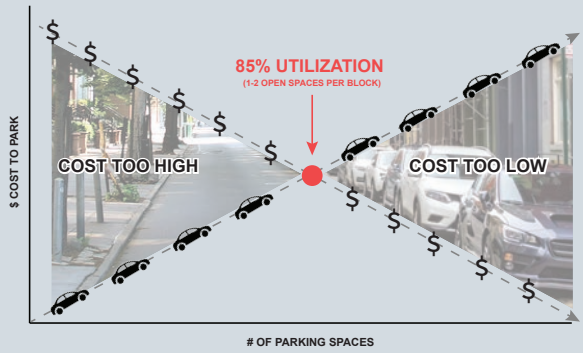

Figure 1: 'Right-priced' parking equilibrium; Source: Parking Reform Network

from patronizing certain businesses altogether. Neither scenario represents the value of the spot. Charging a market-rate price for parking ensures there will almost always be an open spot for customers and visitors. Generally, a rate that creates 85% occupancy is optimal because it allows enough turnover to guarantee drivers a spot on the same block as their destination (Shoup, 2018).

They aim to make higher parking rates more palatable to the public by using the revenue to improve the surrounding area. These funds give areas the capital to address their localized transportation needs and reimagine how our communities understand parking, transportation, and the use of our shared spaces.

This article examines PBD benefits, challenges, noteworthy practices, and lessons learned and is organized in the following sections:

1. PBD Case Studies: This section summarizes two case studies of recently implemented PBDs in Columbus, Ohio and Portland, Oregon.
2. Beyond Parking - PBDs for Equity: This section addresses the potential shortfalls of PBDs as a parking management model, including over-enforcement and concentrating funding within already affluent communities
3. PBD Noteworthy Practices: This section provides insights into practices regarding equity in parking and curbside management.

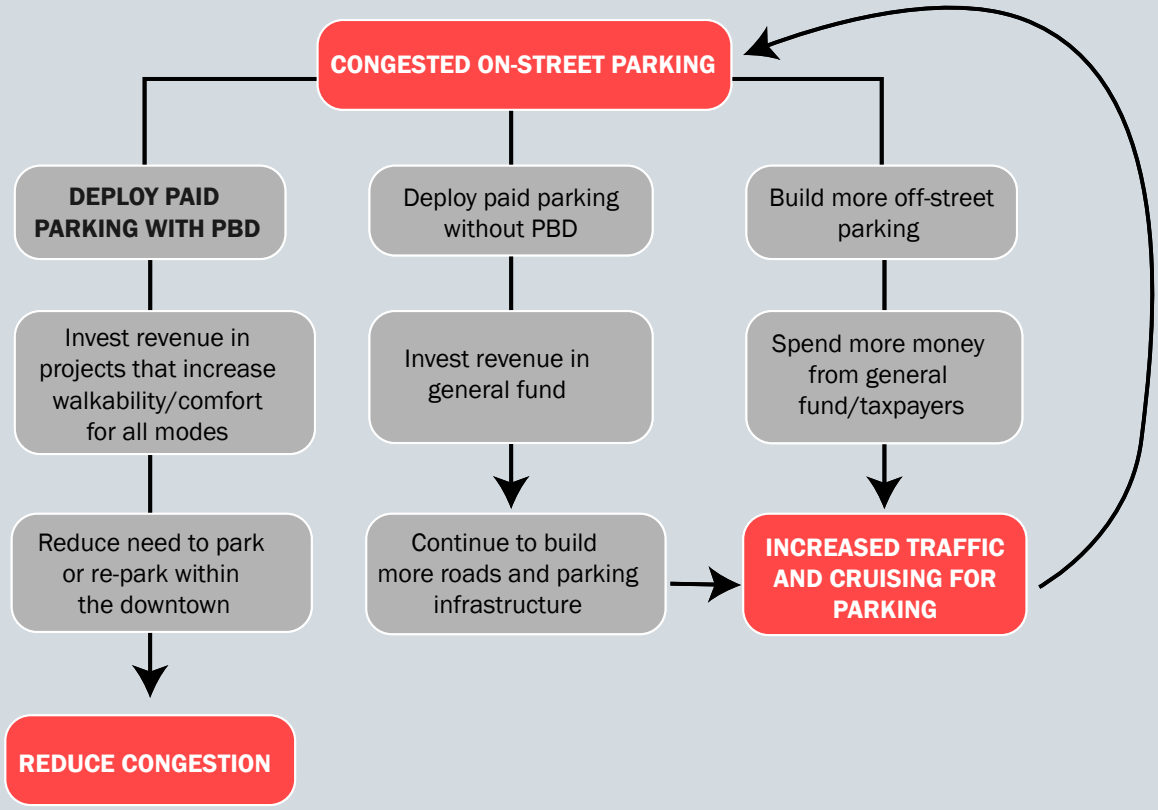

Figure 2: Parking Benefits District Decisions Tree; Source: Parking Reform Network

PBD CASE STUDIES

SHORT NORTH, COLUMBUS, OH

Columbus overhauled its citywide parking policy in 2019 with a new strategic and simplified parking plan. From this plan, the Short North PBD was born as a means to provide mobility options to employees in the mixed-use arts district between downtown and the Ohio State University (Figure 3). The new plan implemented residential permit parking and meters throughout the district, which limited employees' parking options. After their first attempt at an employee shuttle failed, the City continued to work with employers and employees to find a way to use its PBD funds to effectively address the district's needs. Meter revenue was spent on employee discounted transit fares; bike, scooter, carshare, and rideshare memberships; and an employee permit program for both on and off-street parking, giving businesses an opportunity to purchase up to 10 permits at a progressive rate.

The meter revenue funds projects to enhance parking management and alternative transportation initiatives proposed by a committee of community members which are approved by the City on an annual basis. After the first full year of operations in 2019, the meters generated $2.64 million in gross revenue, $535,000 (20%) of which went to the PBD after operating expenses. The district spent $225,000 on a contract with the Short North Alliance, the local business improvement district (BID), to provide and manage the PBD services. Initial programs took the form of off-street parking discounts, parking validation codes for businesses, a communications campaign to educate the public on the parking changes, and the aforementioned employee mobility fund. The remaining revenue was carried over to 2020, where it became an unexpected critical revenue stream to address parking revenue shortages resulting from the COVID-19 pandemic. PBD revenue was used to fund Parking Services' essential expenses without having to take a loan or make cutbacks.

As the economy has begun to recover from the pandemic, the Short North Alliance has planned to capitalize on the return of customers and commuters. In January 2022, they will begin offering a transit pass to employees that affords them one to three months of free transit rides and are planning to expand this program to the district's patrons in May, 2022. This pass is part of a wider effort to shift more transportation to public transit, further decongesting the district.

The entirety of the Short North corridor is meter or permit parking. High Street, which runs directly through the district, is completely metered. Between 8AM and 10PM, guests can park in permit parking for three hours for $1-3 per hour, depending on in which of the five zones they are parked (see Figure 3 for zone distinctions). Permit holders can park anywhere within their zone at any time of day for an annual cost of $25, with a $15 discount for low income residents.

Permit and citation revenue does not contribute to the PBD fund, but instead goes to the City's general fund. Pricing is adjusted twice per year based on occupancy data collected through the use of license plate recognition technology. To date, this process has actually lowered parking prices in certain zones around the central commercial area. This methodology is summed up by Robert Ferrin, Columbus' Assistant Director for Parking Services, saying, "The Short North will never be 'done.' We will use data to monitor, and we'll make changes to meet a goal of on-street occupancy of 60 to 80 percent,

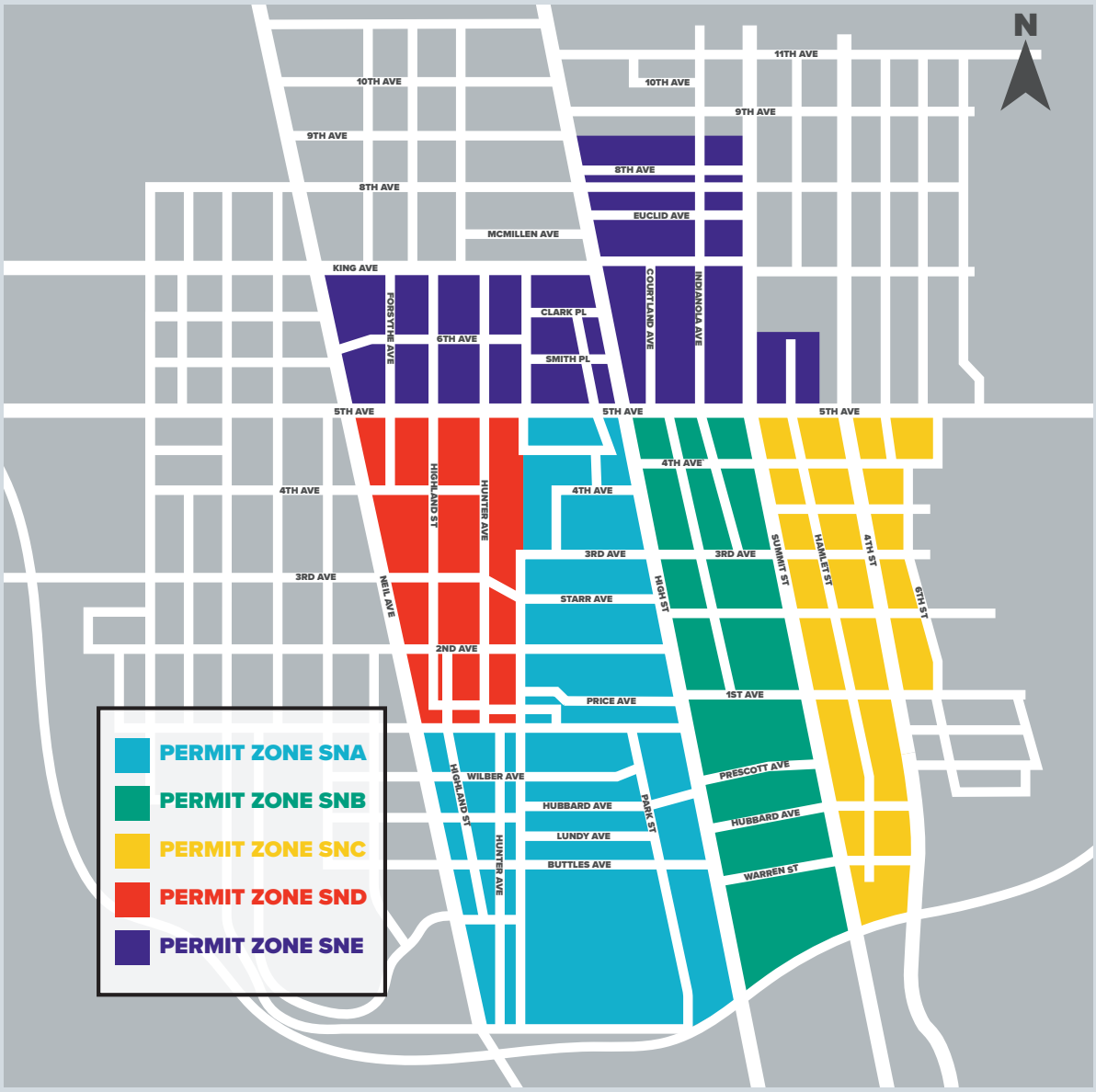

Figure 3: Map depicting the coverage area and various permit zones of the Short North PBD; Source: City of Columbus, Short North Final Plan Detailed Sheet (2019), https://shortnorth.org/wp-content/uploads/2019/03/permit-zone-map.pdf

and we'll do it every three months–we're not going to just put it in and walk away" (Warren, 2019)."

The Short North's success prompted the city to set up a PBD in Downtown Columbus in February 2020. The businesses in this district are mostly restaurants catering to commuters. Since the COVID-19 pandemic has lowered parking demand, the full implementation of this PBD has been impacted, but once demand increases again, a committee of stakeholders set up by the City will take charge of managing the revenue. An early suggestion for spending has been to fund the commuter pass program. Started in 2018, the C-Pass program is funded by the downtown Business Improvement District and has seen companies moving away from their monthly parking benefits towards providing their employees with free transit rides. To date, this program has seen early success, doubling the number of commuters on public transit from 5% to 10%.

PORTLAND, OR

In 1996, Portland adopted its Parking Meter District Policy which outlined how new Parking Meter Districts, now called Parking Management Districts (PMD), should operate. Downtown Portland had metered parking since 1970, but the city wanted to expand metering with a new management strategy. Since then, the City has created four new PMDs, all of which act as benefit districts by reinvesting the revenue into the metered area (Figure 4).

The Lloyd, Marquam Hill, Northwest, and Central Eastside PMDs each have a parking committee of local stakeholders who recommend uses of the parking revenue to the City. After covering operating expenses and splitting revenue with the city, the annual revenue reinvested into the districts ranges between $150,000 in 13-meter Marquam Hill, to $1 million in Northwest.

The PMDs receive 51% of their net meter revenue to spend on "transportation demand management (TDM) programs; parking services; small safety and/or capital projects for walking bicycling, and transit; shared use arrangements for existing parking facilities; investments to improve the movement and delivery of goods and services; and new parking facility development" (Performance Based Parking Management Manual, 2018). These have taken the form of sidewalk reconstruction in Marquam Hill while Northwest has funded transportation wallets and updated meter and permit technology. While conducting parking utilization studies, the Lloyd PBD found opportunities to install protected bicycle lanes, bicycle parking, and walking infrastructure, as seen in Figure 5. Both the Lloyd and the Central Eastside PMDs helped to fund the Congressman Earl Blumenauer Bicycle and Pedestrian Bridge connecting the two neighborhoods over Interstate 84.

Figure 5: NE Multnomah Street post streetscape improvements; Source: Google Streetview

This strip of street on NE Multnomah is part of the Multnomah Street Streetscape Plan. The plan has added bike lanes to 16 blocks along the main street, having received more than $1 million in funding from the Lloyd PBD from 2018-2020.

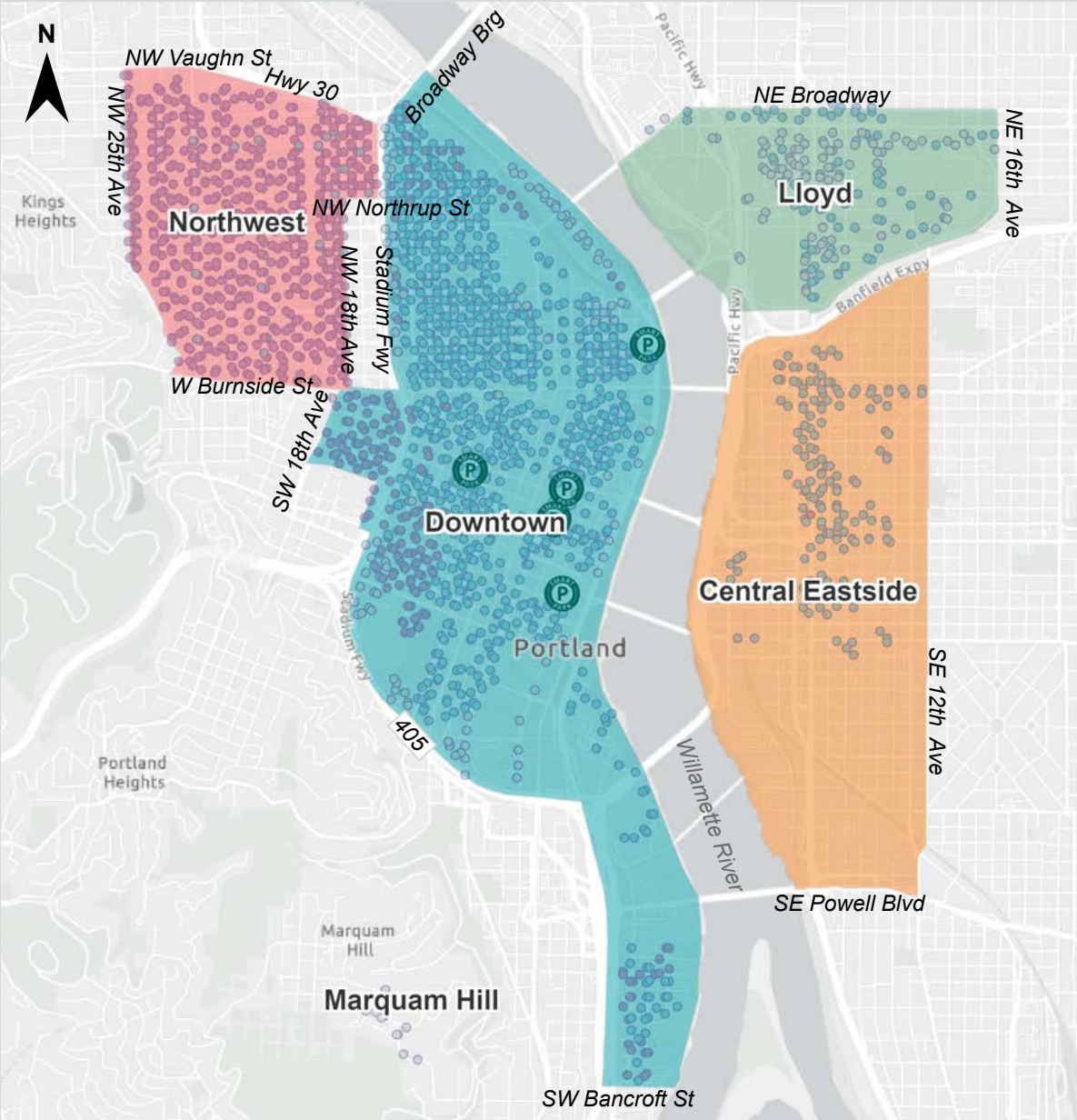

Figure 4: Map depicting the coverage areas of the Portland PMD; Source: City of Portland Parking, 2022, https://pdx.maps.arcgis.com/apps/MapSeries/index.html?appid=ad171d005d4442bba3c640735d070aa3

What's more, the Northwest and Central Eastside PMDs were some of the first in the nation to also leverage parking permit revenue to invest in TDM efforts. These districts have added a surcharge to the citywide permit price: $120 in Northwest; and $280 in Central Eastside. These surcharges are 100% returned to the district to fund transportation wallets for those who live or work in the Northwest and Central Eastside Parking Districts. These wallets offer $769 worth of bus, streetcar, and scooter/bikeshare credit for $99. Low income residents and employees in these neighborhoods can also qualify for a Golden Transportation Wallet which provides all of the same benefits at no cost. To further encourage transit ridership, residents and businesses can also exchange their parking permit in return for a transportation wallet.

In July 2021, the City took another step towards a justice-oriented transportation network as the Portland Bureau of Transportation's (PBOT) Pricing Options for Equitable Mobility (POEM) task force made a series of recommendations to the City Council. Recognizing the disproportionately negative impacts that the current transportation network has on both low-income residents of color and the environment, the POEM task force developed parking pricing strategies for a more equitable and sustainable transportation system. They recommend a flexible commuter benefits program that requires employers who provide free or subsidized parking to provide equivalent benefits to non-driving employees in the form of alternative transportation options or as a taxable cash income. They also suggest adding more metered and permitted benefit districts as well, while making them easier to create. Emphasizing the need for demand-based parking pricing, the task force urged the accelerated adoption of dynamic pricing policies outlined in the Performance Based Parking Management Manual developed by the PBOT in 2018. They recommend that this pricing strategy extend into private parking lots as well, taking the form of an additional fee driven by efficiency and turnover. In February of 2022, the City of Portland took their first action from the POEM task force and passed a resolution to increase parking rates and use revenues gained to create a new "climate and equitable mobility" transaction fee; stabilize transportation revenues; and transition away from relying on revenue from fossil fuels (Stampe & Elkotbeid, 2022).

BEYOND PARKING: PBDS FOR EQUITY

How can PBDs promote equity? In this section, we will examine PBDs as a means to create more just cities and an opportunity to review parking policies as a whole.

AVOIDING A CONCENTRATION OF WEALTH

PBDs work because there is a high demand for parking in a particular area. But if the PBD money generated is reinvested to improve the metered area exclusively, this model is also susceptible to repeatedly enhancing already affluent districts, while continuing to neglect those with fewer resources and economic opportunities. Rather than improving the quality of life for all city residents, this cycle would reinforce existing inequities and benefit areas that already have high levels of investment. Can this unintended cycle be avoided? Are there other ways to share the benefits that PBDs generate?

Many PBDs have a 51 to 49 revenue split between the PBD and the city to help avoid this issue of concentrated investment furthering inequity in public services. It is no secret that areas with higher levels of investment, like downtown business

districts or affluent neighborhoods, often receive priority in spending and services over their low-income neighbors (Feigenbaum & Hall, 2015). One simple recommendation is to share a larger portion of the PBD revenue citywide to fund alternative transportation options and resources throughout the community, as opposed in just one place. Another possibility is to stipulate that the city target PBD revenues on mobility justice measures to keep the money from disappearing into the wider budget. The overall goal should be to invest in infrastructure that all users can access, such as sidewalks, bike lanes, and alternative transportation amenities, as opposed to roadways that only serve those who operate and use a car. This strategy will reduce dependence on single occupancy vehicles and encouraging an oversupply of parking. If the parking revenue is not earmarked for alternative transportation, it becomes a revenue stream based on car dependence. This earmarked spending makes high demand areas more accessible for all residents while strengthening the local economy by increasing the availability of customers and employees.

There are ways to promote this economic accessibility through the PBD's share of the revenue as well. Portland and Columbus' PBDs buy transportation wallets that use the city's existing public transit and micromobility options, which can be used to fund employees' commutes without increasing traffic and parking occupancy. Using PBD revenue in this way directly frees up spaces for customers while expanding the economic opportunities for employees.

While distributing a portion of parking meter revenue throughout the PBD can be a more equitable approach, guaranteeing that nearly half the money will leave the district may spark opposition with stakeholders. There are a few solutions to this problem:

- An initial pilot that keeps revenue within the district can help ease the transition by demonstrating how right-pricing can solve parking problems while acclimating stakeholders to paid parking. Once people see the parking management aspect of right-priced parking at work, they may be more willing to concede some of the revenue.
- Introduce a transitional period over the course of 5-10 years in which the revenue split gradually evens out between the district and the city, giving the PBD ample time to implement various projects before their share of the revenue decreases. If the PBD is located appropriately, the area's 51% of the meter revenue should still generate at least $150,000[1] a year after expenses.
- PBDs could be used to promote equity in a fundamentally different way. As of late, city budgetary priorities across the U.S. are shifting more towards racial and economic justice. Cities could approach PBD eligible areas and explain that this shift has redirected funds towards underserved parts of the city. If the district wishes to continue funding these projects, they could institute a PBD which the city would help them develop. Rather than the area's new meter revenue funding other parts of the city, this approach frames PBDs as an opportunity to compensate for changing budgetary priorities driven by wider societal forces.

1 This revenue projection is based upon the lowest annual net operating income that we found in the course of our research: 13 meters in Marquam Hill, Portland.

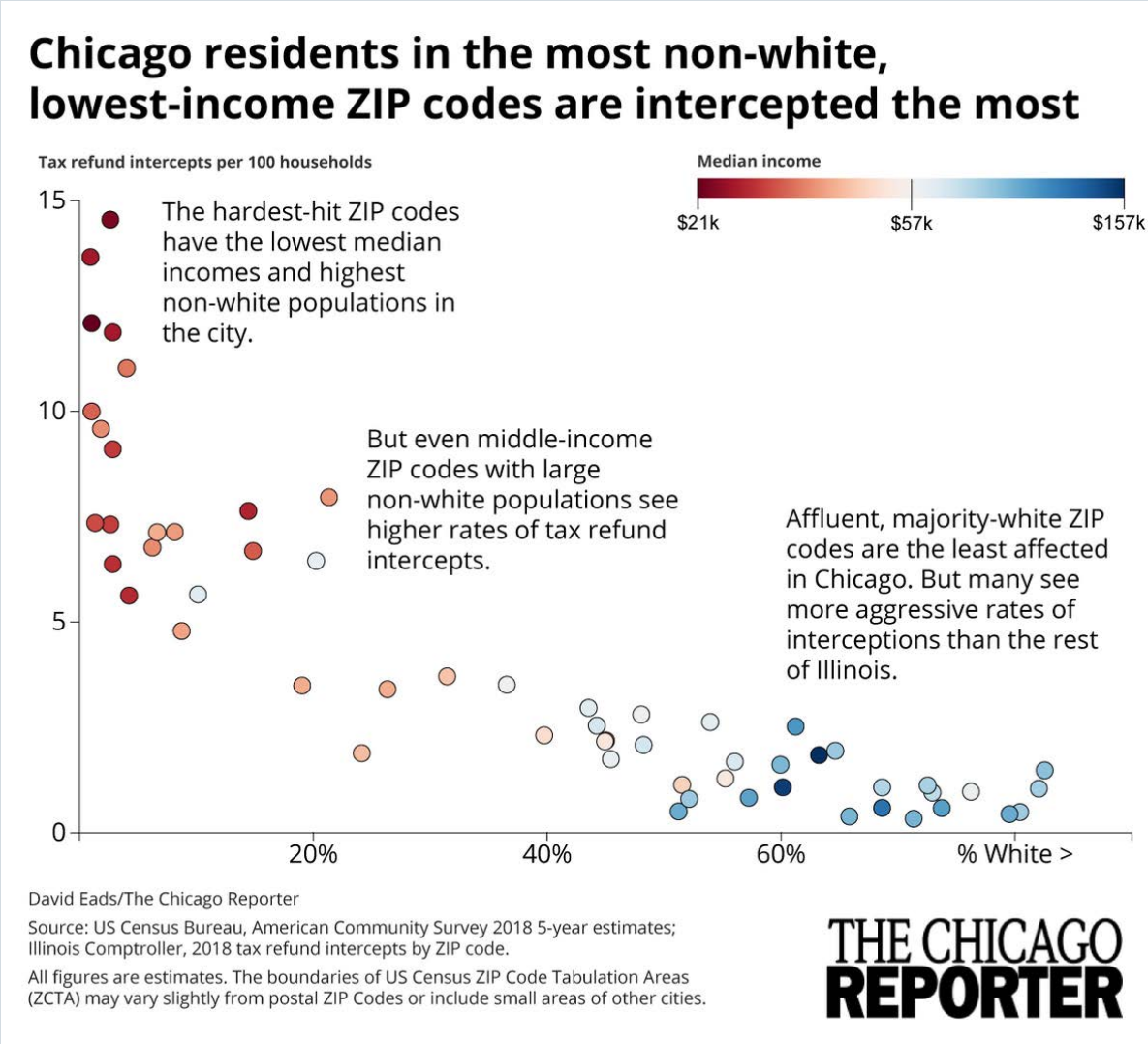

Figure 6: Inequitable monetary burden policies in Chicago, IL; Source: Simon Davis-Cohen (2020), The Chicago Reporter, https://www.chicagoreporter.com/chicago-intercepts-tax-refunds-to-collect-unpaid-debt-hitting-poor-black-areas-the-hardest/

PROBLEMS WITH PARKING ENFORCEMENT

Parking Benefit Districts can also generate inequity through enforcement. Cities often use revenue generated by the PBD to increase or establish parking enforcement and citations. Parking should be priced right, but violations should not be criminalized. The impacts of the same parking violation on people of different financial means could have radically different impacts on them. While one person could simply pay the ticket and move on, the other could face a myriad of consequences: additional late fees, license suspensions, or even losing their car entirely. Several states including Illinois implement programs that allows the city to collect unpaid debts on parking tickets and other court fees, a recent study found that this program largely impacted low-income community in predominantly non-white residents (Davis-Cohen, 2020).

Enforcement is not free. Standard practice is for cities to use meter revenue to finance operation costs, which includes police enforcement. These costs can substantially tax parking revenue earmarked for community projects, instead funding police and the courts as opposed to multimodal transportation solutions. Just as adding parking is often seen as the only fix for a parking problem, adding police is often seen as the only fix for a public safety problem. In some cases, like Pasadena, California, Pittsburgh, Pennsylvania or Ventura, California, the PBD elects to use its revenue to hire police. However, PBDs can be used to promote public safety without funding increased police enforcement. The Chicago Metropolitan Agency for Planning (CMAP) worked with Chinatown residents to create a plan for a PBD that could fund streetlights under an overpass that had previously been avoided for fear of crime. Pittsburgh's South Side Flats expanded its RPP to keep nighttime visitors from parking in nearby residential areas where they had been subject to theft and robbery while walking back from the district's bars late at night. They also removed parking on the main street entirely after 10:00 PM on the weekends to create an emergency vehicle lane.

WHAT COULD EQUITABLE PARKING ENFORCEMENT LOOK LIKE?

To answer this question, we must ask ourselves a few more. In the U.S., parking and traffic violations are a flat rate which can be a substantial burden for one violator, and an afterthought to another. While equal, the fine is not equitable. Similar to income tax, a progressive fine rate based upon income could help balance its impact. Finland, Sweden, Denmark, Germany, Austria, France, and Switzerland have implemented this approach, Finland being most famous for starting earliest (1921) and having the largest fines. In 2002, a Nokia executive was charged $103,000 for going 45 mph in a 30 mph zone (Pinsker, 2015). In the U.S., income is a touchy subject and not easily accessible in the same way as elsewhere in the world. However, vehicles offer a simple proxy. Fines could be based upon the value of the car. With an appeals system in place, this practice of charging appropriately based upon car value is not only fairer, but works to deter illegal behavior without placing a substantial financial burden upon some. For the wealthy, fines are an incentive not to break the law rather than a nominal payment for doing so. For the poor, fines are no longer a looming danger that could bring years of economic consequences.

Until changes to our fine structure are implemented, they will continue to have a larger impact on low income communities. A parking program aiming to be more

equitable should ask itself: how can we restructure fines? Are we encouraging violations through our design or lack thereof? The best system is one that doesn't need to give a ticket because its design discourages violations. Are there trees blocking permit parking only signs? Where is the city issuing fines and what can we do to discourage further violation? If the regulation is in place as a safety or accessibility measure, preventing violations is also a safety and accessibility measure. If no effort is made to stop violations beyond continued ticketing, one wonders whether the city considers violations a genuine public safety matter or a revenue stream.

Who should enforce parking regulations? In most U.S. cities, this job falls to police departments. After the nationwide protests against police brutality in the summer of 2020, Berkley, California and Burlington, Vermont changed this practice: Berkeley is in the process of shifting traffic and parking enforcement duties away from the police department and into a newly created city department (Levin, 2020). Rather than create a new department, Burlington is transferring parking enforcement responsibilities to their Public Works Department (French, 2020). These changes are meant to reduce the number of interactions between armed police officers and community members, especially those of color. This is a great step towards decriminalizing parking and reducing the harm it can perpetuate towards marginalized groups. There are multiple cases of traffic stops ending with police killing civilians, with several beginning with parking violations specifically. Taking this responsibility away from police departments reduces the potential for these fatal interactions. Grand Rapids, Michigan is also making this change, but with a different framing. In February 2021, the city announced their mobility and parking services department would start enforcing parking to free up police officers to "concentrate more on neighborhood policing strategies" (City transfers parking enforcement duties from police department to Mobile GR, 2021).

As referenced above, this shift could take many forms depending on local capacity, but we imagine it working primarily by using the funds that had previously gone to the police department for traffic/parking enforcement to fund another group doing the same work. Berkeley created a new department while Burlington and Grand Rapids expanded an existing one. The main difference is civilian enforcement rather than police enforcement. These jobs could take the form of a parking attendant or ambassador, similar to those employed by private lots. During enforcement hours, these attendants would walk around specific parking areas answering questions, helping people pay, and issuing warnings, before citations.

CONCLUSION

Envisioning a better future for our cities requires imagination. How can we leverage what we have to get what we want? We certainly have parking, now we need to make it work for everyone. The COVID-19 pandemic brought an onset of outdoor dining, parklets, and other curbside activations used to spur economic development in businesses that could no longer operate indoors (Shared Spaces, n.d.; Open Streets, n.d.).

The lot that once housed 15 cars for a few hours a day could be a neighborhood garden and playground. The parking spot in front of your favorite restaurant could be outdoor seating on a warm summer evening. The street you always avoided due to traffic. could become a slow street with a bike lane and raised crosswalks. The possibilities for how to use parking revenue and, eventually, reclaim parking space are limited only by the needs and imagination of the people within our cities.

Further Reading

For more information on the case studies, see:

- Short North PBD Website
- Columbus Underground Article
- Performance Based Parking Management Manual
- Northwest Parking District
- Pricing Options for Equitable Mobility

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Jane Wilberding is a co-founder of the Parking Reform Network and Senior Mobility Manager at HNTB in Chicago. Jane received a 40 under 40 award from the Association of Commuter Transportation in 2017 and named the Emerging Planner of the year from the American Planning Association Illinois Chapter in 2020. She has an undergraduate degree in Urban Studies & Business from Trinity University and a master's degree in urban planning & Policy from the University of Illinois at Chicago.

Evan Kindler

Evan Kindler graduated from Brown University in 2020 with a double major in history and urban studies. He is passionate about making cities more equitable, sustainable, and resilient places that directly cater to the needs of their communities. He is a member and former intern of the Parking Reform Network. He currently works as a real estate appraiser in New York City.

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Cover photo: Parking meter in San Francisco, CA (Unsplash)

FHWA
Federal Lands

SPECIAL FEATURE

A CRITICAL QUESTION

WITH MISTY KLANN & COLE GRISHAM

Misty Klann
Program Planning Specialist

Cole Grisham
Transportation Systems Planner

Misty and Cole are both closely involved in the administration of the FHWA's Transportation Planning in Tribal Communities Research Study, which seeks to align available planning analysis tools to Tribal community needs based on a range of contextual factors and quantify the benefits of planning analysis in the project selection and delivery processes. The Study seeks to ensure any findings optimize Tribal Transportation Program funding decision-making in Tribal communities.

What challenges is the Transportation Planning in Tribal Communities Research Study responding to, and how might the findings have a broader impact on transportation planning?

Misty Klann: The Bipartisan Infrastructure Law authorizes the Tribal Transportation Program funds, and that Program serves 574 federally recognized Tribes. Most of that funding is distributed to the Tribes through a statutory formula, with 2% of their calculated shares going to transportation planning, which Tribal governments and their transportation staff use for transportation planning and also, to meet the Program's planning requirements. These requirements include having an updated long range transportation plan. Tribes must also have an updated Tribal transportation improvement program - known as TTIP - that identifies all the projects and activities that are planned for the next four years, and the FHWA works with Tribes to approve those TTIPs.

Part of FHWA's stewardship and oversight responsibilities of the TTP funds is having the approval authority of the TTIP. While the TTIP is an important planning tool

and this process involves the necessary work of ensuring all legal requirements for the use of TTP funds have been satisfied, other kinds of planning tools that might be overlooked can also bring value to the Tribes. We want to support our Tribal partners so they can grow and succeed, while also fulfilling our oversight responsibilities.

The objective for this study is to come away with practical planning tools to support Tribal transportation planning and beyond, and understand how the FHWA's various departments can be effective partners to the Tribes. Where we can, we'll focus on technical assistance and capacity building and then bring in our partners to help meet those gaps. Generally speaking, we need to work together to improve our infrastructure - and certainly the Tribes are no exception - so this study, I hope, opens doors to build and strengthen and maintain those relationships. The more we know, the better the chances for increased project collaboration and partnerships in project delivery, which is ultimately what we're after.

Cole Grisham: The anecdotal challenge that frames this study - which is in no way unique to Tribal transportation planning contexts - can be thought of in terms of how planners develop plans that do not end up sitting on a shelf and not getting used. Therefore, how do we develop plans that do get used?

A good plan - in my opinion - rarely solves anything directly. What a good plan does is it allows a community to respond to opportunities and challenges that come up after the plan is developed and implemented. Rather than reacting to them, the plan gives communities the foundation to respond from. In that way, we attempt to work backwards from what the key post-plan decisions might be, then think about how the transportation plan can inform those decisions and what tools are needed.

To that end, the big focus for us over the next few months is in-depth discussions with our research panel, which is composed of Tribal planning practitioners, and Tribes themselves. We want to collaborate to see what planning looks like in their community areas of support and compare what's needed across the Tribes.

In terms of how this research study will translate to other planning contexts, I imagine that many of the transportation challenges and opportunities we see in Tribal communities also exist in small city and rural planning contexts, especially. I suspect that the findings from this study will help inform those analogous contexts as well.

We're always happy to talk to anybody who's interested in this study's applications to connections to other work that's going on in transportation planning. Our project website always has the latest updates on our research, the latest project deliverables, and upcoming engagement opportunities.

Expanded Content

Continue the conversation with Misty and Cole in our "Critical Conversations: The State of Transportation Planning in 2022" podcast series, available at planning.org/podcast or wherever you get your podcasts.

https://planning.org/podcast/

Photos courtesy of FHWA, Office of Federal Lands Highway

Misty Klann

Misty Klann is a Program Planning Specialist for the FHWA Federal Lands Highway Office of Tribal Transportation. She leads the office's mission to support Tribes in strengthening their transportation planning capacity. Misty also works with internal and external partners to facilitate planning initiatives that may lead to establishing and building up relationships, which may ultimately result in inter/multi-agency collaboration on project implementation. She is an enrolled member of the Navajo nation.

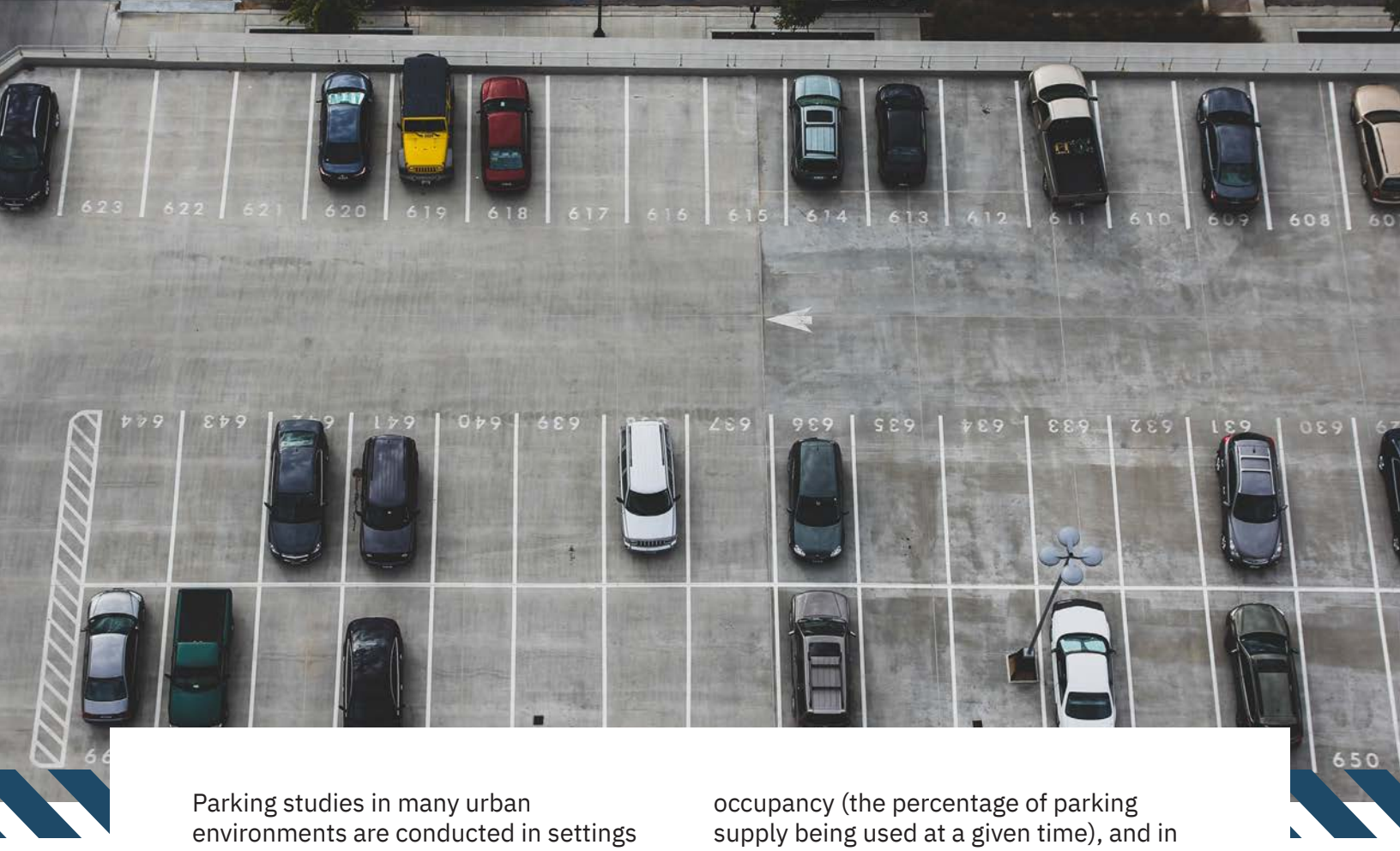
Cole Grisham

Cole Grisham is a Transportation Systems Planner with FHWA Western Federal Lands. Cole's work focuses on long range transportation planning, particularly in the areas of regional and intergovernmental policy in the American Northwest. He's a certified planner through the American Planning Association and holds a B.A. in Political Science and M.U.P. in Regional Planning from the University of Michigan. Cole is a member of the Assiniboine Tribe out of the Fort Peck reservation in Montana.

DESTINATION-BASED PARKING OCCUPANCY

The Application of Accessibility Measures to Parking Studies

Sasha Jovanović



Parking studies in many urban environments are conducted in settings which predate planning regulations requiring on-site parking. Unless these built environments have been aggressively retrofitted with parking, many of the destinations in these neighborhoods tend to have a heavy reliance on off-site parking, much of it located on the street. Within these destination-rich neighborhoods, residents, business interests, and visitors – who each generally perceive the supply to be limited, compete for this common fragmented parking supply. Parking studies are undertaken to assess how much of a parking supply is being used and when, to help cities make informed decisions about how to manage their parking supply most effectively to satisfy those competing stakeholders while also meeting a variety of other planning objectives that may be in conflict with parking, such as adding housing or improving sustainable transportation. Although there is no prescribed standard method for parking studies, these studies typically examine the main variables of parking: supply, occupancy (the percentage of parking supply being used at a given time), and in locations where parking occupancy is very high, frequency of parking turnover (How to Do a Parking Study, 2019).

Parking supply and occupancy are typically collected by each on-street segment and public parking lot in the area of study, and are subsequently presented and interpreted through tables and maps, as shown in Figure 1. However, this presentation of data often lacks the flexibility to communicate the complexity of how parking is sourced in urban environments reliant on off-site parking. The spatial distribution of parking within an urban street network is usually quite irregular with each source of parking having a varying quantity of spaces; also, because most parking is off-site, navigation is often required between the parking location and the destination. Without normalizing data for these factors, it can be difficult to accurately benchmark conditions or make consistent comparisons within a study area. The Destination-based Occupancy approach seeks to overcome

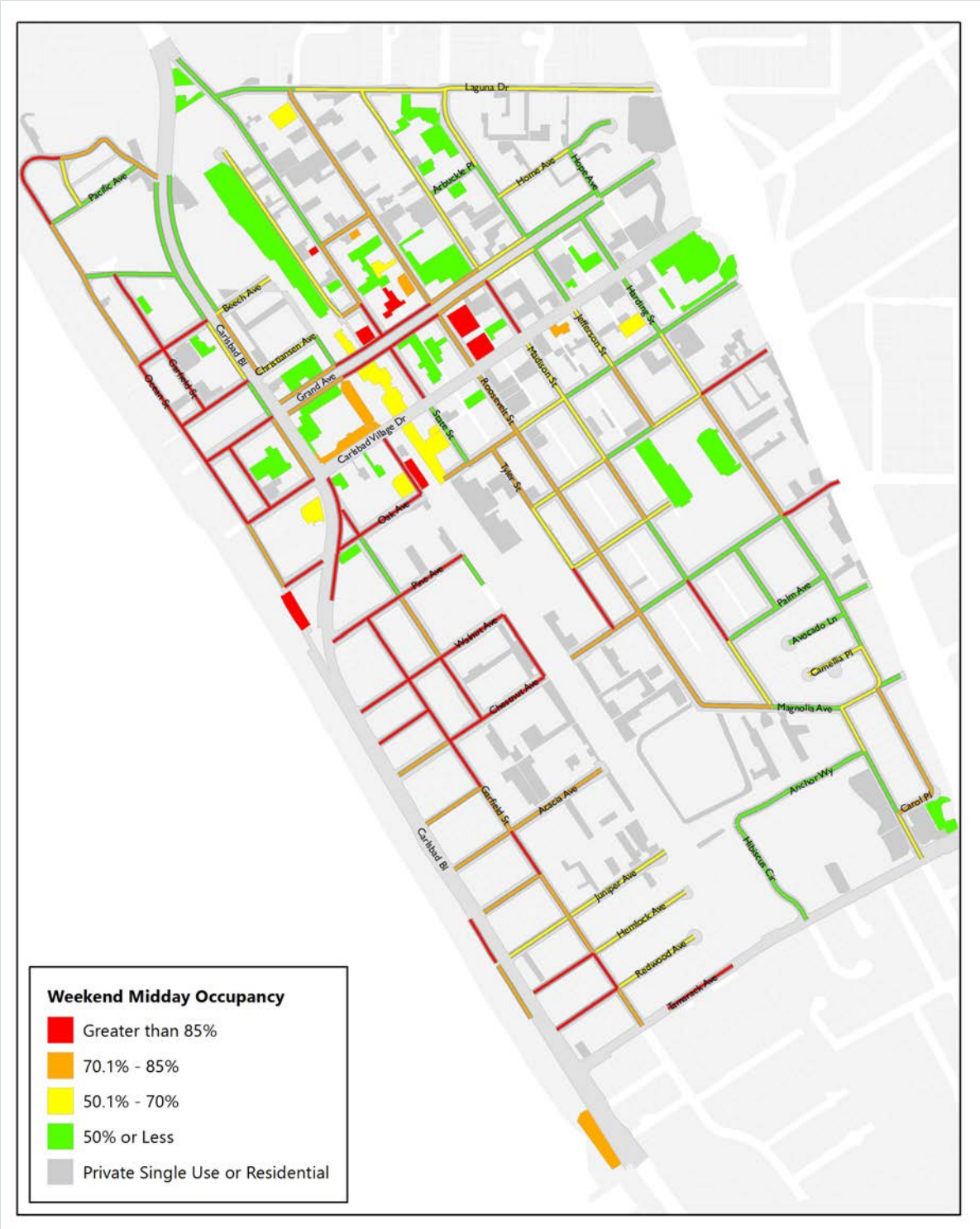


Figure 1: Parking occupancy symbolized by on-street segment and public parking lot (Downtown Carlsbad Parking Study (2021))

those conceptual limitations through the application of accessibility measurements.

Accessibility is the measure of ease of reaching destinations or opportunities within a specified travel time or cost (El-Geneidy et al., 2006). Accessibility measurements facilitate consistent comparisons within every part of the study area by summarizing each destination's parking supply and occupancy within a standardized travel distance. Geographic Information Systems (GIS) network travelsheds are generated for each destination to represent this travel distance and are the mechanism for spatially summarizing the parking data collection. This approach does not alter the way data is collected as it is only a post-processing technique, providing a supplemental way to interpret the data that improves upon the limitations of interpreting occupancy characteristics by the on-street and off-street locations of supply which vary in quantity and spatial distribution. CR Associates has pioneered this technical approach and has applied it in downtown parking studies for several municipal clients in California, including the cities of Chula Vista, Carlsbad and West Hollywood.

Accessibility measurements are often used to help better understand travel behavior, mode choice, and analyze the nexus of transportation systems and land use. The concept of measuring accessibility has been around for decades, notably the theoretical measures advanced by Walter G. Hansen (1959). In recent years, the improvement in the processing capabilities of GIS software and the increasing availability of spatial datasets has allowed the application of accessibility measures in the study of transportation to flourish (Levinson & Cui, 2019) categorized accessibility measures into two typologies: primal measures – which measure

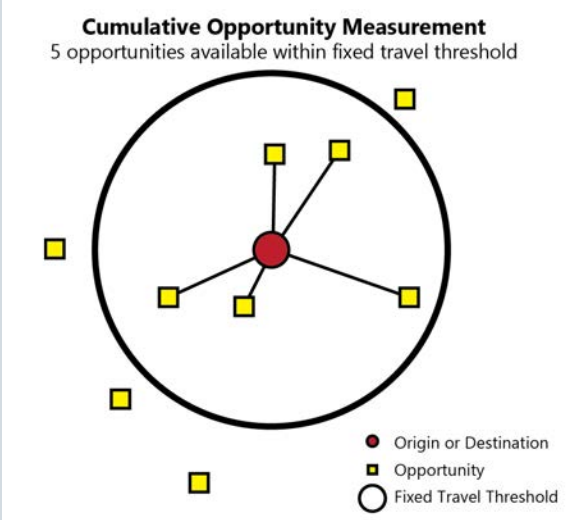


Figure 2: Cumulative opportunity measurements count the number of opportunities within a given quantity of travel

opportunities accessible to an origin or destination within a specified travel time; and dual measures – which measure the travel time required to access a specified number of opportunities from an origin or destination.

Types of primal measures include cumulative opportunity measurements – the most basic measure, shown in Figures 2 and 3, is a count of opportunities that can be reached within a given quantity of travel from an origin or destination, and competitive access measurements – which recognize that some opportunities are rival (such as parking), and that once occupied are no longer accessible to others. Competitive access measurements thus consider both the supply and demand of the opportunity being measured, with the measure discounting opportunities by their corresponding demand or occupancy (as shown in Figure 4).

Destination-based occupancy is an application of primal accessibility measures to parking inventory and occupancy. To avoid additional complexity,

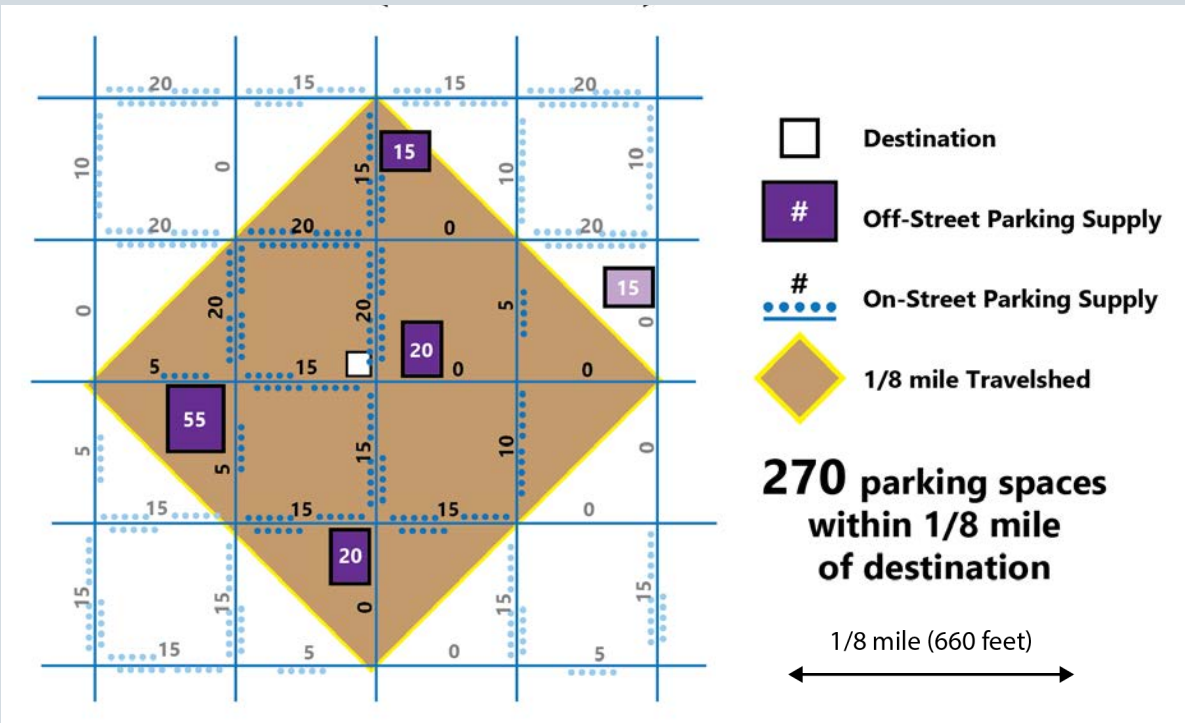


Figure 3: A cumulative opportunity measurement of parking supply within 1/8 mile for one destination. Destination-based Occuvpancy calculates this for every destination (operationalized as a parcel) in a study area and maps display the values measured for each destination

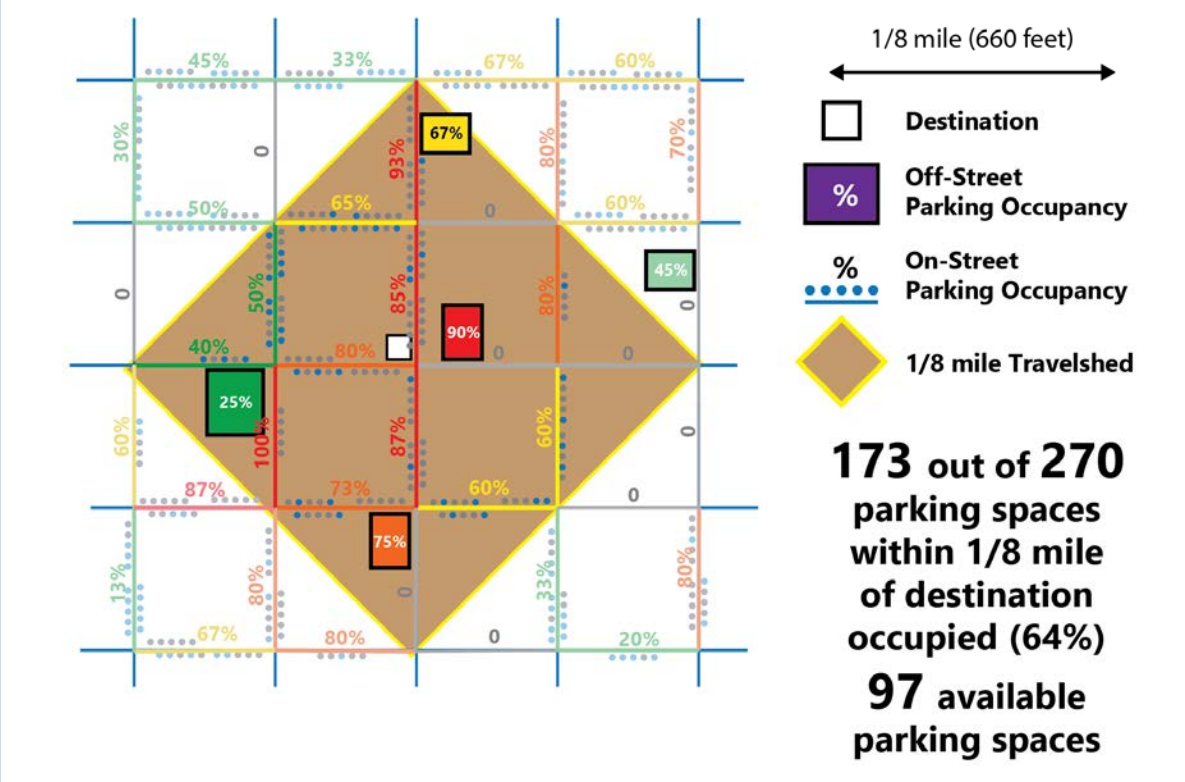


Figure 4: A competitive access measurement can be applied to count the quantity of parking spaces occupied within a 1/8 mile travel threshold of one destination

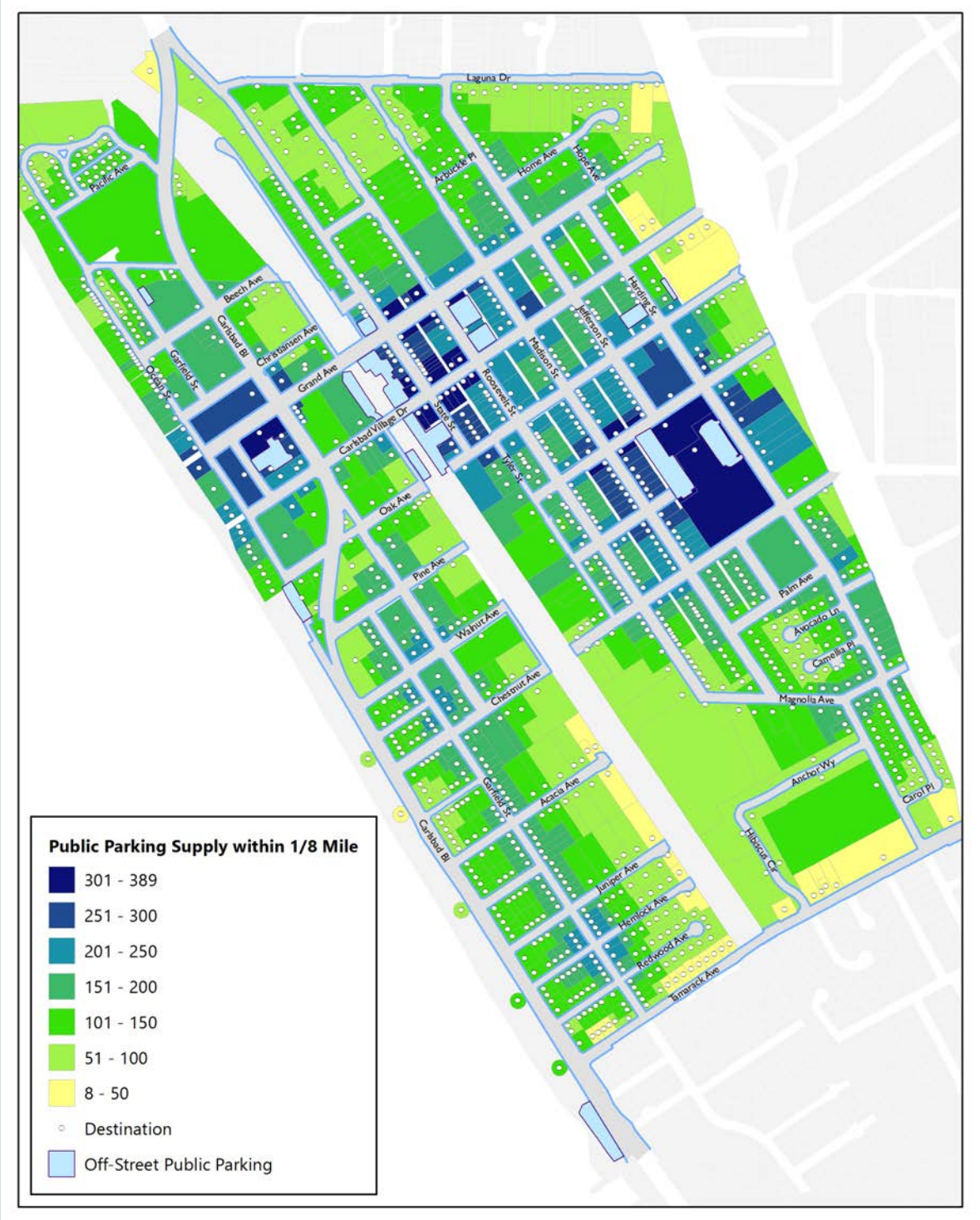


Figure 5: Map which summarizes public parking supply within 1/8 mile for every parcel/destination (Downtown Carlsbad Parking Study (2021))

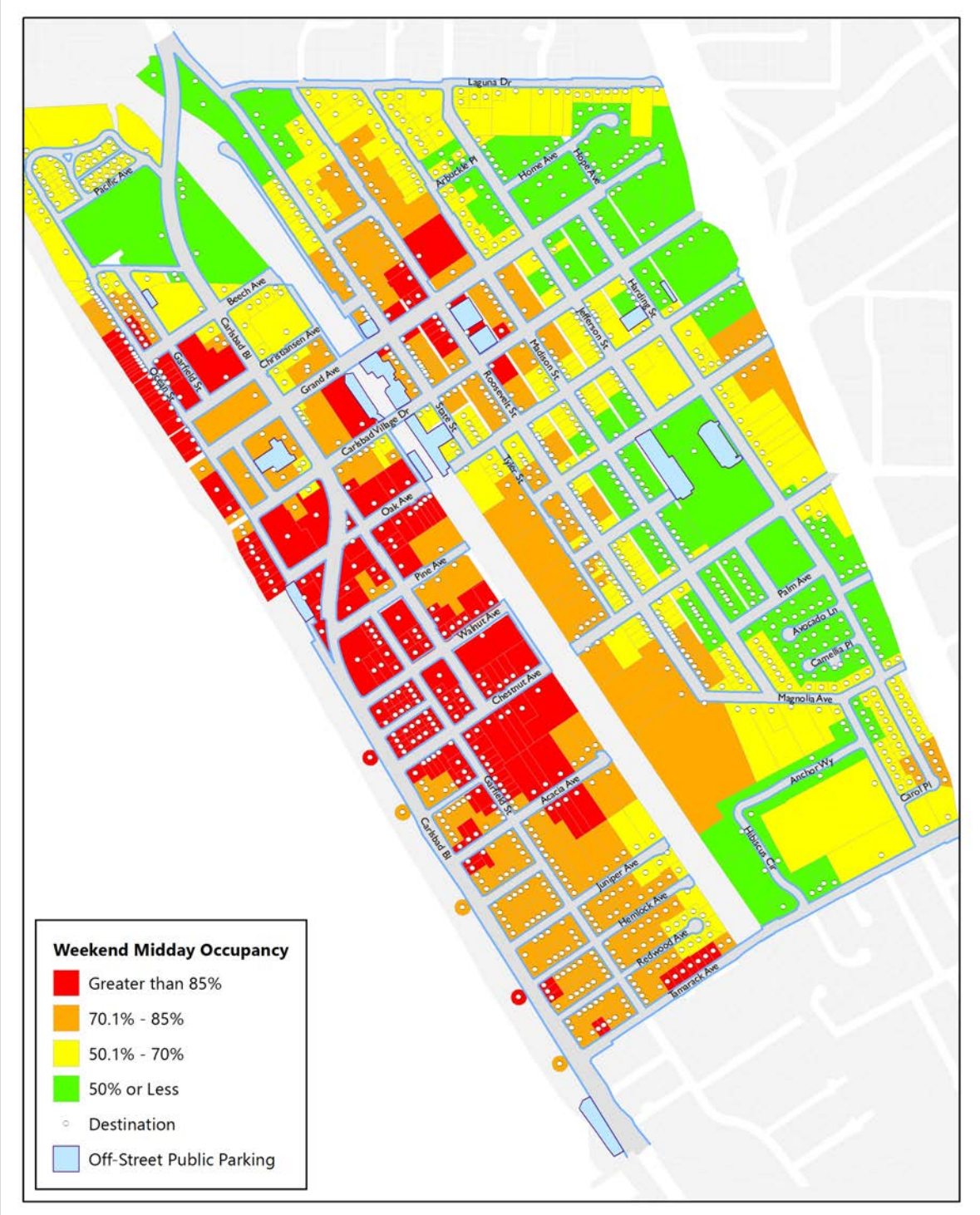


Figure 6: Map which summarizes public parking occupancy within 1/8 mile for every parcel/destination (Downtown Carlsbad Parking Study (2021))

the approach measures favor a simpler, distance-based operationalizing of the travel required, eschewing the incorporation of any cost or time factors. The approach uses a cumulative opportunity measurement to count parking supply within a fixed travel distance of every destination within a study area and a competitive access measurement to calculate an occupancy of parking supply that is destination-specific , providing a composite estimate of the remaining supply available from that destination within the fixed travel distance.

Products of this analysis include parcel-based[1] summaries of total parking supply (Figure 5), percentage occupancy (Figure 6), estimated available parking supply, and peak occupancy time period. In the projects this approach has been used , it has evaluated existing parking supply conditions, temporal variations in parking demand, future scenarios with parking supply changes and future scenarios with both land use and parking supply changes.

Typical maps will display the summarized values of parking supply and occupancy for every destination in the study area by a standardized travel distance . A standardized measure of access to parking for each destination better communicates the irregular geographic distribution of parking conditions within a study area, accounting for the variability in size and spatial distribution of parking, and the navigation required to go from parking to destination in urban settings. The shortcomings corrected by a standardized access measure are evident in Figure 7 which overlays occupancy by supply and destination-based occupancy from one period on the same map. It is common, when comparing the occupancy values on the parcels to the occupancy of its adjacent supply, to find instances of the two occupancy measurements varying significantly from each other.

By generating these standardized measures of access to parking for every destination, Destination-based Occupancy can also elegantly display how peak conditions vary geographically (as shown in Figure 8). Peak parking occupancy represents when parking demand is the highest and, if at high occupancy levels,

1 Destinations being operationalized as parcels

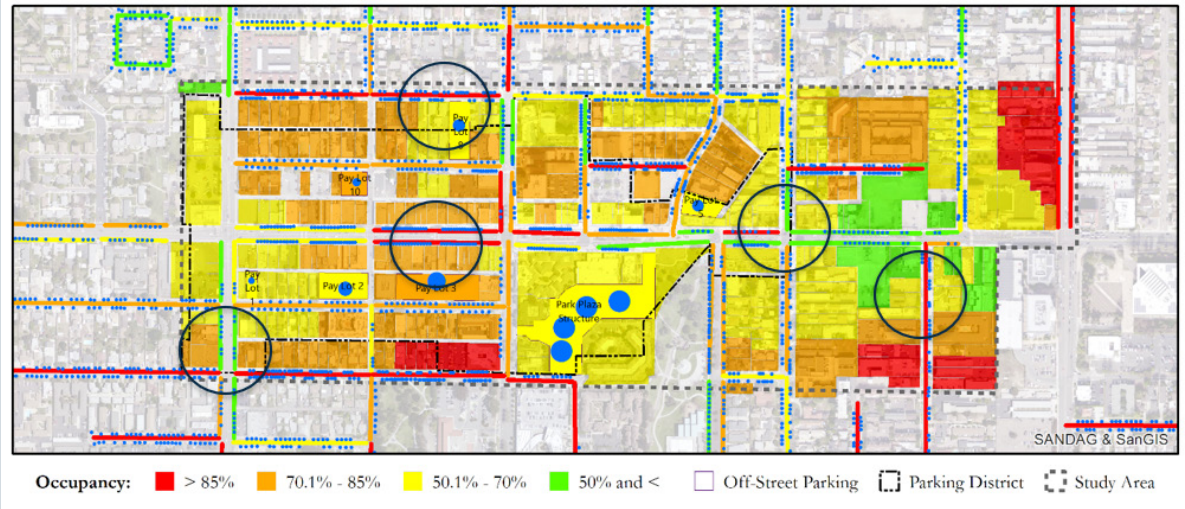


Figure 7: Overlay of occupancy by supply and destination-based occupancy from one period on the same map

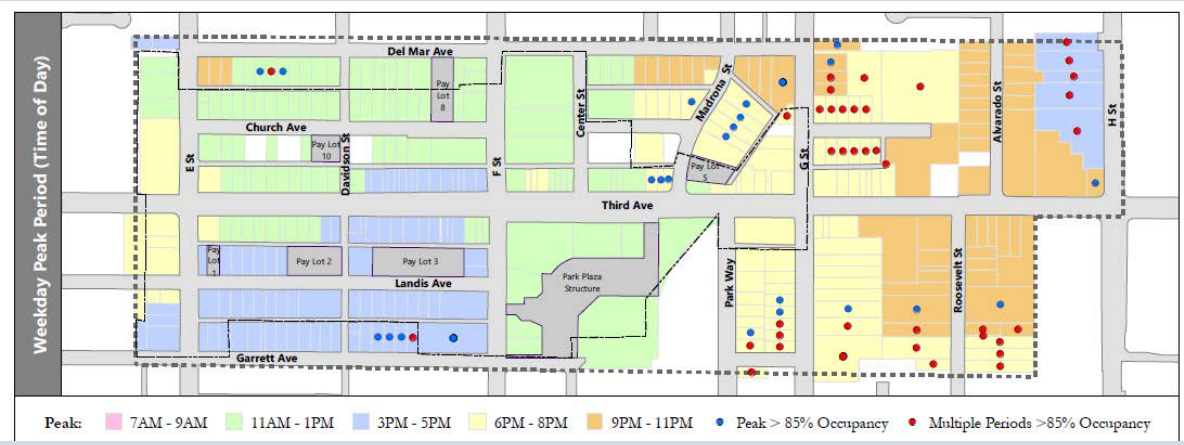


Figure 8: Destination-based Occupancy can display how peak conditions vary geographically

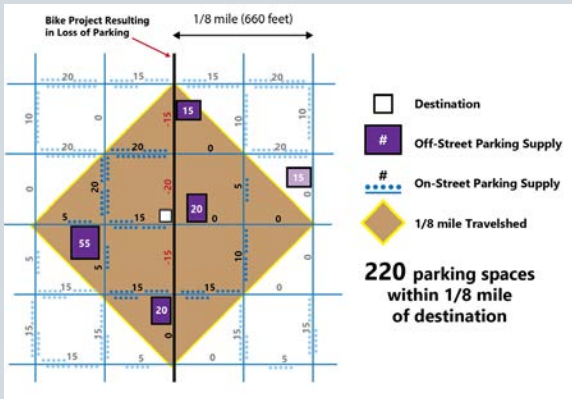


Figure 9: Parking supply within 1/8 mile for one destination with implementation of a bike project that eliminates 50 parking spaces.

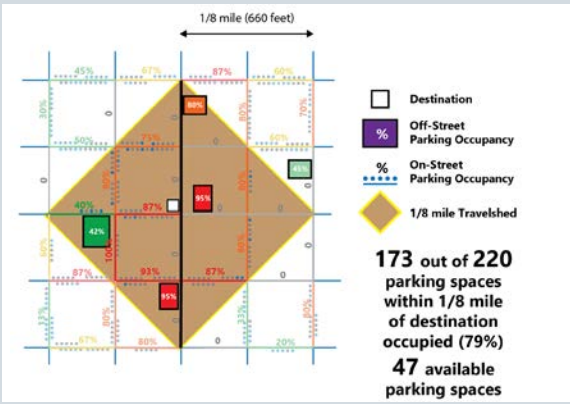


Figure 10: Estimated occupancy of supply and available parking within the 1/8 mile travel threshold of one destination after the loss of the 50 parking spaces. Displaced parking occupants are re-assigned to adjacent parking sources with spare capacity.

would approximate the degree to which an area's parking capacity is at its most strained. Study areas with a variety of land use types may have subareas which peak at different times and decline sharply at other times . Improved understanding of how peak conditions vary within a study area helped make strategic parking recommendations, such as finetuning parking in-lieu fees with better geographic precision, identifying where turnover enforcement or demand-based pricing would be most effective, and where the best opportunity areas may be to integrate future high parking demand land uses with existing parking supply.

Destination-based Occupancy also provides a foundation for other meaningful forms of parking evaluation, including the appraisal of projects which impact the supply of parking and of planning scenarios which would change the demand for parking. This was done in the Downtown Chula Vista Parking Study, where staff wanted to assess how the loss of 43 parking spaces on Third Avenue to post-pandemic outdoor dining structures would impact parking demand if and when

Figure 11: Estimated occupancy of supply and available parking within the 1/8 mile travel threshold assuming pre-pandemic demand and post-pandemic parking supply (Downtown Chula Vista Parking Study (2021))

parking demand returned to pre-pandemic levels. The findings, shown in Figure 9, helped maintain the justification for outdoor dining structures by affirming that the loss of those parking spaces did not impact the availability of parking spaces within a short walking distance during the one of the district's main peak periods. Projects which result in parking supply changes can be modeled easily into the Destination-based Occupancy framework to meaningfully assess the impacts. Calculating the destination-based parking occupancy under project conditions requires summarizing the new parking supply for each destination (Figure 10) and new parking occupancy after re-assigning parking occupants from the displaced parking sources to the nearest sources with available parking (Figure 11).

Destination-based Occupancy can also work for modeling future planning scenarios, which was another application used in the Chula Vista study, the findings of which were used to inform an update of the district's parking in-lieu fee program. Estimation of future parking generation and subsequent updating of the

Destination-based Occupancy framework requires an assumption of parking spillover (new parking demand generated in excess of what can be accommodated on-site) based on information such as the development capacities of each developable site, their on-site parking requirements, and temporal parking generation rates by land-use type. Future scenario parking occupancy by supply is then calculated by adding the spillover parking generation to baseline parking occupancies (spillover parking calculations from each developable site are assigned to the nearest sources of available off-site parking based on baseline conditions). The Destination-based parking occupancy for future conditions is then obtained by generating a refreshed summarization.

In political battles over projects which threaten parking supply, proponents of parking tend to fixate on the loss of supply directly in front of their destination of interest, despite property-adjacent parking only amounting to a tiny fraction of all parking within a short walk of the destination. While uncompromising expectations about parking may fuel much of this sentiment, this framing is also somewhat borne out of not having quality information (as was demonstrated in Figure 7). A standardized measure of access to parking, which Destination-based Occupancy provides, enhances the quality of information generated from studying parking in urban areas. This unique technical approach, first having been applied in Chula Vista, presents a potentially game-changing framework for analyzing how surrounding areas are impacted by projects which remove parking supply or alter the demand for parking.

About the Author

Sasha Jovanović

Sasha Jovanović has 14 years of professional experience as a transportation planner and geographic information systems (GIS) specialist. Throughout his career Sasha has worked on numerous mobility projects, transportation research and other transportation performance evaluation studies. His perspectives from both disciplines have helped give him the creativity to develop innovative technical approaches, many of which have been applied in the mobility planning practice of CR Associates.

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Cover photo: Aerial view of cars in a parking lot (Unsplash)

TWISTS AND TURNS:

Keeping an Open Mind in My Transportation Career

Roger Henderson

I am a "plan-gineer." I began my career as a highway engineer, then, thanks to keeping an open mind I transformed my thinking into a much broader planning view and am now a complete streets "plan-gineer." My career has had plenty of twists and turns like that.

I've had the good fortune to work on a wide variety of transportation projects over a 40 year career. I began in the urban highway design business in Chicago. After three years I changed jobs and moved to California with what ended up as an evolving series of job changes that allowed me to see the built environment from a new perspective. On a few trips I've gone out of my way to see the completed projects that I helped plan or design. As many professionals do, I looked at my old work with fresh eyes, wishing for a do-over. This is my story about twists and turns in a long career, which has been made much better by the extraordinary people I've worked with. It's a reminder to keep an open mind and listen to people who see things differently, making adjustments large and small in how we view our assignments and the world.

How did we do our jobs before Google Earth? I can visit some of my projects from the convenience of my laptop. One that I designed in 1985 was never built to my specs and I'm glad for that. It would have been "carmageddon." I traded in my "Move More Cars" mentality 25 years ago. Before that, I would calculate volume-to-capacity (v/c) ratios to four decimal points just to get a land development project approved. My firm would design the road widening to fit the specs. Thankfully, a wise city planner changed the design to something reasonable. If not, the intersection of Hopyard Road and Owens Drive in Pleasanton, California would be a nightmare to walk or bike across. A traffic impact study I prepared showed that this busy intersection would need four through lanes, triple left turn lanes and triple right turn lanes. The resulting v/c ratio, with the new development, would operate at 0.9049; when rounded off it would be an acceptable 0.90. The development was approved, but the intersection was never widened. Pleasanton has grown from a population of 40,000 in 1985 to about 82,000 today. The City made a wise

decision not to build such a big intersection. I'm glad. The experience opened my eyes to a new way of envisioning the built environment, furthering my path away from my "move more cars" approach.

Pleasanton was bustling. Investors saw big opportunities for this community located 30 miles southeast of San Francisco, at a crossroads connecting California's Central Valley with the economic powerhouse of Silicon Valley and the East Bay. Fearing being overrun by traffic congestion, City officials and the development community worked together. I was impressed that developers paid to widen interstate highways and build interchanges. When our traffic studies assumed 25% of trips could be discounted for people who would walk, roll, stroll, work from home or otherwise flex their commute times to avoid congestion the City made us follow through. The first Transportation Systems Management (TSM) Ordinance (now known as Commute Alternatives or Employee Commuter Programs) was in Pleasanton, California (Curry & Fraser-Middleton, 1984). The City required it before allowing consultants to use big traffic discounts in studies, and our developer client very much wanted to continue those discounts. Thus, every company in the business park had to submit an annual report and follow through on the progress of trying their own ideas; anything to get workers to avoid driving alone in the peak hour. One of the byproducts, of course, was an opportunity for short trips conducive to walking and cycling.

Fresh winds were blowing through the transportation realm, so I changed my career path to follow the breeze. The changes brought by the federal transportation bill known as ISTEA were enough to open my eyes to the fact there were other ways of seeing the built environment, continuing my evolution away from a "move more cars" philosophy. I took a job as Senior Transportation Planner with a Congestion Management Agency (CMA) based in Oakland. CMAs were unique to California; emerging from a successful state initiative to boost funding for transportation projects while putting a governor on growth – what was called growth management. Based on a pact between pro-growth advocates and environmental stewards, the CMAs were born. Growth management strategies in CMA legislation included system level of service standards, transit standards, trip reduction and travel demand management, database and modeling, land use development analysis, capital improvement program, monitoring and conformance, and a deficiency plan. Soon the amassed work programs of 20 or so CMAs amounted to more than Caltrans's budget. I worked on leading edge studies including parking cash-out, dynamic tolling (i.e. congestion pricing), and one of the first demonstration programs for telecommuting. The telecommute demonstration was a total success with one exception; our boss didn't like it, so back to the office for us. The internet was relatively new in 1995 and our little agency assigned our receptionist to be the person to type in a question. Search engines were in their infancy so the questions we asked on the internet produced little in return. My time at the CMA was a game-changer, allowing me to clearly see how transportation planning and investments affect people and the built environment.

I contributed to the work of a big team with an update to the long-range countywide transportation plan. I learned how to review large development proposals with a critical eye, as that was part of our mandate – to report potential impacts to the regional transportation system to our Board, comprised of 14 mayors and a County Commissioner. I also learned how to review draft legislation and write about it.

When thinking about game-changers for my career, my graduate studies at the Institute of Transportation Studies at UC Berkeley taught me how to apply the fundamentals of engineering to all modes of transportation. Many engineers learn capacity analysis for vehicles passing through an intersection or on a highway segment, while we learned passenger flow on trains, platforms, escalators, and turnstiles. Others learn geometric design with a highway interchange or a road on a new location, while we learned by designing a bikeway along a river with interchanges at the roads crossing over the river. We even put in loop ramps for cyclists – so cool! Faculty were constantly challenging students to approach problems with an open mind and to test our bias and presumptions.

Lending a helping hand to colleagues often leads to good things. After a successful relocation to North Carolina, I was asked to step in to help colleagues in our Atlanta office who were pushed by a municipal client to be less traffic engineer, more multimodal planner. The work went well and even included a health impact assessment prepared by team members at Georgia Tech. The work was peer-reviewed by public health professionals at the nearby Centers for Disease Control and Prevention (CDC) who praised the emphasis on active transportation. The study won accolades and awards, which led to a national speaking tour for the Mayor and Planning Director. My contribution to the study was noticed by the founders of the Complete Streets movement. Barbara McCann and Michael Ronkin spent several years criss-crossing the country giving workshops and lectures. They were ready to share the load, so they recruited workshop instructors. I was invited to join the original group, went through training and embarked on a wonderful experience over the span of nine years visiting 60 communities across the country to help convince community leaders to adopt Complete Streets policies and then begin implementing them.

A community-based proposal in Raleigh to transform a four-lane urban thoroughfare to a complete street came about after a local citizen raised funds to hire Dan Burden and his team. With input from hundreds of participants over the span of a week, Dan introduced the idea of narrowing Hillsborough Street to one lane in each direction with a raised median and replacing signalized intersections with modern roundabouts. Over the span of ten years I directed the consultant team in the planning, analysis, and design of the improvements. During construction, I served as Director of the new business improvement district in the benefit zone. It was the summer of 2008 and business and property owners in the construction zone didn't think of it as offering much benefit to them; the economy soured, NC State University students left for summer break and front loaders tore up the street and made access difficult. I worked hard to help them keep an open mind. A study done six years after project completion showed the City's initial $10 million investment in the street project was rewarded 30 fold (30 to 1 return-on-investment) with over $300 million in private real estate investment in the affected area and another $800 million invested in the greater area (Murison, 2016). Many people kept an open mind during the arduous process of securing approval and funding for such an innovative street design.

The national focus now on safe streets, vision zero, complete streets, active transportation, and multimodal safety weren't on my radar when I started my career. I certainly didn't have that vision. But through many twists and turns I managed to work my way into a rewarding and fun career. Some of it was certainly

serendipity – lucky to be in the right place at the right time. Some of it was just saying "yes" more than "no."

I believe some keys to success include keeping an open mind, listening to others, and updating our thinking. The current ideas around equity, diversity, inclusion and access excite me. Applying fairness, differing perspectives, welcoming everyone and removing barriers will be hard work, but so rewarding.

About the Author

Roger Henderson

As the Director of Multimodal and Complete Streets at TJKM he is building a practice in Florida. Roger has expertise in the planning, policy, design and management of transportation projects. He served as an instructor for university courses and contributed to design manuals. He helped launch a new business improvement district in Raleigh, North Carolina after planning and leading the design team on a transformational road diet in the district. He led more than 60 workshops in 26 states for the National Complete Streets Coalition. His work contributed to several clients being recognized with awards by the American Planning Association and the Institute of Transportation Engineers.

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Cover photo: Aerial view of highway interchange (Pexels)

MOBILITY RE-EDUCATION

Saving Our Cities & Ourselves

Stacey Randecker

INTRODUCTION

Human activity causes climate change, and its impacts will become increasingly acute if we do not significantly reduce greenhouse gas emissions (National Research Council, 2010). In the United States the transportation sector is the largest single contributor to greenhouse gasses (GHGs), producing 29% of all emissions. Of those emissions, 58% are from light-duty vehicles or cars(US EPA, 2015).

Our modern-day vehicle fleet is still almost entirely fossil-fueled. Fully electric vehicles constitute just 1% of our nation's vehicle fleet(Plumer et al., 2021). Those combustion engines contribute to both noise and air pollution, which is estimated to be responsible for 10% of deaths in the United States(Vohra et al., 2021), affecting children more severely than adults, and reducing lung capacity even with short-term exposure. Over the long term, air pollution increases the risk of heart attacks, lung diseases, and cancers. Particulate matter has been shown to damage the brain, nerves, liver, and kidneys, causing premature death, and poor respiratory health(American Lung Association, 2020).

In the United States, motor vehicle crashes killed 42,060 people in 2020. This is despite reduced traffic and a drop in vehicle miles traveled (VMT) attributable to shelter in place orders at the onset of the COVID-19 pandemic (Bolotnikova, 2021). The United States has the most road crash deaths of any high-income country. Motor vehicle crashes have been the leading cause of death for those under age 54 (Association for Safe International Road Travel, 2021) and while motor vehicle fatalities have increased since 2010, pedestrians and bicyclists have increased 45% - a rate 3.5x that of motor vehicle occupants(US Department of Transportation, 2022).

Nearly four million have died (Figure 1 - Cumulative Issues) in this country due to motor vehicle crashes since they were first introduced. The only thing more disturbing is that at least that many are severely injured every year. Every death impacts their loved ones. Every injury impacts those

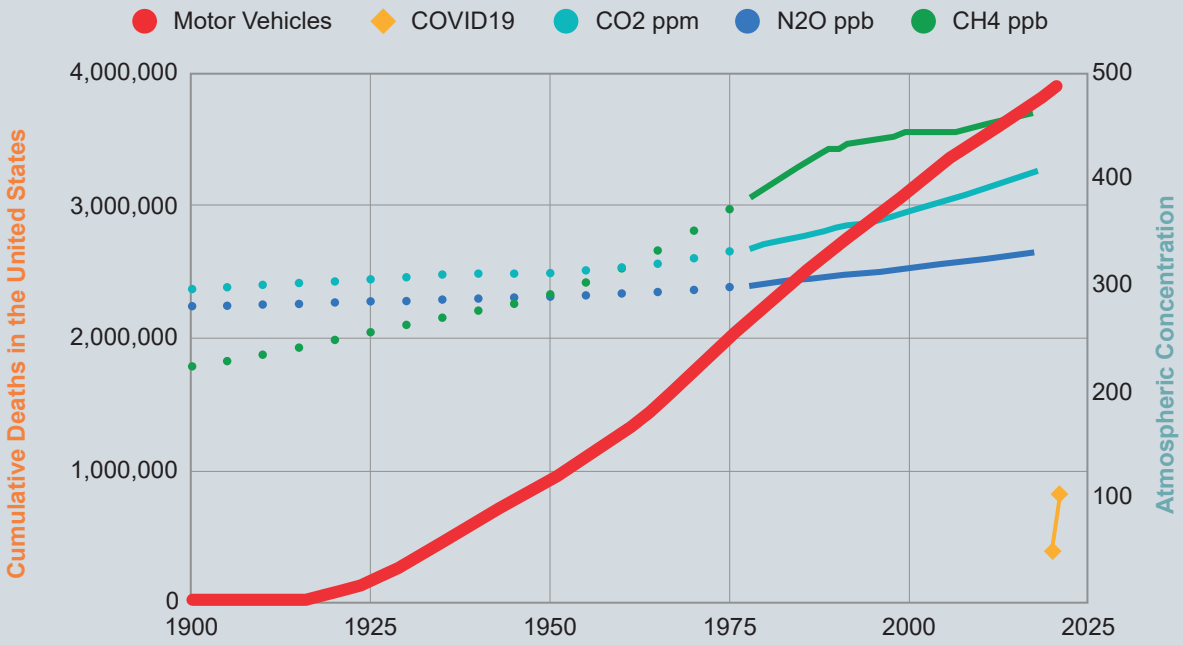

Figure 1: Cumulative Deaths in the US And Global GHG; Source: MV Deaths, FARS + NHTSA; GHGs, climatelevels.org, COVID19, NY Times

survivors. This is not taking into account the property damage, strain on municipal resources and our healthcare system, and the costs to all.

This country needs a rapid restructuring of its transportation. We need a complete re-education on personal mobility to understand the impact our transportation choices have on the environment, reckon with the catastrophe caused by our quest for convenience, and chart a new path built on equity and resilience.

NEED AND PURPOSE FOR MOBILITY RE-EDUCATION

Based on the climate, health, and safety evidence cited, it is very clear that we need a system-level re-imagination of transportation in this country. Yet we have failed to make even modest measurable change in shifting to sustainable and climate-friendly transportation options. The reasons appear to be based on political will and the habits of adults who have inherited and perpetuated the car-centric American lifestyle.

The thesis for this concept is that adults will not willingly change their mobility patterns until policies are implemented which make it easy and attractive to do so, or difficult to justify driving. This requires leadership like which Anne Hidalgo, Mayor of Paris, has exhibited. She has phased out diesel cars, reduced the number of street parking spaces, increased meter prices, established fines for loud vehicles, reduced the speed limit to 30kph (19mph), opened bus lanes and hundreds of bike lanes, and created car-free zones outside of schools. Hidalgo also eliminated through traffic on Rue de Rivoli, a major crosstown thoroughfare, and plans to do the same for an area of 5.4 square miles from Place de la Bastille to Place de la Concorde (Green-Zones.eu, 2021) (Grabar, 2021) (O'Sullivan, 2021).

In lieu of a leader making these changes for their citizens or expecting the average citizen to change well-worn travel patterns, perhaps we could focus on those who have not yet established these patterns–those who don't own a car and aren't licensed to drive: our children. If we can get America's children to ride transit and bikes en masse, perhaps they might never need to become drivers. But how do we get children to bike and ride transit?

In the United States, children, or even human bodies, are rarely considered in our transportation planning, which traditionally focuses on motor vehicle throughput and alleviating traffic congestion. Even in our cities where transit is robust, you don't often see children navigating it by themselves until they are "old enough."

Alternatively, Tokyo first graders travel solo on transit, sometimes with an hour-long commute (CBS News, 2015). Children throughout Europe travel solo at school age. Whereas kids in the United States don't often ride public transportation solo until age 12-13 (Benjamin, 2019), the lone exception being New York City where kids may start riding alone at age 9-10 (Geikhman, 2019).

That leaves school buses to transport children, but many U.S. school districts have been reducing or eliminating school bus programs due to the cost of maintaining them. In California, school districts are only required to provide transportation for students whose Individualized Educational Plans require it. San Francisco Unified School District buses just 7% of its students, while the national average is about one-third of students. Other California districts have resorted to charging families for an annual school bus pass. Capistrano Unified, Orange County's largest school district, charges $575 per school year (Goulding & Kopetman, 2021).

When schools reduce/eliminate transportation, parents are forced to fill in the gaps, further exacerbating the negative impacts of our transportation system on safety, traffic, health, and the environment.

- Each parent who replaces a bus ride with driving their child to school uses approximately 180 additional gallons of fuel per year, spends an additional $663 on fuel, and puts 3600 miles on their car (American School Bus Council, 2021).
- Every vehicle mile in a personal vehicle increases air pollution, GHG emissions (Argonne National Laboratory, 2018), and increases traffic congestion by as much as 20 to 30% (Dubay, 2003)
- Approximately 800 school-age children are killed in motor vehicle crashes during normal school travel hours each year. Just 2% of these deaths occur on school buses, while 74% occur in private passenger vehicles. Approximately 22% of these deaths are students on bicycles or pedestrians. More than half of these deaths overall are due to a teenage driver (TRB Special Report 269, 2002).

Furthermore, as much as we need our children to "get on the bus", we need that vehicle to be fully electric. America's fleet of roughly 480,000 school buses drives nearly 3.5 billion miles every year transporting students to and from school (U.S. State by State Transportation Statistics, 2016-17). Some 95% of these school buses run on diesel, a known cancer-causing agent, with air pollution inside buses up to 12 times higher than typical outdoor levels (Beatty & Shimshack, 2011). Children are especially susceptible to these environmental issues due to the fact they are still growing. Daily exposure to these pollutants contributes to asthma and respiratory diseases as well as cognitive

impairment, harming test scores and attendance (Amercian Lung Association, 2020).

Students from low-income communities are particularly exposed: 60% of students from low-income families ride the bus to school, compared to 45% of students from families with higher incomes. Moreover, communities of color are more likely to suffer from vehicle-based air pollution due to historically racist lending, transit, housing and zoning policies that concentrated black and brown communities closer to highways and other pollution sources (Lazer, 2021), or the infrastructure was built through them creating "sacrifice communities."(Fears, 2021)

The U.S. Department of Transportation estimates that the construction of our interstate highway system displaced more than 475,000 households, that's more than a million people nationwide who were moved, and those who remained lived in the "hollowed-out communities" after the bulldozers left. Those people and neighborhoods were overwhelmingly Black and poor (Archer, 2020).

School transportation is incomplete. Our school buses today only serve students riding the bus to (public) school and home immediately after school. Very few districts provide transportation to after-school activities or charter/private/parochial schools. Access to after-school programs is often an equity issue with higher-income families being more likely to have accessible options due to budget and transportation (Duffett, 2004). For instance, approximately 59 percent of school-aged children from low-income families participate in sports, compared with 84 percent of children from wealthier families (annual income $75,000+)(Pew Research Center, 2015). This opportunity gap exists for private lessons and participation in specialized clubs as well. We should not just worry about the gap in terms of access; we should also be concerned about outcomes (McCombs & Whitaker, 2017).

The inequity of child transportation isn't just a concern for the children. It's also an issue for the parents as well. Women's travel is more affected than men's. Limited research exists on mothers and alternative travel modes; the obstacles discouraging women from using non-auto modes tend to be social, economic, scheduling, and infrastructure inadequacies (Wenzinger, 2017).

While it is important to acknowledge that dual-earner households with children manage and organize everyday life in the context of the family situation, mothers still bear an unequal responsibility for transporting children. On average this responsibility results in shorter trip distances but longer travel times due to the complexity of mothers' travel patterns. In order to negotiate this trip complexity, mothers often rely on the car as their primary transportation mode, citing flexibility and time savings as reasons for its use.

Children need more than just a ride to and from school. They need to have transportation from home to school to after-school activities and home again. This is a matter of independence and equity, and the path to healthier communities, people, and the planet. Our climate, cities, and society have reached a point that can longer tolerate business as usual. We must take radical steps to drastically reduce VMT, air pollution, GHG emissions, traffic congestion, and systemic inequities, and increase active transportation, transit ridership, opportunity, and safe space for people in their cities.

MOBILITY RE-EDUCATION CONCEPT

Program Purpose and Focus

The mission of the Mobility Re-education concept is to accelerate the adoption of active and public transit, reduce dependence on personal cars, and ensure access to shared, fully electric transportation.

Unlike most pilots which start small and grow over time, this program would start by "swallowing the ocean." A traditional pilot would attempt to patch a few vehicles together with willing and (flex)-able participants. It would also mean part-time driving schedules which makes it more difficult to find qualified drivers who are already difficult to find (Avalos, 2021). Instead of starting small, it is recommended that this pilot concept starts with a year of planning in which a city would restructure its transportation of ALL school-aged children and the scope of paratransit operations via a number of public-private partnerships, the organization of which would resemble something similar to a war effort. This method would mean the full user base is available and routes can be crafted to suit actual need rather than building a system that might not work for people.

Figure 2: City of San Francisco (47 Square Miles)

Proposed Pilot Program Location

San Francisco makes an ideal first city to implement due to its unique "sandbox" design. It is a compact 47 square miles and surrounded by water on three sides, with very clear geographic boundaries that are both the city and county limits. As one of the world's tech capitals, an estimated 30% of its residents work in technology (Swartz, 2021). This would likely translate to more technology-savvy users, thereby resulting in less support needed with the application. San Francisco also has the distinction of having the lowest concentration of children (13%) of any major city in the US (Neilson, 2021), and due to its unique assignment system and one of the nation's highest proportion of children attending private schools (30%) (Lorgerie, 2015), children are unlikely to attend the school closest to their home. And as the second densest large city in the US (Sumida, 2021), there is significant need and opportunity to reduce car dependence.

In 2016 the San Francisco County Transportation Authority conducted a study on the state of child transportation in the city. The study–limited to the K-5 cohort and only considering transport to/from school–estimated that parents driving children to and from school accounted for between 60,000 and 80,000 miles daily (San Francisco County Transportation Authority, 2016). Including other cohorts and non-school trips (e.g. extracurricular), it's reasonable that the total is closer to 200,000 miles daily–equivalent to80 metric tons of CO_2 every school day (US EPA, 2016). That amounts to about 1% of San Francisco's annual transportation emissions (City and County of San Francisco, 2018).

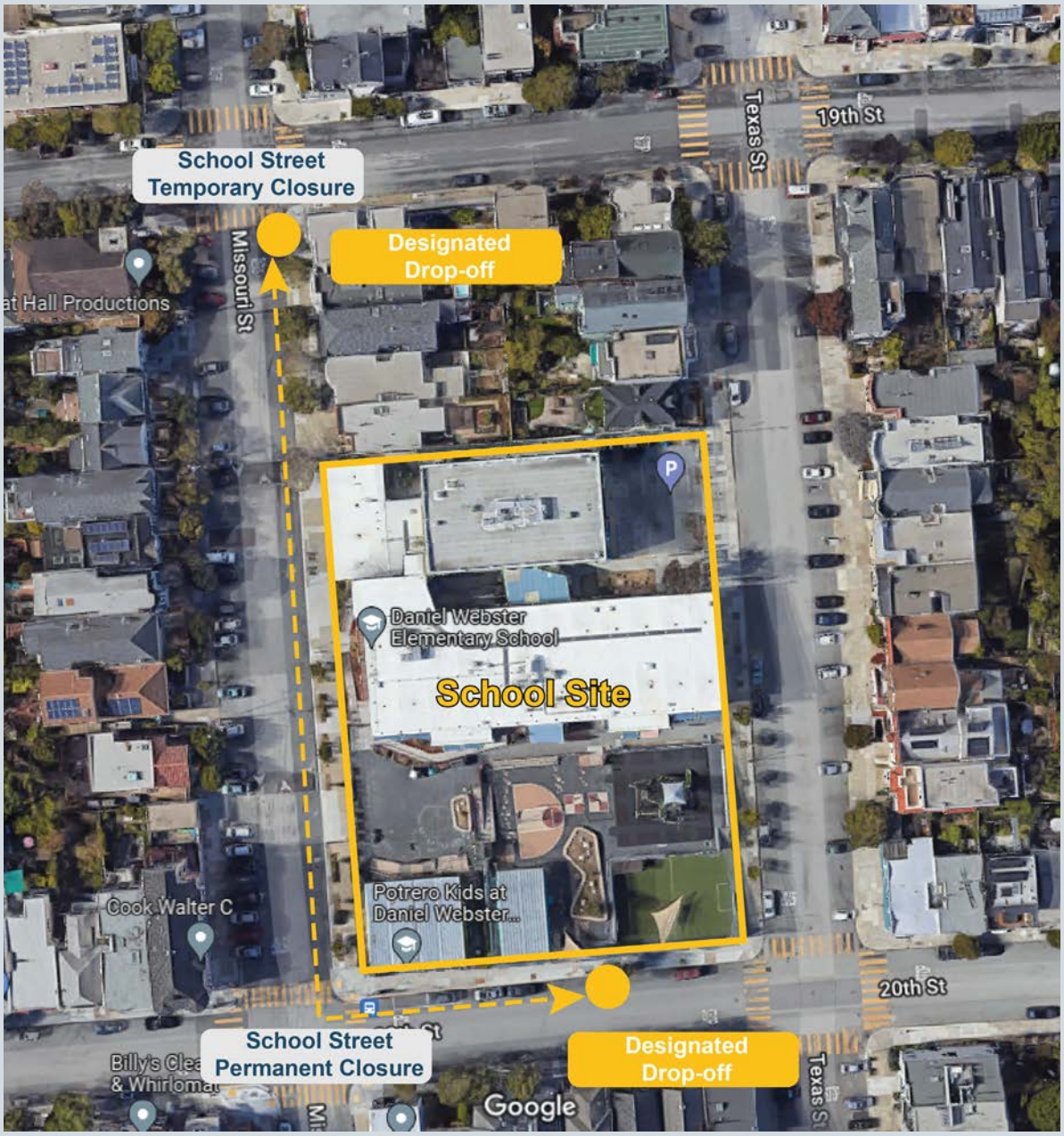

Figure 3: School Street Example

Program Principles

The goals of the Mobility Re-education Program are to:

- help all school-aged children move through the city in the lightest, safest mode possible. By helping children become more comfortable walking, biking, and taking transit they can start establishing lifelong patterns, while also freeing their parents to utilize alternate modes of transportation (transit, walk or bike). Ideally all children would travel in the lightest, safest manner for their age, location, and schedule.
- ensure that before children leave middle school, they are familiar with and can independently ride local transit (Muni, BART) as their schedule demands, know how to ride a bike, and can navigate their home and school neighborhoods, if not all of San Francisco. With confidence and habits instilled, they might never need to own or operate a car, instead opting to bike, walk, take transit or shared rides.

Program Target Population and Detailed Program Description

The main group to be served are kids K-6. Students in 7th-12th grade can either be riding local transit (Muni), biking, or walking. There are exceptions to this if a student has a lengthy commute with an early start time and/or late activities/ practices that would make it difficult for them to get home at a reasonable hour, we want to include them. Children will be grouped by routes that make the most sense based on their origination and destination. This means children will likely be riding with kids from other schools. The cross-pollination intends to break down some of the silos in San Francisco.

The program will be priced at a rate that is reflective of the family's utilization without being overly complex so that all children could have access to safe and reliable transportation, not just those who can afford it. Prices are on a semester basis and can be billed monthly. The top cost for the program would be similar to an adult Muni pass. There is no cost for walking, biking, or Muni route guidance (route data would be shared with SFMTA so that it might inform future increases in ridership as children age out of "kid transit". Subsidies would be provided for families who need support - similar to the Free/Reduced Lunch Program. These costs would be offset through grants and transportation dollars spent via city agencies like Department of Children, Youth, and Family (DCYF) and foundations like The John D. and Catherine T. MacArthur Foundation, The Knight Foundation, and Bloomberg Philanthropies.

All schools would be required to designate at least one "School Street" bordering campus which would be closed to cars during the school week if not permanently. Neighborways and Safe Routes would be identified as arteries running to the School Street. There would be a campaign asking San Franciscans to do their part in watching out for our kids in their travels through the city — waiting for a shuttle, walking to school, riding a bike or Muni.

Transportation would be a part of the kids' school experience. Curriculum needs to be developed with educators to talk about the benefits of active and public transit, and integrating with the neighborhood. We hope to welcome school staff to ride along in our shuttles, and Walking School Bus/BiciBus programs.

Vehicles will be fully electric passenger vans. Drivers will be employees who pass all licensing, background checks, and program training. There will need to be a stock of substitute drivers - those

that cannot accept full-time employment scheduling wise, but could be called in as-needed. They would get paid better than rideshare driving and no wear/tear on their vehicle.

This initiative should be administered by a (to-be established) non-profit or B-corp. This is necessary to keep family fees low while transportation education and community engagement remains high. This isn't about profits, but about a necessary system change that must be grounded in being equitable and for all.

Why this works

- Can serve all students rather than just those who can afford to opt-in, which could help to build a robust ridership base to higher frequency and more route options.
- All rides would be booked virtually, in advance. Routes could therefore be optimized so that the service is operating efficiently and is cost-effective for riders.
- Provide location information of children, seniors, disabled (opt-in), patients to just those who need to know/when they need to know.
- Integration with school attendance trackers
- After-hours service for adult riders can be subsidized by employers and Section 123 elections.
- Employers and agencies are already transporting people. We're simply organizing resources, people, processes in a way that makes the transition happen faster by reducing barriers and friction to people doing the right thing.

Step 1 - Build the Foundation - Year Zero

The spine of the operations is built upon serving San Francisco Unified School District. In 2019, SFUSD spent $29M to provide bus service for 3,500 students. The average expense per child, per day works out to $46, which could reasonably cover 2-3 solo rideshare trips. School bus utilization seems to be quite low. With improved routing and increased user base, more kids can ride together, those same District dollars can serve more children .

One additional near-term consideration is that SFUSD has a contract with a bus service provider which may last through 2024. There may need to be a partnership or buyout of the contract if all parties are amenable. But this funding will go so much further when combined with other funding streams.

Vehicle Acquisition

Ideally, vehicles would be leased. Alternatively, there are various local/regional, state, and federal grant programs that SFUSD could pursue to could cover large percentages if not the total cost of electric buses, vans, and charging infrastructure (Table 1.)

The key to the shuttle portion of the program is in smaller electric vehicles. This means shorter, faster routes for riders, but also means more vehicles and drivers than typical school bus programs. Niche shuttle operations like Chariot by Ford (commuter shuttle, 2017-2019) (Korosec, 2019) and Boost by Mercedes-Benz (kid transit shuttle, 2013-2015) (Kaplan, 2014) closed due to high operation costs and low vehicle/driver utilization.

Sustainability via Utilization

The way to support the number of vehicles and the need for drivers is to partner with,

Table 1: Grants available for purchasing electric buses and shuttles - December, 2021; Source: California Incentive Roadmap: Navigating zero-emission vehicle, infrastructure, and manufacturing funding, California Mobility Center

Agency	Grant Name	Amount Available
BAAQMD (Bay Area Air Quality Management District)	Carl Moyer Program	$40M
BAAQMD	Transportation Fund for Clean Air	$750K annually
BAAQMD	Community Health Protection Program	$28M
CA HVIP (Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project)	Clean Truck and Bus Incentives	$45K • $85K • $210K per vehicle
PG&E (Pacific Gas & Electric)	EV Fleet Program	$42K/charger + $9K/vehicle
VW Mitigation Trust (Valley Air District)		$400K/vehicle
American Rescue Plan	Electric School Bus Rebate	$300K/vehicle
DERA (Diesel Emissions Reduction Act) U.S. EPA	School Bus Rebate	45% of cost, $65K/ vehicle

not replace current paratransit and shuttle operators. The goal is to eliminate their dirty vehicles and incorporate their drivers, who are often part-time and/or under-utilized, as full-time employees. The next category is “After Hours” - replacing car trips for those who must travel when transit is not available. They could use transit or corporate shuttles at one end of their day, but that isn’t an option at the other end of their day. And lastly, filling in where transit isn’t.This optimized service would increase driver and fleet utilization, as well as reduce fleet capacity needs. This is done with four service lines:

1. Kid Transit - core service
    - 1.1. As described for transportation of kids from home to school to after school activities and home again
    - 1.2. For school field trips and athletic events
    - 1.3. Available on weekends and holidays for club teams, schools, group gatherings with families
2. Paratransit - service extension to electrify city fleet and increase driver pool. Services can use Kid Transit vehicles at super low cost and/or in exchange for drivers.
    - 2.1. Working with traditional paratransit operators so that drivers can have complete shifts/better pay and vehicles are electric
    - 2.2. Medical appointments
    - 2.3. Meals on wheels deliveries

3. After Hours - supplemental service to encourage transit ridership of adults servicing 24-7 employees pre/post transit-hours
    - 3.1. Dawn Shift - bakers, baristas, construction workers, and childcare providers who need to be places before transit is running, but can go home during normal transit hours
    - 3.2. Graveyard shift - bartenders, waitstaff, and entertainers who can take transit to work, but need a way home after transit has often stopped running
    - 3.3. Other potential off-hours workers - biotech manufacturing, hospitals, security guards, taxi drivers, janitorial staff, transit operators
4. TransitX - Boosting transit
    - 4.1. Circulators from Caltrain, Transbay Terminal, Ferry Landings
    - 4.2. Intracity Campus Connections - Replace Academy of Art, Williams-Sonoma, Candlestick, UCSF, etc...vehicles
    - 4.3. Hillclimber - Giving people a lift up hilly neighborhoods. Enabling vehicle closure for Twin Peaks
    - 4.4. Park & Rec Connect - Enabling vehicle closure for Twin Peaks, Golden Gate Park, Great Highway, Embarcadero. Connecting far flung neighborhoods to these destinations by shuttle.
    - 4.5. Culture Connect - Museum sponsors can donate charters from neighborhoods that don't have easy access to their facilities.

Figure 4 is a rough estimate of the initial potential of all services initiated. Instead of spending $29M to bus just 3500 children, it could be the foundation for a program which serves about 42K children and 10K adults daily with per person ride costs a fraction of what they are today.

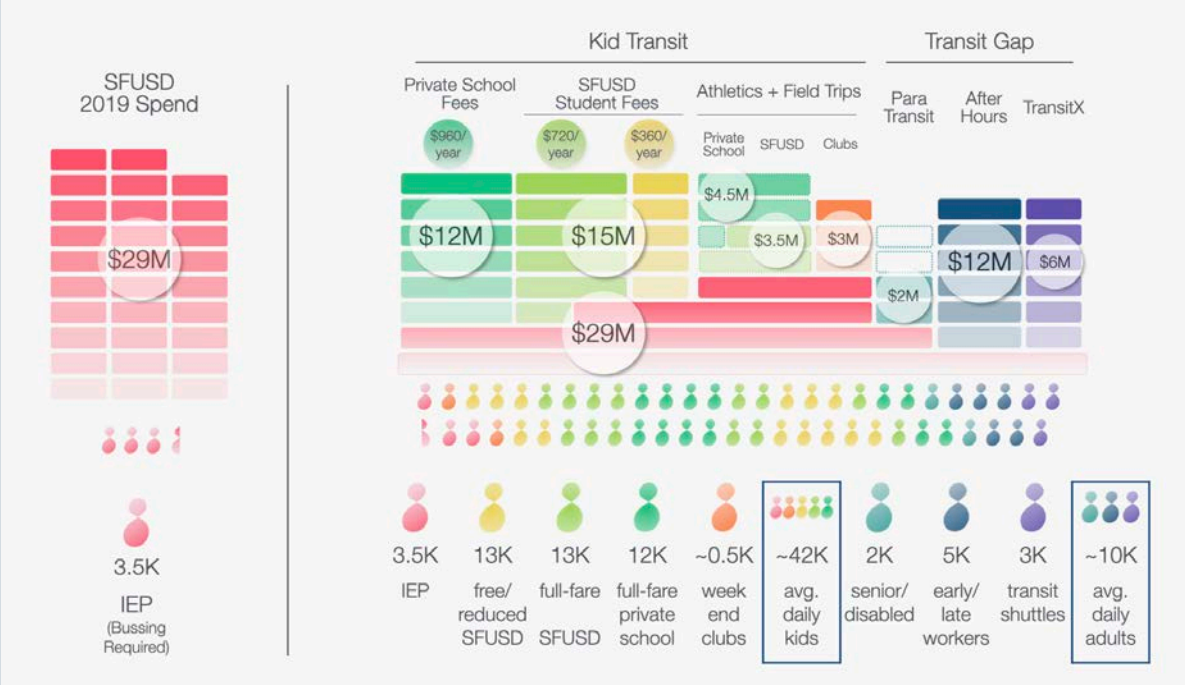

Figure 4: Conversion Estimates of Mobility Re-education Electric Shuttles: Source: SFUSD 2019 RFQ and interviews, SFMTA, author estimates

Step 2 - Data Verification/ Announce the Movement

Let everyone know about the big change we're gearing toward in one year. Every school administrator. Every family. Every kid. Get people excited about what is being implemented.

Nuts and Bolts

All families with school-aged children would be asked to complete a self-evaluation which would help families decide the best travel option for their kids based on their home(s) address, school, and after school activities. Current year information would be requested to test routing capabilities and there might be a chance of some "year zero" testing. It would also get parents familiar with the system and give them a chance to make suggestions and requests.

Extensive cross-referencing people/ program information:

- Parents enter their child's home(s), school, activity information
- Schools enter their enrollment information — cross-check
- Activity providers/after-school operators supply rosters/information
- District and City work with all locations to establish pick-up and drop-off protocols.

All entities (parents, schools, providers) would be asked to update actual year one information six weeks before the start of school so route planning, scheduling, and staffing could occur.

Active Marketing/Fun

Events would be scheduled throughout year zero. This could include:

- Mode Orientation - everything to get kids and families comfortable with biking and transit
    - Begin bike lessons using Wheel Kids, but subsidized so it's low/no-cost
    - Provide information about buying bikes, facilitate group discounts and bulk ordering for bikes. Host bike swaps in conjunction with Bike Kitchen or similar group.
    - Work with San Francisco Recreation and Parks to host Muni camp and "Kid Transit" camps to get familiar with the vehicles, protocols, etc.
- School Street Demonstrations/Celebrations - Demonstrate the different styles of street closure: diverters/no thru traffic, temporary, permanent, etc. Showcase drawings and lightweight fixtures to stage a repurposed space on permanently closed streets. Establish truly quick build bike lanes for testing to the schools/events. Zero input initially, but take reaction from those using it.
- Transportation Counter - Every school could be provided a transportation carbon counter that shows their school's footprint calculated on the current travel methods for students and staff that displays total and per capita information. Discuss how it will encourage friendly competition between other schools. Encourage staff to do their part. Ideally the system will be able to expand to accommodate staff in Year Two.
- Ambassador Program - Encourage involvement by recruiting bike and transit ambassadors at all school sites.
- Marketing Materials - Produce fun videos targeted for kids of different age groups. Have a contest so the kids can produce their own with winners receiving bike shop certificates, transit swag, Muni passes, etc.

Route Planning

A considerable amount of route planning and development would transpire prior to launch. Route considerations include:

- Trip length: rides aren't too long
- Shared rides: reasonable age span of riders
- Travel safety: booster seats available if needed
- Flexibility/accommodation: ample time plus care for children with special needs
- Pick-up/drop-off safety: waiting spots are well lit; the walking path used by the child to the waiting spot is reasonable
- Location: School Street is in place with designated drop-off zones
- System access: confirm all parents, schools, partners can send and receive data to the system
- Bike capacity: ensuring sufficient bike racks at all schools.

All routes should be validated initially via an engine using a combination of Google Street View analysis, crowdsourcing, and school site assistance. Dry run testing would be done virtually with pickups, routing, and drop-offs via simulation and later done in real world conditions to check the composition and logistics for every ride - whether by van or by bike.

Step 3 - Launch

The week before school starts, each school would be encouraged to have a "Back to School" Day where kids can go see the school and their friends. If staff is not available, we would recruit parent volunteers to receive the kids. This would serve as a dress rehearsal in the pursuit of a flawless First Day of School.

If something unexpected happens, parents, staff, and kids would all be well versed in what to do. San Francisco being aware comes into play. Local stores, shops, citizens would all be asked to be on the lookout for kids who might need help. If that child doesn't have a phone, they can help them get in touch with the number where people can help.

As the school year begins, addressing individual and systemic issues will be an all encompassing effort. Reminding everyone what is at stake, working together, being open to alternatives, and keeping laser focused on reducing car dependence for these kids and everyone around them will hopefully see this effort through the inevitable growing pains.

Step 4 - Program Reflections/ Considerations

Setting up the different partnerships and determining hours of operation and staffing is key to the success of all programs. Knowing which services you can offer outside of the core Kid Transit school runs is critical. Weekend trips are a lot less critical than kids missing school or a company that has an existing shuttle program. Partnering with organizations with enough qualified drivers and recruiting new drivers months in advance is not easy, but it can be done.

School start times may need to be tweaked based on optimization and staffing. This organization would look to absorb Safe Routes to School and Vision Zero staff and resources and any other city initiatives that are dedicated to transportation safety, mobility and environment, reducing motor vehicle traffic, etc.

The corporate shuttles and After Hours offerings would be ideal candidates for autonomous drive systems. Finding a provider who is amenable and can work with the vehicle type selected would be a top priority. The eventual driverless shuttle would reduce operation costs and be a welcome addition to Mobility Re-education.

There is an enormous technological lift required to build the routing and various user applications as well as language translation and the testing involved. The assumption is that this would either be a partnership with a company that has already developed this or that a foundation would underwrite the considerable expense to build it. Once it works for San Francisco, it could be repurposed for other areas.

Tracking metrics over time including transportation (VMTs, GHGs, transit ridership, bike ridership, Vision Zero), health (coordinate with DPH), and satisfaction (users, families, teachers, employers) over the long term will be key to determining the success of the program.

The goal of re-educating people on mobility starts with the first city's children and the adults in their life. This initiative hopes to spread transportation re-imagination throughout the city and far beyond.

Mobility Re-education is a concept only. Precise numbers were used wherever possible. Precision budgeting is not available. This program is a new approach tackling a very large system - transporting children and those not served by traditional transit. To achieve this in the amount of time that our cities and climate require necessitates a colossal and rapid build. To ensure its success, funding streams

including contracting may need to be bridged or expedited and would bend the traditional boundaries of public-private partnerships. For this reason, it does not make sense as a fully private venture. It must be run as a non-profit or public-benefit corporation. There must be full transparency and that no one is unfairly profiting from the undertaking. The hope is that the public sector and foundations would step in to ensure that the project could operate and stabilize so that it might be replicated sustainably in other cities as well so that we might all ensure a safer, healthier, and more equitable mobility future.

About the Author

Stacey Randecker

Stacey Randecker is a Mobility Optimist. Her goal in life is to get people and goods to move in a lighter and safer fashion. As co-host of “The Flying Car” she covers the transformation of transportation and has made it her business to know everyone who is moving us toward the sustainable and just future of mobility. Since the real world paused, she’s co-hosted “The Climate Chat Club” where there are weekly conversations with climate scientists about just how dire our situation is, and “Future of Cities Global” with discussions on what cities are doing to reduce GHGs, increase livability, and adapt to the inevitable effects of climate change.

Stacey has ridden shared micromobility in 40 different cities, crossed the country on Amtrak three times just since COVID, and hasn’t met a (truly) autonomous vehicle that she doesn’t like. In addition to working in advanced automotive, she has built and run two preschools and as the mother of two children often lamented that there must be a better way to move our kids.

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11,500 miles @ 22mpg = 4.6 metric tons CO2 * 200,000 miles = 80 tons CO2

80 tons CO2 * 250 days = 20K tons CO2 /2,336,427 tons (2017 data) = 0.85%

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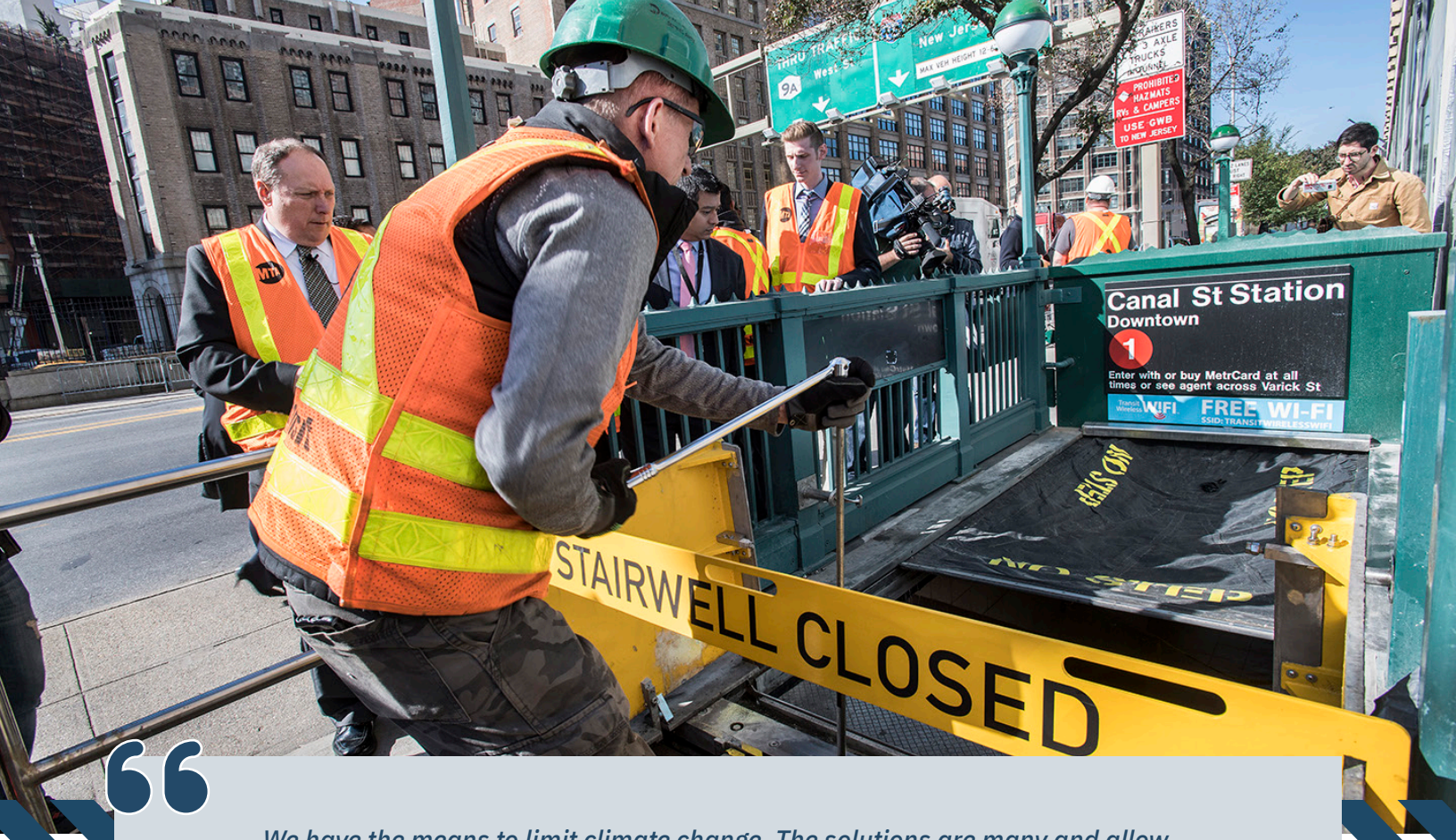
Cover photo: Nextbike rider in Leipzig, Germany (Unsplash)

Space Coast TPO's

TRANSPORTATION RESILIENCY MASTER PLAN

Planning a Resilient Transportation System For Now and the Future

Christopher Bame
Sigal Carmenate
Sarah Kraum



> *We have the means to limit climate change. The solutions are many and allow for continued economic and human development. All we need is the will to change, which we trust will be motivated by knowledge and an understanding of the science of climate change.*
>
> *- R.K. Pachauri, Chair of the IPCC*

INTRODUCTION

This article highlights the key approaches and significant takeaways from analyses for the Space Coast Transportation Planning Organization's (Space Coast TPO) first Transportation Resiliency Master Plan (Transportation RMP) that started in 2020, and will be completed by late 2022. The RMP's major milestones and findings will be detailed in a forthcoming final Transportation RMP. The article begins with a brief history of relevant climate change trends, which is an impetus for transportation resiliency efforts. The history section is followed by a summary of the Transportation RMP's outreach approach, network analysis methodology, and next phases. This article will be of particular interest to transportation planners and those seeking to incorporate resilience into the long-range transportation planning process.

Opening quote: Concluding installment of the Fifth Assessment Report: Climate change threatens irreversible and dangerous impacts, but options exist to limit its effects. (2014) (1st ed., p. 1). Copenhagen. Retrieved from https://www.ipcc.ch/pdf/ar5/prpc_syr/11022014_syr_copenhagen.pdf

BACKGROUND: CLIMATE CHANGE AND A CALL TO ACTION

The Intergovernmental Panel on Climate Change (IPCC) was formed in 1988 to "provide governments at all levels with scientific information that they can use to develop climate policies."[1] The IPCC emerged from the existing United Nations Environment Programme (UNEP) and World Meteorological Organizations (WMO) to assess research and data from scientific, quantitative, and socio-economic studies performed worldwide. In 1991, the IPCC gathered factual data, culminating in the entity's first scientific assessment on climate change. The document titled, Climate Change: The IPCC Scientific Assessment reported that over the last one hundred years, global average temperatures had risen 0.3 to 0.6 degrees Celsius.[2]

Later in 2011, the human population reached seven billion, only twelve years after reaching six billion. By 2013, climate change proved not to be a theory, conspiracy, or bad scientific practice anymore when the IPCC released their Fifth Assessment Report, declaring that it is "extremely likely" that human workings are the major cause of global warming since the 1950s. This report explained that sea-level rise (SLR) would be extreme in some regions by 2100 and that 70% of coastlines would experience a sea-level change in the 21st century and beyond. Though SLR, like global temperatures, is variable due to the Earth's natural cycles, the concern lies in the preparedness of coastal areas for this change and whether the built environment can adapt.

The delicate cycles governing ocean levels are disturbed by the growing amount of greenhouse gases in the atmosphere. Glaciers, groundwater, ocean circulation, ice sheets, and the relationship between the atmosphere and ocean are delicately intertwined. Temperature shifts due to climate change led to a "significant" change in the ocean's volume because of thermal expansion and thermal contractions. A SLR is dangerous for people living in coastal cities; it can lead to displacement, transportation issues, habitat degradation, loss of ecosystem services, and much more.

The threats of SLR, among other potential impacts to transportation systems, create a call for action for transportation planners to incorporate resiliency efforts into their planning activities. Furthermore, federal infrastructure legislations such as the 2015 Fixing America's Surface Transportation (FAST) Act and the Infrastructure Investment and Job Act (IIJA) passed into law in 2021 require Metropolitan Planning Organizations/TPOs to consider and include resiliency in their transportation planning efforts.

SPACE COAST TPO RESILIENCY EFFORTS

The Space Coast TPO encompasses Brevard County, Florida's 10th most populous county, including sixteen cities and towns, two airports, one seaport, and one spaceport. Brevard County is located on the east coast of Florida bordered by the Atlantic Ocean, the Indian River Lagoon, and the St. Johns River. As a coastal area, the population is subject to environmental, social, and economic vulnerabilities due to regularly occurring natural hazards and associated increasing frequencies and intensities.

1 About the IPCC. www.ipcc.ch. Retrieved 25 January 2022, from https://www.ipcc.ch/about/
2 Climate Change: The IPCC Scientific Assessment. 1st ed. New York: Press Syndicate of the University of Cambridge, 1990. Web. 1 June 2016.

In 2017, the Space Coast TPO took its first steps in resiliency planning by completing a SLR Vulnerability Assessment. The assessment utilized the Sea-Level Scenario Sketch Planning Tool, created by the University of Florida (UF) GeoPlan Center and the Florida Department of Transportation (FDOT), to assess transportation features and public service facilities that would be subjected to SLR inundation in the years 2040, 2070, and 2100 using the U.S. Army Corps of Engineers (USACE) and National Oceanographic and Atmospheric Administration (NOAA) projection rate curves. The assessment looked specifically at assets that contribute to the County's transportation functionality, including roadways, railroads, airports, transit, and other critical facilities deemed necessary for countywide transit.

Next in 2020, the Space Coast TPO embarked on its first Transportation RMP, building on its 2017 SLR Vulnerability Assessment work and subsequently focused on developing a plan for transportation resiliency. Transportation resiliency is defined as the ability of the transportation system to recover and regain functionality after a major disruption or disaster. The Transportation RMP uses a collaborative, multi-jurisdictional approach to identify the transportation impacts of the greatest shocks and stressors: SLR, flooding, the combined effects of hurricanes/wind, storm surge/shoreline erosion, and fire/heat/drought. The final phase of the Transportation RMP will create categories of mitigation strategies for Brevard County and different jurisdictions to implement. Figure 1 illustrates the transportation RMP process.

BUILDING THE TRANSPORTATION RMP

The Transportation RMP builds on past work to define potential transportation-specific stressors, to identify vulnerable and critical corridors in Brevard County, and to recommend mitigation strategies to improve the adaptability/ recoverability of the system. Resiliency focuses on the ability to bounce back from events and forces that negatively impact natural and man-made resources. For purposes of the Transportation RMP, these events are known as shocks and stressors. Shocks are single, sometimes sudden events that threaten a community, and stressors are continuous or reoccurring issues or events that impact or weaken the fabric of a community on a day-to-day or cyclical basis.

For the Transportation RMP, analyzing existing transportation elements, infrastructure, and natural areas is complemented with data for planned future transportation assets based on efforts (previous planning work) completed by the Space Coast TPO, such as: the State of the System (SOS), 2045 Long Range Transportation Plan (LRTP), and Bicycle and Pedestrian Master Plan (BPMP). Meetings and work sessions with task force members and stakeholders supplemented data collection efforts to identify and confirm the important assets and areas in Brevard County. Federal, regional, and local agencies have been researching and developing plans that address many aspects of the natural and built environment. Many of these plans include information related to resource management within Brevard County and identify existing considerations and management practices. Existing resource management plans predominantly focused on land acquisition, reducing pollutant loading to water resources, and restoring

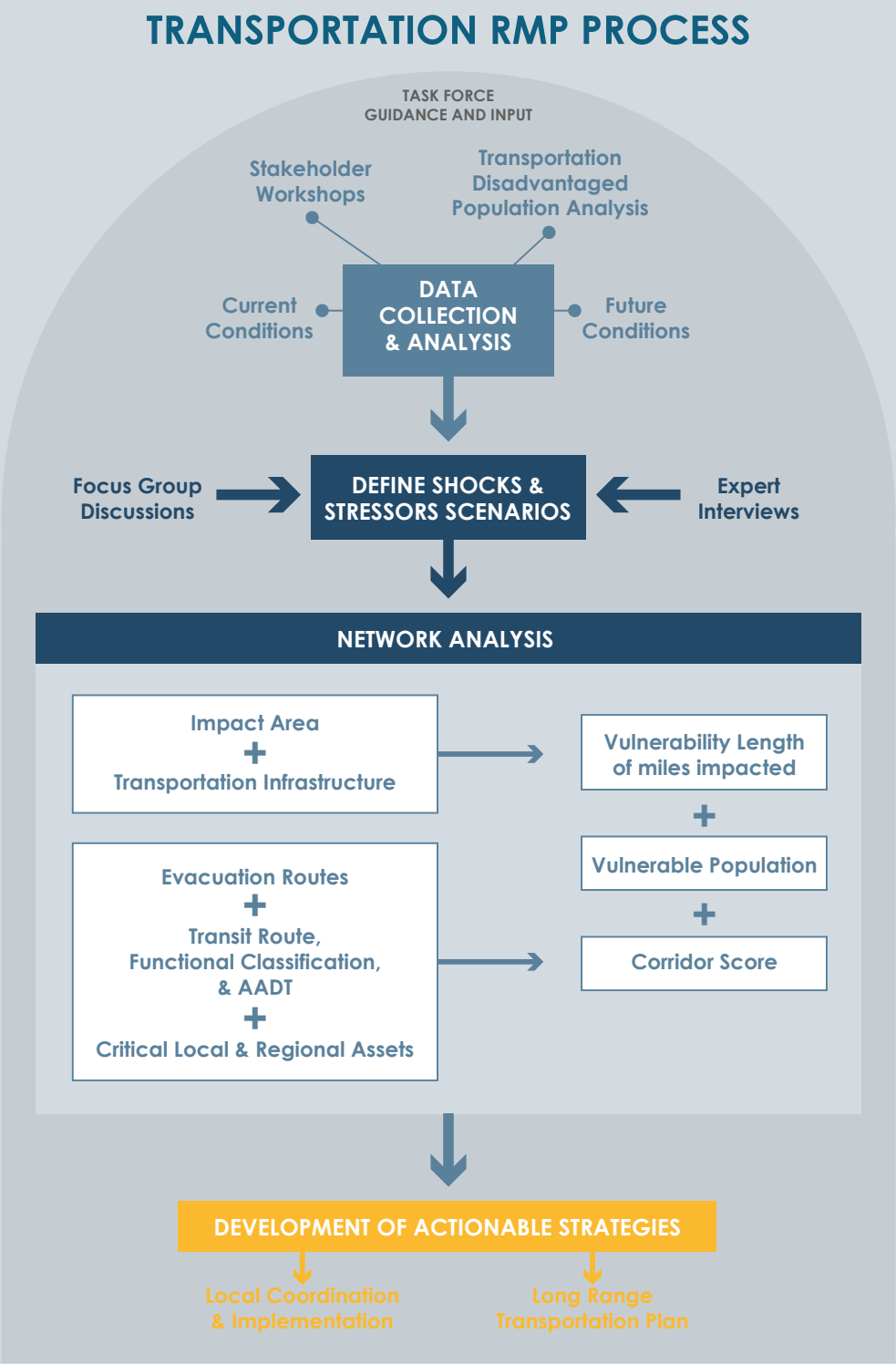


Figure 1: Transportation RMP Process

natural water systems. In addition, case studies from other parts of the country were reviewed to gather information about novel methodological approaches. These case studies contain aspects relevant to developing a resilient transportation system that can be adapted to the development of the Space Coast Transportation RMP.

EDUCATION AND ENGAGEMENT FRAMEWORK

Due to the nature of the Transportation RMP, the Space Coast TPO planned to engage the public with a multi-faceted approach to the public involvement process using a variety of methodologies. Throughout the Transportation RMP development, meetings and work sessions with the Task Force members, Stakeholders, Space Coast TPO Governing Board and Committees, focus groups, transportation disadvantaged (TD) communities, and the general public will keep each group updated on the progress and milestones achieved, and sustain an open channel of communication to receive and share data and information. Outreach and involvement were preplanned and mapped through an Education and Engagement Framework that outlined whom to engage, their roles, tools for engagement, and key decision points for the groups shown in Figure 2.

The public has been engaged through social media campaigns, polls, and e-blasts. Two social media graphics examples are

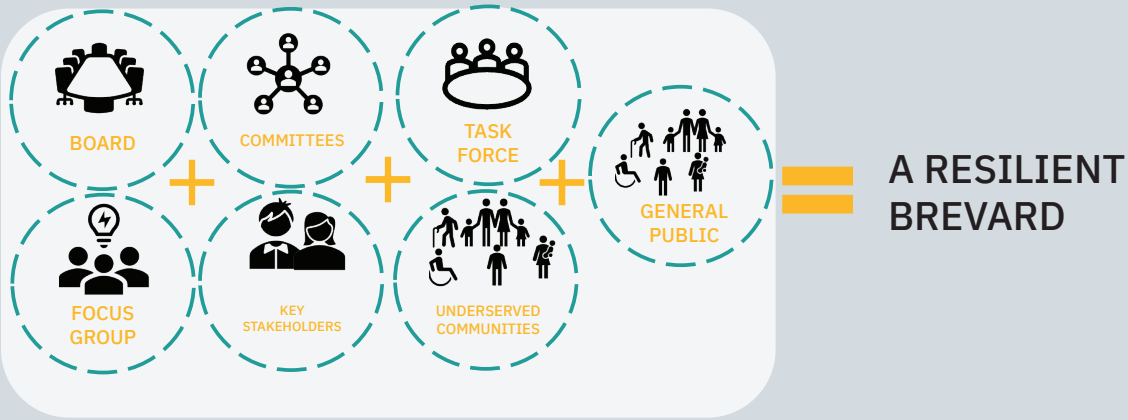


Figure 2: Persons and Groups for Education and Engagement

Figure 3: Example social media graphics.

presented in Figure 3. One of the most significant takeaway from this public engagement is that we need to work to better educate the public about the County's transportation resiliency and planning efforts. Educational videos will be developed to accomplish this goal.

The impacts on socioeconomically vulnerable communities and their experiences are important parts of the Transportation RMP development. Vulnerable communities encompass the communities that may be impacted by shocks and stressors, including TD communities. The Transportation RMP builds on past work to identify these communities in Brevard County. An analysis was completed that identified TD communities in Brevard County, including the creation of a TD population index representing populations most likely to rely on walking, biking, and transit as primary modes of transportation. The population groups in the TD index included:

- Overburdened renters, or people that pay 40% or more of their household income on rent;
- Population under age 18 in a single-parent household;
- Population with a disability
- Population under age 10;
- Population over age 75
- Workers without vehicle access
- Population with limited English proficiency
- Low-income population, or residents whose income is less than 200% of the Federal Poverty Guidelines
- Communities of Color (CoC) (all races and ethnicities other than White, non-Hispanic)

Engagement and discussion with TD communities in the Transportation RMP aim to describe the planning process, share educational materials, and gather input on how various shocks/stressors may impact TD communities in Brevard County.

NETWORK ANALYSIS: DETERMINING CORRIDOR VULNERABILITY AND CRITICALITY

After a series of discussions with the Task Force, stakeholders, and experts, the network analysis to determine the transportation network vulnerability was based on the impacts from SLR, flooding, and the combined effects of hurricanes/wind, storm surge/shoreline erosion, and fire/heat/drought. The network analysis identified the impact areas of these shocks and stressors. These impact areas and the TD population groups in proximity to them were evaluated to create a set of vulnerable corridors in the transportation system. The criticality of the network was assessed using subsets of data that determined critical functions and critical destinations in Brevard County. For corridors in the network that rank highest for vulnerability and criticality, different types of mitigation strategies will be developed, and potential funding sources will be identified.

Defining Shocks/Stressors Scenarios

The shocks/stressors were defined based on previous Space Coast TPO and related resiliency work, fthe education and engagement process findings, and best relevant practices. For flooding, the FEMA 100-year floodplain dataset (a well known and reputable data source), represents areas with a 1% annual chance of flooding based on historical occurrences. The area covered parts of Brevard County

experiencing flooding during regular rainfall events and those flooded due to severe storms. For SLR, the NOAA 2100 High Curve reflected the transportation impacts depicted by the SLR Vulnerability Assessment and work completed by Space Coast TPO's local partners. It was determined that category three hurricane storm surge/winds reflected an accurate impact on transportation infrastructure in Brevard County. For shoreline erosion, a 50-foot buffer from the Indian River Lagoon aligned with historical cases of roadway being impacted in Brevard County. Fires in undeveloped lands that do not have a schedule for managed burns present the highest risk in Brevard County, particularly undeveloped and unmanaged lands close to developed areas. This assumption was confirmed by land managers interviewed and represents the best assumption to identify transportation in the impact zone for fires/smoke.

The network analysis completed for the Transportation RMP is broken into two main components 1) the vulnerability analysis, and 2) the criticality analysis. Roadways vulnerable to shocks/stressors are first determined, then vulnerable roadways that play a critical role in Brevard County's economy and quality of life for residents and visitors are identified. Vulnerable and critical roadways are scored to identify the top-corridors impacted by any hazard and critical for transportation in Brevard County. The point system is tiered so that the "Most Vulnerable" and "Most Critical" corridors receive more points than "Vulnerable" and "Critical" corridors. The top-scoring corridors will have categories of actionable mitigation strategies developed for the Space Coast TPO and local partners to advance.

Vulnerability Analysis Methodology

The vulnerability analysis determined the length of miles of corridors in the Space Coast TPO transportation system impacted by a shock/stressor. Corridors with more than zero and up to ¼-mile impacted by shocks/stressors were identified as "Vulnerable," while corridors with greater than¼-mile impacted were "Most Vulnerable." Additionally, fire and flooding produce the most vulnerable corridors in Brevard County, followed by SLR, storm surge, and shoreline erosion, which present the smallest share of vulnerable corridors, as shown in Figure 4.

Another element of vulnerability for corridors is the proximity to vulnerable populations. Based on the TD Population index developed for the Transportation RMP, corridors that serve areas with the most disadvantaged populations (top 20%) were deemed "Vulnerable." If this criterion was not met, corridors could still be considered "Vulnerable" if they served the top 20% of any one of the following five population characteristics:

- Poor and Struggling
- Zero Car Households
- Persons of Color
- Households Including a Person with a Disability
- Persons Over 65

About 25% of all corridors are identified as "Vulnerable." If a corridor served the top 20% of two or more of the five populations listed above, it was considered "Most Vulnerable." About 36% of all corridors are "Most Vulnerable" because of their proximity to an area with two or more of the five population characteristics.

Criticality Analysis Methodology

The criticality analysis determined the length of miles of corridors in the Space Coast TPO transportation system serving a critical function or providing critical access to local or regional assets. Like the vulnerability analysis component, critical roadways were scored so that a specific roadway function or access criterion garners more points than others.

Corridors that serve a "Critical" function are defined as those corridors that have a roadway functional classification of a principal arterial or higher, that have annual average daily traffic (AADT) of 40,000 or more, have a Space Coast Regional Area Transit (SCAT) route along the corridor, or if they are an evacuation route. These criteria encompass major roadways in the county that facilitate a large movement of people and goods. Corridors with either a SCAT route, or those that have an AADT of 40,000 or more, or those with a functional classification of primary arterial or higher are considered "Critical." Corridors with an evacuation route are considered the "Most Critical" and receive more points than the other functions. About half of all corridors serve a critical function, of which about a quarter are "Most Critical."

Critical local assets in Brevard County included community centers, hospitals, government centers, downtown areas, goods and services (suburban commercial and residential centers), fire stations, and police stations. A corridor gets points if critical local assets are situated within a half-mile of it. About half of all corridors

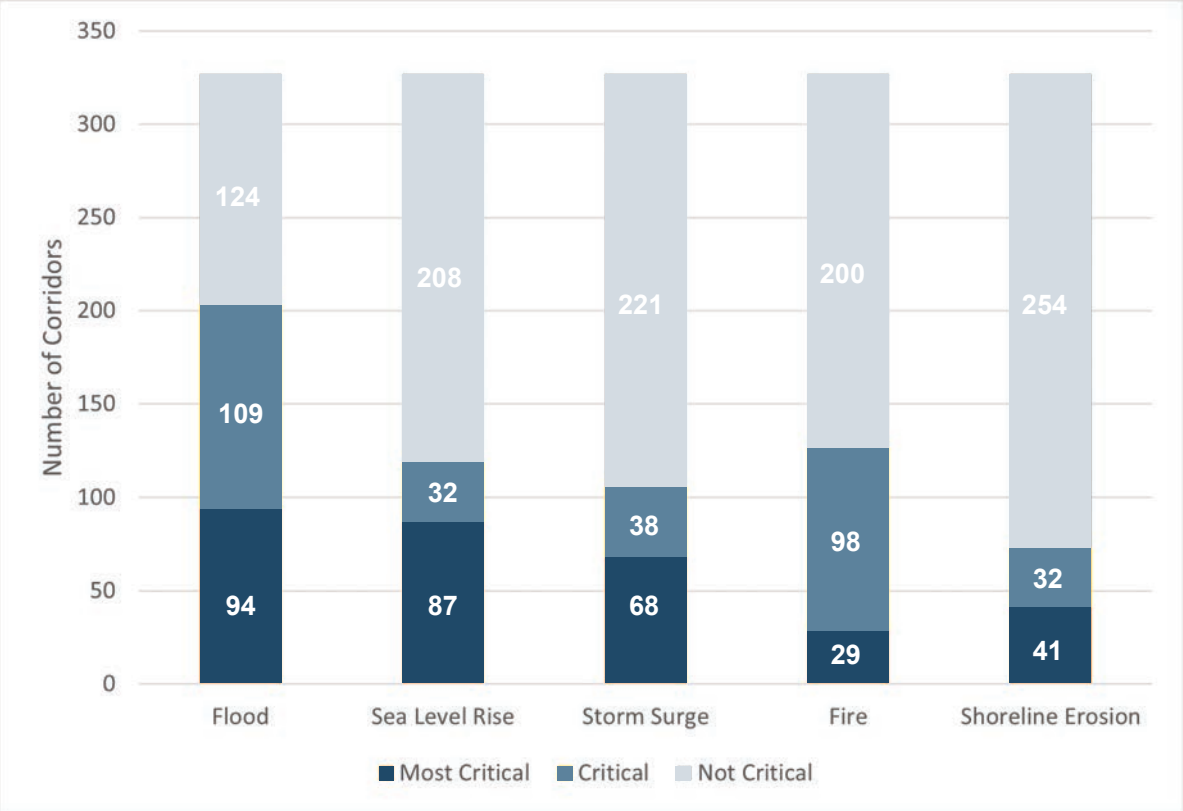


Figure 4: Corridors by Vulnerability

have two or more local assets present within a half-mile of it. The number of corridors that have a critical function and provide critical access to local assets, is illustrated in Figure 5.

Critical regional assets are analyzed separately from local assets. Corridors that serve as access to these destinations are considered for actionable resiliency mitigation strategies regardless of their proximity to the regional asset. Critical regional assets include Port Canaveral, the Patrick Space Force Base, the Kennedy Space Center, the Space Coast Regional Airport, and the Melbourne-Orlando International Airport.

NEXT PHASES FOR THE TRANSPORTATION RMP

The Transportation RMP Task Force will play a key role in reviewing the top-scoring corridors and providing feedback to finalize the impacted network. The analysis findings will be shared with the TD community liaisons, and the network analysis will be finalized and documented in a technical memorandum for distribution.

The final Transportation RMP will culminate in a plan that details short-, mid-, and long-term categories of actionable mitigation strategies based on the corridors ranking highest from the network analysis. The strategies will be refined with the Task Force and geared for the Space Coast TPO, stakeholder agencies, and local

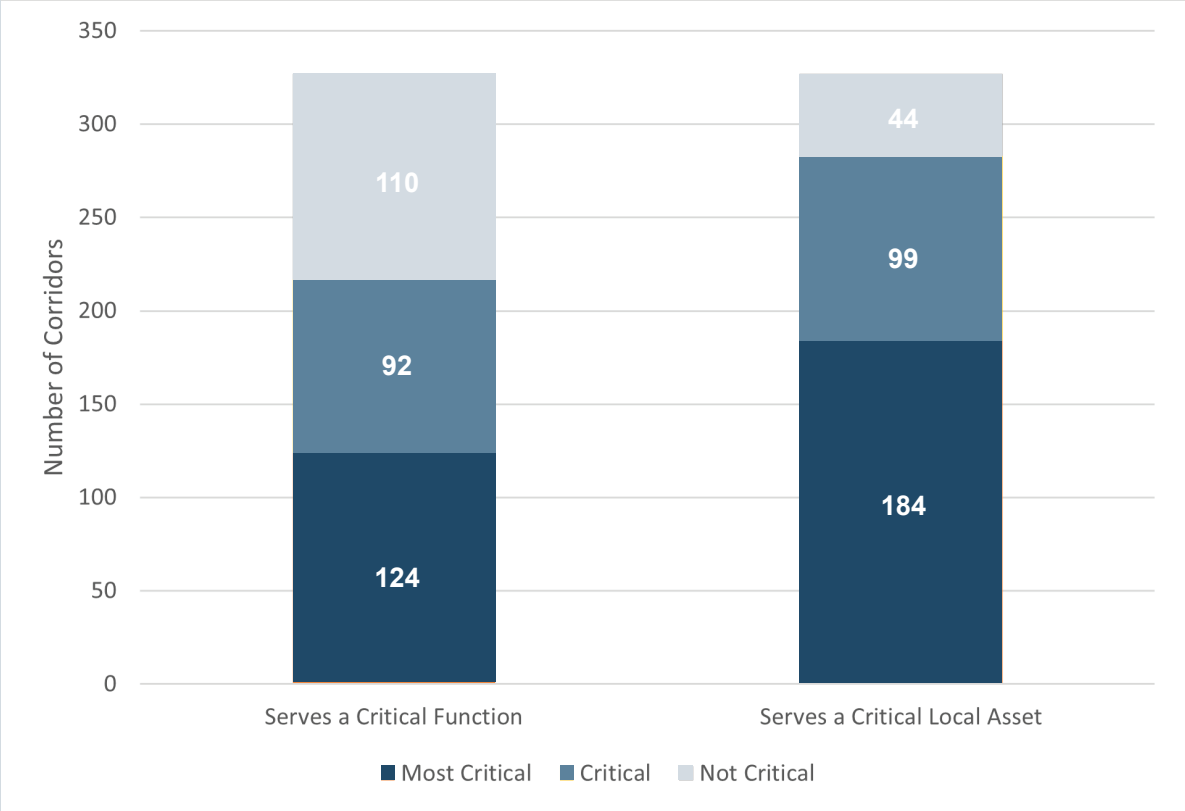


Figure 5: Corridor by Criticality

partners to advance. As part of defining actionable categories of strategies, the RMP implementation guides will be developed to provide information about the needs and opportunities on how to implement the strategies, and help to guide and trackprogress over time. The final list of resiliency strategies will be presented to the Space Coast TPO Governing Board for adoption. The Space Coast TPO is committed to tackling regional resiliency and will build on this first iteration of the Transportation RMP to advance transportation sustainability and resiliency initiatives in Brevard County.

Cover photo: Courtesy of Metropolitan Transportation Authority of the State of New York

About the Authors

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Chris Bame is an Engineer at Kittelson & Associates in Portland, Oregon. He is a graduate of Oregon State University and has a Bachelor of Science in Industrial Engineering. Chris excels at developing analysis methodologies and prioritization processes to solve complex problems and achieve stakeholder goals. He uses a variety of data sources to inform decision-making, including data for crashes, demographics, roadway characteristics, environmental conditions, and travel patterns.

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Sigal Carmenate is a Planner at Kittelson & Associates in Orlando, Florida. She is a graduate of the Georgia Institute of Technology's City & Regional Planning Program, and has a Bachelor of Science in Sustainability and the Built Environment. Sigal has experience analyzing safety data, creating and synthesizing surveys, strategizing for and facilitating public outreach, moderating workshops with stakeholders, planning for active transportation and complete street, and collaborating with diverse teams to solve complex transportation issues.

Sarah Kraum

Sarah Kraum is the Senior Transportation Planner for the Space Coast Transportation Planning Organization. She provides regional and long-term transportation planning activities in Brevard County, Florida. Her work focuses on resiliency, sea-level rise; bicycle, pedestrian, trails, and transit planning and coordination. She also serves on the East Central Florida Regional Resilience Collaborative's Steering Committee and is a Co-Chair of the Infrastructure TAC. She has her B.S. from Florida Gulf Coast University in Legal Studies. Prior to her time at the SCTPO, she worked in conservation and environmental education. When she is not working, she enjoys going on adventures with her son and husband, exploring trails, going to the beach, and painting.

5

STUDENT PAPERS

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American Planning Association members can read the full papers on the APA website.

FIRST PLACE

Pranjali Shah

PARK IT. BUT WHERE? FRAMEWORK FOR IDENTIFYING CAMPUS LOCATIONS FOR BICYCLE SHELTER: A STUDY OF UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN

Promoting bicycling over driving in the world of automobiles is a complex riddle to solve. The key to changing people's attitudes towards biking lies in building user-oriented biking infrastructure (Jennifer Dill, 2014). One of the critical constituents of biking infrastructure that hasn't received much attention in recent studies is long-term parking. The need for secured, weather-proof long-term parking becomes even more crucial for the biking community at university campuses and campus towns since biking is becoming a popular commute mode within campuses due to shorter distances. If installed at appropriate locations on the campus, such secured long-term biking shelters can prevent bike theft and weather damage. However, developing such a long-term parking facility requires an extensive study to determine the optimal location of the parking shelter.

Most existing methodologies for identifying optimal locations are focused on large cities and are too complex to be applied directly to campuses that have a much smaller area and well-defined boundaries. Therefore, we recognize a need for a dedicated framework for campuses and propose a novel methodology that is comprehensive, data-driven, modular, simple yet extendable to any university campus or campus town. We show the effectiveness of our framework through a pilot case study for identifying long-term bike parking locations at the University of Illinois, Urbana-Champaign campus. Our methodology consists of a GIS-based overlay model that incorporates and weighs various parameters affecting bike infrastructure safety and convenience. Our model brings context-based adaptability and data-based flexibility as an added benefit.

Pranjali Shah is a masters student in Urban Planning at the University of Illinois at Urbana-Champaign (UIUC). Prior to that, she earned a bachelor's degree in civil engineering followed by a masters in Infrastructure Engineering from India. At UIUC, she is associated with the Transportation SWATeam and works as Research Assistant at Smart Energy Design Assistance Center. Her interest in active and public transportation comes from her experience. She is interested in transportation planning, modeling, and sustainability studies, and looking for hands-on opportunities in this field.

SECOND PLACE

Ignacio Lafuente

REDESIGNING THE FUNDING STRUCTURE AND STORYTELLING FOR BUENOS AIRES' RER

The purpose of this term paper is to reconsider the importance of the Red de Expresos Regionales (RER) in Buenos Aires, the project reconnecting the city's main commuter rail lines, despite its recent failure. The well-known reasons for its abandonment (mostly financial and political) will be contrasted with many of its mostly undisputed advantages, namely travel time savings, fare equity, and improved opportunities for land use. A need for reshuffling will come up as the way to isolate a good project from its unsuccessful implementation. After discussing the context, the options that failed, and some unexplored but also unpromising alternatives, a bold (yet quite experimental) national-level Tax Increment Financing district will be proposed as a relevant source for investment and/or debt repayment.

Ignacio Lafuente is an economist and urban planner from Argentina. After performing economic analyses addressing project valuation, land policy, and public-private development for the government of the city of Buenos Aires for 4 years, he is now completing his Master in Urban Planning program at the Harvard Graduate School of Design, concentrating in Transportation and Infrastructure. His career goal lies at the intersection between those two experiences: designing effective land policies to fund transportation infrastructure projects.

THIRD PLACE

Samuel Haas

ALL-ABOARD TO MEXICO: THE POTENTIAL FOR PASSENGER RAIL

Throughout the 19th and 20th century rail has played a prominent role in shaping the economies and social geography of the borderlands. Territories were organized, settlements were founded or expanded, and rail helped facilitate access to national and international markets. The border often created limitations, but in many cases rail development actually transcended the international boundary (Widdis 2019).

Hundreds of thousands of passengers every year cross the Northern United States border via train. This helps alleviate congested air and road networks, minimize the carbon footprint of travel (Robertson 2018), and strengthen regional economic activity. The southern border; however, remains inaccessible via passenger train. This was not always true. There are numerous cultural and economic connections between the Southwestern United States and Mexico, prompting a high demand for travel. As a result, every year millions of people cross the southern border for a variety of reasons.

The purpose of this paper will be to study potential passenger rail connections between the U.S. and Mexico. This will be done by contextualizing and examining the following: a brief history of the southern border region and of past binational rail connections, the barriers that prevent rail as a modal choice, the particular challenges of travel across an international boundary, and the specific challenges at the U.S.-Mexico border.

Samuel Haas is an aspiring transportation planner from San Antonio, Texas. He is attending the University at Albany to help better understand and help facilitate intercity rail.

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A FINAL NOTE

APA's biannual SoTP report brings together our community of learners, designers, thinkers, and transportation professionals to provide a snapshot of transportation planning around the world. In a time of immense and unprecedented transformation, our collective transportation ecosystem remains innovative, dynamic, and resilient. This year's report comes at a critical time where transportation projects are solving problems that are new, multi-generational, and global. Our lived experiences are at the intersection of growth and change and we must continue to share them.

We proudly endorse this report in alignment with APA and the APA Transportation Planning Division's (TPD) mission statements. TPD is one of many divisions within the larger Association that facilitate technical and nontechnical information sharing and strategy - connecting members from all 50 states and territories. We strive to create a thriving network of professionals who are linked through transportation planning.

As we continue to learn and grow as a field, the dynamic experience and voices of our members is of paramount importance to us. We look forward to continued growth with our upcoming events, webinars, and publications. Our priorities as a Division will always prioritize the interests and needs of our members, and our members greatly influence our success.

If you are new to APA, or new to TPD, we encourage you to reach out and get connected! Our 2022 Executive Board would love to connect and assist you in getting involved with the Division. Visit us on the web at any time at http://transportation.planning.org.

As we move towards the future of transportation planning, our hope is this year's SoTP report connects more professionals and continues to move us all forward.

Signed,

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