Equity in Bike Share: A Geo-Spatial Analysis of Los Angeles' Metro Bike Share

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Abstract:

L.A.'s

questions: What factors are relevant in the locations of Metro Bike Share's docked bike share

a quantitative approach, using ArcGIS to map Metro Bike Share's

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Introduction:

Bike sharing systems are a growing phenomenon in the United States, as the National Association of City Transportation Officials (NACTO) (2019) found that bike share trips were

lot of potential for disadvantaged populations, stations must be placed in their communities so that they have fair access to the program and the same opportunities to use the bikes as others.

Following other major cities such as Washington D.C. and Chicago, a bike share system was created in Los Angeles in 2016. Called Metro Bike Share, the system is a partnership between the Los Angeles County Metropolitan Transportation Authority (L.A. Metro), the City of L.A., and the Port of L.A ("About," 2018). At the time of this study, it operated 24/7 in Downtown L.A., Central L.A., North Hollywood, the Port of L.A., and the Westside ("About," 2018). Depending on the station, users can find a Classic Metro Bike, an Electric Metro Bike, or a Smart Metro Bike ("About," 2018). Before implementation, L.A. Metro was sensitive to where their bike stations would be located. They included relevant research in their system plan as well as solicited feedback from the community on station sitting. However, the chosen locations of the bike share stations have not been thoroughly studied since implementation. This research paper conducts a geo-spatial analysis of L.A.'s Metro Bike Share program in order to answer the questions: What factors are relevant in the locations of Metro Bike Share's docked bike share stations? Do the factors of race, education level, and income impact station location in a way that creates inequity?

It takes a quantitative approach, using ArcGIS Online (ArcGIS) to map Metro Bike Share's station locations against census tract data on race, educational attainment, income, job density, population density, and journey to work for L.A. County and L.A. City. It then uses STATA to analyze which factors are more likely to influence where a station is placed and if there are any equity issues. Based on previous studies in other cities, this paper hypothesizes that race, educational attainment, and income level are factors that impact Metro Bike Share's station placements, resulting in stations placed more often in whiter, more educated, and higher-income

The third generation of bike sharing saw a rise in the use of technology to improve the systems. It started in England in 1996, where magnetic stripe cards could be used to rent a bike. Other technological advances “including electronically-locking racks or bike locks, telecommunication systems, smartcards and fobs, mobile phone access, and on-board computers” further enhanced systems in this generation and made it much more difficult to steal bikes (DeMaio, 2009, p. 42). There has been a large growth of these third generation bike share programs with a diversity of business models and service providers outside of Europe and across the world (DeMaio, 2009, p. 43; Shaheen, Guzman, & Zhang, 2010, p. 10).

Finally, Shaheen et al. (2010) propose a fourth generation of bike share called ‘Demand Responsive, Multi-Modal Systems’ (p. 15). These systems improve on the third generation and “emphasize

pass). The National Association of City Transportation Officials found that among station-based bike share riders, those with annual or monthly passes were more likely to use bike share during traditional rush-hours and those with day passes or single-trip rides were more likely to ride for longer periods of time in the middle of the day and on weekends (NACTO, 2018). Thus, it is likely that annual and monthly pass holders use bike share to commute while others use it for more social and recreational purposes (NACTO, 2018). In addition, convenience is consistently found to be a key motivator for choosing bike share, among other reasons such as speed and access (Fishman et al., 2013). In fact, a study of a bike share program in China found that a majority of respondents found bike share more convenient than using a private bicycle (Fishman et al., 2013). Clearly, bike share systems are taking hold in cities around the world in many forms and are serving many purposes.

by 2035; and maintain at least 50% by 2050” (pp. 72-74). With this goal in mind, L.A. Metro is partnering

including Los Angeles County Bicycle Coalition and People for Mobility Justice, conducting outreach and getting feedback on the bikeshare program in both English and Spanish (McNeil et al., 2019). They posted informational flyers at proposed station locations and provided a phone number for people without internet access to call. According to the McNeil et al. (2019) study on bike share equity programs, about 1,200 people voted on the potential station locations. Again,

Literature Review:

New mobility options have exploded in recent years, from rideshare services and autonomous vehicles to bike share systems and electric scooters. These mobility options have emerged alongside a larger phenomenon of a sharing economy made up of collaborative consumption and often aided by smartphones and technology, where companies like Uber and Airbnb have quickly become huge players (Cohen & Kietzmann, 2014). The growth of the sharing economy has potential sustainability benefits, especially as urbanization is occurring on a global scale and cities are becoming more crowded (Cohen & Kietzmann, 2014). One subset of this sharing economy is shared mobility, where users can access a mode of transportation as-needed for relatively short amounts of time (American Planning Association, 2016). Services can be roundtrip, one-way and station-based, or one-way and dockless (American Planning Association, 2016). Within shared mobility, a trend of micromobility options has emerged, made up of "all shared-use fleets of small, fully or partially human-powered vehicles such as bikes, e-bikes, and e-scooters" (NACTO, 2018). In 2018, shared micromobility accounted for 84 million trips in the U.S., more than double the number of those trips taken in 2017 (NACTO, 2018). Bike share systems are a large part of emerging micromobility, and business models can range from station-based to dockless to a combination of both. While some bike share services and systems have gone dockless, docked bike share programs are an important piece of shared mobility that present unique questions because they are place-based.

The rise of bike share systems has numerous potential benefits for urban regions and individuals. Bike sharing has been found to decrease driving and taxi use “almost universally” and can either reduce or increase the use of public transit depending on the circumstances (Martin & Shaheen, 2014, p. 2). For example, a study done on annual members of Washington D.C.’s Capital Bikeshare program found a shift in transportation use from rail to biking, especially in the downtown area of the city where the rail system is more congested and bike share potentially offers a faster alternative mode of transportation (Martin & Shaheen, 2014). While the larger shift was away from rail, a portion of the sample increased their use of rail with the use of bike share. These riders were more likely to live away from the urban core and thus

development of more public and active transportation infrastructure (Los Angeles County Department of Public Health, 2014).

For individuals, bike share provides an increase in mobility options and has health benefits such as increasing exercise and improving mental wellbeing (Ogilvie & Goodman, 2012). Physical

economic hardship whereas only 245 (11.9 percent) of stations are located in communities with high or highest economic hardship" (Smith, Oh, & Lei, 2015, p. 18). Economic hardship was

stations next to lower-income housing, and including the targeted communities in deciding where stations should be located through outreach efforts (McNeil et al., 2019). One potential problem of placing stations in lower-income communities is generating enough revenue to sustain the stations, thus external funding is often sought in addition to these equity efforts (McNeil et al., 2019).

The city of Chicago's Divvy bike share program had experience with this, as it was launched in 2013 and received criticism for locating stations in predominantly white and affluent neighborhoods (Wisniewski & Pratt, 2017). Going back to the Smith, Oh, and Lei (2015) study

If managed in a way that ensures access and equity, bike share systems have a lot of potential for specifically helping low-income populations and communities of color. Bike share can help overcome mobility limitations for those without a driver's license, access to a car, or a working bicycle (McNeil, Broach & Dill, 2018). In addition, McNeil, Dill, MacArthur, Broach, and Howland (2017) conducted a survey study in Philadelphia, Chicago, and Brooklyn and found:

> Some of the most common barriers to bicycling cited by lower-income people of color included not having a bike or related gear (47%), not having a safe place to leave a bike where they need to go (36%), the expense of buying a bike or related gear (41%), not having a safe place to store a bike at home (32%), not knowing a place to get a bike fixed (23%), and worries about something going wrong with a bike, such as a flat tire (20%). (p. 1)

Thus, bike share can reduce barriers to access and motivate lower-income people of color to bike because it addresses a number of the reasons these populations might avoid biking. In regards to the positive health impacts of biking, the McNeil et al. (2017) survey study found that lower-income people of color responded at a much higher rate (71 percent) than other respondent groups that a reason they would use bike share would be to get exercise. The possibilities of bike share have huge opportunity implications for low-income populations, as studies have shown a link between transit access and upward mobility (Jiao & Bischak, 2018). While bike share has the potential to improve transportation access for all, history reveals a common theme of inequity when it comes to transportation benefits.

Transportation benefits are not equitably distributed, as wealthier and more educated sections of a population generally benefit more, whereas less wealthy sections are more burdened (Bullard, 2003). In this sense, equity "refers to the distribution of impacts (benefits and costs) and whether that distribution is considered fair and appropriate" (Litman, 2019, p. 3). Equity can

Aultman-Hall, 2015). Under a wider umbrella of “environmental exposures” which can include things like air pollution and burdensome traffic routes, a number of studies have found that African Americans and communities of color are more likely to face a disproportionate burden than white communities (Freudenberg, Pastor, & Israel, 2011). Lower-income status also led to a higher burden of environmental exposures (Freudenberg, Pastor, & Israel, 2011).

Transportation inequity holds true for biking, as infrastructure for active transportation tends to favor already advantaged populations in the U.S., such as middle-class residents in suburban neighborhoods (Lee, Sener, & Jones, 2017). This is important in terms of biking infrastructure as a study found “a statistically significant relationship between bike share activity and the presence of bike lanes — even when controlling for population and retail opportunities around docking stations” (Fishman et al., 2013, p. 160). Thus, a deterrent to bike share among disadvantaged groups of people such as lower-income communities of color may simply be the lack of infrastructure and not a lack of interest. Ridership reflects inequality, as shown by Shaheen et al. (2012 & 2013) who conducted surveys of public bike share members in Montreal, Minneapolis and Saint Paul, Toronto, and Washington D.C., finding that “relative to the population within the four cities, bike sharing members has slightly higher incomes, were younger, more educated, and had a higher percentage of Caucasians than the general population.” (Martin & Shaheen, 2014, p. 3). Men also made up a majority of bike share members in every city (Martin & Shaheen, 2014).

This is not a result of a lack of interest among low-income people and people of color. A survey study in Philadelphia, Chicago, and Brooklyn found that lower-income people and people of color were using bike share less than higher-income white people, however they had the same level of interest for using it in the future (McNeil, Broach & Dill, 2018). In addition, a survey

study of residents in Berkeley, California found similar levels of interest in using Berkeley bike share among low- and high-income respondents, with station location being the most important factor in the likelihood of using bike share in the future (Savickas & Sohn, 2015). Finally, McNeil, Broach and Dill (2018) found that once lower-income people and people of color utilized "equity-focused discounts or related programs" and became members of bike share programs, they used it as often as other members, including higher-income white members, and were twice as likely to report that "bike share was saving them $21 or more per week on travel costs" (p. 34). Thus, bike share offers the potential to fill a persistent inequality gap and improve the lives and economic possibilities of low-income people and people of color as an independent mobility option or as a link to public transit.

Methodology:

This research paper uses quantitative methods to conduct a geo-spatial analysis of which factors are most prevalent in and around the locations of Metro Bike Share's docked bike share stations. Further, it analyzes if the factors of race, education level, and income impact station location in a way that causes inequity. Data for the study was obtained primarily from IPUMS, a free online database of census microdata. Using the IPUMS NHGIS Data Finder, five-year data from 2013 to 2017 was taken from the American Community Survey (ACS) at the census tract level. The ACS was chosen as the dataset because the last U.S. census was conducted in 2010, and the ACS provides more recent, publicly available data available at census tract level. Data on jobs totaled by work Census Block was retrieved from the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES). All of this data was manipulated in Excel and then imported into ArcGIS Online and mapped against Los

Angeles County census tracts. In addition, Metro Bike Share's docked station locations were downloaded from their website and mapped on ArcGIS ("Data," 2018). The explanatory variables measured were analyzed in relation to Metro Bike Share's docked station locations using the statistical software STATA.

The dependent variable in this study is Metro Bike Share's docked station locations, operationalized as number of stations per census tract. The explanatory variables are race, educational attainment, income, job density, population density, and journey to work. Beyond the socio-economic characteristics (race, educational attainment, and income) included to examine equity, Smith, Oh, and Lei (2015) found that population density, job density, and journey to work are among other factors that may play a role in placing bike share stations, therefore they are included in this study as control variables. A number of other variables were also found to impact station placement, however they were not included in this study due to a

Figure 1: Model of Study Variables

The dependent variable, Metro Bike Share's docked station locations, was operationalized as number of stations per census tract. In order to get this information, L.A. Metro's publicly available GeoJSON file of live station locations and status information was downloaded on October 3, 2019. This data was imported into ArcGIS, and the station locations were mapped as points. The total number of docked stations per neighborhood

on this information, a second dummy dependent variable was created for the statistical analysis. This variable consisted of 0, meaning no bike share stations in a census tract, and 1, meaning one or more bike share stations in a census tract.

Table 1: Total Number of Docking Stations by Neighborhood

Neighborhood	Number of Stations
Downtown L.A. and Central L.A.	108

equivalent, made up of regular high school diploma and GED or alternative credential, **some college**, made up of less than 1 year of college, 1 or more years but no degree, and an associate's degree, **bachelors,**

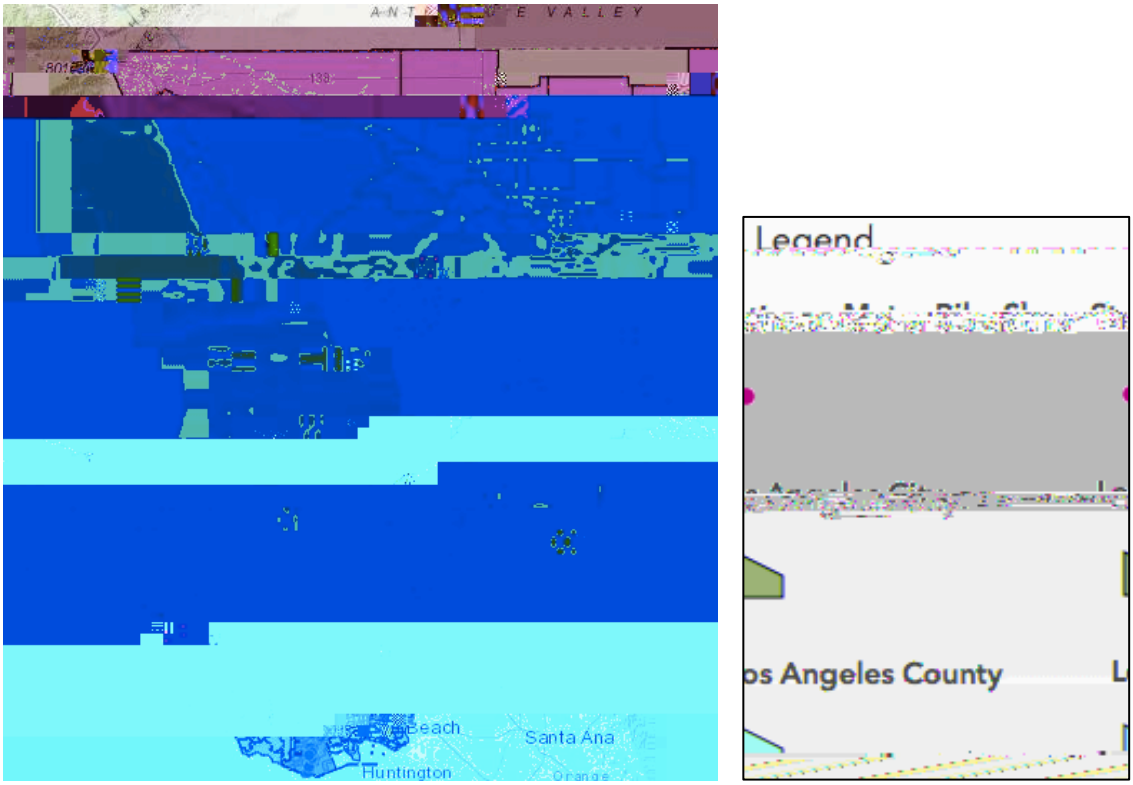
into percentages to aid in the analysis. Population density was created by dividing the total population in each census tract, obtained from NHGIS, by the area of the census tract in square miles. Job density was created by downloading Workplace Area Characteristic (WAC) data on total number of jobs per work Census Block from U.S. Census LEHD Origin-Destination Employment Statistics. This data was aggregated into census tracts using Excel, and job density was created by dividing the number of jobs per census tract by the area of the census tract in square miles. All of this information was imported into ArcGIS. **Table 3** compares the mean of each of these variables for tracts without bike share stations and tracts

Median Household Income		61,940.75472	55,403.04082
Journey to Work	Drove	.7901871	.6634862
	Public Transportation	.0963858	.1481545
	Walked	.0322253	.0778844
	Bicycle	.01032586	.02627516
	Other Means	.070876	.0841997

Journey to Work	Drove	.8377043	.6652887
	Public Transportation	.0638905	.1453165
	Walked	.0267135	.0781828
	Bicycle	.00820433	.02656294
	Other Means	.0634873	.0846491
Population Density		8,980.543	14,369.83
Job Density		2,626.348	1,3985.9

A visual of each cluster of bike share stations (Downtown L.A. and Central L.A., North Hollywood, the Port of L.A., and the Westside) can be seen on the completed map in **Figure 2.**

Figure 2: Metro Bike Share Stations in the Context of L.A. County and L.A. City



The statistical software STATA was used to analyze the data from the map. First, variables for job density and population density in thousands were created in order for the model to reflect the effect of a more meaningful change in density than one person. In addition, the education level variables were combined into those with —made up of the education levels less than high school, high school or equivalent, and some college— and those with **or above**—made up of those with a bachelor's degree, a master's degree, a professional school degree, and/or a doctorate degree. This was done in order to make the results and analysis more clear. The above variables, along with the median household income scale, journey to work categories, and race categories made up the

explanatory variables in the statistical models. A logistic (logit) regression and a Poisson regression were then run on both the city and county level to find which explanatory variables are more likely to determine if a tract gets a bike station. The logit regression was used to consider the binary dependent variable discussed above (no bike share station versus one or more bike share stations). The Poisson regression considered the dependent variable count of stations, meaning the specific

regression are shown in Appendix A. The pseudo R-squared value is .2315, showing that the explanatory variables in this regression can explain 23% of why bike share stations are placed where they are. While this number is not super high, it is reasonable for urban research. In the urban setting, any location decisions are likely to have many correlates, and bike share stations are no different. Still, the variables in this analysis explain nearly one quarter of location variation at the census tract level and can provide an interesting view into bike share location decisions. Moreover, the prob>chi2 shows that the results are jointly significant because the probability is below .0000, meaning that together, these variables do a reasonable job of explaining the dependent variable.

The logit regression revealed a number of things about the explanatory variables. The explanatory variables job density, population density, public transportation, biking,

with 2,318 census tracts compared to 1,003 at the city level. With this larger sample size, the variable higher income became statistically significant at the 5% level, with a p value of .0014

variables constant, an increase in job density by 1,000 people per square mile only increases the incidence rate of receiv

less than .000. Finally, the results show that relative to the very low income category, as the percentage of people in the middle income category increases in a census tract, the incidence rate of an additional bike share station placed in that census tract increases, holding all oth 7 (e) 7 (s)-6 (, hol) 7 (d) -

cities and systems consider when deciding where to place stations (Smith, Oh, & Lei, 2015, p. 18; Ursaki & Aultman-Hall, 2015). It is especially surprising that an increase in population density seems to result in a decrease in the odds of receiving a bike share station. However, it is important to remember that the decrease in odds is not very large, as well as to note that population density is much higher in L.A. City than in L.A. County. So, looking at L.A. City as a rough proxy for Metro Bike Share's service area (as all but three stations are located within L.A. City), population density is higher inside of the service area of the bikeshare stations than outside of the service area. While population density in each census tract varies, the stations are still placed mostly in L.A. City and thus in a very population dense area. In terms of journey to work, the odds of receiving one or more bike share stations go up for census tracts where people more often use public transportation and biking relative to cars to get to and from work. This is a very strong relationship, and it makes sense as commuters who walk or bike to work may be better served by bike share than people who rely on driving. This variable was meant to act as a control variable, and the results were as expected.

Looking at the equity variables in question—race, education level, and income level—with the logit reveals interesting findings and equity issues that must be looked at more closely. The results for the race variable seem to indicate that bike share stations are more likely to be placed in areas with high concentrations of Asian people. However, this relationship does not hold at county level. This may be explained by considering the spatial distribution of Asian people by census tract in L.A. City compared to L.A. County. Downtown L.A. and Central L.A., where clusters of Metro Bike Share stations are located, include the communities of Chinatown, Little Tokyo, and Koreatown, which have high densities of Asian people. Therefore, it makes sense that a relationship exists at this level and not at the county level. Another interesting

finding, given that there are so many Hispanic and Latino people in Los Angeles, is that Hispanic or Latino race does not significantly impact station location. **Figure 3** shows the spatial distribution of the Hispanic and Latino population for all of L.A. County, zoomed in to the

The logit regression flags an equity issue when it comes to education level. At both the city and county level, more educated census tracts—with a bachelor's degree or higher—are much more likely to have bike share stations. Thus, education level is an important factor in the location of Metro Bike Share's docked stations, and the hypothesis that stations are more often placed in higher educated areas is supported. Finally, while there was no statistically significant relationship at city level—and only a minor one at county level—between median household income and bike share stations, this does not mean stations are equally spread. The finding of no significance is important, as stations should potentially be targeted towards low-income areas for equity purposes, as will be discussed in the recommendations section. The fact that income level and bike share station placement does not have a statistically significant relationship indicates that median household income is not a factor that impacts Metro Bike Share's docked bike station placements. In addd m i l'

Considering the variables used to measure equity, the Poisson regression output shows a more comprehensive picture of how race impacts bike share station placement. On the city level, there is a positive, statistically significant relationship between all non-white races and incidence rate of receiving an addis

taken away from that moment and policy recommendations that apply to Metro Bike Share as well as other bike share systems more generally.

An additional limitation of this study stems from the variation between docked and dockless bike share systems within Metro Bike Share. The neighborhoods of the Westside and North Hollywood both operate with the Smart Metro Bike system, where bikes can be locked at any Smart Metro Bike Share station or at any public bike rack for a convenience fee ("Smart Metro Bike," 2018). Thus, the smart bikes are not as strictly place-based as the Downtown L.A., Central L.A., and the Port of L.A. bike systems. This limits the findings of the study because they are based on the premise that the bikes must be parked at the docked station locations. In addition, three Metro Bike Share stations were located outside of L.A. City at the time of the study and therefore were not included in the regressions run at city level, further limiting those findings.

Another limitation of this study is omitted variable bias. Smith, Oh, and Lei's (2015) study reviewed relevant literature and identified over 20 potential non-socioeconomic factors that might be considered in the placement of bike share stations. Among these were

> proximity to transit (especially rail stations with high numbers of boardings and frequencies); population density; job density; major destinations, points of interest; crime

available data at census tract level. Because of this, the effects of the measured variables may be

place bike share stations at two public housing complexes and actively engage residents and encourage them to use the program (McNeil et al., 2019). L.A. Metro should partner with the Housing Authority of the City of Los Angeles in order to identify suitable locations for bike share stations near public housing where more low-income people can be served. In order to make sure these stations are successful, Housing Authority staff should be used to educate residents of the public housing on the bike share program and assist them in taking advantage of the reduced fare passes. For extra funding to make this happen, L.A. Metro should look to organizations such as Better Bike Share Partnership and ClimateWorks Foundation for grant opportunities.

(De La Cruz-Viesca et al., 2016). Thus, additional bike share stations in Southeast L.A. would greatly expand access to populations who would benefit greatly from it.

Figure 4: Median Household Income per Census Tract Relative to Metro Bike Share Stations

Additionally, L.A. Metro should incorporate a “dock optional” system like Bike Share Connect, which allows users to lock bikes at any public bike

Bike," 2018). This system creates an equity concern for two reasons. First, the use of a fee makes Metro Bike Share much more convenient for people who can afford to pay to leave a bike wherever they want. In addition, the Smart Metro Bike system is only available in certain neighborhoods- the Westside and North Hollywood. As **Figure 2** shows, these neighborhoods are generally higher income than Central L.A., Downtown L.A., and the Port of L.A. Thus, higher-income neighborhoods tend to have a more convenient bike share system, creating inequalities between neighborhoods. Opting for a dock optional

their missions. This should make it easier for the public and the bike share systems themselves to make sure programs are meeting equity goals.

As detailed in the background section of this paper, L.A. Metro explicitly took equity into consideration when planning their bike share system and deciding on station location. They engaged in community outreach in both English and Spanish, partnering with local organizations in order to get this done (McNeil et al., 2019). As the results show, the only major equity concern flagged in terms of where stations are placed showed up with education level. Every regression performed showed a strong relationship between having a bachelor's degree or above and access to bike share stations. This is similar to bike share systems in other U.S. cities, as the Ursaki & Aultman-Hall (2015) study of six major cities found that the percentage of people with college degrees living within bike share service areas was greater than those without in every city. While this is something that Metro Bike Share must address, they did outperform many other cities in terms of making sure most bike share stations were not placed in predominantly white and high-income neighborhoods. The regressions show that census tracts that were more ethnically diverse often had a positive relationship with station placement, which was a positive result in terms of equity considerations. In addition, income level did not significantly impact station location. Thus, while more can and should be done, the commitment to equity and the work done before the roll out of the program was clearly beneficial in terms of considering the needs of the underserved and making sure the station placements served a broad population. Other cities and communities looking to implement bike share should take these practices into consideration, specifically partnering with local community organizations and utilizing languages beyond

English to gain community feedback. In addition, Metro Bike Share must continue these partnerships and community engagement in future expansions, with a critical look at how station placement relates to education level.

During the writing of the findings and recommendations for this research study, a new coronavirus called COVID-19 became a global pandemic. COVID-19 is a respiratory illness that transmits easily from person-to-person, thus keeping at least six feet of distance from others is recommended. At the time this paper was written, there were over two million confirmed cases of COVID-19 and over 128,000 deaths worldwide ("Coronavirus," 2020). In addition, there are country and state shutdowns as people are told to quarantine inside and social distance from one another. Given the nature of bike share as a widely-used transportation option that allows riders to stay a safe distance from others, it is important to analyze bike share's role in this pandemic and offer recommendations.

In early March, as the pandemic was spreading in the United States, bike share ridership seemed to spike for many systems. For example, Divvy bike share in Chicago saw a 100% increase in the number of rentals from March 1st to March 11th 2020, compared to the same time in 2019 (Greenfield, 2020). This is likely due to people finding that bike share was a better option compared to riding on confined, potentially crowded public transportation where they could be exposed to the virus. After this initial spike, bike share usage decreased as non-essential businesses and workplaces were shut down and people were encouraged to stay home (Greenfield, 2020). Nevertheless, bike share remains a good transportation option during this time—although washing hands before and after use, wearing gloves, and wiping off the handle

bars with disinfectant is recommended—and many systems are doing relatively well (Linton, 2020).

Bike share systems in the United States have had varied responses to COVID-19. Some, such as those run by Lyft in New York City, Boston, and Chicago are

Conclusion:

The field of urban mobility is going through an exciting and transformative time, as new technologies rapidly enter the market and work to solve pervasive transportation problems. Bike share is an example of this, as it began to grow and spread only about a decade ago and is now quickly advancing in technology and taking hold in cities all over the world. While there are many opportunities with new mobility technology, there are also many ways that those who have been historically disadvantaged by transportation policy, specifically low-income communities of color, could continue to be marginalized.

This study looks specifically at the Metro Bike Share program in Los Angeles, considering why stations are placed where they are and if the equity dimensions of race, educational attainment, and income level played a role in station placement. It highlights potential equity issues in terms of stations being placed in more educated areas, however it also shows that Metro Bike Share has some success in terms of serving an ethnically diverse population. As Metro Bike Share continues to grow, a measurable definition of what equity means when it comes to their system and station sitting must be created. In addition, Metro Bike Share must continue to work with the community to determine docked station placements, and should prioritize lower-income communities with new stations in order to reach more lower-income, non-white, and less educated populations. Looking forward to future bike share programs and new mobility options—especially with a potentially large spike in bike share programs post-pandemic—equity must be prioritized at every step of the way in order to ensure that transportation is serving the needs of all people and providing the opportunity for all to succeed and thrive.

While this research paper has provided insight into Metro Bike Share at a moment in time, additional research can build on this study by conducting an updated analysis of bike share stations and utilizing mixed methods. For the quantitative analysis, future research should utilize 2020 census data for Los Angeles County and include additional explanatory variables such as proximity to transit, sun exposure, and existing bike infrastructure for a more full picture of which factors impact the locations of Metro Bike Share's docked stations. In addition to quantitative methods, qualitative methods such as interviews or surveys could be used to understand the perspectives of community members, Metro staff, and policy makers on station placement and bike share usage.

Additionally, further research could build on the equity dimensions used in this paper by taking a more nuanced look at education level or breaking up the income categories in a different way. It could also consider other dimensions of equity, such as the impact of price on bike share use or having Smart Metro Bikes versus Classic Metro Bikes. As discussed in the limitations section, future research should take a broader look at bike share in Los Angeles and analyze all of the bike share programs that operate in L.A. County, instead

Bibliography:

About. (2018). Retrieved from https://bikeshare.metro.net/about/.

About Metro. (n.d.) Retrieved from https://www.metro.net/about/about-metro/.

Ajao, A. (2019, Feb. 1). Electric scooters and micro-mobility: Here's everything you need to know. Retrieved from https://www.forbes.com/sites/adeyemiajao/2019/02/01/everything-you-want-to-know-about-scooters-and-micro-mobility/#1ed330d55de6.

Amadeo, K. (2019, June 18). What Is Considered Middle Class Income?. Retrieved from https://www.thebalance.com/definition-of-middle-class-income-4126870.

American Planning Association. (2016). Planning for Shared Mobility: Executive Summary. Retrieved from https://planning-org-uploaded-media.s3.amazonaws.com/document/PAS-Report-583-Executive-Summary-rev.pdf.

Better Bike Share Partnership Emergency Response Grants 2020. (2020). Retrieved from http://betterbikeshare.org/wp-content/uploads/2020/04/BBSP-Emergency-Response-grant-guidelines-2020.pdf.

Bike Share. (n.d.). Retrieved from http://beverlyhillsbikeshare.com.

Bullard, R. D. (2003). Addressing urban transportation equity in the United States. Fordham Urb. LJ, 31, 1183.

Chauhan, N.S. (2019, March 11). Real World Implementation of Logistic Regression. Retrieved from https://towardsdatascience.com/real-world-implementation-of-logistic-regression-5136cefb8125.

Choose a Plan. (n.d.) Retrieved from https://www.longbeachbikeshare.com.

Cohen, B., & Kietzmann, J. (2014). Ride on! Mobility business models for the sharing economy. , (3), 279-296.

Coronavirus at a Glance: Infographic. (2020). Retrieved from https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-facts-infographic.

Data. (2018). Retrieved from https://bikeshare.metro.net/about/data/.

De Hartog, J. J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the health benefits of cycling outweigh the risks?. Environmental health perspectives, 118(8), 1109-1116.

De La Cruz-Viesca, M., Chen, Z., Ong, P. M., Hamilton, D., & Darity Jr, W. A. (2016). The color of wealth in Los Angeles.

.

DeMaio, P. (2009). Bike-sharing: History, impacts, models of provision, and future.

, (4), 3.

Fehr Peers (2015). . [PDF

Jiao, J & Bischak, C. (2018, March 16). *Dozens of U.S. cities have 'transit deserts' where people* Retrieved from https://www.smithsonianmag.com/innovation/dozens-us-cities-have-transit-deserts-where-people-get-stranded-180968463/.

L.A.'s Green New Deal: Sustainable City pLAn. (2019). Retrieved from https://plan.lamayor.org/sites/default/files/pLAn_2019_final.pdf.

Lee, R. J., Sener, I. N., & Jones, S. N. (2017). Understanding the role of equity in active transportation planning in the United States. Transport reviews, 37(2), 211-226.

Linton, J. (2020, April 14). L.A. County Bike-Share Systems Varied Responses to COVID-19. Retrieved from https://la.streetsblog.org/2020/04/14/l-a-county-bike-share-systems-varied-responses-to-covid-19/.

Litman, T. (2019). Evaluating transportation equity. Victoria, BC, Canada: Victoria Transport Policy Institute.

Los Angeles County Department of Public Health. (2014). Active Transportation and the Built Environment. Retrieved from http://publichealth.lacounty.gov/docs/ActiveTranspBuiltEnviroment.pdf.

McNeil, N., Broach, J., & Dill, J. (2018). Breaking Barriers to Bike Share: Lessons on Bike Share Equity. , (2), 31-35.

McNeil, N., Dill, J., MacArthur, J., Broach, J., & Howland, S. (2017). Breaking Barriers to Bike Share: Insights from Residents of Traditionally Underserved Neighborhoods.

McNeil, N., MacArthur, J., Broach, J., Cummings, A., Stark, R. L., Sanders, R., & Witte, A. (2019). National Scan of Bike Share Equity Programs: Approaches and Best Practices for Promoting Equity in Bike Share.

Martin, E. W., & Shaheen, S. A. (2014). Evaluating public transit modal shift dynamics in response to bikesharing: a tale of two US cities. , , 315-324.

NACTO. (2019, April 17). NACTO Bike Share and Shared Micromobility Initiative Retrieved from https://nacto.org/bike-share-statistics-2017/.

NACTO. (2018). Shared Micromobility in the U.S.: 2018. Retrieved from https://nacto.org/shared-micromobility-2018/.

Ogilvie, F., & Goodman, A. (2012). Inequalities in usage of a public bicycle sharing scheme:

Steven Manson, Jonathan Schroeder, David Van Riper, and Steven Ruggles. IPUMS National Historical Geographic Information System: Version 14.0 [Database]. Minneapolis, MN: IPUMS. 2019. http://doi.org/10.18128/D050.V14.0.

Appendix A:

Logit Regression Output, L.A. City

	1,003
2(14)	14 . [illegible]
2	0.0000
2	0.231
	-24 [illegible]

					%

Appendix C:

Poisson Regression Output, L.A. City

'	1,003
2(14)	3
2	0.0000
2	