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Bicycling to Level the Field: A Study of Divvy in Chicago

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PREFACE

It goes without saying that the year 2020 was one of precarity and surprises for Americans, especially with the onset of COVID-19. The Center for Disease Control was constantly updating guidelines on how to effectively avoid contracting the deathly virus and many people altered their lifestyles accordingly. Personally, I went from being a commuter graduate student to a remote learner, studying from the confines of my two-bedroom apartment in the western suburbs of Chicago. COVID-19 had drastically changed my day-to-day life, and I felt it the most when the summer came and the shining sun was inviting me to rejoin the outside world, albeit in a safe and protected manner.

While hiking became a hobby of mine last summer, I knew that a more sustainable daily activity would be bicycling. Afterall, bicycling was something I always enjoyed. I found myself at a great loss when I couldn't find an available bike for purchase at the usual retail stores. I was advised by several people to try my luck on OfferUp and Facebook Marketplace, where people were selling their used bikes online. I found the process to be very frustrating because the sellers online were charging exorbitant prices and the bikes were selling so quickly that I couldn't get my hands on anything through these platforms. Clearly, there was a huge interest in bicycles that summer and the surge in demand was not expected even by retailers who would otherwise have prepared their supplies accordingly.

As a sociology student interested in micromobilities, my mind wandered to the case of Divvy bikes in the City of Chicago and I have been curious about what may have happened to

Divvy usage with the onset of COVID-19. This paper synthesizes my findings from my research project that compares Divvy bike usage in 2019 and 2020 and discusses the implications of COVID-19 on micromobility use. This is an intriguing inquiry because COVID-19 is known to have accelerated change in a lot of aspects of our lives. For instance, seamless remote working as soon as 2020 was not fathomable for most of us. I am very interested in quantifying these changes, especially by focusing on Divvy usage in the City of Chicago.

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ABSTRACT

With the onset of COVID-19, norms across the world shifted, including the way people moved in major cities. In order to conduct a comparative analysis, understanding transportation habits before COVID-19 hit cities is important. In this paper, I have focused on Divvy bikes in the city of Chicago, which are touted as a means to achieving first- and last-mile transit especially in underserved communities. I am interested in initiating the line of inquiring into who Divvy bikes served during a time when there was major fear around high transmission of COVID-19 on trains and buses due to the close proximity. Behaviorally, bicycling also become very popular after the pandemic started and it would be helpful to understand how much of those habits become apparent through Divvy usage. In order to get a snapshot before COVID-19 hit Chicago, I limited this project to quantifying 2019's Divvy usage. I conducted research by utilizing the City of Chicago Data Portal and its closed-sourced data analysis tool for creating maps, pie charts and histograms. I narrowed down my use of Divvy data to the peak usage months of 2019. I found that the common users of Divvy bikes were young, male users belonging to affluent neighborhoods. In total, those who bought annual subscriptions initiated more trips than those who didn't. However, non-subscribers made longer trips than subscribers. Understanding such trends grants insight into whose needs micromobility technology serves and also facilitates the process of conducting future comparative research.

CHAPTER I

INTRODUCTION

Bike sharing-systems have been growing in North America since the early 2010s. Chicago's Divvy bikes program is among the largest bike-sharing systems in the United States. The bike-share system was introduced by Mayor Rahm Emanuel in 2007; his initiative was inspired by a similar bike-sharing system program he had observed during a visit to Paris, France. By 2019, Mayor Emanuel had established a shared mobility taskforce which 'comprised of 20 experts and thought-leaders from government, business, neighborhood and civic organizations, research institutions, and not-for-profits in the transportation, mobility and technology sectors' (*Roadmap for the future of transportation and mobility in Chicago*, 2019, p. 7). One of the key features of the recommendations made by the task force was the increasing use of micromobility on city streets (such as bikes and scooters). The rationale behind the task force's recommendations was to encourage urban equity and address global climate change.

Micromobility technology enters the urban fabric of cities like Chicago by way of private-public partnerships. Such partnerships involve private sector partners and cities; cities demarcate their needs from the industry and seek services from private sector representatives. Cities actively engage with the private companies to ensure that public interests are being services and they also establish metrics to monitor the success of these partnerships. Very often, such metrics are data-driven and data is publicly accessible off of the data portals managed by

cities (*Roadmap for the future of transportation and mobility in Chicago*, 2019, p. 16). Chicago, for example, manages a robust City of Chicago Data Portal which has several datasets on Divvy.

Divvy bikes in Chicago are meant to serve several purposes. For starters, they are used for recreational purposes, especially for tourists in the Loop area. For residents, Divvy is meant to act as a means of transportation for short trips and to also allow residents to reach train and bus stations if they do not live a walkable distance from a stop. Therefore, it's worth investigating how Divvy usage may have been impacted when the Chicago Transit Authority (CTA) was shaken up by the onset of COVID-19. According to news sources, even though CTA offered normal train and bus services and did not reduce the frequency of rides (Morell & Puente, 2020), ridership did plunge by 80 percent and the company was losing millions during the start of the pandemic (Rogers, 2020). There may have been several reasons why CTA ridership plunged even though the company had not reduced the number of rides. People may have been fearful of catching COVID-19 during a crammed train ride. Many people were also working remotely, leading for lesser needs to commute.

At the same time, there was a noticeable increase in interest in bicycling. For instance, Divvy began offering free bike rides for healthcare workers. Divvy also slashed its annual membership fee by half (Greenfield, 2020). According to the Chicago Department of Transportation commissioner, greater access to Divvy was key as a safer transportation alternative especially for essential workers who didn't have access to remote working privileges. She also acknowledged that Divvy would continue to serve as a first- and last-mile transit option for Chicago residents.

In this paper, I am interested in studying the trends in usage that were prevalent before the onset of COVID-19. Since COVID-19 impacted many different aspects of city life, a pre- and post-COVID analysis would be helpful in understanding how micromobility technology use changed with the arrival of a deadly virus. During a time when sharing closed spaces with strangers (such as, on trains and buses) was worrisome, one could speculate that Divvy bikes may have become a viable alternative for getting around. More importantly, I want to initiate such an engagement to understand who Divvy bikes actually benefited in times of greatest needs; this includes the neighborhoods that Divvy serviced the most as well as the sociodemographic groups that benefited most from it. This paper will help initiate such conversations about how the pandemic impacted Divvy use and bicycling behavior in the city. As the background literature chapter will show, this analysis must be made in light of Chicago's history of transit segregation as well as the coming together of public and private interests. The implications of such trends may have a major impact on usage trends as well.

Research Question

What spatial and sociodemographic trends in Divvy ridership were prevalent during the peak usage months in 2019 (before the onset of COVID-19)?

Organization of paper

In this paper, I review literature on deployment of micromobility, especially focusing on what the expectations have been about such technology becoming a part of Chicago's urban fabric. I also delve into trends in American transit history and its tendency to segregate based on classist and racist lines. I also discuss literature that addresses the motivations behind inserting innovative technologies onto the urban landscape and who such technologies serve. In the next

chapter, I describe my data and methods for this investigation. I also acknowledge the shortcomings of my chosen methods. The next chapters delve into the results and discuss them in light of the literature.

CHAPTER II

BACKGROUND LITERATURE

McKinsey predicts that 50 urban areas which are proactively engaging with advancing their mobility potential may have radical changes in their urban landscapes and mobility services by 2030 (Hannon, McKerracher, Orlandi & Ramkumar, 2016). With urban population density on the rise, shared mobility is being perceived as an essential avenue for city governments to deal with the increasing influx (Hannon et al., 2016). According to McKinsey's report (Hannon et al., 2016), Chicago will follow the 'Seamless Mobility' model by virtue of its large population and status as a high-income city. As part of this 'Seamless Mobility' model, the future city will purportedly turn into the following vision:

> Travelers have many clean, cheap, and flexible ways to get around, and the boundaries among private, shared, and public transport are blurred. Mobility is delivered through a combination of self-driving, shared vehicles, with high-quality public transit as the backbone. EVs become far more common, spurred by economics, consumer interest, incentives, and the creation of low-emission zones… In a seamless-mobility system, people would potentially travel more—likely by 20 to 50 percent— because it is cheap and easy. However, the number of cars would likely remain the same or decline, due to the high level of sharing and significantly higher utilization. (Hannon et al., 2016, p. 4)

Since major corporations and city governments are working together to reshape cities around such innovative mobility solutions, it is essential to understand the logic behind such initiatives and understand how the ordinary city resident is positioned within the narrative.

Transit, segregation and social inequality

The notion of social equality is linked to transit access, as it determines access to well-paid jobs, healthcare facilities, recreational activities, and other important needs (Wellman, 2015). This is why transit equity becomes an important concern. Public transportation is often not a space of equity. Its inequities keep some people trapped in place (physically and symbolically) while allowing others to freely and easily access and experience the wealth and delights of the urban core. Public transit spaces are not only embedded with inequalities, thus reproducing unequal spaces (Bullard, 2006; Tomer, 2011), but this inequity is also reproduced through social interactions on public transport systems (Purifoye, 2017). Wellman (2015) argues that in American policy, transit inequality is often based in racial and class inequalities.

Hertel, Keil & Collens' (2016) work on transit justice adds to the discussion on transportation by highlighting that transit equality can only be achieved when the needs of the majority are met. They explain that the benefits of transit investments are mostly reaped by those with higher socioeconomic standing and that new transportation models have the tendency to further stratify society along the lines of class and race by prioritizing the needs of certain groups. The aim for transportation planners should then be to bring about transit equity, which "is viewed as the outcome of removing structural obstacles from the fair distribution of goods and services by the regional transportation system" (Hertel et al., 2016, p. 8). As an example, Bradtner, Lunn & Young (2017) explain that city infrastructure is planned to prioritize car owners over those who can only access public transit and can be assessed from the simplest element of urban design: the availability of sidewalks. The lack of sidewalks compels residents of areas to own cars, while at the same time limiting access to areas outside the neighborhoods.

Urban design, at large, encompasses public transportation and has a strong association with racial segregation in city spaces. Stephanie Farmer (2011)'s work specifically on Chicago's transit system illustrates this by historicizing the consolidation and growth of the Chicago Transit Authority (CTA) train and bus network. She argues that after the economic decline between the 60s and 80s, Chicago was projected as a global city which offered place-based advantages, especially in the shape of transit. She argues that areas adjacent to the Loop were given priority in developing transit networks, the West and South side suffered. Farmer (2011) argues that much of transit development plans, especially for the South side, were curbed by the shift in demographics past 95th Street. As the White population moved out of the South side by the time the Red Line's expansion was due, the project was conveniently cut short. At present, there are 35 blocks between the last Red Line stop and the city's limits on the South side. Such racist trends are not outliers but are rather characteristics of transit services in the United States. Sanchez & Ma (2004) state that transit developments are historically played a fundamental role in segregating communities along racial lines, which have repercussions on access to jobs, schools and healthcare.

First- and last-mile transportation

One of the key manifestations of this existing inequity within transit is the first- and last-mile transit problem. Although major cities in the United States have public transit systems, many city residents are deprived of its benefits because they do not have access to first/last mile transit access (Boarnet, Giuliano, Hou & Shin, 2017). Studies have shown that such transit access can help social equality issues, especially by giving city residents access to jobs. Boarnet et al. (2017) found that in San Diego, car drivers (who did not face first/last mile transit access

issues) were thirty times more likely to access low-wage jobs than those without cars. The study gives insight into access to other essentials (such as healthcare access) and the barriers that transportation inequality cause. Since developing railways and other means public transit can be expensive, within mobility circles, the shared micromobility is seen as a way forward. The usage of such technology is posed as being beneficial because it will provide a cost-efficient solution to the first/last mile transit access issue, especially when such vehicles are shared (in the same way that city residents share buses and trains) and are not privately owned (Shared-Use Mobility Center, 2019).

Technological determinism

While policy circles share utopic visions of smart cities with shared micromobility vehicles, it is important to note that academics have identified major disadvantages of a large-scale use of such vehicles for cities' transportation needs. Green (2019) concedes that technology does help aid some issues pertaining to cities. However, he cautions away from using 'tech goggles' (which compel planners to see all urban issues as ones that can be fixed by the use of technology). Instead, he suggests that cities should be designed to be smart *enough*, whereby technology is only used when justifiable and used for the residents' benefit.

Neo-marxism and technological innovation in American cities

It's also important to acknowledge that deploying micromobility technology (such as Divvy bikes) into city streets is tied to capitalism. Understanding how capitalism impacts the city is therefore very important. In *Right to the* City, Harvey (2008) provides a useful entry into the notion of the city undergoing changes in infrastructure, housing projects and the likes and sees such changes as a means to stabilize economies. Harvey (2008) delves into the technicalities of

urbanization being driven by the pursuit to increase capital surplus absorption in cities. By that argument, Harvey (2008) clearly illustrates his point of view that capitalist interests motivate changes in cities. In his opening passages, he famously says:

> The question of what kind of city we want cannot be divorced from that of what kind of social ties, relationship to nature, lifestyles, technologies, and aesthetic values we desire. The right to the city is far more than the individual liberty to access urban resources: it is a right to change ourselves by changing the city. (Harvey, 2008, p. 315)

As a result, in order to democratize the "right to the city", Harvey (2008) argues that residents must examine "who commands the necessary connection between urbanization and surplus production and use" (Harvey (2008), 2008, p. 331).

Harvey (2008) offers a neo-Marxist explanation of how cities are shaped, arguing that urbanization and capitalism are inextricably linked together. He focuses on the economic factors that drive innovation in cities and the disparity in who gets to choose how those changes emerge. While this is useful, Jennifer Light (2005) discusses the historical context specifically in the United States during the Cold War that shaped American Cities from the 1950s to the 1980s. Through her historical analysis, she outlines how innovations in defense during the cold war were transferred to city management. Even though she attempts to build a historical argument where the social context motivated cities to change, her argument does overlap with Harvey's (2008), especially because she goes into financial incentives also. Light (2005) argues that this transfer of innovations across sectors was rooted in the ambitions of military contractors to 'diversify markets, to profit from the growth of federal domestic spending, and to keep their institutions in operation for the long term' (Light, 2005, p. 64).

After historicizing the transfer of technological innovation to urban areas and the logics that followed into city planning, Light (2005) also illustrates how such transfers were justified in the name of city residents. She discusses various trends that emerged during and immediately after the Cold War, such as the wide usage of cable communications (later to be known as cable television) through the efforts of defense departments and research think tanks. These organizations had justified the usage of cable communications in cities as a means to deliver social services and strengthen communities through citizen-produced programming. In this way, the reason to allocate resources to bring defense innovations to cities had a social service dimension.

While Light (2005) doesn't use the term 'smart' city for American cities undergoing changes from military innovations, she historicizes the advent of technocratic problem solving in city problems. Through her historical analysis, Light (2005) too sheds light on the capitalist motivations behind innovation in cities. Jennifer Clark's (2020) more recent work is a more explicit engagement with the notion that capitalism drives the smart cities project.

Smart cities today

To begin with, Clark (2020) establishes the fact the technological innovations being adopted in cities is not new. The difference between the innovations that Light (2005) outlines and the newer innovations that Clark (2020) discusses is the fact that the smart cities narrative comes with a hype and a perception of novelty. She says that "the message to cities and to citizens from smart cities advocates is that you don't know what you're dealing with, but you don't want to get left behind" (Clark, 2020, p. 204).

As a whole, in *Uneven Innovation – the work of smart cities*, Jennifer Clark (2020) expands on the current motivations of the smart cities project and the norms of the industry that lead to an inequitable distribution of the benefits of technological innovations in urban areas. Her arguments are based on her heavy engagement with a project as a researcher and a participant-observer for five years where she worked at Georgia Institute of Technology. Clark (2020) argues that within circles that support smart cities, there's an assumption that all kinds of usages of technology in cities are good. She challenges this by saying that many times, using technologies in city planning sustains underlying patterns of inequality and powerlessness. The city itself is very important to Clark's (2020) analysis because the smart cities project is hyperlocalized. The city provides two key essentials for the project: clear jurisdictional boundaries and diffused power with different actors making key decisions about the city. This highlights the strategic impetus for situating the project in cities. Moreover, the city becomes a key emergent market for the tech industry.

Fundamentally, the smart cities project identifies the city as both a customer and a location for the innovation, production, distribution and consumption of the products and services it designs and develops (Clark, 2020, p. 64). As a result, she says that the city has become what David Harvey (2008) saw it as: "a particular site of capitalist accumulation in capitalist market economies" (Clark, 2020, p. 70). For her, the problem with smart cities is not even the over-usage of technology but the policy that drives it. With an increased emphasis on privatization, she says it's important to ask who owns the infrastructure of smart cities and its data, systems and operations. The other problem that she notes with the smart city is that of access: who pays for this city and who eventually benefits from it?

Who does Divvy benefit?

The works of Light (2005) and Clark (2020) offer a strong framework on the potential motivations behind public-private partnerships that cities are entering into. With Divvy bikes in particular, I'd like to raise the very question of who such technologies benefit especially during a time when the status quo of urban life is dismantled by the power of a global pandemic. In times of need, even though CTA operations weren't curtailed (Morell & Puente, 2020), there was a general hesitation in occupying closed spaces with other people. Were there changes in patterns of Divvy usage?

To inform my investigation, I also reviewed available literature specifically on Divvy bicycles. In fact, other disciplines have engaged more with the notion of e-scooters entering city spaces. Since scooters are often touted for an environmentally friendly alternative to cars, Eccarius & Lu's (2020) work used behavioral theory studied how the choice to ride electric shared scooters (ESS) is influenced by various factors, such as usage intention. Based on their findings from Taiwan, they argue that urban planners need to address gaps in bringing behavioral shifts in populations where ESS usage is being encouraged. Similarly, human-computer interaction scholars such as Tuncer & Brown (2020) have studied how the user experience of scooters and their mobile applications have an impact on how they're used to traverse the city.

Laa and Emberger (2020) touch on bike-sharing services and how abiding to regulations depends on the kind of bike-sharing program. Felix, Cambra & Miura (2020) approached micromobility through bike-sharing also and found that even in cities that were less mature in cycling habits, establishing cycling networks and introducing bike-sharing systems increased

use. Bai and Jiao (2020) have engaged with e-scooters by studying how effective crowdsourcing is to report e-scooter usage violations.

Zhu, Zhang, Kondor, Santi & Ratti's (2020) comparative analysis of usage trends between shared e-scooters and shared bikes found that e-scooters are used relatively more than bikes. They found that certain areas, such as university campuses and tourist attraction spots, are more likely to encourage e-scooter use.

With this literature in mind, I would like to understand how the city of Chicago's efforts to instill equity into their pilot in 2020 impacted usage, especially in marginalized communities that it was meant to help. My methodology is inspired by the work of Singleton, Spielman & Folch (2018). They recognize that cities have started to produce organic data about current trends. They distinguish organic data with purposive data (which is collected through surveys). They argue that organic data from cities can allow for a more macroscopic understanding of urban trends and help understand more about the movement throughout city spaces.

CHAPTER III

METHODS

This chapter discusses the methods utilized to answer the research question around usage trends across Chicago neighborhoods. I will describe my process of selecting the timespan for this inquiry and also the dimensions and measures of Divvy data that I utilized for this project. I will then delve into my choices for visualizations and the limitations that I faced while completing this project.

Rationale for methodology

The descriptive nature of my inquiry allowed me to utilize quantitative methods for analysis. Since I was interested in usage trends, I decided to rely on visualizations to note where usage peaked and ask questions around who was using Divvy bikes (by gender and type of member) as well as learning about trip duration. I chose to note trends by community areas in the city of Chicago. Because the project scope did not extend into looking at why usage was distributed in a certain way across community areas, I decided to steer clear of qualitative and mixed methods for this project.

Dataset

I collected Divvy bike data from the City of Chicago data portal. The City of Chicago data portal is public and is a user-friendly resource especially meant to provide transparency to Chicago residents. Once a year, the Divvy dataset on the portal is refreshed with new data. I chose to extract data from the city's portal instead of Divvy's own website because the City's data provided some additional information. The dataset available on the City of Chicago data

portal provided basic information of each ride made using Divvy bikes in the city. This included a trip ID, the start and end date and time of each Divvy ride and the geolocations of the start and end location. Additionally, the City website in particular provided some demographic data on each Divvy user. This data was only available for paid subscriber users and included information about birth year and also gender. All of the data on the portal was anonymized which meant that there was no way to analyze trends in each subscriber member's use across the year.

Scope of dataset use

Since I was interested in investigating Divvy bike usage trends before the onset of COVID-19, I chose to focus my inquiry by studying usage trends specifically during the high usage months before COVID-19 had a sizable impact on city life. Early on in my inquiry, I had realized that expanding my research project to include a whole year would not be feasible because of the load that the dataset added to the software and operating system that I was using. Therefore, I had to make a decision to filter my dataset to select a portion of 2019's Divvy rides for analysis. I observed trends in the City of Chicago data portal's prepared dashboard visualization (see Figure 1). In this visualization, each curve represents one year worth of data. The curve moves up and down based on the number of trips that were initiated per month. The dashboard visualization offers a clear understanding that Divvy bike usage has surged during the summer months since the services began being offered to Chicagoans in 2013. While this helps understand that the summer months are an important area of inquiry, I decided to look past just the dashboard's visualizations and created a visualization using the Chicago Data Portal's visualization tools (to be described in more detail later in this chapter) to shortlist a few months that I would look into.

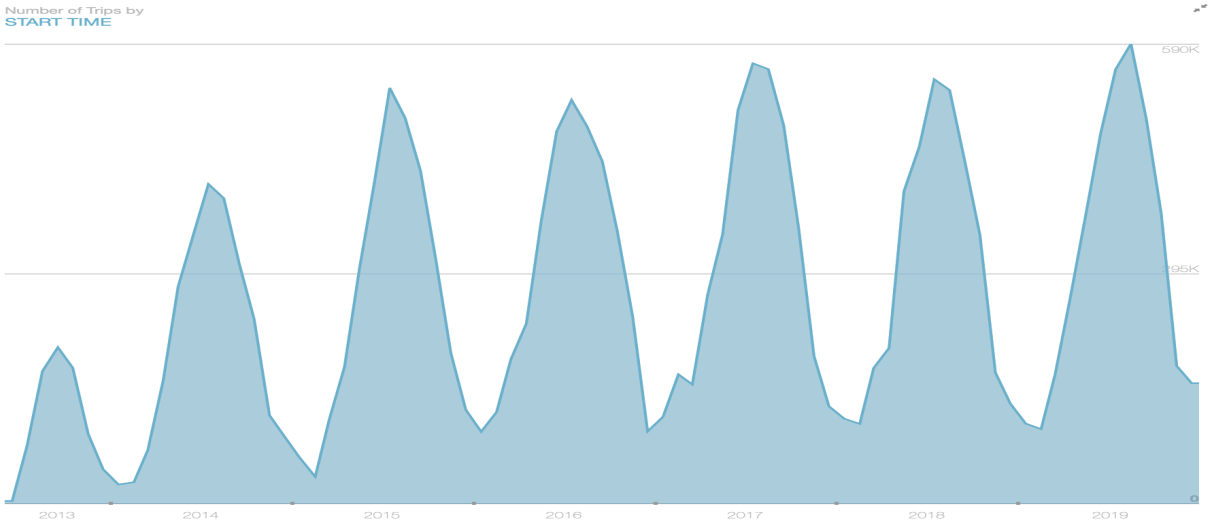

Figure 1. Number of Divvy rides per month since 2013.
Source: Chicago Data Portal (2021)

The visualization created (Figure 2) for 2019's Divvy usage shows that usage surges between May and October 2019. While the number of trips in April (about 320 million) was also not significantly lower, I chose to demarcate some boundaries while selecting months for analysis by establishing an arbitrary number. Months with less than 400 million trips per month were excluded from my analysis, which meant that I was left with 6 months of data to work with.

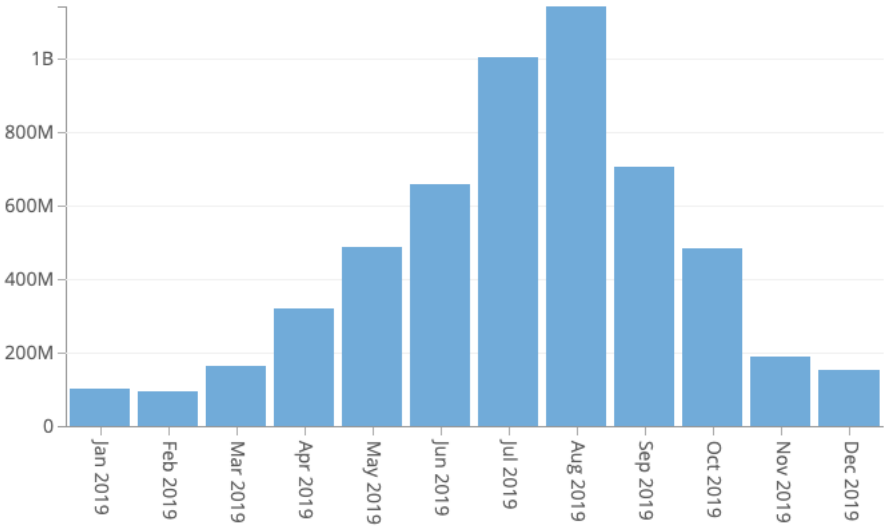

Figure 2. Number of rides per month in 2019.
Source: Chicago Data Portal (2021)

Analysis tool

As mentioned, the dataset for Divvy bike usage in 2019's peak months was available on the City of Chicago data portal. After much consideration, I decided to use the data portal's own closed-source visualization tool managed by Socrata to analyze the data. I have discussed the limitations of this tool toward the end of this chapter and the rationale behind continuing to use it. Before delving into that, it seems fair to delve into how the tool was used for analysis.

Detailed Methodology

As discussed, I filtered the dataset to ensure that I was working between the dates of 05.01.2019 and 10.31.2019. After filtering the dataset, I was interested in working with four dimensions: Start Location, End Location, Birth Year, Gender, and User Type. The measures I used were sums of the count of rows during the time period (indicating the number of trips taken) and trip duration (computed by using Start Time and End Time). When spatial boundaries were needed (for instance, in the region maps that illustrated which areas had high ridership), I

chose to work with community areas. I preferred the use of community areas instead of zip codes, census tracts or wards. This choice was informed by my desire to find a middle ground in terms of granularity in my analysis. I rationalized that zip codes and wards would be less granular than community areas while census tracts would be more granular than needed. It also seemed reasonable to consider the argument that community areas are defined by natural boundaries such as water bodies, rail roads and parks (Seligman, 2005). It seems fair to assume that when considering what behavior is exhibited in micromobility use per geographic region, natural boundaries are very important. Such boundaries are likely to shape how city residents experience travelling around the city.

Location included the geolocation of where Divvy bike trips started and ended. This information especially helped answer the spatial aspects of my inquiry, such as offering insight into how many trips were initiated per community area. Using this information, I created region maps, with each region representing one Chicago community area. Two types of region maps were created by aggregating points and using graduated colors and 5 classes; darker colors represented higher usage. The first type of region map showed usage by the count of rows (i.e., number of trips) per community area. Areas with more trips appeared darker. The second type of region map showed usage by trip duration, with areas having a higher value of the sum duration of all trips starting in an area having a darker color. The practice of working with both the sum of trip duration and number of trips was consistent across my analysis because it helped understand if there were any differences or if results from both showed consistency. For instance, I wanted to see if there was a possibility that more trips were initiated in one type of region, but other regions had a larger sum of total trip duration.

Visually, I decided to choose one color for the graduated scheme for the region maps, instead of choosing other schemes which ranged from blue to red. Having one color shaded from lighter tones to darker tones offer the story of Divvy bike usage more clearly. Moreover, while the visualizations could have been created using any basemap in the suite of options provided by the portal, I made the decision of using Google's roadmap as my basemap because it was easiest to look at visually with the mild colors (such as gray and light brown).

I was also interested in utilizing the few sociodemographic dimensions that the dataset offered through the trip details of subscriber users. The User Type dimension bifurcated users into those who paid for an annual subscription for Divvy user (Subscriber) and those who paid per trip (Customer). Given that subscriber type provided some information about the gender and birth year of users, I used this to understand what social groups typically subscribed to Divvy bike plans and what their habits were. I generated visualizations to understand the distribution of subscriber users' trips through region maps. I also created histograms and pie charts to understand trends in number of trips of taken and the sum of trip durations per group (i.e., subscriber/customer and male/female). Moreover, I utilized the birth year details to understand trends of use by age group. In working with age groups, I found that clustering birth years by the decade was visually offering a clear understanding of usage trends as opposed to viewing trends per users in each birth year.

Benefits of methodology

The benefit of this method is that it provides a snapshot into the usage of Divvy bikes at a certain point in time (2019). Especially with researchers becoming interested in how urban life changed with the onset of COVID-19 and which of these effects lingered after the ease of

COVID-related restrictions in major cities like Chicago, such work provides important information to conduct comparative research. COVID-19 is often discussed as a catalyst in changing many urban habits and the way in which mobility is navigated (either through major transit, personal cars or micromobility technologies) is an important piece of the puzzle. The visualizations developed through this method contribute to this dialogue.

Constraints in methodology

The decision-making process regarding the methods for my research project was highly iterative. As a preface, it is important to note that the descriptive nature of my inquiry was motivated by the general circumstances brought upon by closures and reduced physical interactions due to COVID-19. Being fearful of catching COVID-19 and transmitting it to immunocompromised members of my household, I had come to the decision that more interesting 'why' inquiries would require qualitative field work. I was not convinced that the risks of conducting qualitative research during a pandemic were worthwhile.

While this is understandable, the necessary iterations to my plans that I was not expecting as a result of COVID-19 had to do with my quantitative approach. My initial plans involved a comparative analysis of 2019 and 2020 using ArcGIS and Tableau. I had planned to generate heat maps and region maps with graduated colors after establishing a Spatial Join between Divvy bike data points and Chicago community area polygons using ArcGIS. I was also planning on creating other descriptive visualizations using Tableau. I ran into two problems with this. The dataset had about 5GB of data and my computer wasn't able to process such a large dataset. Also, using ArcGIS off of Loyola's remote access tool (Aporto) was not feasible on my personal computer because the connection would have a lot of load. I had learned to use ArcGIS in ideal

circumstances before the onset of COVID-19 on high quality computers at Loyola University Chicago's labs that serviced the environmental science department students. Attempting to conduct my own research without such resources proved to be strenuous and after weeks of attempting to make my analysis work with the limited resources I had off-campus, I decided to switch gears.

Moreover, it is unclear how many unique subscriber users utilize Divvy bikes in Chicago based on this data. It is possible that there are very few unique subscriber users. Even if they use Divvy bikes more, they may skew the data by offering a representation that all subscriber users in general have different habits from users, when there are a few subscribers who use the service more and their use has a large effect on the data of subscriber users. I attempted to do some Google searches to understand how many unique Divvy subscribers there are every year but I wasn't able to find any information on this beyond what I found and reported in my results chapter.

As stated, deciding to use the Socrata platform came with its benefits and costs. The quicker computing speed and smoother database access meant that I was able to generate the descriptive visualizations I was most interested in. The drawbacks of this approach meant that some more sophisticated techniques were unavailable to me. For instance, I wasn't able to normalize my data by accounting for the number of Divvy bikes per community area. To refine this project at a future time, normalizing data would be essential to understand how much of the trends shown in the visualizations are merely because of the increased presence of Divvy bikes in some community areas over others. I have discussed this more in my results chapter.

Moreover, I also wasn't able to create a heat map that could explain much about trends in Divvy usage in Chicago due to the system features offered by the city's platform.

The process of completing this project was certainly bumpy. However, it has been informative in giving me insight on how to approach planning my PhD dissertation project. In that sense, I believe that the constant iterations in my methodology taught me more about conducting research than a smooth-sailing project could have.

In the next chapter, I will discuss the outcomes of the research project.

CHAPTER IV

RESULTS

In this chapter, I will be discussing the outcomes of the visualizations generated through the City of Chicago's closed-source data portal called Socrata. As discussed, I have chosen to describe the trends of Divvy bike usage between the peak ridership months of May to October of 2019. The descriptive findings from this chapter will provide a general overview of trends in the ages and reported gender of users, their preferences to utilize services as members or subscribers, and location of trips by community areas. After presenting the results, I will discuss them in light of dialogue around transportation equality, urban segregation and political economy.

Membership

Divvy ridership was divided between Subscriber users (who purchased annual plans for unlimited rides lasting 45 mins) and Customer users (who paid a fee per ride based on the duration of the ride). The pie chart in Figure 3 shows that about 60% of the Divvy trips initiated in the Chicago area were by Subscriber members and that fewer trips were initiated by Customer user types. Judging by just this pie chart, it could be argued that Subscriber users are the major consumers of Divvy bikes in the Chicago area. However, Figure 4 offers more insight into the behavior of Customers and Subscribers. Figure 4 shows that the sum of trip durations is larger for Customer users compared to Subscribers. Customers account for two-thirds of the time spent riding Divvy bikes across the city.

One shortcoming of these representations is that there are no unique IDs that indicate how many subscriber users there are in total and what percentage of subscriber users are being overrepresented especially in Figure 3. It is possible that more trips were initiated by a small number of Subscriber users who are dependent on Divvy more than usual. As a result, such users may have skewed Figure 3 by offering the idea that Subscriber users take more (but shorter) trips using Divvy bikes.

In order to surpass this shortcoming, I had connected with Sean Weidl who works as an Assistant Commissioner at the Chicago Department of Transportation. The connection was created through networking with Loyola's Public Policy graduate students who were working as fellows at the City. Due to contractual constraints in the agreement between the City and Divvy by Lyft, Weidl was unable to share more detailed datasets.

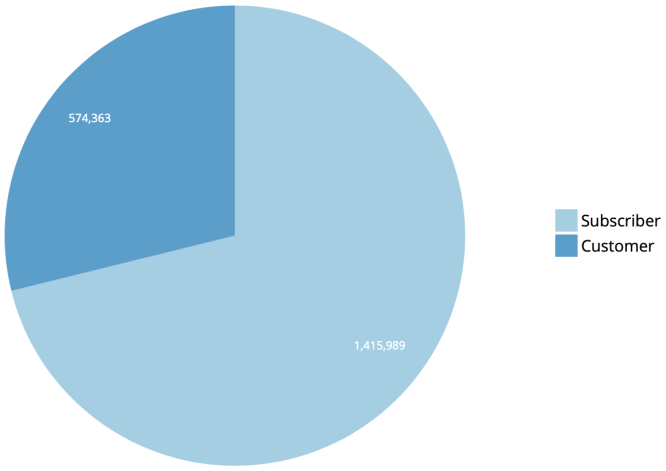

Figure 3. Number of rides taken by Subscribers and Customers.
Source: Chicago Data Portal (2021)

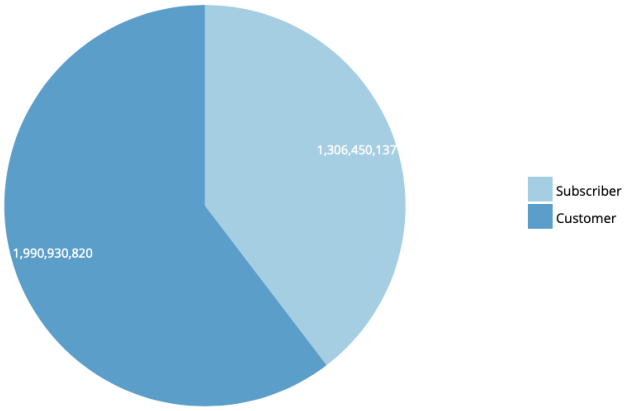

Figure 4. Sum of trip duration of Customer and Subscriber users.
Source: Chicago Data Portal (2021)

Characteristics of Subscriber users

The advantage of having the dataset bifurcated between Subscriber and Customer riders was that the former group offered some additional sociodemographic information about the users. This included the gender and the birth year of the Subscriber users. While there are far more interesting variables that one would be interested in, such as race and income group, getting an understanding of the gender and ages of typical users can also offer insight. This is because such information explains which groups take advantage of the potential first- and last-mile transportation benefits that micromobility is touted to offer.

Gender

Figure 5 shows the gender distribution of rides taken during the peak usage months in 2019. Almost 70% of the rides initiated by Subscriber users who identified their gender were by males when signing up for the year. Only about 30% of the rides initiated by subscribers who identified their gender were by females.. The chart shows a ‘no value’ category which represents Customer users; gender information was not available for such users. Figure 6 illustrates similar

trends in terms of trip duration. Male users account for almost twice the amount of time spent riding Divvy bikes in the Chicago area during the peak usage months of 2019 (38%) while female users account for just 21%.

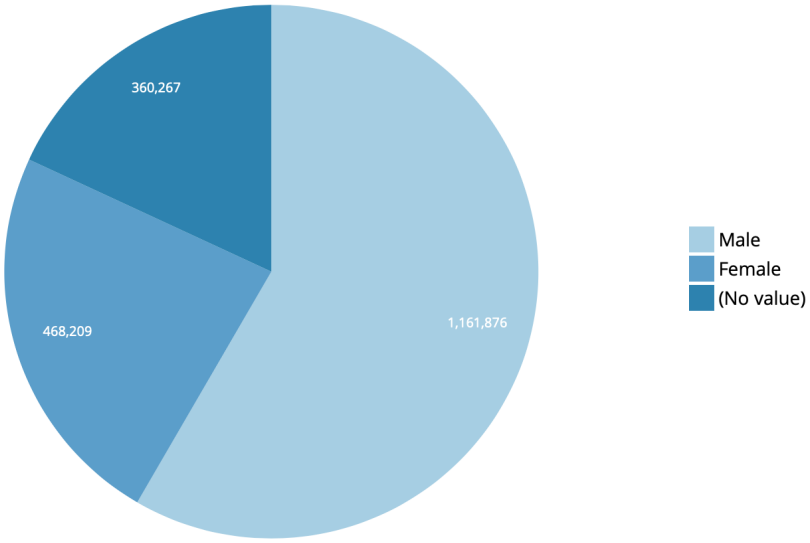

Figure 5. Subscriber users' number of trips by gender.
Source: Chicago Data Portal (2021)

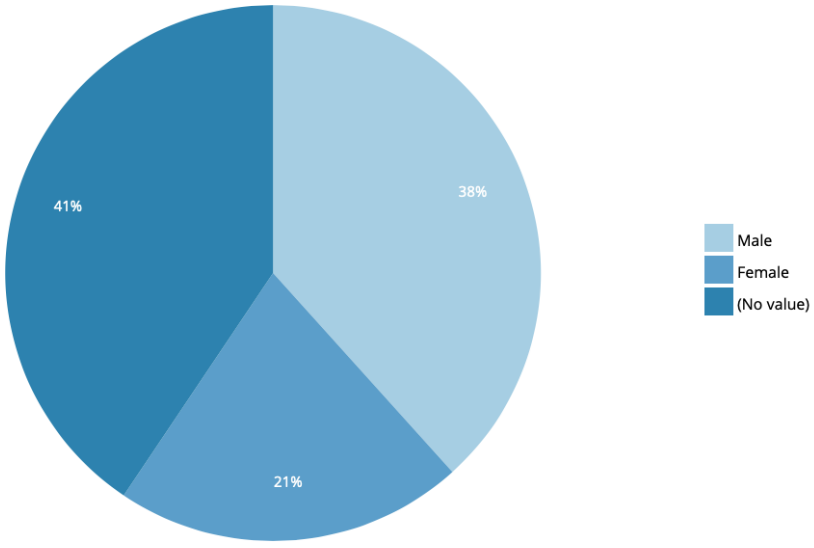

Figure 6. Sum of trip duration of subscribers by gender.

Source: Chicago Data Portal (2021)

Age

Given that micromobility is argued to make the city more accessible for all urban dwellers, seeing the age distribution of users gives insight into who access is increasing for. Figure 7 shows the sum of trip duration (measured in seconds) clustered by the decade. It shows that the highest usage is by those born in the 1980s and 1990s, meaning that folks who are now in their 20s and 30s are the typical users of Divvy bikes in the Chicago area. People in this age group differ largely from those of other age groups, especially in Subscriber users. While those born in the 1980s account for almost 250,000 hours in usage and those born in the 1990s account for 333,000 hours in Divvy usage, the remaining users contribute a total of about 167,000 hours in usage. This shows that there's a clear trend, at least in Subscriber users, about who Divvy bicycles benefit in Chicago. The discussion chapter will delve into this more. Figure 8 also maintains the same results, even in terms of who is initiating Divvy trips more. The highest usage (indicated by the longest bars on the left) is by those born in the 1980s and 1990s.

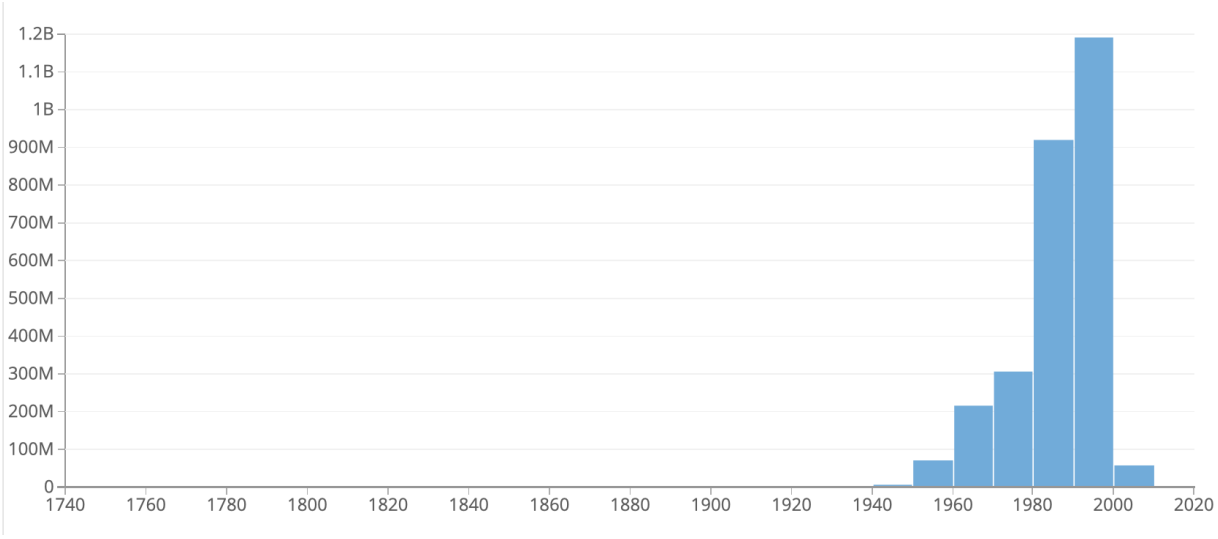

Figure 7. Sum of trip duration of subscribers by birth year.
Source: Chicago Data Portal (2021)

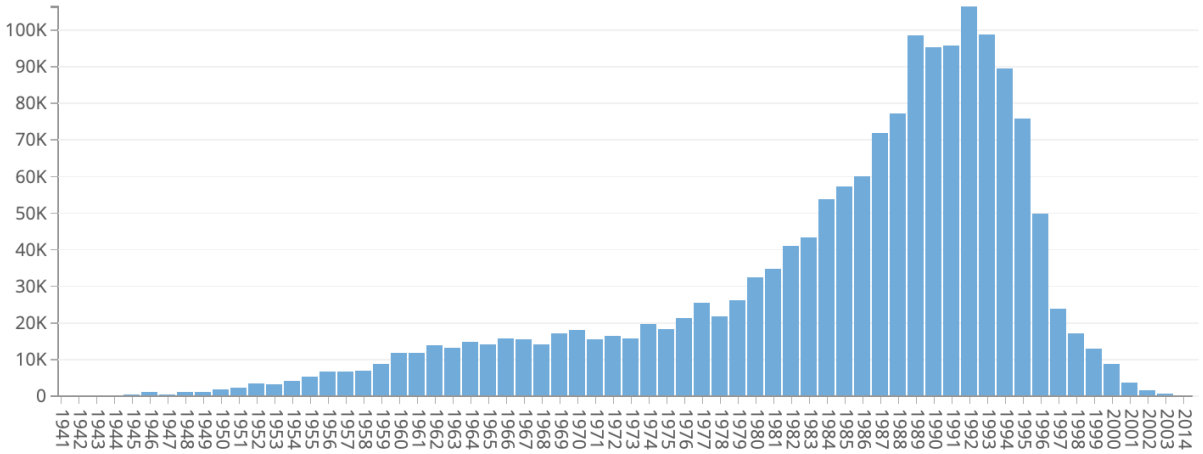

Figure 8. Number of trips taken (by Subscribers only) by birth year.
Source: Chicago Data Portal (2021)

Geographic distribution of ridership

The most important area of inquiry was the geographic distribution of Divvy rides. As a whole, I have found that more affluent neighborhoods had higher Divvy ridership in the Chicago area. This finding remained consistent when comparing results based on the number of initiated

trips and their trip duration. It also remained consistent whether one observed where rides started and where rides ended.

In each of the maps (Figures 9-11), graduated colors have been used to indicate usage trends. Darker colors indicate higher usage. The polygon outlines represent community areas. While most community areas are colored in some shade between yellow and brown, a few have no color filling the shapes. This is because such areas report zero Divvy ridership in terms of trips being initiated or ending there. Since Divvy stations are not placed in these neighborhoods, this finding is understandable. However, it is important to note that neighborhoods without any stations are usually those located on the West and South side of the city.

Figure 9 shows the community areas where trips were initiated in the Chicago area. It shows that the highest number of rides were initiated in the Loop and Near North Side. The second group of community areas with high ridership are surrounding those areas. The remaining community areas generally have a lower number of rides being initiated in them. Similar trends are apparent even in Figure 10, meaning that the trips consistently ended more in the Near North Side and the Loop. We cannot argue that even if trips were initiated in the Near North Side and Loop, they ended in other community areas with more frequency. Figure 11 shows that similar trends extend to the map which accounts for the sum duration of Divvy rides taken per community area. The Loop and Near North Side continue to maintain their spot in having the most ridership by both metrics: highest sum durations per community area and highest number of trips initiated and/or ending per community area.

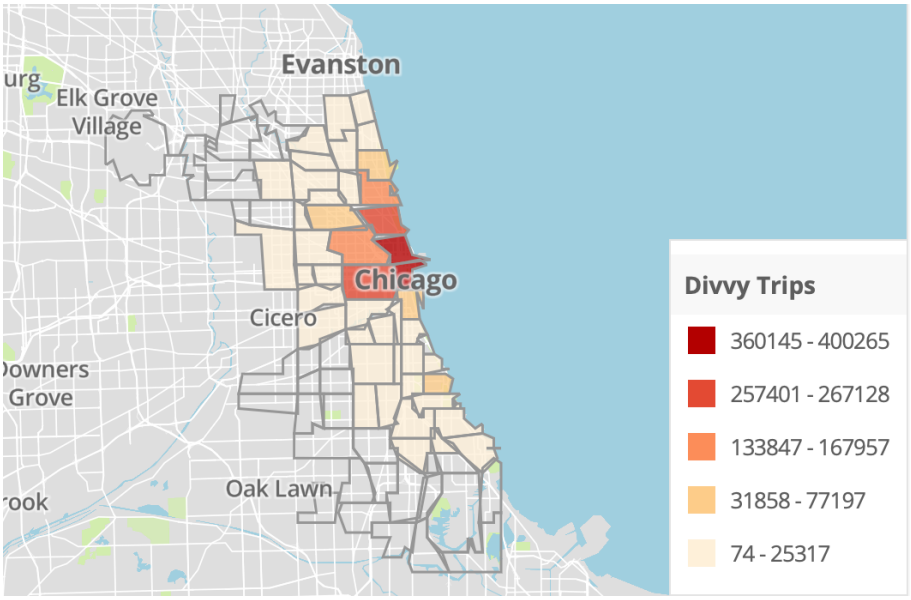

Figure 9. Number of total trips starting per community area.
Source: Chicago Data Portal (2021)

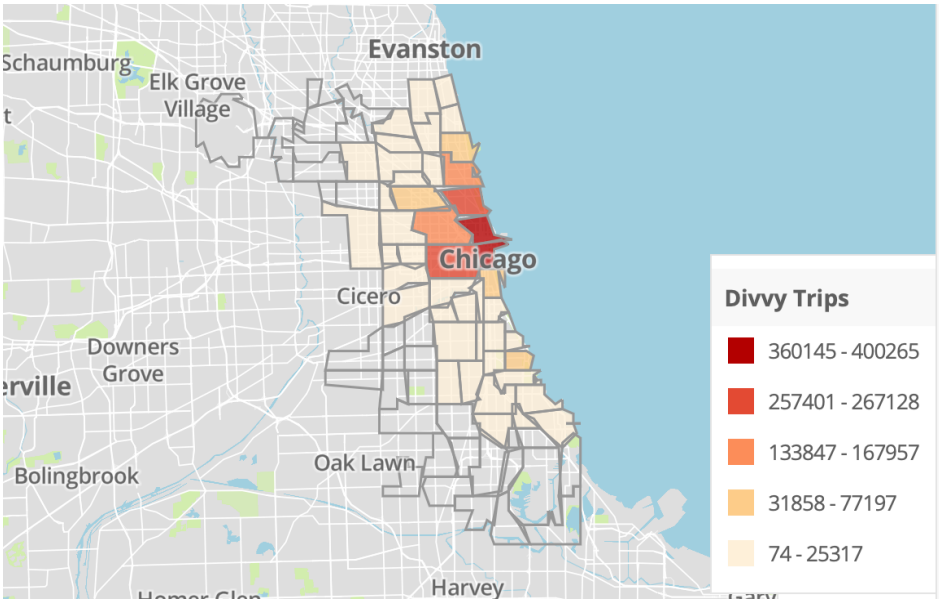

Figure 10. Number of total trips ending per community area.
Source: Chicago Data Portal (2021)

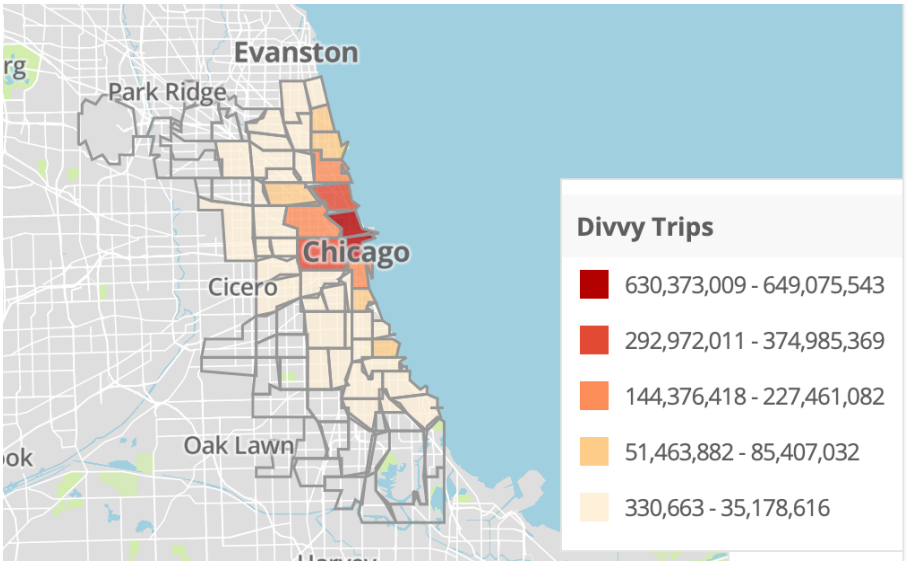

Figure 11. Sum duration of total trips (in seconds) starting in each community area.
Source: Chicago Data Portal (2021)

A shortcoming of these findings is that the maps could not be normalized by dividing the number of rides or trip duration by the number of Divvy bikes per community area. After discussing my options with the Assistant Commissioner at the Chicago Department of Transportation, I made some nascent observations about the link between ridership trends and the placement of Divvy bikes in community areas. Figure 12 shows that more Divvy bikes are in fact present in places that have higher ridership. This raises the question about whether trends in Divvy usage can be explained by just Divvy availability or also by neighborhood characteristics and the behaviors of urban dwellers in each unique neighborhood. I identify this as an area of inquiry in the next chapter.

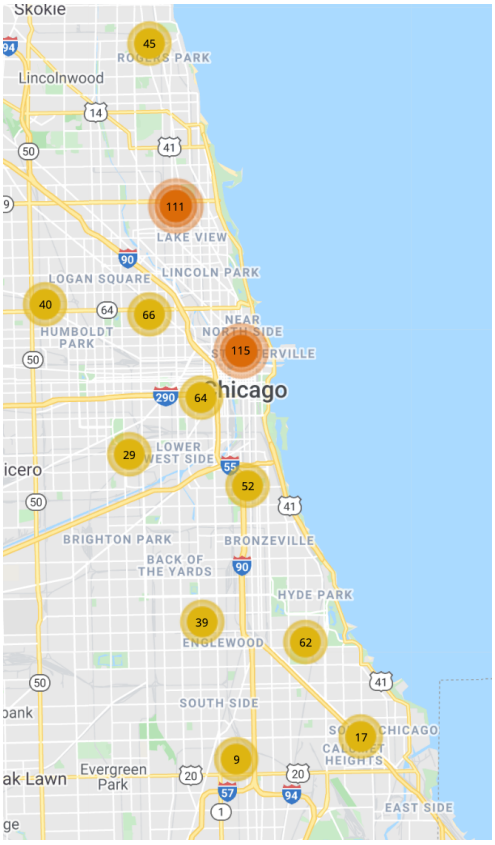

Figure 12. Divvy station distribution across the Chicago area.
Source: Chicago Data Portal (2021)

This chapter has discussed the results of the analysis run on Divvy data from 2019's peak usage months. The analysis explains that men and younger people (currently in the ages of 20s and 30s) are frequent users of Divvy bikes. Moreover, Customer users spend more time on Divvy bikes even though Subscriber users begin more rides. Finally, most of the Divvy trips take place around the affluent areas of the city such as the Loop and Near North Side. In the next chapter, I will discuss these findings in more detail.

CHAPTER V

DISCUSSION

As discussed in the literature review chapter, the intent behind introducing Divvy bikes in the city of Chicago was to bring docked micromobility technology to the streets which would facilitate short trips, especially those that would help solve first- and last-mile transit issues. Mayor Emanuel's Shared-Mobility Task Force included Divvy bikes in its scope and argued that the services provided by bikes and escooters would help grant Chicagoans access to better jobs, healthcare and food. By this argument, those who need Divvy the most are those who are most disenfranchised by the city, such as those living in the West and South Side. While this aligns with the ideals of shared mobility as a solution to a population influx in large cities such as Chicago (Hannon et al., 2016), it is worth investigating the extent to which such shared mobility programs are creating benefits.

Figure 12 in the previous chapter offers a clear picture that the very neighborhoods that should be benefiting from the supposed benefits of Divvy are the same neighborhoods that have lesser Divvy stations. Most stations are concentrated in wealthy neighborhoods around the Loop, where streets are walkable, amenities are easily accessible and multiple transit options are available throughout the day. Smith and O'Neil (2018)'s work out of DePaul's Chaddick Institute for Metropolitan Development shares the same observation that services such as Divvy are often not benefiting those who need it the most. They share that this is due to the scarcity of

stations in such neighborhoods. They also find that the unbanked may have trouble using Divvy because the most popular way of renting a bike is by use of credit card.

On a positive note, in the case of Chicago, efforts are being made to make Divvy more accessible to folks living in communities that often have fewer mobility options. For instance, the city is investing $50 million dollars into the expansion of Divvy in the Far South Side. Estimates show that the expansion from 71st to 138th Street and from lakeshore and state line to Western Avenue will approximately serve an additional 300,000 Chicago residents (“Far South Side Expansion”, n.d.). Moreover, Chicago and Divvy have partnered to introduce Divvy4E (Divvy for Everyone). D4E offers an annual plan that costs $5 for qualifying residents and even gives them an option to pay for the subscription in cash. Qualifying residents are those ‘SNAP, WIC, LIHEAP, FAFSA or public housing assistance’ or those who can prove that their income is 300% below Federal Poverty Level ("Divvy for Everyone", n.d.)

While special programs are being created to increase access and money is constantly being invested, it is fair to look into the trends behind such investments. The 50 million dollars investment commitment comes for a public-private partnership between the city and Lyft (which owns Divvy). While such partnerships have become the norm in Chicago, they are important areas of inquiry because the outcomes of such inquiry have the power of shaping the fabric of the cities that they are made in. For instance, the creation of Divvy stations across the South side may become an outcome of the investment. However, will Divvy bikes be used effectively and provide the desired outcome in such neighborhoods?

So far, scholarship has noted that most shared mobility services are predominantly utilized by young, White, affluent males living in neighborhoods that historically have had

strong transit networks (Chicago Department of Transportation, n.d.). It is for this reason that another shared mobility service in Chicago (eScooters) adopted an equity lens when piloting the viability and effectiveness of expanding shared mobility in the city. Their aim was to evaluate how effectively the pilot improved "mobility and accessibility for residents who face elevated economic, health, mobility or accessibility barriers" ("City Of Chicago Terms And Conditions For The Second Business Operations Window Of The Scooter Sharing Emerging Business Permit Pilot Program", 2020). They demarcated priority zones so that they covered neighborhoods where residents face systemic disadvantages following generations of underinvestment and inequitable access to resources and opportunities. The Chicago Department of Public Health's Healthy Chicago 2.0 "Economic Hardship Index" was combined with additional mobility and demographic factors to identify the equity priority zone.

> The priority area covers neighborhoods where residents face systemic disadvantages following generations of underinvestment and inequitable access to resources and opportunities. The Chicago Department of Public Health's Healthy Chicago 2.0 "Economic Hardship Index" was combined with additional mobility and demographic factors to identify the equity priority zone. (City of Chicago, 2020)

Such efforts to insert equity into the conversation around smart mobility are commendable, but still beg the question about why usage in such zones is low. Afterall, even with such robust attempts to bring eScooters in the South and West side, with at least half the scooter fleet being placed in these areas, less than a quarter of the rides occurred here (Claffey & Hofer, 2021). Most of the rides continued to be initiated in the more affluent areas of Chicago. With Divvy's expansion into the Far South Side with such a large dollar amount, one must wonder if such a large investment will be fruitful.

There has been some research which provides insight into why usage is lower in less affluent and racially diverse neighborhoods. It was found that lower-income residents and people of color reported to facing more barriers to using bicycling as a means of transportation. Some barriers including traffic safety and even personal safety. Those of minority race groups shared that using bicycling as a means to commute made them feel exposed and more likely to become targets of crime and even police attention (Smith & O'Neil, 2018). Smith & O'Neil (2018) also found that biking required material resources such as storage area for bikes at home, access to safety gear and also a lack of knowledge on how to maintain bikes. With regards to using bike-share systems in particular, lower-income residents shared that they were especially concerned with using bike-share services due to fears of being held liable if the bike were damaged (Smith & O'Neil, 2018). Smith & O'Neil (2018) state that one of the rationales behind adding credit cards and apps as a necessary condition to renting a Divvy bike was, in part, to hold people accountable if they were to damage a bike. Even in terms of gender, Sanders, Branion-Calles and Nelson (2020) found that women share that they are discouraged to test shared micromobility services because of the lack of infrastructure available to use such technology (such as separate bike lanes) which couples with their fear of getting hurt. Finally, the benefits of shared micromobility technology is reaped mostly by young adults up to the age of 34; there are very few users who are older than the age of 55 (Heinke, Kloss & Scurtu, 2020).

It seems from the literature then that low usage of shared micromobility in the South and West side of Chicago (as was the case in my analysis as well) is not just due to a scarcity of Divvy stations. There are underlying fears and material realities that drive the trends of shared micromobility usage in the South and West side of Chicago. Moreover, minority race groups,

women and the elderly are not benefiting much from such services being made available in cities. The spatial and sociodemographic trends manifested themselves even in my project about Divvy usage in 2019. Harvey's (2008) discussion on the right to the city becomes most important here. As the literature review had mentioned, it is important to think about who has the power to shape the city. Light's (2005) work discussed how the introduction of innovative technologies into city spaces was often incentivized by capital needs to diversify markets and enhance usage of developed technologies. Clark's (2020) work does reiterate this possibility by discussing how the city is the perfect space for the introduction of such innovative technology since it can act as both the producer and also the customer for it. While it is difficult to bring intentionality into the discussion of Divvy expansion in Chicago at this point, it is a matter of curiosity that a huge investment is being made for shared micromobility technology to enter the urban fabric as opposed to investing toward building more robust bike lanes generally or even expanding the CTA system. It could be that the tech goggles that Green (2019) warned against are being utilized to force such technologies into city spaces, especially to align with the smart city narrative which pushes for constant technological innovation and assumes that more technology is always good.

This may explain why, apart from the geographic expansion of the fleet, more types of Divvy bikes are being introduced into the city. For instance, in 2020, Divvy installed e-bikes, which have pedal-assist features making it easier to ride bikes and take longer trips. Divvy (2020) has pitched these pedal-assist bikes as a shared micro-mobility device which is accessible to people who are also older and may be less prone to ride regular 'classic' Divvy bikes. The rationale behind their installation is that ebikes will help connect people to transit in the South

and West side, especially because of the fact that riders will be encouraged to take longer trips due to the pedal-assist technology. Another rationale shared in the Divvy ebike fact sheet document is that it will make Chicago greener by offering an option of transportation that doesn't harm the environment (Divvy 2020). The most fascinating element of the Divvy ebike, for me, is that it is a dockless technology, meaning that it can infiltrate across the city with more ease. Unlike classic pedal bikes by Divvy which can only be parked at designated Divvy stations, Divvy ebikes can be parked at any public bike rack. The assumption that this is positive and that all Chicago residents will value this new feature may be very flawed. The document doesn't cite any scholarship on whether this was demanded by Chicagoans; it seems as though the assumption that the expansion of such technologies being objectively good has carried forward. If such technology is good, it begs the question: who is it good for? If it is continuing to only enhance the city's access for white, young, affluent males, it may not be worth the price of 50 million dollars in investment.

In a time when the city was most shaken and being mobile came with a lot of fear of virus transmission, it is fair to ask who shared micromobility became useful for. While I couldn't conduct a comparative analysis at the time, the Divvy website describing D4E (Divvy for Everyone) illustrates that the poor are the first to be disenfranchised when crisis hits. The Divvy website offers a flashy description of the D4E program, talking about how it is meant to enhance Divvy access by making it affordable for the city's needy residents and also for those who are under- and unbanked. There are a total of six sites where D4E passes can be acquired in-person, which is especially useful if someone doesn't have a credit card to make the payment. For a city as large as Chicago, six sites are evidently far from sufficient. Regardless, even now, with

COVID-19 restrictions being lifted, these sites are still closed due to the pandemic, meaning that physical D4E passes aren't available. While cutting-edge technological innovation in city spaces is being touted as an avenue for urban equity, it is unfortunate to note that those who are typically disenfranchised face even more barriers and their lack of access to the city is even more strongly intensified due to the pandemic.

Finally, the region maps shown in the previous chapter make spatial trends in Divvy usage in Chicago very apparent. While one cannot give a definite statement about the dominant race group, based on the region maps, it is highly likely that White people utilize Divvy them most. This assumption is fair because reports by the City of Chicago generally note that across shared micromobility options, White (and affluent young) people are the most popular users (City of Chicago, 2019). Moreover, spatially, the neighborhoods with more diverse communities have proven to have lower Divvy usage, as shown by the region maps in the previous chapter. It is interesting to note that transit inequalities within the realm of micromobilities also manifest themselves on racial and classist lines. Chicago is known for the racial segregation prevalent within the CTA system, which reduces access to the city for those living in spaces that benefit minority groups.

In the case of Divvy (and other shared micromobility), this continuation of similar trends is fascinating because such services are meant to close the gap between residents and CTA buses and trains via first- and last-mile transit benefits. In fact, it offers a segue into Nelly Oudshoorn's (2003) work titled *How Users Matter* which suggests that the user and technology are often co-created. She argues that users of any technology shape the way in which it is used and also that the technology in turn shapes the user. Oudshoorn (2005) discusses how it is important to look at

both the producers of technologies and the users/non-users. Her book collection suggests that it is essential to study the 'actions and reactions of both producers and consumers' (Oudshoorn, 2005, p. 17). Other scholars in Oudshoorn's (2005) book also offer useful insight that non-use is not always dictated by a lack of access to technology; in fact, it may be voluntary due to many reasons. With regards to Divvy usage being predominant by young, White, affluent males, it is worth investigating what it is about the Divvy program and its technology that creates a user which is specific following a gender, race and class pattern. I recognize this inquiry as an avenue for future research as well; it would involve studying the use and non- use dynamics, evaluating how complicated underlying histories and gender- and race-based experiences impact the way in which Divvy bikes are used within the city of Chicago. It may offer insight into the degree to which the co-creation of the user and technology feeds into existing transit inequality norms in the city.

Another area of future inquiry involves trends in annual membership. An interesting observation that emerged from my project has been the difference in habits between Customer and Subscriber users. While qualitative research may be necessary to understand the reason behind the differences in use of the two types of users, one can speculate that those with more financial stability will have a greater capacity to purchase annual subscriptions. The results showed that subscriber users made more trips of short duration while customers made fewer trips of longer durations. Customer users may be reliant on Divvy for covering certain distances, even if they cannot afford to buy a pass all at once. I recognize this as an avenue for future research. While I am setting myself up for a future comparative analysis, the current structure of that analysis doesn't allow me to investigate the changes in Divvy usage by tourists before and after

the pandemic. Tourism is another reason why Divvy was spread across the city and it is worth investigating in the future how this may have been effected.

In this chapter, I have discussed the goals of the city to expand Divvy in the Far South Side and my concersn regarding this. While the aim of this project has been to prepare for a comparative analysis with data before and during COVID-19, I have used the case of D4E to suggest that spatial segregation may have been even more intensified due to the pandemic, even when it came to shared micromobility. Finally, I have recognized areas of future inquiry.

CHAPTER VI

CONCLUSION

This paper was initiated by a desire to study how shared micromobility was impacted by the onset of the pandemic. CTA trains and buses were heavily impacted during this time and such trends were coupled with an increased interest in outdoor activities such as bicycling. In this paper, I have focused on preparing for a comparative analysis by studying trends prevalent before the onset of COVID-19. I did this by identifying peak usage months (May to October) and creating visualizations using the City of Chicago Data Portal's analysis platform.

I have found that in 2019's peak usage months, Divvy usage was most common in the affluent regions of Chicago and the bikes were being used more by men and those aged in their 20s and 30s. Due to the limitations in methodology, I was unable to normalize my data, which I concede is a major setback in establishing robust findings. However, my discussion chapter has also shed light upon the fact that the ratio of rides and Divvy stations per community may not necessarily be the largest concern; instead, I argue that qualitative analysis may be more important in the future to understand why certain communities benefit less from shared micromobility technologies such as Divvy, even if they are available. I have found Harvey (2008), Light (2005) and Clark's (2020) discussions are useful to argue that Divvy can be identified as a technology that is being encouraged in light of capitalist ideals and with the assumption that more technology is objectively good for the city. Moreover, studying how why Divvy attracts a certain

type of user may be an important question to ask, especially by engaging with literature on the co-creation of the user and technology.

REFERENCE LIST

Bai, S., & Jiao, J. (2020). From shared micro-mobility to shared responsibility: Using crowdsourcing to understand dockless vehicle violations in Austin, Texas. *Journal Of Urban Affairs*, 1-13. doi: 10.1080/07352166.2020.1798244

Boarnet, M., Giuliano, G., Hou, Y., & Shin, E. (2017). First/last mile transit access as an equity planning issue. *Transportation Research Part A: Policy And Practice*, *103*, 296-310. doi: 10.1016/j.tra.2017.06.011

Brandtner, C., Lunn, A., & Young, C. (2017). Spatial mismatch and youth unemployment in US cities: Public transportation as a labor market institution. *Socio-Economic Review*, *17*(2), 357-379. doi: 10.1093/ser/mwx010

Bullard, R. (2005). All Transit Is Not Created Equal. *Race, Poverty & the Environment, 12*(1), 9-12. Retrieved May 30, 2021, from http://www.jstor.org/stable/41555221

City of Chicago Department of Transportation. *Lyft E-Bike Fact Sheet* [Ebook]. Retrieved from https://www.chicago.gov/content/dam/city/depts/cdot/Divvy/Lyft_E-Bike_FactSheet.pdf

City Of Chicago. Terms And Conditions For The Second Business Operations Window Of The Scooter Sharing Emerging Business Permit Pilot Program. (2020). Retrieved 30 February 2021, from https://www.chicago.gov/content/dam/city/depts/cdot/Misc/EScooters/2020/City%20of%20Chicgo_EScooters_Pilot%20Program_Terms.pdf

Claffey, M., & Hofer, S. (2021). CDOT Releases Evaluation of 2020 E-Scooter Pilot Program. Retrieved 8 May 2021, from https://www.chicago.gov/city/en/depts/cdot/provdrs/future_projects_andconcepts/news/2021/may/cdot-releases-evaluation-of-2020-e-scooter-pilot-program.html

Clark, J. (2020). *Uneven Innovation: The Work of Smart Cities*. New York: Columbia University Press.

Divvy for Everyone. Retrieved 30 March 2021, from https://www.divvybikes.com/pricing/d4e

Far South Side Expansion. Retrieved 30 March 2021, from https://www.divvybikes.com/blog/far-south-side-expansion

E-Scooter Share Pilot Program. (2020). Retrieved 30 February 2021, from https://www.chicago.gov/city/en/depts/cdot/supp_info/escooter-share-pilot-project.html

Eccarius, T., & Lu, C. (2020). Adoption intentions for micro-mobility – Insights from electric scooter sharing in Taiwan. *Transportation Research Part D: Transport And Environment*, *84*, 102327. doi: 10.1016/j.trd.2020.102327

Farmer, S. (2011). Uneven Public Transportation Development in Neoliberalizing Chicago, USA. *Environment And Planning A: Economy And Space*, *43*(5), 1154-1172. doi: 10.1068/a43409

Félix, R., Cambra, P., & Moura, F. (2020). Build it and give 'em bikes, and they will come: The effects of cycling infrastructure and bike-sharing system in Lisbon. *Case Studies On Transport Policy*, *8*(2), 672-682. doi: 10.1016/j.cstp.2020.03.002

Gray, L. (2019). Members of Chicago's New Transportation and Mobility Task Force. Retrieved 30 February 2021, from https://sharedusemobilitycenter.org/chicagos-new-transportation-and-mobility-task-force-releases-a-roadmap-for-the-citys-transportation-future/

Green, B. (2019). *The Smart Enough City: Putting Technology in Its Place to Reclaim Our Urban Future*. MIT Press.

Greenfield, J. (2020). Chicago's pandemic plan includes free Divvy for healthcare workers, $1 rides [Blog]. Retrieved from https://chi.streetsblog.org/2020/03/24/chicagos-pandemic-plan-includes-free-divvy-for-front-line-workers-1-rides-for-everyone/

Hannon, E., McKerracher, C., Orlandi, I., & Ramkumar, S. (2016). An integrated perspective on the future of mobility. Retrieved 30 January 2021, from https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/Our%20Insights/An%20integrated%20perspective%20on%20the%20future%20of%20mobility/An-integrated-perspective-on-the-future-of-mobility-article.ashx

Harvey, D. (2008). The right to the city. *New Left Review*, *53*.

Hertel, S., Keil, R., & Collens, M. (2016). *Routes to fairer transit access in the Greater Toronto and Hamilton Area*. Toronto: The City Institute atYork University. Retrieved from https://city.apps01.yorku.ca/wp-content/uploads/2016/02/Transit-Equity_Reduced_020216.pdf

Heinke, K., Kloss, B. & Scurtu, D. (2020). The future of micromobility: Ridership and revenue after a crisis. Retrieved 30 January 2021, from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-micromobility-ridership-and-revenue-after-a-crisis

Laa, B., & Emberger, G. (2020). Bike sharing: Regulatory options for conflicting interests – Case study Vienna. *Transport Policy*, *98*, 148-157. doi: 10.1016/j.tranpol.2020.03.009

Light, J. (2005). *From warfare to welfare*. Baltimore: Johns Hopkins Univ. Press.

Morell, C., & Puente, M. (2020). Chicago-Area Transit Agencies Face 'Drastic' Service Cuts As Pandemic Ridership Plummets. *WBEZ*. Retrieved from https://www.wbez.org/stories/chicago-area-transit-agencies-face-drastic-service-cuts-as-pandemic-ridership-plummets/eee8850e-73af-4443-be32-c3f996169117

Oudshoorn, N. (2005). *How users matter*. Cambridge, Mass.: MIT Press.

Purifoye, G. (2017). Transporting Urban Inequality through Public Transit Designs & Systems. *City & Community*, *16*(4), 364-368. doi: 10.1111/cico.12266

Rogers, P. (2020). Fewer Drivers And Passengers Mean New Realities For Chicago Transportation Agencies. *NBC Chicago*. Retrieved from https://www.nbcchicago.com/news/local/fewer-drivers-and-passengers-mean-new-realities-for-chicago-transportation-agencies/2266447/

Sanchez, T., Stolz, R., & Ma, J. (2004). Inequitable Effects of Transportation Policies on Minorities. *Transportation Research Record: Journal Of The Transportation Research Board*, *1885*(1), 104-110. doi: 10.3141/1885-15

Sanders, R., Branion-Calles, M., & Nelson, T. (2020). To scoot or not to scoot: Findings from a recent survey about the benefits and barriers of using E-scooters for riders and non-riders. *Transportation Research Part A: Policy And Practice*, *139*, 217-227. doi: 10.1016/j.tra.2020.07.009

Seligman, A. (2005). Community Areas. In *The Electronic Encyclopedia of Chicago*. Chicago Historical Society.

Singleton, A., & Spielman, Se., & Folch. D., *Urban Analytics*. Sage, 2018.

Smith, C., & O'Neil, R. (2018). *Dimensions of Divvy* [Ebook]. Chicago: Chaddick Institute for Metropolitan Development at DePaul University. Retrieved from https://las.depaul.edu/centers-and-institutes/chaddick-institute-for-metropolitan-development/research-and-publications/Documents/ChaddickInstitute_DivvyReport_Feb2018.pdf

Tomer, A. (2011). *Transit Access and Zero- Vehicle Households Adie Tomer*. Washington, D.C.: Brookings Institution. Retrieved from https://www.brookings.edu/wp-content/uploads/2016/06/0818_transportation_tomer.pdf

Tuncer, S., & Brown, B. (2020). E-scooters on the Ground: Lessons for Redesigning Urban Micro-Mobility. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. doi:10.1145/3313831.3376499.

Wellman, G. C. (2015). The social justice (of) movement: How public transportation administrators define social justice. Public Administration Quarterly, 117-146.

Zhu, R., Zhang, X., Kondor, D., Santi, P., & Ratti, C. (2020). Understanding spatio-temporal heterogeneity of bike-sharing and scooter-sharing mobility. *Computers, Environment And Urban Systems*, *81*, 101483. doi: 10.1016/j.compenvurbsys.2020.101483

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