

**Enhancing Bike-Share Access:**  
Navigating Equity Challenges in Los Angeles

A thesis submitted by

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## **Abstract**

This thesis delves into the interplay between urban mobility, equity, and sustainability through an equity analysis of the Los Angeles Metro bike-share system. Drawing on a comprehensive review of existing literature and empirical data, the study explores the correlation between bike-share ridership and demographic characteristics using spatial analysis. By employing spatial analysis techniques, disparities were found in the bike-share access and usage across different socio-economic groups and neighborhoods in Los Angeles. The analysis suggests that policy makers should find ways to enhance the participation of transit users, Hispanic and limited English households in the bike share system.

## **Acknowledgements**

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# 1. Introduction

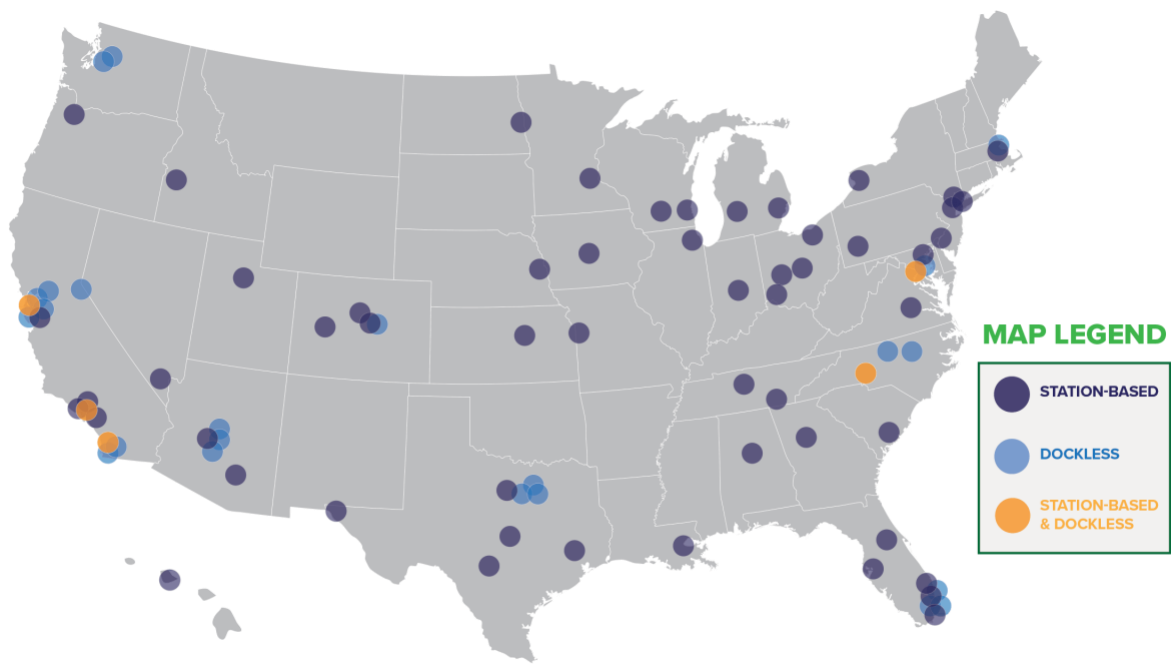
## Background

The popularity of bike-share programs has seen significant surge across the United States in recent years. It is estimated that the total number of bike-share bikes in the United States rose from 42,500 by the end of 2016, to around 100,000 just 12 months later, with ridership growing by 25% (NACTO 2018). Bike-Share, a micro-mobility solution, has gained traction due to its convenience, affordability, and promotion of alternative transit with significant health benefits. Beyond individual advantages, bike sharing contributes to broader societal benefits like reducing traffic congestion and pollution while providing a cost-effective transportation method. Bike-share programs offer a unique solution by promoting active travel while bypassing the need for external energy sources and space required by other modes of transportation (Ursaki and Aultman-Hall 2015). The concept of shared mobility originated in Europe with the iconic “White Bikes” program launched by Witte Fietsen on the streets of Amsterdam in 1965 (Fishman and Allan 2019) (Figure 1). While it was the first known bike share system, it was short lived as a result of theft and vandalism. Nevertheless, this concept finally reached the United States in 2008, with numerous cities embracing similar initiatives over time (Figure 2).



Figure 1 White Bike program, Amsterdam mid-1960s. Image: Luud Schimmelpennick

However, a closer examination of the distribution of bike-share infrastructure and marketing reveals disparities in reaching certain user demographics, particularly in terms of equity. Comprehensive research is needed to explore potential disparities and challenges related to accessibility, inclusion, and equitable distribution of these mobility systems in the United States. Numerous studies have investigated bike share systems in various U.S. cities, aiming to assess their equity of access. However, challenges emerge when attempting to compare these systems due to significant differences among the cities involved. Nevertheless, existing data demonstrates exclusion of low-income individuals and people of color from participating in bike-share program.



*Figure 2 More Systems, More Cities, More Bikes, More Companies – NACTO.ORG*

This thesis conducts an in-depth analysis of Los Angeles’ bike-share program, managed by the Los Angeles Metro. Unlike private or nonprofit structures, the City of Los Angeles and

Santa Monica employs a public dock-station bike-share model, operating 24/7, 365 days a year in areas such as Downtown LA, Central LA, Hollywood, North Hollywood, and the Westside (Metro 2023). The program offers three bike-sharing options: **traditional pedal-powered bikes, electric assist bikes, and smart bikes.**

Los Angeles, historically a car-centric city, has only recently invested in alternative transportation solutions amid wealth disparities and a significant homelessness crisis. Factors such as household income, vehicle ownership, language proficiency, and neighborhood characteristics significantly influence individual choices regarding micro-mobility (Ursaki and Aultman-Hall 2015).

In light of this complex urban landscape, this thesis explores enhancing equitable access to bike-share services in Los Angeles and Santa Monica. The analysis considers household income, vehicle ownership, racial demographics, language spoken at home, geographic distribution, infrastructure, and access to alternative transportation methods. By examining these elements, I aim to shed light on challenges and opportunities for enhancing fair and just access to bike-share services in all communities and inform Metro officials and key stakeholders of existing inequities.

## Research Question

Given the existing disparities in bike-share access in Los Angeles, can the city enhance equity in accessibility across diverse demographic groups? The following research questions guide this inquiry:

1. To what extent does bike-share accessibility align with income levels in Los Angeles, and where are the areas of greatest disparity?
2. How does the distribution of bike-share access differ across racial demographics in Los Angeles, and what patterns of inequity emerge?
3. In what ways does the method of transport impact the equitable provision of bike-share access in Los Angeles?
4. What strategies have been effective in other cities for expanding bike-share access in underserved communities, and how can these lessons be applied to Los Angeles?

To address these inquiries, I will employ spatial analysis and refer to research conducted in other U.S. cities that have encountered disparities in bike-share access, examining the measures implemented to enhance equity.

The final objective of this thesis is to inform Metro officials and key stakeholders of existing inequities in bike-share accessibility and present tangible steps to enhance equity in access. The positive impacts of bike-share systems should be accessible to all, offering efficient mobility, health benefits, environmental positivity, and affordable transportation. Transportation, infrastructure, programs, and service investments must be targeted toward those with the greatest mobility needs first, in order to improve access to opportunity for all (Metro 2017). As a public transportation agency, it is LA Metro's responsibility to actively reflect on whether its bike-share system is accessible for all, as the benefits can be life-impacting for members of the LA community.

## 2. Literature Review

### *What is Bike-Share? What are the Benefits?*

Bike-share programs facilitate short-term bicycle rentals through strategically positioned infrastructure, offering convenient, sustainable, and cost-effective alternatives to traditional transportation. These programs (Figure 3) include station-based systems and emerging dockless technologies, each presenting unique benefits and challenges (Shaheen et al., 2013).



Figure 3 LA Metro Dock Station-Based Bikes

### Environmental Sustainability:

Bike-share programs contribute to environmental sustainability by reducing air pollution, traffic congestion, and carbon emissions. For example, in 2016, bike-sharing in Shanghai saved 8,358 tons of petrol and reduced CO<sub>2</sub> and NO<sub>x</sub> emissions by 25,240 and 64 tons, respectively (Zhang and Mi, 2018). The LA Metro bike-share system has similarly reduced 6,946,681 pounds of CO<sub>2</sub> emissions to date (Los Angeles County Metropolitan Transportation Authority, n.d.).

Figure 4, developed by the Institute for Sensible Transport, shows the significant disparities between environmentally friendly and polluting transport modes, emphasizing both emissions and space consumption on a per person, per kilometer basis. These figures illustrate

the transformative impact that Los Angeles would have on its community and environment by investing and adopting greater equity of access within their Metro bike-share system.

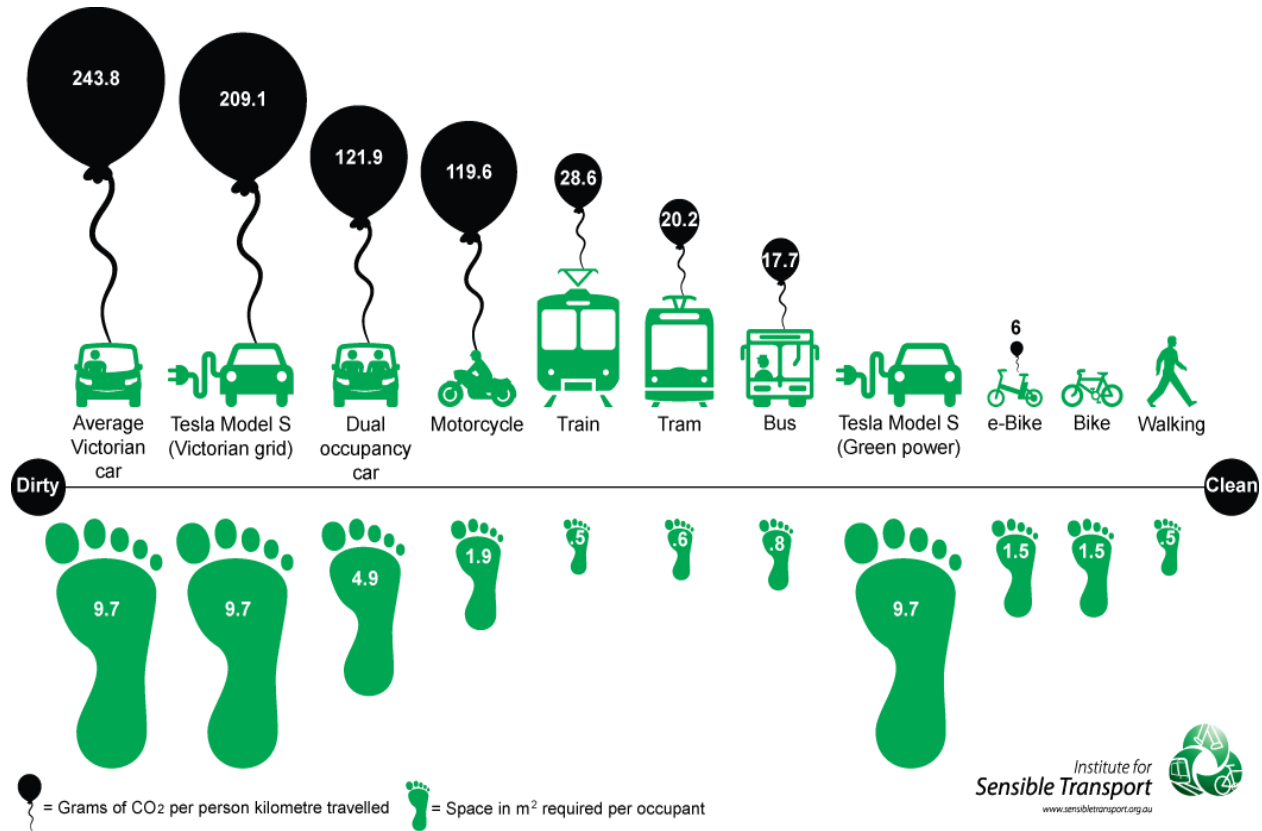


Figure 4 Transport and Climate Change, Institute for Sensible Transport

Smart Bike estimates that its trips cover substantial distances, resulting in considerable reductions in carbon dioxide emissions compared to car travel (Shaheen, Guzman, & Zhang, 2010). Similarly, programs such as Velib in Paris and the Hangzhou Public Bicycle Program in China contribute to emission reductions through increased bike usage. For instance, Velib users cover an estimated 312,000 km per day, resulting in reduced emissions compared to car travel (Shaheen, Guzman, & Zhang, 2010).

## Health Benefits

At the intersection of transportation and public health, bike-share programs stand as champions of physical activity and well-being. In an era marked by sedentary lifestyles and rising rates of chronic disease, the accessibility and affordability of bike-sharing initiatives present a compelling opportunity to promote active living. By encouraging individuals to incorporate cycling into their daily routines, these programs offer a pathway to improved cardiovascular health, reduced stress levels, and enhanced overall well-being, thereby empowering communities to lead healthier, more vibrant lives.

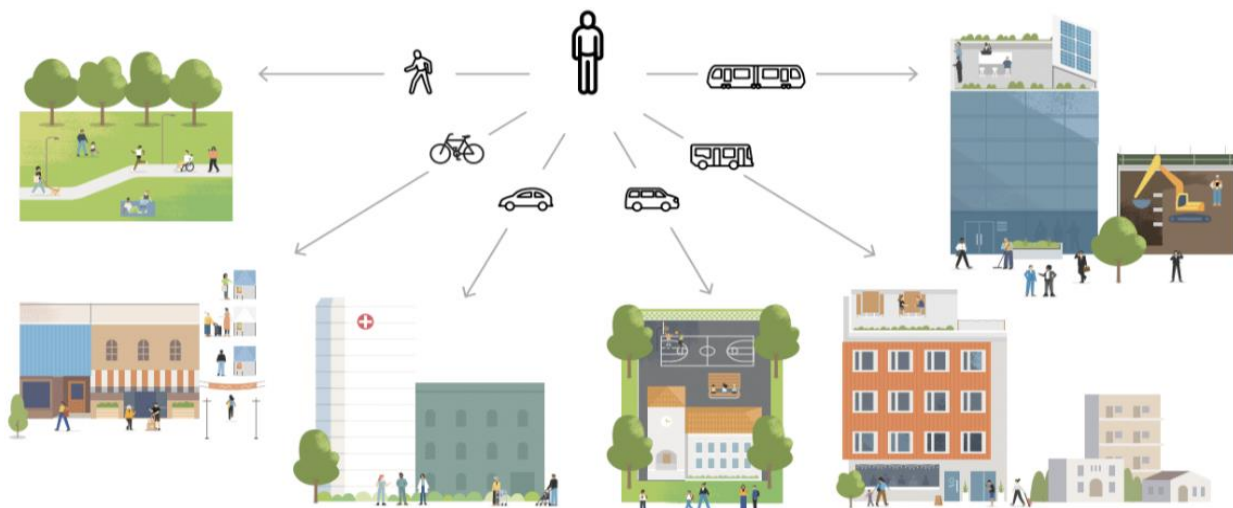
To date, riders of the LA Metro bike-share system have burned 292,491,844 calories, highlighting the tangible health benefits of these programs. A study by Clockston and Rojas-Rueda (2021) investigated the health impacts of bike-sharing systems in the United States, focusing on various modes of transportation transition to bike-share. They found that across different modes of transport, including walking, public transport, and car use, the shift to bike-sharing systems resulted in significant health benefits. For instance, bike-share system users in the U.S. experienced an estimated 4.74 fewer premature deaths annually, primarily due to increased physical activity.

Similarly, in New York City, bike-sharing users experienced reductions in premature deaths and disability-adjusted life years (DALYs) when transitioning from different modes of transport. The study “Exploring the Health and Spatial Equity Implications of the New York City Bike-Share System” conducted by Babagoli et al. (2019) examined the distribution of Citi Bike stations and assessed the health and economic impacts using the HEAT model. The researchers categorized neighborhoods based on poverty levels and calculated crude mortality rates for each

category. They analyzed the distribution of Citi Bike stations, which initially concentrated in central business districts and later expanded to contiguous neighborhoods. The study used data on annual Citi Bike membership and trip duration to estimate the health benefits of cycling, considering factors like air pollution exposure and cycling crashes. The results indicated a substantial increase in Citi Bike utilization over time, with longer average trip durations. Despite the expansions into additional neighborhoods with higher poverty rates, the study found significant health benefits associated with cycling, highlighting its potential impact on public health and spatial equity.

Last-Mile Connectivity:

Bike-share programs enhance last-mile connectivity, bridging gaps between public transportation hubs and final destinations. Integrated bike-share systems, like the one envisioned in LA Metro’s Regional Bike Share Implementation Plan (Figure 5), make public transport more cost-competitive by efficiently serving first-and-last mile connections (Iwamasa, 2019). This connectivity is particularly crucial for those who cannot afford to drive cars.



*Figure 5 Transportation Enables Access to Opportunities, Metro Equity Platform*

### Economic Impact:

Beyond their environmental and health benefits, bike-share programs wield considerable economic influence within urban landscapes. They create jobs, generate revenue, and save costs, contributing to the economic vitality of cities in multifaceted ways. From employment opportunities in bike maintenance and state management to potential savings in healthcare from increased physical activity, bike-sharing fosters sustainable economic growth and prosperity within communities.

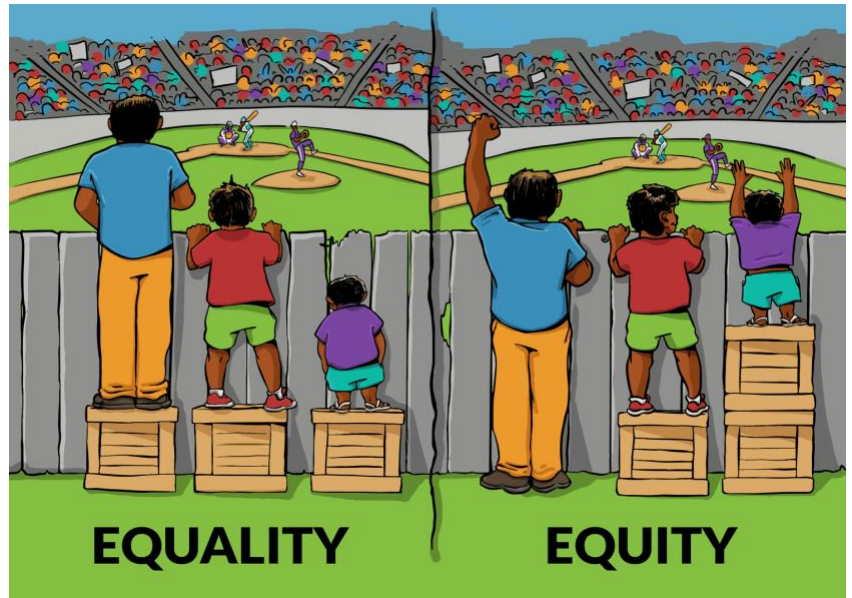
A study by Bullock et al. (2017) on Dublin's dublinbikes program highlighted substantial journey time savings, averaging 34% per trip, and identified wider economic benefits like productivity gains and improved labor force participation. The study underscored the economic viability of public bike-share systems, revealing a significant benefit-cost ratio and enhancing urban mobility and sustainability.

Similarly, Wuerzer and Mason (2014) analyzed the economic benefits of Washington D.C.'s Capital Bikeshare (CaBi) through user and business surveys. They found that CaBi users were motivated by shorter travel times, enjoyment, and lower costs. Many users traveled to spending destinations near CaBi stations, positively influencing local businesses. The presence of CaBi stations was linked to increased customer traffic and sales, with overall support for the system's expansion.

In Pittsburgh, Pelechrinis et al. (2017) revealed that bike-share infrastructure led to significant increases in median real estate prices, with an average rise of \$850 citywide and \$3,000 at the zip code level. The study also found a modest but significant rise in rental prices, demonstrating the localized economic benefits and the enhanced attractiveness and value of urban neighborhoods.

## *What is Equity and What does Equity in Bike-Share Access look like?*

Equity involves ensuring everyone has the resources and opportunities they need to reach a similar outcome, considering individual differences and addressing systemic barriers. On the other hand, equality focuses on providing everyone with identical resources and opportunities, disregarding individual differences and barriers. An effective and frequently employed analogy to illustrate the distinction between equity and equality involves three children situated on one side of a fence, attempting to watch a baseball game. In the context of equity, each child is provided with a stepping



*Figure 6 Interaction Institute for Change, 2016.*

stool tailored to their individual needs, ensuring they can view the game optimally (Figure 6). Conversely, equality is demonstrated when each child is given an identical stepping stool, regardless of their specific requirements for game visibility.

In the context of bike-share systems, equity refers to the just distribution of bike-share infrastructure ensuring that all riders enjoy fair and inclusive opportunities associated with bike-share systems. In a survey distributed to bike share system managers, Buck (2012) found that many respondents indicated that placing bikeshare stations in low-income communities was the most essential strategy for equity, and that their bikeshare systems either had done this or had plans to do this. This includes those with limited access to other transportation modes, such as automobiles. In order to fulfill this objective, it is imperative to establish a comprehensive

definition encompassing various attributes like bike types, payment methods, membership plans, and marketing strategies to fully grasp the scope of bike-share programs.

Although certain bike-share programs assert their commitment to equity, persistent challenges remain. Accessing station-based bike-share systems, for instance, may require smartphone applications, introducing technology-related barriers. Iwamasa (2019) states that it is crucial to continue developing the LA Metro bike-share system in alignment with the Metro Equity Platform Framework, which consists of the four pillars identified in Table 1: Define and Measure, Listen and Learn, Focus and Deliver, and Train and Grow. These pillars provide LA Metro with a solid foundation for promoting and establishing equity in bike-share access.

*Table 1 LA Metro Four Pillars, Metro Equity Platform 2024.*

<b><u>Pillar</u></b>	<b><u>Statement</u></b>
<b>Define and Measure:</b>	To ensure equity, we must both understand it and define how it's measured, thus this pillar embraces the key task of defining and measuring "equity" as it relates to Metro's work.
<b>Listen and Learn:</b>	Metro is working to improve its effort to listen and learn from the communities that we serve. We recognize that to increase access to opportunities for all, we must understand how to increase access for those who face barriers. No matter our intent, we will not be successful unless we work to address their needs first. Metro can only serve those with the greatest needs by understanding their needs through intentional listening.

<p><b>Focus and Deliver:</b></p>	<p>The Focus and Deliver pillar center’s needs-based analyses to plan, build, invest and operate in a manner that removes barriers and supports increased access to opportunity for all. The Equity Platform is focused on results and change over time. Thus, Metro is developing tools to consistently identify disparities, their root causes, and strategies to address them, while improving access to opportunity for all.</p>
<p><b>Train and Grow:</b></p>	<p>This pillar focuses on Metro as an organization and recognizes that successful implementation of the Equity Platform requires commitment, education and training, and prioritization of the pillars across Metro at all levels and in all departments.</p>

Equity, in this context, involves ensuring universal access to bikes, irrespective of smartphone or credit card possession. Pricing is another crucial aspect, as highlighted by Younes and Baiocchi (2022), who reference operators in cities like Washington D.C. that must provide programs for non-smartphone users and requires that operators also have a low-income customer plan in place. Language also plays a pivotal role, as suggested by NACTO (2019), emphasizing the preference for customer support services in multiple languages, particularly in areas with diverse populations like Santa Monica.

In essence, equity in bike-share access should manifest as a system that ensures fair, inclusive, and accessible opportunities for all riders, regardless of their background, resources, or technological capabilities. Adopting the Metro Equity Platform is a step in the right direction for

LA Metro as it will inform, shape, and guide every facet of the agency's business, on a continuing basis, to shape projects, investments, and new initiatives. Several key principles represent true equity in bike-share access. These principles include but are not limited to universal accessibility, comprehensive scope, financial inclusivity, technology considerations, language accessibility, guidance from equity frameworks, community engagement, and continuous evaluation and adaptation. These factors will be explored further throughout the thesis.

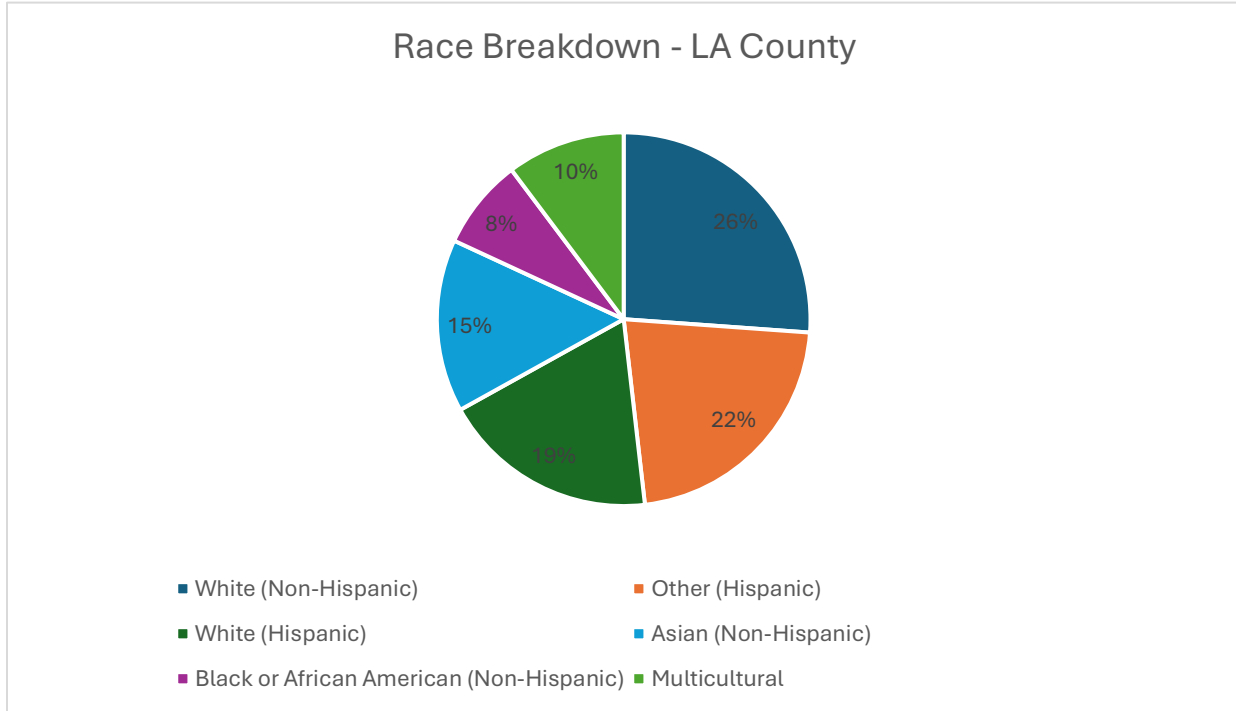
## *Who will benefit from bike-sharing?*

In exploring the transformative potential of bike-sharing initiatives, it becomes essential to discern the diverse array of individuals and communities positioned to reap the rewards of these innovative programs. While the advantages of bike-sharing extend far and wide, from environmental sustainability to economic prosperity, the question arises: who stands to benefit most from the proliferation of bike-sharing systems? By examining the intricate mix of demographics, behaviors, and needs of prospective users, we can uncover the diverse range of beneficiaries ready to leverage bike-sharing for various purposes. From urban dwellers seeking convenient and eco-friendly transportation options to tourists craving immersive experiences in unfamiliar cities, and from underserved communities striving for equitable access to mobility solutions to health-conscious individuals prioritizing active lifestyles, the breadth of potential beneficiaries underscores the inclusive nature of bike-sharing as a catalyst for positive change within urban landscapes.

To date, the impact of LA Metro's bike-share system is remarkable, with a total of 2,097,252 trips completed, 301,269 passes sold, 294,491,844 calories burned, 7,312,296 miles traveled, and 6,946,681 pounds of CO2 emissions reduced (Metro, 2023). These historical metrics not only signify extensive usage but also highlight the positive impact that the LA Metro bike-share system has on Angelenos, tourists, and the environment. These metrics stand as evidence of the city's strong need for an alternative transportation system, aiming to alleviate the dominance cars currently hold over Los Angeles.

When examining the demographics of Los Angeles County, the U.S. Census Bureau reports a population of nearly 10 million people. This diverse community comprises individuals

of various ethnic backgrounds (Figure 7).



*Figure 7 Race Breakdown - LA County*

Additionally, 56% of families in the city speak a language other than English at home. Commuting patterns reveal an average travel time of 30 minutes for workers aged 16 and above. The median household income stands at \$76,135, with a poverty rate of 16.8%. Additionally, 38.2% of the population hold a bachelor’s degree or higher (United States Census Bureau, n.d.).

While demographics offer crucial insights into the composition of Los Angeles County’s population, understanding who will benefit from bike-sharing extends beyond mere statistical profiles. Indeed, while data illuminate disparities in access and usage among various demographic groups, it only scratches the surface of a complex socio-economic landscape. Factors such as infrastructure development, cultural perceptions of cycling, and community engagement also play pivotal roles in determining the efficacy and inclusivity of bike-sharing initiatives. Thus, while demographic analysis provides valuable information, a comprehensive

assessment must consider a multifaceted range of influences to ensure equitable access and maximum benefit for all residents.

In Fishman and Cherry's (2016) comprehensive review of e-bike research, two notable studies shed light on the demographics of e-bike users in North America. One study conducted in California revealed that e-bike users in the Sacramento area tended to be older, more educated, and have higher incomes compared to the general population (Popovich et al., 2014). Similarly, another study focused on e-bike users in North America found that the majority were male, over 44 years old, and Caucasian, with a significant portion holding graduate degrees and having prior experience riding traditional bicycles (MacArthur et al., 2014).

In their examination of cycling as a sustainable transportation option, Pucher and Buehler (2017) highlight the growing support for cycling across various spheres. They note the proliferation of professional and academic conferences dedicated to cycling, along with the increasing influence and interconnectedness of local, state, national, and international cycling organizations. Moreover, they emphasize the role of online platforms, such as internet sites and social media, in facilitating the sharing of knowledge about best practices in cycling. This expansion of resources and networking opportunities has led to the creation of a worldwide community of researchers, planners, advocates, and cyclists, who actively promote cycling as a viable mode of transportation. Pushing initiatives like the Metro bike-share system towards a more equitable distribution of resources and access not only benefits the dominant demographic users of the region but also those with limited access or awareness. Providing thorough education and outreach efforts can help inform all residents about the benefits of bike-sharing and encourage its widespread adoption, thereby fostering a more inclusive and sustainable transportation system.

Additionally, in their study on the usage of bike-sharing systems in highly deprived areas, Goodman and Cheshire (2014) challenge prior media characterizations of bike-sharing as exclusive to affluent individuals. They found that residents in London's highly deprived areas utilized the bike-sharing scheme, particularly after its extension to cover some of the city's poorest areas. This suggests that the scheme was not solely utilized by affluent professionals commuting into central London, such as the financial center of Canary Wharf. Instead, the research indicates that local residents in highly deprived areas actively used the bike-sharing system when it was accessible in their neighborhoods. This local access is significant, especially considering that few individuals from deprived areas regularly commute into London from outside regions (Lyons and Chatterjee, 2008). While bike-sharing schemes may disproportionately serve more affluent individuals who commute to the city, they also have the potential to serve residents from all income groups. Furthermore, the study suggested that the socio-economic profile of registered users was little affected by price increases, but poorer casual users reduced their usage of the scheme. This decrease in usage among low-income individuals following price hikes may have had negative effects on health and health equity in London, despite the overall net health benefits associated with bike-sharing system use (Rojas-Rueda et al., 2011; Woodcock et al., 2014). This example shows the repercussions of an inequitable bike share system.

According to the Southern California Association of Governments (2019), an analysis of Metro Bike Share user demographic data reveals that bike-share users are not representative of the region. While data related to demographics of Breeze users was unavailable, Metro Bike Share data indicates underrepresentation of Black and Latino community members among passholders. Specifically, Latino users, who constitute 49 percent of Los Angeles residents,

comprised only 19 percent of Metro Bike passholders, while Black residents, comprising 9 percent of Angelenos, represented only 5 percent of pass holders. Additionally, the data showed a gender disparity, with 64 percent of pass holding members identifying as male and only 36 percent as female. Moreover, approximately 55 percent of Metro Bike Share pass holders earn an annual income of \$95,000 or more, while only around 15 percent earn less than the median income for Los Angeles (\$55,909). These findings suggest barriers to bike share entry for women, ethnic minorities, and middle to low-income populations.

U.S. Census and Metro data along with literature studies highlights that the ridership of the LA Metro bike share system does not accurately mirror the demographics of the most vulnerable populations in the region. A transportation system designed to serve as a cost-effective alternative is, in practice, predominantly utilized by white males with incomes exceeding the median household threshold, contrary to its intended purpose. Clearly, drawing from current research and data, one can reasonably conclude that improving equity in bike share access would not only benefit all visitors and residents of Los Angeles but also contribute positively to the environment. Fishman and Allan (2019) state that the bicycle, owing to its positive impact on physical activity, air quality, and climate change combined with its space efficiency and affordability, has emerged as a critical element of this new urban mobility.

### **3. Data and Methods**

This thesis will employ spatial analysis to understand access and demand for bike-share in Los Angeles. The primary datasets utilized will be census data from the American Community Survey for the year 2021, Geographic Information Systems (GIS) bike-share and infrastructure data from the city's online platform, and information from LA Metro. Census data includes sociodemographic variables such as median household income in US Dollars, the number of vehicles per household, the percentage of zero vehicle households, the percentage of households using transit, the means of transportation to work, and race. LA Metro data include bike trip characteristics, such as ride duration, origin and destination points, membership pass acquisition, and bike type.

Data sourced from the city's dataset on bicycle lanes, bike paths, and bike routes provided context for the existing bike-share infrastructure. I mapped the data to measure disparities in LA Metro's bike-share access, particularly for groups in Los Angeles that do not have access to personal vehicles but evidently may need to commute to work. The spatial scale for of my disparity analysis will focus on census tracts within the Los Angeles metropolitan area, with a specific emphasis on areas where disparities in LA Metro's bike-share access are prominent. In terms of temporal scale, my analysis was conducted in 2023.

I first conducted a suitability analysis using Geographic Information Systems (GIS) to determine which census tracts in LA would benefit most from bike access, drawing upon variables identified in the literature. Subsequently, I applied General Linear Regression to

investigate the association between bike ridership and vulnerability characteristics such as race, income, limited English, and zero-vehicle households.

To begin, I obtained ridership data from the LA Metro Bike Share website, available as Excel files. This data was imported into GIS as tables and geocoded using the XY point data tool based on latitude and longitude coordinates. To ensure a comprehensive analysis, I incorporated ridership data from all four quarters of 2023, as published by Metro Bike Share.

In addition to ridership data, I collected social, infrastructural, and demographic data from the LA City GeoHub website. This included the Los Angeles city border shapefile for accurate visual depiction of the study area. Key shapefiles at the census tract level, such as those for Limited English Households, Median Household Income and Area Median Income (AMI), and Households Without Vehicles, were also incorporated into the GIS map. As these datasets originally covered all of LA County, I clipped the data to focus solely on the City of Los Angeles.

Table 2 Summary of Data Sources, Spatial and Temporal Resolutions, and Citations

Data Source	Spatial Resolution	Temporal Resolution	Citation
American Community Survey (ACS)	Census Tracts within Los Angeles County	2021	United States Census Bureau. 2021. <i>American Community Survey</i> .
LA Metro Bike Share	Coordinate Data (X, Y) in LA Metro Area	2023	Los Angeles County Metropolitan Transportation Authority. (n.d.). <i>Bike Share Data</i> . Retrieved August 6, 2024, from <a href="https://bikeshare.metro.net/about/data">https://bikeshare.metro.net/about/data</a>
LA City GeoHub (Bike Lanes, Sidewalks, City Boundary shapefiles)	Census Tracts within The City of Los Angeles	Current	City of Los Angeles. (n.d.). <i>GeoHub</i> . Retrieved August 6, 2024, from <a href="https://geohub.lacity.org">https://geohub.lacity.org</a>

## **4. Los Angeles as a Case Study: Unraveling Bike-Share Dynamics**

Equity in bike-sharing goes beyond mere accessibility; it encompasses considerations of fairness, inclusivity, and social justice. In this context, we will discuss key themes such as demographic representation, geographic distribution, affordability, accessibility, and barriers to entry. By examining these dimensions, we seek to illuminate, utilizing GIS analysis, the challenges and opportunities inherent in fostering an equitable bike-share system, ultimately contributing to the advancement of a more inclusive and accessible urban transportation solution.

### Introduction to Los Angeles Bike-Share Program:

The Los Angeles Bike-Share Program represents a significant milestone in the city's efforts to revolutionize urban mobility and promote sustainable transportation alternatives. The evolution of bike-sharing in Los Angeles County has followed a unique trajectory, marked by the launch of Breeze Bike Share in November 2015 in Santa Monica. Initially equipped with 500 bicycles and 80 stations, Breeze Bike Share received partial capital funding from Metro and the Air Quality Management District. Notably, Breeze operates as a hybrid system, allowing bikes to be docked at stations while also offering the flexibility of smart bikes that can be parked anywhere within the service area. Subsequent expansion efforts in 2016 and 2017 extended the program to Beverly Hills, West Hollywood, and UCLA. Although operating under different names and contracts these systems are unified under Bike Share Connect since April 2018.

In contrast, Metro Bike Share, funded and operated by the Los Angeles County Metropolitan Transportation Authority (Metro), commenced operations in July 2016 with 1,000 dock-based bicycles, primarily serving downtown Los Angeles. Subsequent expansions in 2017 extended the program to the Port of Los Angeles, Venice, and Pasadena, with additional bikes

stationed at Metro Stations in Santa Monica. However, the Pasadena program ceased operations in August 2018.

Infrastructure and Expansion:

The LA Metro Bike Share system provides service to the following regions: Downtown LA, Central LA, Hollywood, North Hollywood, and on the Westside. Figure 8 provides a detailed representation of the Metro Bike Share station and bikeway location within the City of Los Angeles. Los Angeles employs a classification system for its bikeways, categorizing them into four main types. Class 1

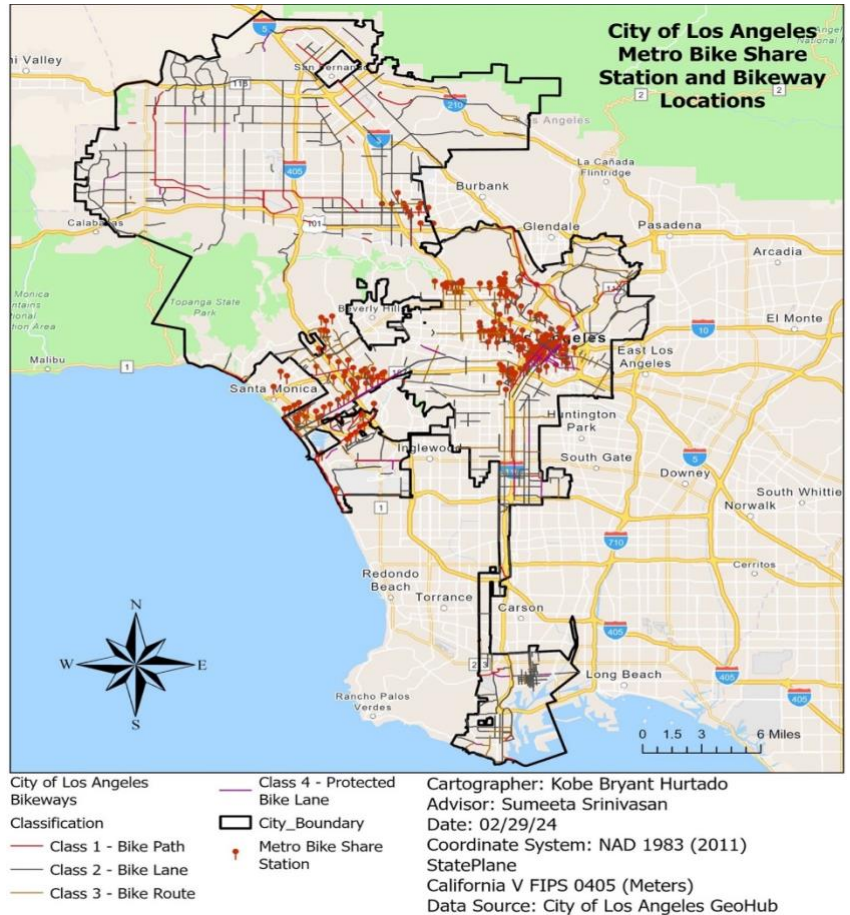


Figure 8 Map of Metro Bike Share stations in Los Angeles

bikeways, known as bike paths, offer dedicated routes separate from motor vehicle traffic, often found along scenic corridors or within parks. Class II bikeways, or bike lanes, designate specific lanes on roadways exclusively for cyclists, demarcated by striping or markings. Class III bikeways, called bike routes, are shared roadways where cyclists and motorists coexist, with cyclists having the legal right to use the full lane. Finally, Class IV bikeways, known as separated bikeways or protected bike lanes,

provide physical separation between cyclists and motor vehicles using barriers or curbs, enhancing safety and comfort, particularly on busy streets. This classification system helps planners tailor infrastructure to promote cycling as a sustainable mode of transport while enhancing safety and accessibility for cyclists across the city.

Figure 9 highlights the distinct regions located within LA, while Figures 10 and 11 reflect the geographic distribution of median income and Area Median Income (AMI) categorization in LA. Notably, there exists a concentration of Metro bike-share stations in the West and Central regions of Los Angeles. The Western region, often regarded as one of the most affluent regions in the city, includes wealthy neighborhoods like Bel-Air. Conversely, an examination of the current classification of bikeways reveals a disparity in coverage, particularly in South Los Angeles and the San Fernando Valley and Verdugos regions. These areas are notably underserved, as seen by the sparse presence of bike-share stations. South Los Angeles stands out as an economically disadvantaged area, home to neighborhoods such as Crenshaw and Hyde Park. It must be noted that when the Metro bikeshare program was launched, infrastructure and services were established in locations like Pasadena and the Port of LA. However, operations in these areas have since been discontinued.



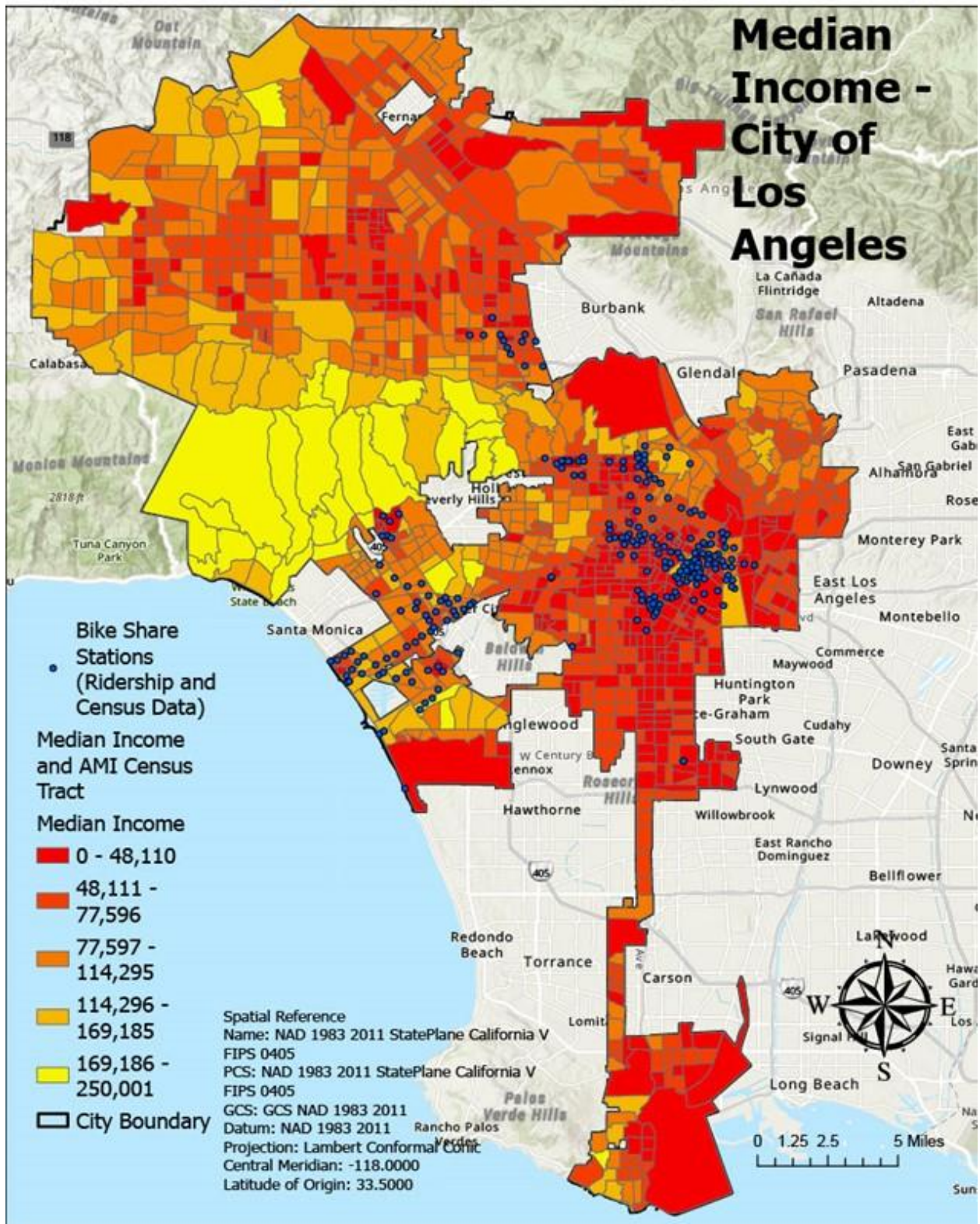


Figure 10 Median Income - City of Los Angeles

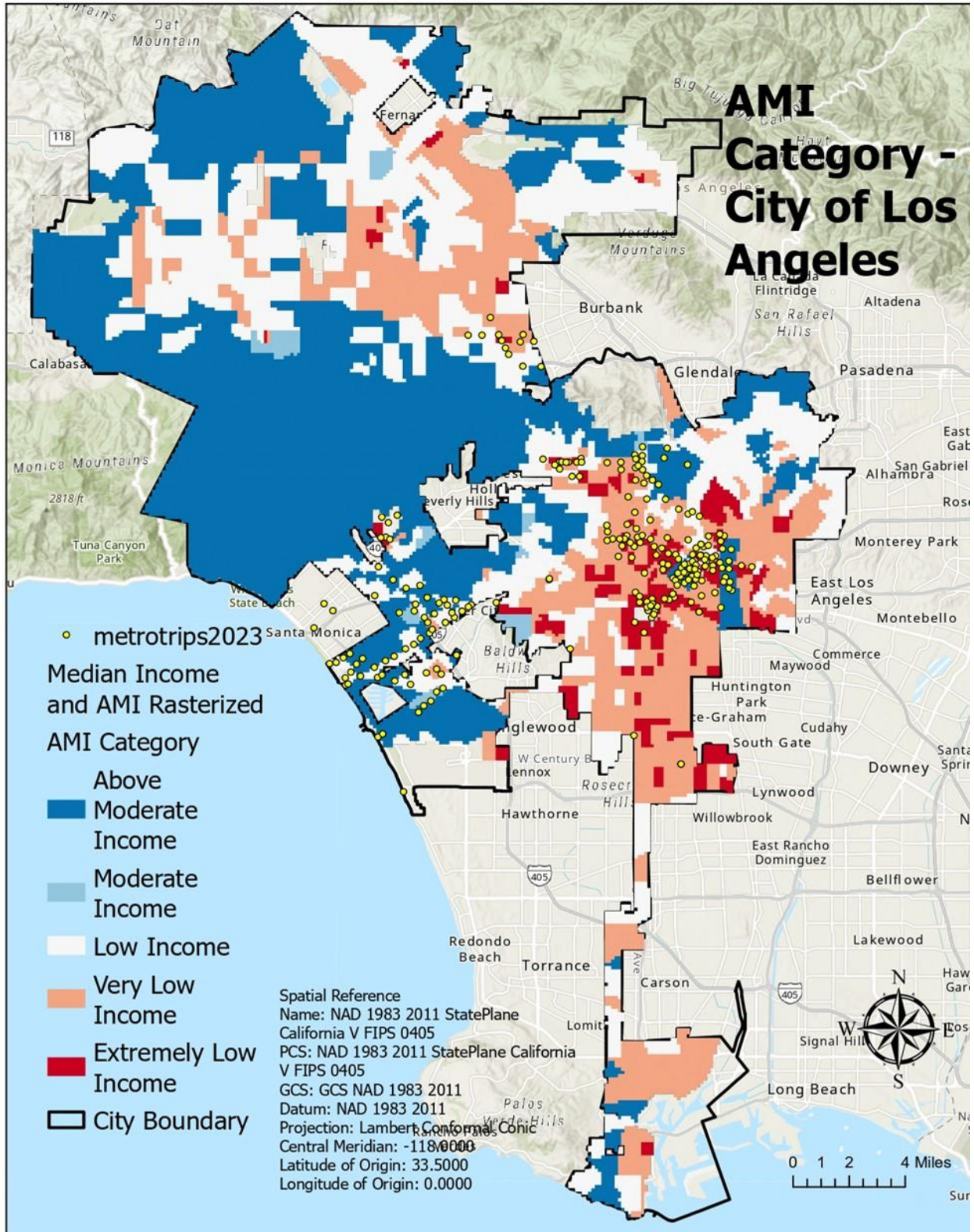


Figure 11 AMI Categorization - City of Los Angeles

When Figures 12 and 13 are overlaid with Figures 15-19 a more complex story begins to unfold. These figures, containing key factors, demonstrate the intricate interplay between spatial distribution of bike sharing infrastructure and the socio-economic characteristics of different neighborhoods. By analyzing the geographic distribution of bike-share stations with socio-economic indicators such as income levels, English proficiency, and Means of Transportation to Work, we can discern patterns of inequity and identify areas that may be disproportionately impacted by the lack of access to bike-sharing services. The maps illustrate that metro bike-share stations are predominantly concentrated in the Westside and Central LA regions, while areas characterized by marginalization are primarily found in Northeast/Eastside LA, as well as the San Fernando Valley and the Verdugos.

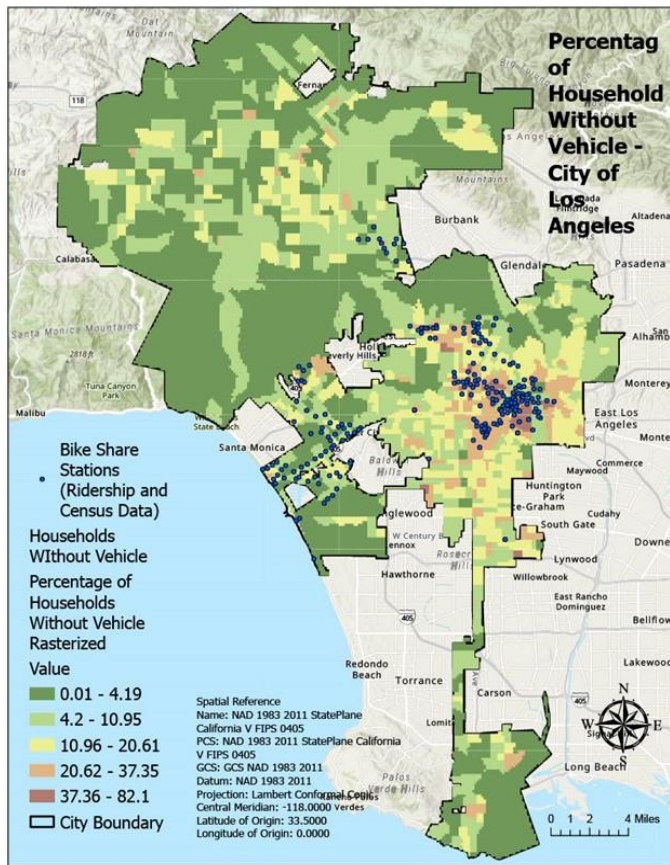


Figure 12 Households without Vehicles – City of Los Angeles

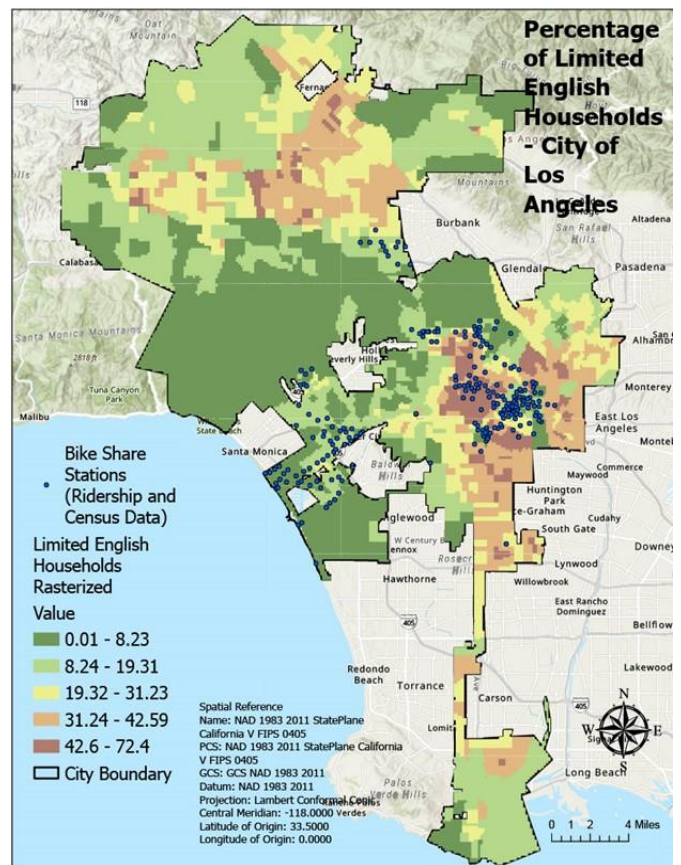


Figure 13 Limited English Households - City of Los Angeles

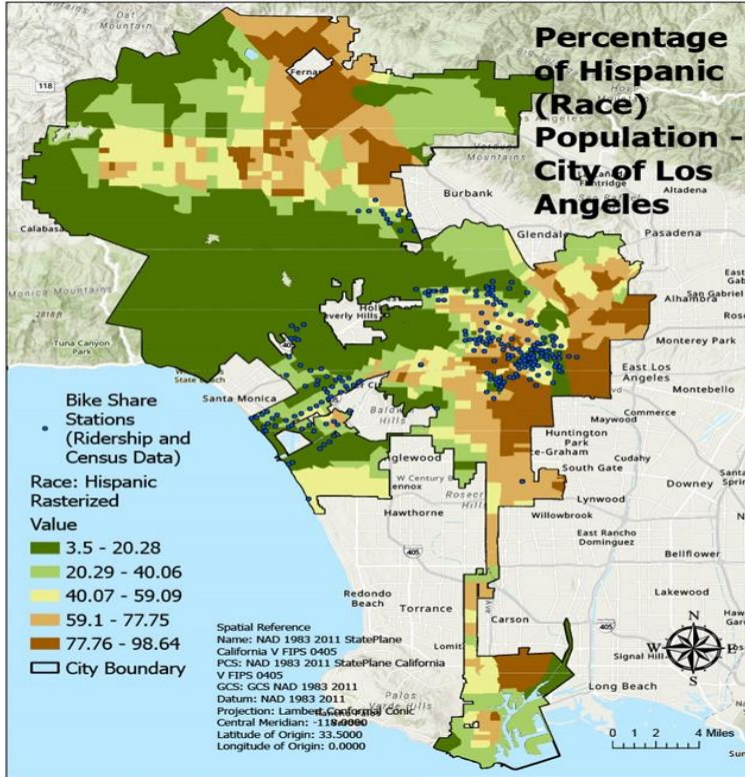


Figure 14 Percentage of Hispanic Population - City of Los Angeles

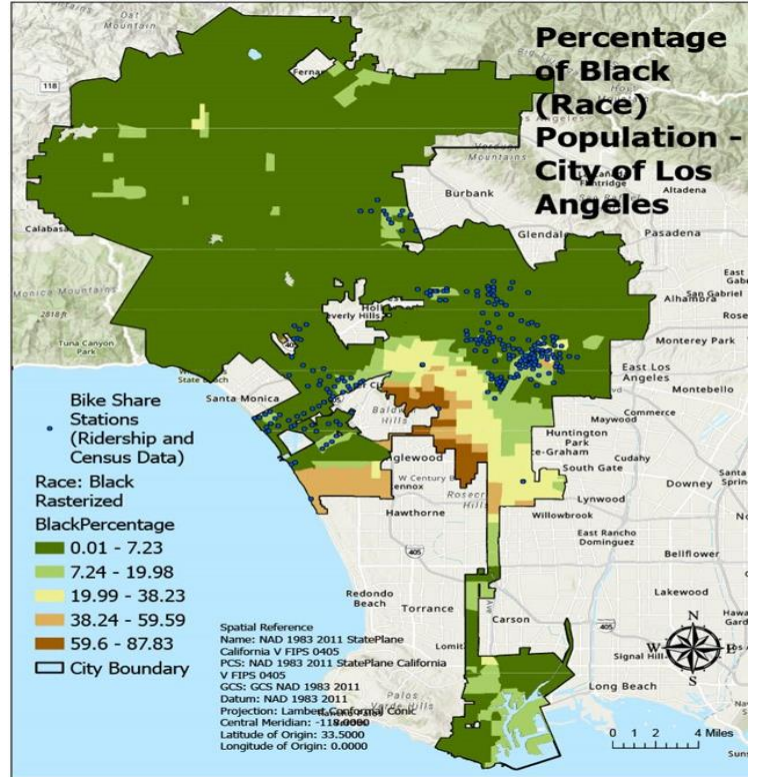


Figure 15 Percentage of Black Population - City of Los Angeles

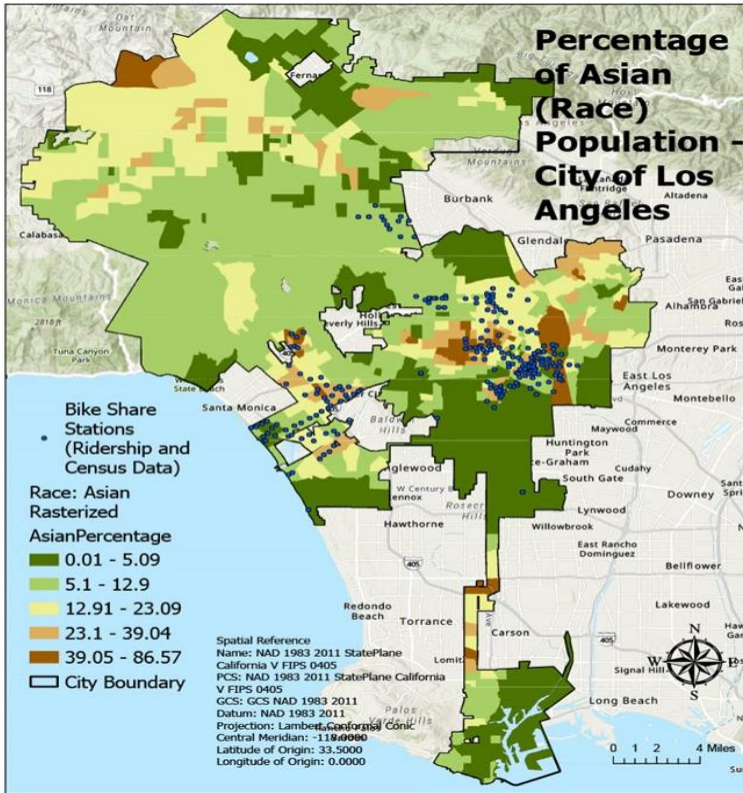


Figure 16 Percentage of Asian Population - City of Los Angeles

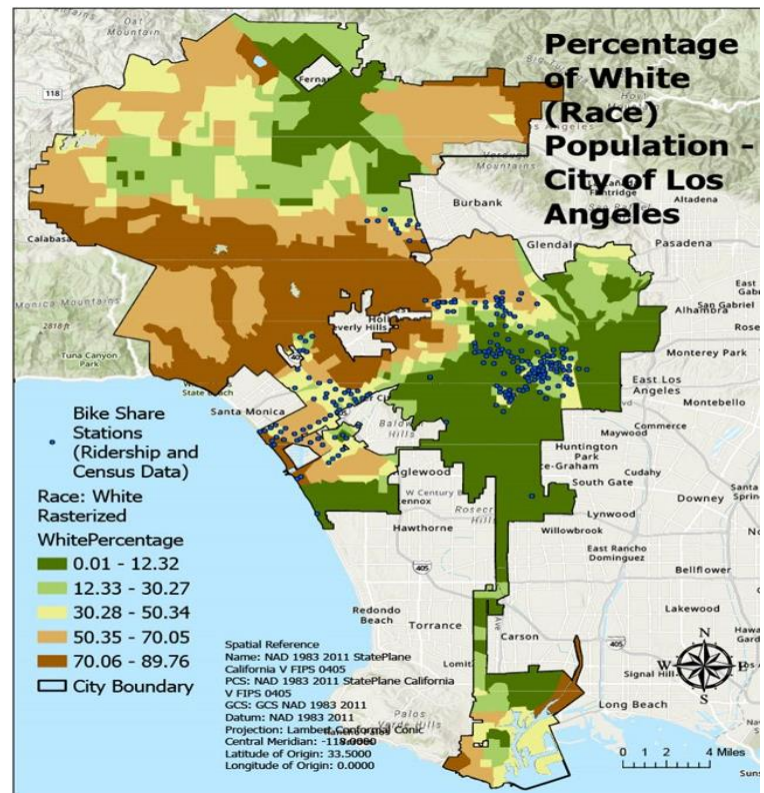


Figure 17 Percentage of White Population - City of Los Angeles

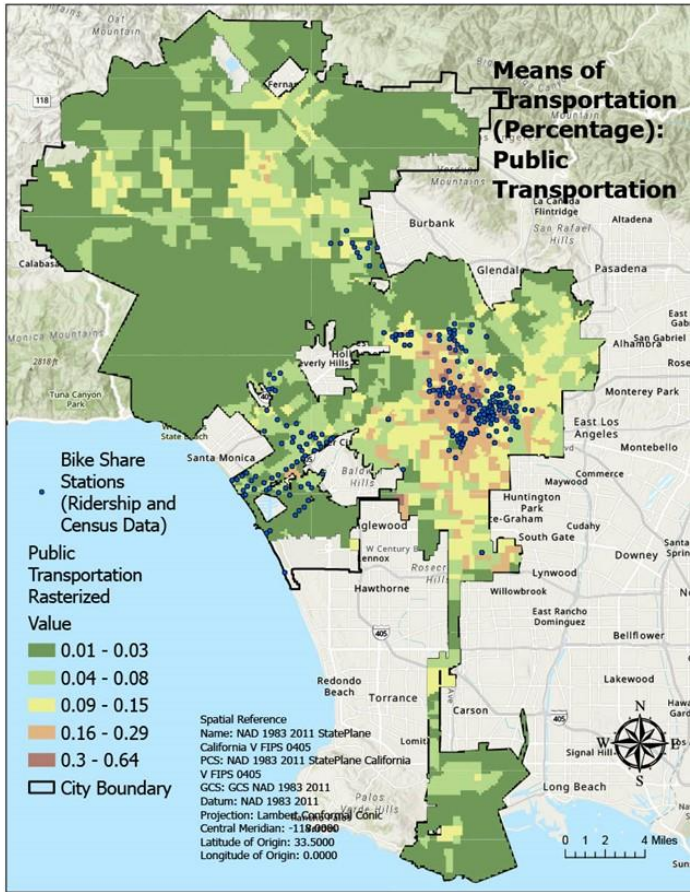


Figure 18 Means of Transportation to Work - Public Transportation

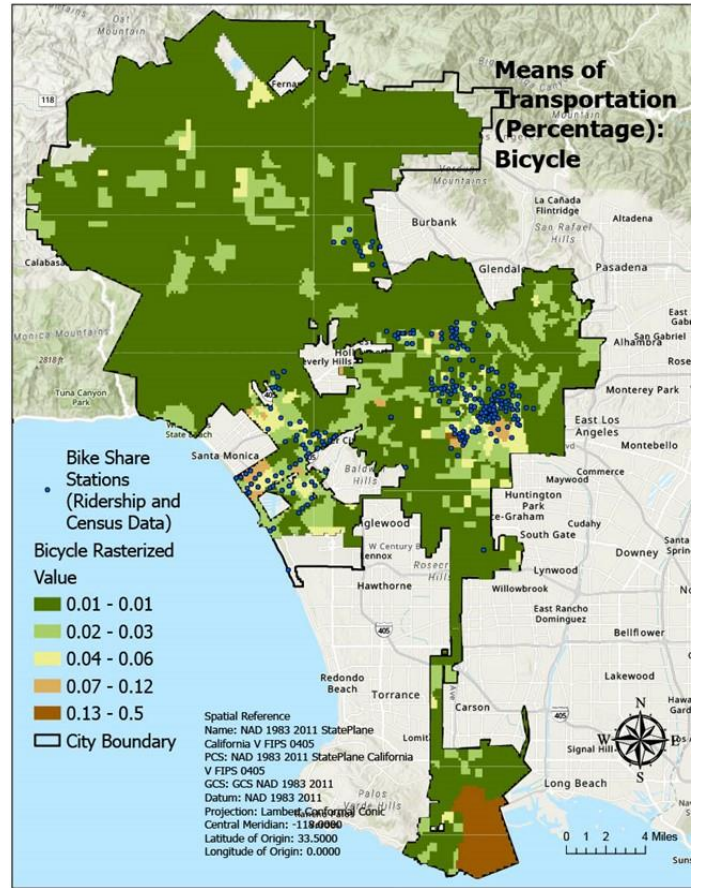


Figure 19 Means of Transportation to Work - Bicycle

### User Demographics and Usage Patterns:

Southern California Association of Governments (2019) employed a comprehensive survey of bike sharing. It is important to note that this survey was designed by the research team to be accessible to a diverse range of participants, being available both online and in physical format. Moreover, to ensure inclusivity, translated versions of the survey were provided in English, Spanish, and Mandarin. This survey remained open for a duration of 2 months, from February 3 to April 8, 2019. Throughout this dedicated timeframe, a total of 351 valid responses were collected, with 201 originating from Metro users and 150 from Santa Monica users, which

provided a comprehensive understanding of user perspectives across different segments of the bike share system's user base.

Expanding on the analysis of system performance, one of the primary metrics used is trips per bike per day (t/b/d), which provides insights into efficiency and operational costs. While t/b/d has shown a gradual increase in the Metro system, variations exist among different regions. For instance, areas like the Port of LA experience lower usage rates compared to regions like Venice and Downtown LA. These variations are influenced by factors such as population density, employment, and station density.

Additionally, examining usage patterns throughout the day reveals distinct travel behaviors among members and casual users. Weekdays show spikes in commute activity during typical rush hours, with additional peaks observed during lunchtime. On weekends, both user groups exhibit similar behavior, with a daytime peak occurring in the afternoon. Analyzing trip destinations provides us with valuable insights into user preferences and popular routes. In Downtown LA, trips between Union Station and 1<sup>st</sup> and Main St are the most frequent, followed by trips between stations at 7<sup>th</sup> and S Flower Street and 7<sup>th</sup> and S Spring Streets. Similar trends are observed in Venice, with trips connecting the Expo Line's Downtown Santa Monica station to locations along Venice Beach being the most popular.

Moreover, understanding the types of bike share system users further explains usage patterns. Casual users, characterized by spontaneous or opportunistic usage, contribute to system usage through options like Metro's "Day Pass." On the other hand, Members are active passholders with access to multiple pricing plans, offering them unlimited trips within certain time limits. These distinctions in user types influence system dynamics and revenue streams. Additionally, internal and external factors play a significant role in shaping system usage and

user trends. Metrics such as trips per bike per day (t/b/d) serve as indicators of system performance, with fluctuations observed in response to program expansions, pricing changes, and the introduction of scooter share programs. Moreover, correlations between system usage and land use context highlight the influence of factors such as employment density, population density, proximity to transit hubs, and the presence of other bike-share stations.

#### Equity and Accessibility:

In terms of affordability and pricing, the LA Metro bike-share system implements a varied model that caters to the diversity of demographics within the city. Similar to most U.S. bike-share systems, full-priced and reduced priced fares are available to users. The discounted passes available are the 30-Day Reduced Fare Pass for \$5 a month and 365-Day Reduced Fare Pass for \$50 a year. All rides 30 minutes or less are free, \$1.75 per 30 minutes thereafter for both plans. There are 5 ways to verify a user's eligibility for a reduced fare pass: Transit Assistance Program cardholders, CalFresh EBT cardholders, people with ADA-recognized disabilities, students 16 or older, and seniors 62 or older.

As mentioned earlier, the distribution of bike-share stations in Los Angeles reveals significant concentration in certain areas, while leaving others deprived of any bike-share infrastructure. Figure 8 suggests that the bike-share system is designed to offer residents and tourists access primarily to downtown areas and popular tourist destinations on the westside. Evidently, residential areas located on the Northern and Southern parts of Los Angeles lack bikeshare stations making it almost impossible to get into the main part of the city for work or essential services. The observed geographic distribution is likely a significant factor contributing to the underrepresentation of certain demographic groups in bike-share usage. The LA Metro

Bike-Share system advances toward equity and accessibility by offering educational courses on e-bike safety and guidance on purchasing and maintaining bicycles. This initiative is facilitated through the Bicycle Education Safety Training (BEST) Program, often conducted in collaboration with local non-profit organizations. Individuals are given the opportunity to view upcoming events/classes and register in accordance with their availability and preferences. These initiatives, alongside programs such as "Bike Share for Business" and "Perks & Rewards," facilitate the growth and expansion of the system. In the "Bike Share for Business" program, local organizations and companies are given the opportunity to purchase bike-share passes for their employees which have significant health and environmental impacts. Similarly, the "Perks & Rewards" program allows individuals to spread the positive impacts of bike-sharing with their family and friends while earning rewards such as gear and day passes.

#### Integration with Public Transit:

Lastly, integration with public transit is a critical aspect of the LA Metro Bike-Share system, aiming to enhance the overall transportation network's efficiency and accessibility. The bike-share system is strategically designed to complement existing public transit options, making it easier for residents and visitors to combine different modes of transportation into their everyday activities.

One of the key strategies for integration involves placing bike-share stations near major transit hubs, such as metro stations, bus stops, and transit centers. This proximity allows users to seamlessly switch between biking and other forms of public transportation. For example, bike-share stations near Union Station and various Metro Rail lines enable commuters to complete the first and last miles of their journey with ease.

Metro Bike-Share actively promotes multimodal travel through initiatives such as the “Bike Share for Business” program, which encourages employers to provide bike-share passes to their employees. This program not only supports sustainable commuting practices but also helps reduce traffic congestion and improve air quality.

Evidently, ongoing data collection and analysis play a vital role in optimizing the integration of bike-share with public transit. By monitoring usage patterns, the agency can identify high-demand areas and adjust the placement of bike-share stations and public transit services accordingly. By strategically placing bike-share stations near transit hubs, improving infrastructure, Metro Bike-Share programs can enhance the overall transit experience and support sustainable urban mobility.

## 5. Results

As the GIS analysis shows (Figures 8-21) each factor that was used in measuring bike share station need was spatially clustered. Areas of high concentration of low income and minority were located near Downtown LA (DTLA), parts leading down to the South Bay, and parts of the Northern San Fernando Valley. Specifically, social factors such as limited English households, households without vehicles, median income, area median income (AMI), and the use of bicycles and public transportation for commuting had high-interest areas mainly in DTLA. In contrast, race group factors were distributed throughout the Los Angeles metropolitan area and were not exclusively concentrated in DTLA. A high percentage of black households were found in the Southwestern region of LA (Figure 15) while Hispanic households were concentrated in East LA in neighborhoods such as Boyle Heights (Figure 14). Asian households were found to be clustered in the heart of LA which might be attributed to neighborhoods such as Koreatown (Figure 16).

The suitability analysis combined all the factors after converting them to raster's and weighting them as shown in Table 3. The results (Figure 20) showed that the most need for transportation alternatives is in the neighborhoods of Koreatown, Downtown Los Angeles, Westmont/Watts.

*Table 3: Weight Distribution of Factors for Raster Calculator*

<b>Factor</b>	<b>Assigned Weight</b>	<b>Percentage</b>
Means of Transportation Bicycle	0.08	8%
Means of Transportation: Public Transportation	0.08	8%
Median Income and AMI	0.15	15%
Limited English Households	0.15	15%
Households Without Vehicles	0.15	15%
Race: White	0.07	7%
Race: Black	0.07	7%
Race: Hispanic	0.07	7%
Race: Asian	0.07	7%
Race: American Indian/Alaskan Native	0.03	3%
Race: Pacific Islander	0.03	3%
Race: Other Races	0.03	3%
Race: Multiple Races	0.02	2%
<b>Total:</b>	1.0	100%

The weights assigned to each factor in Table 3 represent the relative importance of each factor in determining the need for bike-share stations. The methodology for determining these weights involved a combination of literature review, empirical analysis, GIS analysis, and personal judgement with a focus on equity.

1. Literature Review:

I reviewed existing studies and reports on bike-share programs and factors

influencing bike-share usage. This helped me identify key variables that are commonly associated with bike-share demand.

## 2. Empirical Analysis:

Using GIS tools, I analyzed spatial data to understand the distribution and correlation of various factors with bike-share usage in Los Angeles. This analysis included:

- Calculating the percentage of households using bicycle or public transportation as a means of transportation to work.
- Assessing median income and Area Median Income (AMI) data.
- Evaluating the proportion of limited English households and households without vehicles.
- Analyzing the racial composition of different areas.

## 3. GIS Analysis:

- GIS analysis played a critical role in understanding how each factor interconnects and impacts bike-share accessibility. By mapping these factors, I could visualize disparities and inequities in bike-share access.
- For instance, the analysis revealed that the black population had disproportionately less access to bike-sharing compared to the white population (See Figure 15 & 17). This significant finding led to assigning a higher weight to the black population factor to address this inequity.
- Similarly, economic and social factors such as means of transportation to work, median income, limited English proficiency, and households without vehicles were assigned heavier weights. This decision was guided by the

equity lens of the thesis, emphasizing the importance of addressing barriers faced by disadvantaged communities.

4. Equity Lens:

- The equity focus of the thesis influenced the weighting of factors. Factors that directly impact marginalized communities were given higher weights to ensure that the analysis addresses their specific needs and challenges.

Lastly, while the literature review, empirical analysis, and GIS analysis provided a foundation, the final weights assigned to each factor were influenced by my perceptions and motivations. Recognizing that personal bias may play a role, I aimed to balance the weights to reflect both the quantitative data and qualitative insights gathered during the study.

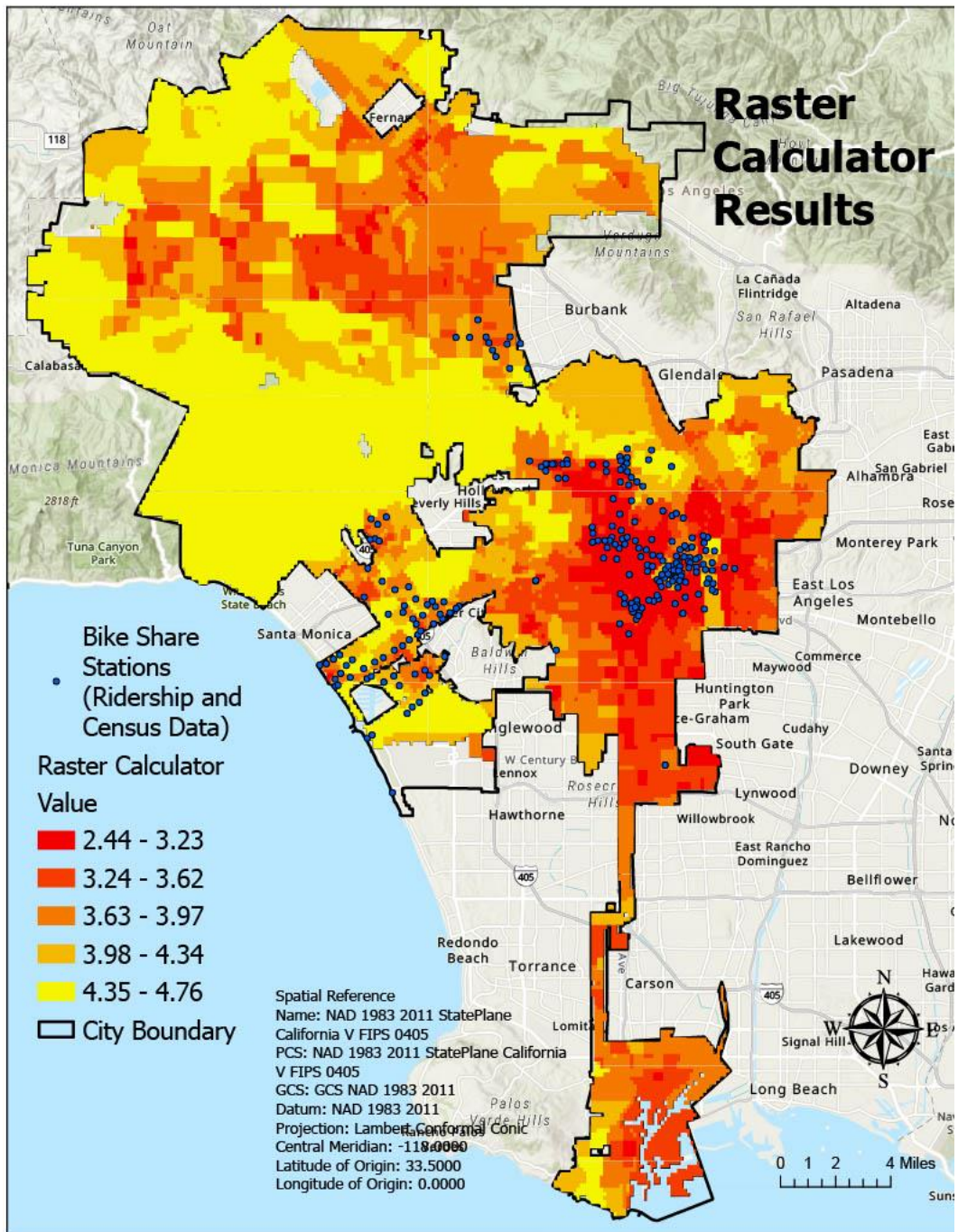


Figure 20 Raster Calculator

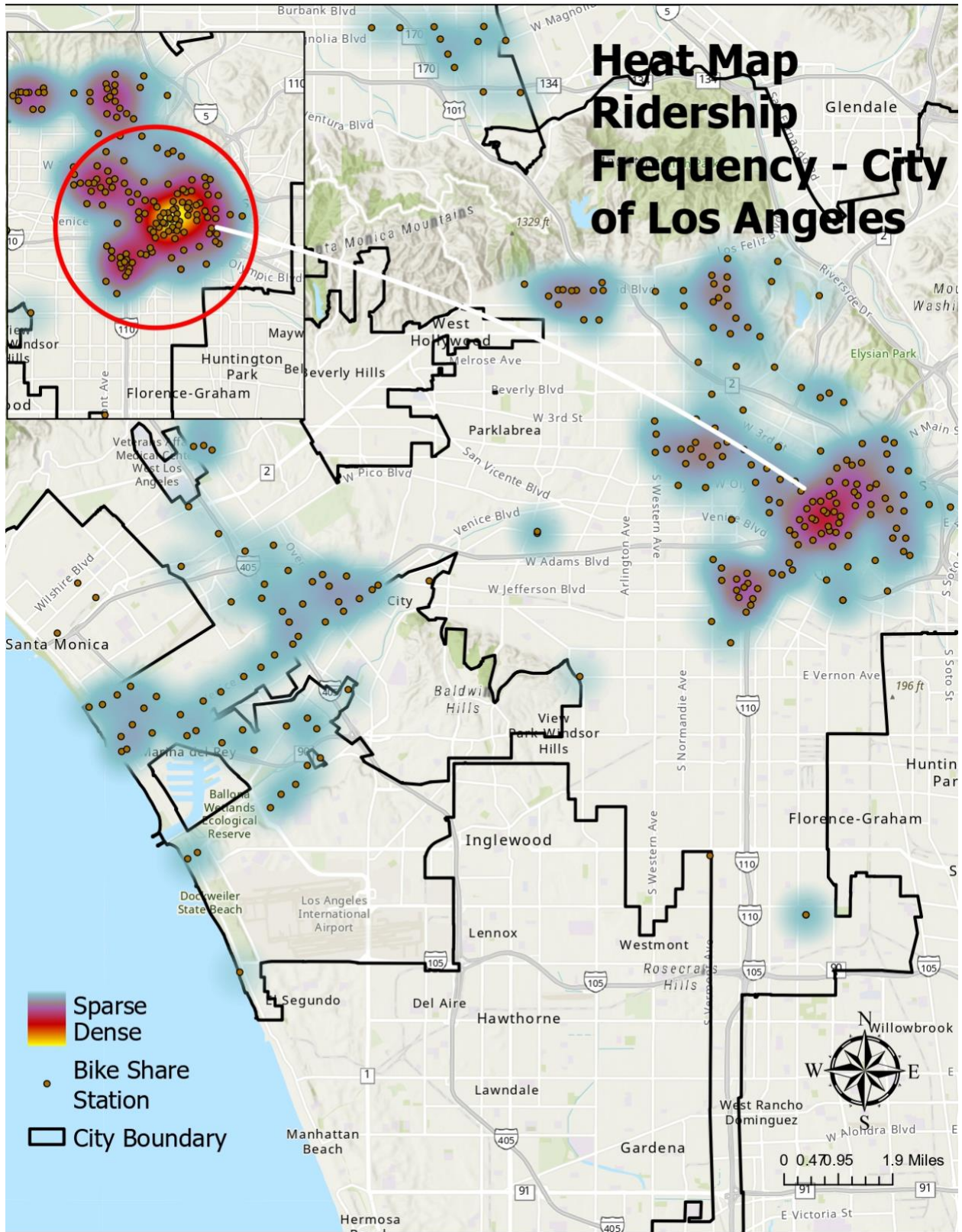


Figure 21 Heat Map Ridership Frequency - City of Los Angeles

A pairwise intersection of the ridership data with the socioeconomic factors provides a detailed understanding of how each factor correlated with bike share usage. The analysis of bike share station placement and ridership (Figures 8 and Figures 20-21) confirms that areas with a higher concentration of bike stations tend to experience increased usage. This highlights the importance of strategic placement of bike stations to optimize ridership and ensure equitable access across different neighborhoods. Notably, the coverage extends comprehensively, barring one significant exception—the Port of LA. This is likely due to the limitations in biking feasibility in this locale. However, pivotal regions like Downtown LA (DTLA) and Santa Monica exhibit substantial bicycle usage for commuting, fittingly complemented by Metro Bike Share stations.

Turning to public transportation, findings illuminate a prevalent reliance on transit within the DTLA/Central LA corridor. However, the placement of bike share stations in Santa Monica and Northern LA appears disjointed from these commuting patterns, with lower engagement figures. Nevertheless, the southern fringes of DTLA/Central LA emerge as hotspots for public transit users, emphasizing a potential synergy between biking and public transportation in these areas.

While the DTLA region seems to be adequately served, regions such as the San Fernando Valley and The Verdugos, as well as South LA leading down to the ports are underserved. Figure 20 shows that areas located south of DTLA have high need, but ridership is concentrated in the heart of the city as shown in Figure 21.

To further examine this disconnect between need and current ridership, I fitted a generalized linear regression (GLR). The socioeconomic factors included the percentage of the Hispanic population, the percentage of households without a vehicle, the percentage of

households with limited English proficiency, median household income, the percentage of people using bicycles to commute to work, and the percentage of people using public transportation to commute to work. These factors were chosen such that they had the lowest Variance Inflation Factor (VIF), which measures how much the variance of a regression coefficient is inflated due to multicollinearity with other variable in the model. Essentially, by selecting variables with a low VIF, I ensured that there was no multicollinearity, meaning that the explanatory variables were not overly correlated with one another, which could skew the results of the regression model.

Table 4 provided in the analysis shows the VIF values for each explanatory variable. A VIF below 10 generally indicates that multicollinearity is not a concern, and in this model, all VIF values were well within that range, confirming the absence of significant multicollinearity. The coefficients, probabilities, and robust probabilities in the table help quantify the influence of each factor on bike-share usage, with statistically significant results marked by asterisks.

The other factors that were used to create the need index, such as the percentages of White, Black, American Indian, Asian, Pacific Islander, Other Race, and Multiple Races population, were dropped from the model since they were highly correlated with the chosen explanatory variables.

Table 4: Generalized Linear Regression Table Results

Explanatory Variable	Coefficient	Probability	Robust Probability	VIF
Intercept	2392.64	0.000023*	0.000061*	-----
Hispanic percentage	-23.17	0.000631*	0.000014*	2.1
Zero Vehicle percentage	4.89	0.707335	0.668368	3.34
Limited English percentage	-21.64	0.0627	0.033516*	3.21
Median Income	-0.001577	0.74478	0.783336	2.13
Bicycle commute percentage	72.48	0.249154	0.068355	1.31
Public transit commute percentage	33.99	0.080899	0.003184*	3.39

Several factors were significant in predicting bike share usage in Los Angeles. These are summarized in the next section.

**Percentage of Hispanic Population:**

The analysis showed that areas with a higher percentage of Hispanic population tend to have lower bike share ridership (Table 4). This variable is significant in the model as it highlights potential cultural or socioeconomic barriers that might influence the use of bike share programs. It suggests that targeted outreach and education campaigns could be necessary to encourage bike share usage in these communities. Additionally, improving the accessibility and affordability of bike share programs could help bridge this gap.

**Households without Vehicles:**

Another finding was the correlation between bike share ridership and the percentage of households without vehicles (Figure 22) though the variable was not significant in the regression (Table 4). Areas with a higher proportion of households without vehicles showed increased bike share usage. This aligns with the expectation that individuals without personal vehicles might rely more on alternative transportation modes, such as biking, for their daily commutes. This insight underscores the importance of integrating bike share programs into broader transportation planning, particularly in car-dependent cities like Los Angeles.

**Limited English Proficiency:**

The model also indicated that households with limited English proficiency are less likely to use bike share services (Table 4). This could be attributed to language barriers that prevent these households from accessing information about the bike share program or understanding how to use it effectively. Addressing this issue could involve providing multilingual resources and support to ensure that language is not a barrier to accessing bike share services.

**Median Household Income:**

Median household income was not a significant factor in determining bike share usage based on the GLR. The correlation analysis (Figure 22), however, showed that areas with lower median incomes had lower ridership rates. This suggests that economic barriers might be limiting access to bike share programs for low-income households. To mitigate this, implementing pricing strategies that make bike share more affordable for low-income users could be beneficial. Additionally, providing subsidies or financial assistance programs could help increase ridership among economically disadvantaged groups.

**Bicycle Commute Percentage:**

The percentage of people using bicycles to commute to work also had a strong correlation with bike share usage (Figure 22) though it was not significant in the model. Areas with higher bicycle commute rates naturally exhibited higher bike share ridership. This finding indicates that bike share programs are more likely to be successful in areas where there is already a culture of biking. It suggests that expanding bike infrastructure and promoting biking as a viable commuting option could further boost bike share usage.

**Public Transportation Commute Percentage:**

Similarly, the percentage of people using public transportation to commute was positively correlated with bike share ridership and was a significant variable in the GLR (Table 4). This points to the potential of integrating bike share programs with public transportation systems to create a seamless and efficient multi-modal transportation network. Enhancing connectivity

between bike share stations and public transit hubs could encourage more people to use both modes of transportation.

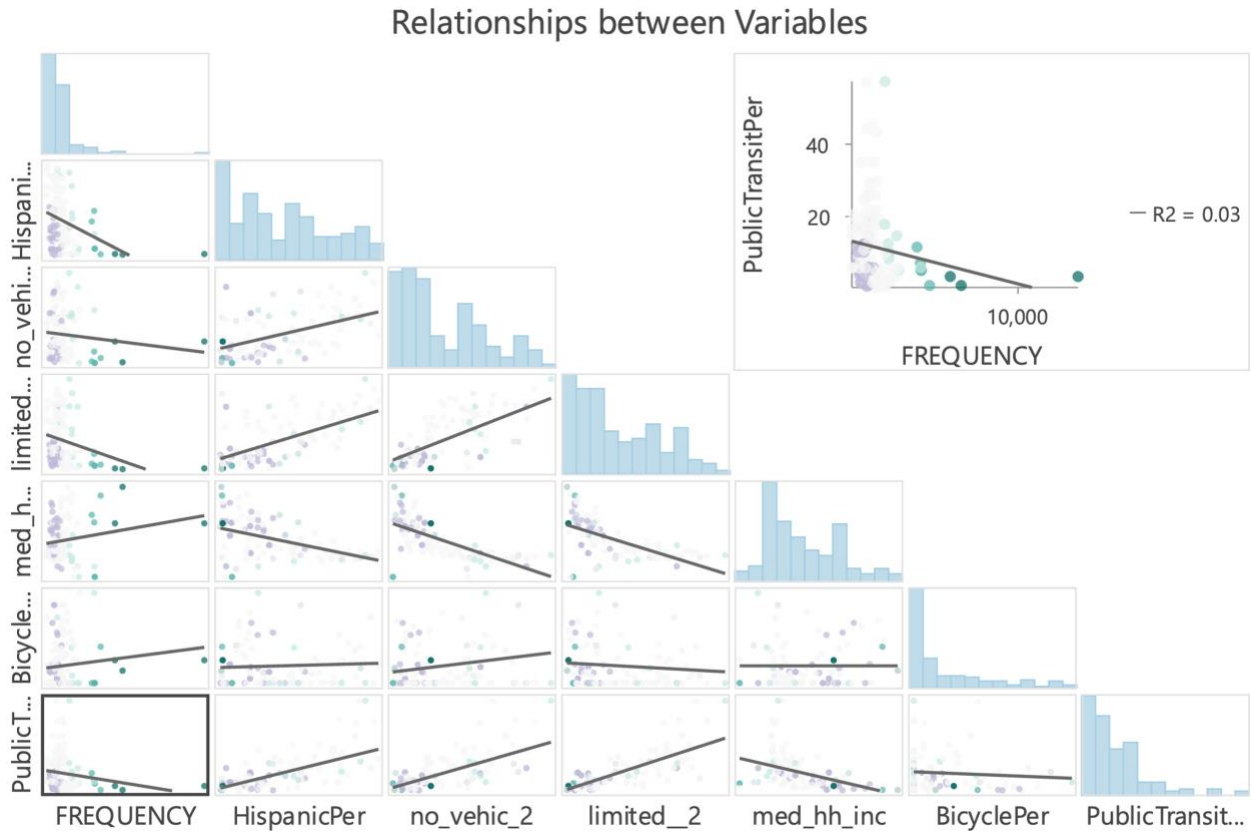


Figure 22 Relationships Between Variables

## **6. Policy Implications and Limitations**

This study has several limitations that should be acknowledged. First, the socioeconomic and ridership data were analyzed at different scales. Conducting a suitability analysis at the census block group or neighborhood level could result in different findings due to the Modifiable Areal Unit Problem. The Modifiable Areal Unit Problem (MAUP) is a source of statistical bias that can significantly impact the results of spatial analysis. The manner in which data is grouped, into different geographic areas (e.g., census tracts, neighborhoods), can change the outcome of the analysis. Secondly, there was no data about the riders so it was assumed that the ridership reflected the location in which the bike station was situated. It is likely that riders are walking or using public transportation to get to the bike share stations. Lastly, the ridership data was limited to a single year (2023), and patterns could differ in other years, affecting the generalizability of the findings. Furthermore, this analysis did not account for public health factors or crash risk, both of which could significantly impact bike-share ridership. The exclusion of these elements presents a limitation in understanding the full scope of influences on bike-share usage.

The findings from this analysis have several policy implications that can be applied to enhance the effectiveness and equity of the bike-share program of Los Angeles.

### **1. Educational Campaign for Limited English and Hispanic Users:**

An educational campaign tailored to limited English proficiency and Hispanic users is crucial. By providing information in multiple languages and culturally relevant contexts, these campaigns can bridge language gaps and increase awareness and understanding of the Los Angeles Metro bike-share program. Such initiatives could involve partnerships with community organizations and local media to ensure that the information reaches the target populations effectively.

**2. Multimodal Planning:**

Given the close link between transit and bike-share ridership, a multimodal planning approach is essential. This involves better integration of bike-share stations with public transit hubs, creating seamless connections between biking and other modes of transportation. Strategies could include co-locating bike-share docks at major bus and train stations, offering discounts for combined bike and transit usage, and improving wayfinding systems to guide users through multimodal journeys.

**3. Equity Research by LA Metro and Transit Agencies:**

Continuous research focused on equity is necessary to address disparities in bike-share access and usage. LA bike and transit agencies should collaborate on studies that analyze demographic data, usage patterns, and barriers faced by different communities. This research can inform the development of targeted policies and programs aimed at reducing inequities and ensuring that bike-share systems serve all residents equitably.

**4. Safety Analysis:**

A comprehensive safety analysis is critical, particularly for vulnerable road users such as bikers, pedestrians, and those transferring between transit modes. This analysis should assess crash risks and develop strategies to mitigate these risks, such as improving bike lanes, enhancing traffic calming measures, and increasing visibility at intersections. By prioritizing safety, the city can build confidence among potential users and encourage greater adoption of the Los Angeles bike-share system.

Whether a bike-sharing system is privately owned, publicly operated, or managed by a non-profit organization influences its operational dynamics, including the collection and utilization of data. Different ownership models may dictate varying approaches to data collection, as well as the types of data gathered and their specific purposes. There's a lack of exploration into the policy implications of equity considerations in bike-sharing initiatives. For instance, studies may fail to analyze the effectiveness of policy interventions aimed at promoting equitable access, such as subsidies for low-income riders or zoning regulations to ensure station placement in disadvantaged neighborhoods. As bike-share continues to grow across the U.S. and on the global stage, one can hope that research will soon bridge these gaps and delve deeper into the nuanced equity components of these systems.

There is a notable scarcity of research dedicated to examining the integration of the LA Metro bike-share system with public transportation, particularly in a city that is undergoing a significant shift towards prioritizing public transit investments after decades of being predominantly car centric. This gap in the literature overlooks the crucial role that bike-share systems can play in enhancing first and last-mile connectivity, promoting multi-model transportation usage, and reducing reliance on private vehicles in Los Angeles. Addressing this gap is essential for maximizing the potential benefits of bike-share programs and fostering a more sustainable and interconnected transportation network in the city. Furthermore, comprehending the integration of the LA Metro bike-share system with public transportation enables an analysis of equitable access concerning the placement of bike-share stations and understanding which communities benefit from better integration compared to others. This insight is vital for identifying potential disparities in access to sustainable transportation options and informing strategic efforts to address them, ensuring all residents, regardless of their location

or socio-economic status, have equal opportunities to utilize and benefit from bike-share services.

In conclusion, this analysis of ridership data, combined with social, infrastructural, and demographic factors, has provided valuable insights into the factors influencing bike share usage in Los Angeles. By addressing the identified barriers and leveraging the opportunities highlighted in this study, policymakers and urban planners can enhance the effectiveness and inclusivity of bike share programs, ultimately contributing to a more sustainable and equitable transportation system

## **7. Conclusion**

This thesis has explored the multifaceted factors influencing bike-share usage in Los Angeles, focusing on the intersection of social, infrastructural, and demographic elements. By examining ridership data from 2023 and integrating these findings with an analysis of the city's broader transportation landscape, this study has highlighted the critical barriers and opportunities that shape the accessibility and equity of bike-share programs in an urban environment like Los Angeles.

One of the central insights gained from this research is the complex role that socioeconomic disparities play in determining bike-share usage. The study revealed that cultural, economic, and language barriers remain significant obstacles to participation, particularly among underrepresented communities such as those with limited English proficiency and lower-income groups. Addressing these barriers through target educational campaigns and community engagement efforts is essential for ensuring that bike-share programs do not inadvertently exclude the very populations they aim to serve.

In addition to socioeconomic factors, the physical integration of bike-share systems with existing public transportation infrastructure emerged as a crucial determinant of success. The potential for bike-share programs to complement and enhance multimodal transportation networks in Los Angeles is immense, yet underutilized. By improving the spatial and operational connections between bike-share stations and transit hubs, the city can create a more seamless and efficient transportation system that encourages higher ridership and reduces reliance on private vehicles. This multimodal approach is particularly vital in a city like Los Angeles, which is in the midst of a significant shift toward prioritizing public transit investments after decades of car-centric development.

Looking ahead, the success of bike-share programs will depend on the city's ability to adapt to changing demographics, technological advancements, and evolving transportation needs. By continuously refining its approach and embracing innovative solutions, Los Angeles has the potential to lead the way in redefining urban mobility for the 21<sup>st</sup> century. This thesis, while addressing specific challenges and opportunities within the current context, also serves as a foundation for future research and policy development, guiding the city toward a more just and sustainable transportation future.

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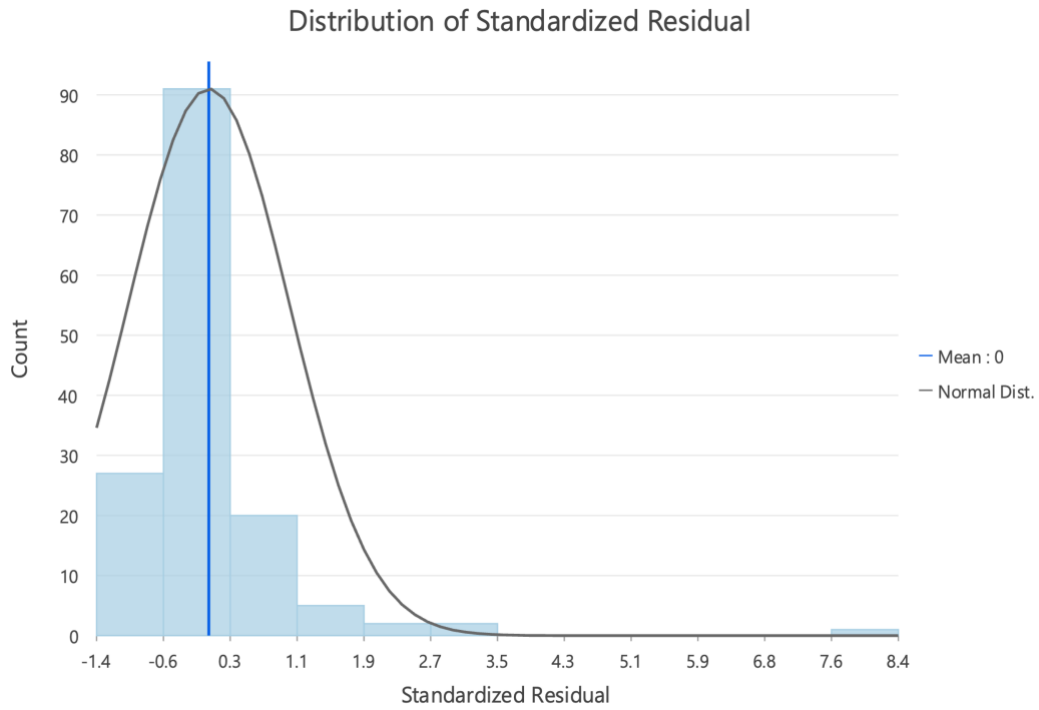
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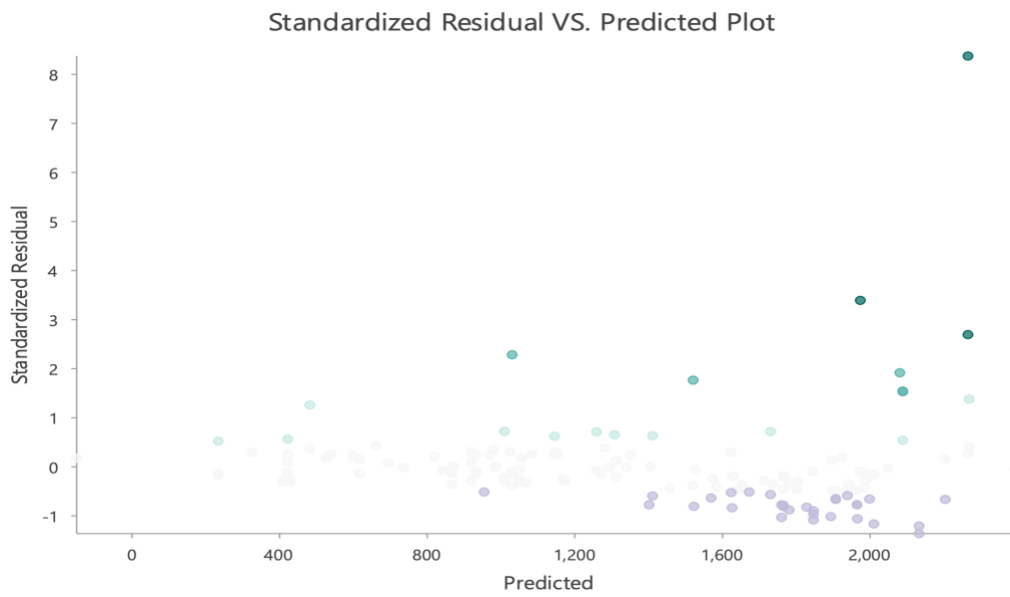
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# Appendix

## Appendix 1: Distribution of Standardized Residual



## Appendix 2: Standardized Residual vs Predicted Plot



## Appendix 4: Summary of GLR Results

Summary of GLR Results [Model Type: Continuous (Gaussian/OLS)]									
Variable	Coefficient^a	StdError	t-Statistic	Probability^b	Robust_SE	Robust_t	Robust_Pr	VIFc	
Intercept	2392.63755	543.280672	4.404054	0.000023*	576.024242	4.15371	0.000061*	-----	
SHEET1__HISPANICPER	-23.16845	6.618577	-3.500518	0.000631*	5.097454	-4.545102	0.000014*	2.06919	
HOUSEHOLDSWITHOUTVEH_PROJECT_NO_VEHIC_2	4.889463	12.9966	0.376211	0.707335	11.389306	0.429303	0.668368	3.336093	
LIMITEDENGLISHHOUSEH_PROJECT_LIMITED__2	-21.633143	11.53049	-1.876169	0.0627	10.077131	-2.146756	0.033516*	3.207991	
MEDIANINCOMEANDMICE_PROJECT_MED_HH_INC	-0.001577	0.004836	-0.32618	0.74478	0.005725	-0.275506	0.783336	2.12968	
SHEET1__BICYCLEPER	72.481312	62.636231	1.157179	0.249154	39.46164	1.836754	0.068355	1.305864	
SHEET1__PUBLICTRANSITPER	33.990169	19.333015	1.758141	0.080899	11.324911	3.001363	0.003184*	3.390622	

## Appendix 5: Raw Sample of Metro Ridership Data (2023 Quarter 4: October – December)

trip_id	duration	start_time	end_time	start_statio	start_lat	start_lon	end_statio	end_lat	end_lon	bike_id	plan_duration	trip_route_category	passholder_type	bike_type
307634320	6	10/1/2023 0:06	10/1/2023 0:12	3042	34.0493	-118.239	4491	34.04744	-118.248	13600	30	One Way	Monthly Pass	standard
307635047	37	10/1/2023 0:08	10/1/2023 0:45	4212	33.98813	-118.472	4553	33.99958	-118.441	12190	1	One Way	Walk-up	standard
307634510	8	10/1/2023 0:10	10/1/2023 0:18	3011	34.04113	-118.268	3025	34.03286	-118.268	12364	1	One Way	Walk-up	standard
307634662	12	10/1/2023 0:12	10/1/2023 0:24	3078	34.06428	-118.239	4516	34.04585	-118.254	16102	30	One Way	Monthly Pass	standard
307649592	58	10/1/2023 0:14	10/1/2023 1:12	4248	34.02835	-118.289	3064	34.04613	-118.258	24230	30	One Way	Monthly Pass	electric
307751103	504	10/1/2023 0:14	10/1/2023 8:38	4514	34.04621	-118.451	4215	34.01431	-118.491	29314	1	One Way	Walk-up	electric
307634998	30	10/1/2023 0:14	10/1/2023 0:44	3024	34.05772	-118.249	4456	34.05243	-118.302	23734	30	One Way	Monthly Pass	electric
307634791	12	10/1/2023 0:18	10/1/2023 0:30	4597	34.16522	-118.355	4601	34.16171	-118.373	13531	1	One Way	Walk-up	standard
307649514	49	10/1/2023 0:21	10/1/2023 1:10	4446	34.05323	-118.278	4273	34.02586	-118.284	15142	30	One Way	Monthly Pass	standard
307649719	55	10/1/2023 0:21	10/1/2023 1:16	4210	33.98434	-118.472	4212	33.98813	-118.472	25161	30	One Way	Monthly Pass	electric
307634724	6	10/1/2023 0:21	10/1/2023 0:27	4613	34.06975	-118.445	4528	34.06097	-118.444	25395	30	One Way	Monthly Pass	electric
307649759	55	10/1/2023 0:22	10/1/2023 1:17	4210	33.98434	-118.472	4214	33.99556	-118.482	28380	30	One Way	Monthly Pass	electric
307634827	10	10/1/2023 0:23	10/1/2023 0:33	4214	33.99556	-118.482	4212	33.98813	-118.472	13068	30	One Way	Monthly Pass	standard
307634938	13	10/1/2023 0:28	10/1/2023 0:41	3026	34.06318	-118.246	4578	34.04298	-118.253	29972	365	One Way	Annual Pass	electric
307634949	9	10/1/2023 0:32	10/1/2023 0:41	3042	34.0493	-118.239	4491	34.04744	-118.248	15409	30	One Way	Monthly Pass	standard
307649527	37	10/1/2023 0:33	10/1/2023 1:10	4404	34.04813	-118.271	4273	34.02586	-118.284	24843	30	One Way	Monthly Pass	electric
307635275	18	10/1/2023 0:39	10/1/2023 0:57	4410	34.06335	-118.297	4450	34.06349	-118.287	06018	30	One Way	Monthly Pass	standard
307635250	13	10/1/2023 0:43	10/1/2023 0:56	4266	34.02629	-118.278	4266	34.02629	-118.278	29293	30	Round Trip	Monthly Pass	electric
307635305	9	10/1/2023 0:49	10/1/2023 0:58	4387	34.03352	-118.242	3030	34.05194	-118.244	30363	30	One Way	Monthly Pass	electric
307649409	16	10/1/2023 0:50	10/1/2023 1:06	4632	33.98667	-118.441	4557	34.0118	-118.419	23001	30	One Way	Monthly Pass	electric
307648933	12	10/1/2023 0:51	10/1/2023 1:03	4601	34.16171	-118.373	4597	34.16522	-118.355	25183	1	One Way	Walk-up	electric
307642072	8	10/1/2023 0:53	10/1/2023 1:01	4515	34.03974	-118.442	4492	34.03687	-118.425	30240	30	One Way	Monthly Pass	electric
307642073	7	10/1/2023 0:54	10/1/2023 1:01	4515	34.03974	-118.442	4492	34.03687	-118.425	22219	30	One Way	Monthly Pass	electric
307649659	18	10/1/2023 0:56	10/1/2023 1:14	3011	34.04113	-118.268	4512	34.04381	-118.265	14904	1	One Way	Walk-up	standard
307649668	18	10/1/2023 0:56	10/1/2023 1:14	3011	34.04113	-118.268	4512	34.04381	-118.265	30504	1	One Way	Walk-up	electric
307649344	7	10/1/2023 0:57	10/1/2023 1:04	4602	34.16495	-118.364	4606	34.16863	-118.377	30374	30	One Way	Monthly Pass	electric
307649726	15	10/1/2023 1:01	10/1/2023 1:16	4215	34.01431	-118.491	4214	33.99556	-118.482	15100	30	One Way	Monthly Pass	standard
307649412	4	10/1/2023 1:02	10/1/2023 1:06	4450	34.06349	-118.287	4447	34.0616	-118.282	25326	30	One Way	Monthly Pass	electric
307650168	24	10/1/2023 1:07	10/1/2023 1:31	4447	34.0616	-118.282	3005	34.0485	-118.259	24287	30	One Way	Monthly Pass	electric
307650390	26	10/1/2023 1:12	10/1/2023 1:38	3064	34.04613	-118.258	4512	34.04381	-118.265	24230	30	One Way	Monthly Pass	electric
307649933	7	10/1/2023 1:15	10/1/2023 1:22	4474	34.11003	-118.287	4438	34.09493	-118.285	30432	30	One Way	Monthly Pass	electric
307650025	7	10/1/2023 1:18	10/1/2023 1:25	4476	34.08252	-118.273	4510	34.07735	-118.265	29335	30	One Way	Monthly Pass	electric