Metro's MicroTransit Pilot Program: Policy Recommendations for Equitable Impact Amongst Low-income Populations in Los Angeles

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I. INTRODUCTION

While technology-enabled transit solutions have revolutionized the way Americans think about transportation mobility, the disparate access to technology can result in what scholars have called transit inequity. Transit inequity refers to disparity in quality and quantity of services offered to lower income and higher income people. Technology-enabled mobile services have gained popularity leading to a rapid expansion of public-private partnerships. Services like *Micro-transit*, an IT enabled, multi-passenger transportation service which uses dynamically generated routes, has gained traction in cities such as Seattle, New York, Columbus, and now Los Angeles. As this app-based service in the demand-economy expands, so does the public sector's role in ensuring that these new services are accessible to all customers regardless of their income, race, and gender.

Today, the Los Angeles County Metropolitan Transportation Authority (Metro) is in the process of investing in a MicroTransit Pilot Program, in an effort to expand mobility options for their customers. While the idea of providing an app-based transit service to the city of Los Angeles has peaked the interests of the public and its private investors, it has simultaneously raised concerns about equity and access. Many of these technology based apps rely on an individual's ability to have access to smartphones and/or credit cards, which for the large population of Angelenos who are transit-dependent, often times do not have.

Historically, transportation investments in Los Angeles County have not always met the needs of low-income communities of color (Investing in Place, 2016). Over 70% of rail riders and over 90% of bus riders within the Los Angeles Metro transit system earn less than $55,000 per household income, which the Housing and Urban Development agency metrics for the Los Angeles County considers low-income. In planning for the impementation of a MicroTransit

service, L.A. Metro has the opportunity and obligation to integrate equity metrics, By taking a "Just Growth" approach, I aim to investigate how the implementation of L.A. Metro's micro-transit program will impact low-income populations in Los Angeles County. This thesis assesses the needs of low-income populations and smartphone ownership rates across the county. This study focuses on transit equity regarding access to service, rather than including costs to individuals. Potential service zones for this pilot program are also reccomended.

II. LITERATURE REVIEW

Metro's Goals and Priorities

In 2015, Metro introduced Phil Washington as their new CEO. Washington has led two significant initiatives which have long-term impacts on the direction of the agency. The most significant is the successful passage of Measure M with 71% of the vote in November 2016. It is estimated to generate $860 million a year in 2017 dollars through an ½ cent sales tax that will continue until voters decide to end it. A second initiative Washington has led is the creation of the Office of Extraordinary Innovation (OEI). This new office was established to explore new ways to move LA by finding and testing leading-edge ideas that have potential to improve mobility for the people in the region. They use three tools: internal consulting, developing an agency strategic plan, and accepting unsolicited proposals. Most significant, they are welcoming the private sector to create partnerships that can aid the agency by leveraging the private sector's capital and technology. This expanded source of funding is immense; a newfound openness to leveraging technology and creating private-public partnerships is equipping Metro with the resources necessary to change the landscape of public mobility. With this incredible opportunity, it is crucial to consider and prioritize the transit-dependent population that Metro serves.

Depending on how we measure progress, there is room for failing to meet the needs of traditionally marginalized populations, specifically those that are low-income.

Metro has outlined a broad range of goals, at the agency level, department level, and project level. Authors Brian Taylor and Eric Morris contend in their article titled, "Public transportation objectives and rider demographics: are transit's priorities poor public policy?" that transit agencies across the country have goals that are too ambiguous and broad and therefore difficult to accomplish and measure. One reason why transit agencies have such broad goals is that they hold such a greater role in society than just a transit role. Transit is an important factor in many people's lives—allowing access to healthcare, grocery shopping, employment amongst other important living needs (Gottlieb et al., 2005). Not only that, but as a large institution, any decision made from a transit agency has ripple effects on the region as a whole, including environmental and economic ones. Another reason why goals are so broad is because transit agencies, such as Metro, often rely on securing funding by vote of the public (e.g. Measure M), who of which are not always their riders. This wide net of stakeholders puts public transit in a political battlefront and forces the agency to carefully balance interests, particularly as various interests are not always weighed the same.

The voting population typically belongs to a higher income bracket than the typical public transit patron. This creates a discrepancy between what voters are willing to approve and what current ridership needs. Ridership is declining across the country and drastically in Los Angeles, "In fact, transit ridership has declined more than 19% since 2013" (Neighborhood Data for Social Change, 2018). Metro is also looking to attract new riders. Enhancing their focus on attracting new customers which also shifts priorities and investments. While Metro has finite resources and diverse interests, it must not only balance but prioritize the needs of its core riders.

The Los Angeles Metropolitan Agency is a chartered by state law to be a regional transportation agency. Metro is responsible for the continuous improvement of an efficient and effective transportation system for Los Angeles County.

None of Metro's goals explicitly mention equity, nor low income or transit-dependent populations (APPENDIX II). It does mention "improve customer experience and expand access to transportation options" as well as "increase ridership and transit use." The goals of Measure M take their accessibility goal further by explicitly stating, "Make public transportation more accessible, convenient, and affordable for seniors, students, and the disabled." Still, no explicit mention of low-income populations. The goals of Microtransit also do not mention anything about low-income or transit dependent populations less their aspiration to provide a service that meets or exceeds ADA requirements. As Taylor and Morris would contend, that broad goals such as "improve quality of life" are goals few would argue with, but it is too difficult for a transit agency to determine what is meant by "quality of life." The second problem with this goal is that just as it is difficult to define, it is difficult to measure.

After taking a closer look at the Request for Proposal, there are two instances that get closer to explicitly stating these populations. Metro, with whomever they grant the contract to:

- *Aims to gain knowledge regarding how to develop a business model that achieves a balance between market considerations (e.g. pricing) and public policy considerations (e.g. equity) for technology solutions.*

- *Metro can potentially leverage this technology to serve the agency's broader social goals such as focusing on pooled rides and connections to other transit types, accessibility for passengers with disabilities, providing service to those without smartphones or bank accounts. Metro requests the qualified firms or Contractor Teams address each of these social goals within their responses to the solicitation.*

In their first mention of equity, it still stands as something that has to be balanced against market considerations and not an explicit priority. The second mention of equity pertaining to lower-income people is to potentially provide service to those without smartphones or bank accounts. Mentioning those specific barriers to access is a progressive step forward. Still, it is not an explicitly stated priority. Equity remains equally one of many other considerations for Metro's service. "An equitable transportation system is one that: 1) Provides equitable access to safe, reliable, and affordable transportation options; 2) Shares the distribution of benefits and burdens of transportation investments; and 3) Includes communities as partners in planning, investment, and implementation processes" (Invest in Place, 2016).

Demographics of Metro Riders

Metro riders are predominantly low-income people of color. From Metro's 2017 system wide Customer Satisfaction Survey, 73% of metro riders earn less than $25,000 a year (Metro Research, 2016). This is well below Los Angeles County's median income, $57,982 (Census Bureau, 2016). Within bus riders, the median household income is just over $16,000, placing 61% of riders below the poverty line. 66% are Latinos, 15% are African American, 7% are Asian/Pacific Islander, and 8% are White. On rail, 51% earn less than $25,000, the median income is $24, 390, with 39% of riders below the poverty line. 46% are Latinos, 17% are African American, 18% are white, and 12% are Asian/Pacific Islander. As Metro struggles with declining ridership, it is low income, riders of color who are maintaining Metro's ridership numbers. In 2016, the Consumer Expenditure Survey (CE) administered by the Bureau of Labor Statistics (BLS) identified transportation as the second largest household expenditure category (16.2% of total expenditure. This means that for LA Metro riders, who are mostly low income, transportation has the potential to significantly impact rider's financial well-being. The CE also

reports that the average household devotes most of its transportation budget to purchasing, operating, and maintaining private vehicles. Only 6.8% of LA county's population are using public transit (Neighborhood data for social change, 2018) and that over 16% of people in LA County live under poverty, (Census Bureau, 2016) this demonstrates many that low-income people are still choosing private car-ownership over using public transportation. Metro is not the most convenient option nor is it accessible for everyone. The University of California's Institute for Transportation Studies concluded that "a redirected focus toward transit's core customer base of low-income people offers the best way to improve financial standing, service effectiveness, and ridership" (2014). Considering private transportation consumes such a significant portion of low-income families' household income and low income, people of color are maintaining Metro's ridership, it is imperative that Metro prioritizes optimizing the service it provides for low-income people.

Transportation Cost Burdens

The Consumer Expenditure Survey (CE) shows that households in the United States spent an average of $8,755 on transportation in 2016, making transportation the second largest household expenditure category after housing. The average household spends 92% of their transportation budget on purchasing, operating and maintaining their vehicle. The remaining 7.1% of household transportation expenses is on public transportation which includes airline fares, bus, train, and ship fares. Public transportation is significantly less costly than private vehicle ownership Los Angeles, however, is notoriously known to have been built around the automobile and public transportation is not available everywhere. Its car culture fits the mold for a place that assumes high mobility. The U.S. Department of Transportation defines transit

dependent as people who do not own a private vehicle and people who live below the poverty or median income levels. This is because even when a person who is low-income purchases a car, the cost to maintain the vehicle is burdensome. Across all income categories, households spend similar percentages on transportation ranging from 14.4 to 17.8 percent. While the percentages are similar, households in the top quintile spent 4 times more than households in the bottom income quintiles in 2016. This is because higher income households are more likely to own multiple vehicles. Households in the top quintile ($103, 041+) own an average of 2.7 vehicles per household while households in the lowest quintile ($0 to $19,868 own .9 vehicles per household. Overall, transportation as a spending category has grown at a smaller rate behind healthcare and housing. This may be due to the accelerated growth rate of housing costs across the country. While transportation expenditure share is declining, I am curious to know what that number looks like in Los Angeles County. Los Angeles is car-centric, where driving is almost a necessity and insurance cost can be higher in areas with high crime rates and congestion. This signals that transportation cost share for lower income people Los Angeles may be in higher than national averages.

Lack of mobility is linked to social and economic exclusion (Ohnmacht et al. 2009, Lucas, 2012). There is a conceptual link between transport and poverty explained by social exclusion theory, spatial mismatch and entrapment, and social justice. Spatial mismatch speaks to trends that show cheaper, more affordable housing is in areas with poor transport connectivity, making it more difficult for people with lower incomes without cars to access to resources that affect their quality of life. Social exclusion theory focuses on the consequences of lack of access to transportation, deprivation to transport leads to the "process by which people are prevented from participating in the economic, political, and social life of the community, due to whole or in

part to insufficient mobility in a society and an environment built around the assumption of high mobility" (Kenyon et al. 2002). Social justice theories focus on the relationship between poverty and transport-related disadvantages from a perspective of inequality and relate more closely with policy and political ideals. Studies show that car ownership increases accessibility to better jobs, educational institutions, social services, and other living necessities (Blumbenberg and Ong, 2001; Grengs 2010; Shen 2001; Taylor and Ong 1995). However, there's a significant cost associated with private vehicle ownership and for low-income households, it can be a detrimental burden. Transportation agencies are tasked to increase mobility, and although they are not directly social service providers, mobility is crucial for people to achieve full social participation. People need reliable and equitable transit to enable them to "reach jobs, schools, food markets, healthcare and human services. Public transportation is an especially critical resource to those who do not have any other means of transportation. ..Public transit [...] is an indispensable social service [...] for people who because of income, disability, do not have regular access to private motor vehicles, (Iseki and Taylor, 2010). Lack of equitable public transit investment cannot only hinder access but also can increase social inequities.

Distribution of Transit Costs and Benefits

The distribution of transit costs and benefits among transit users is regressive in respect to income. Neglecting the prioritization of equity in transportation investment has "[resulted] in freeways that crisscrossed communities of color and bus service cuts that disproportionately affected communities of color and low-income transit riders. These same communities continue to experience reduced access to economic opportunity, higher traffic fatality and serious injury rates, and toxic environmental conditions" (Investing in Place, 2016). "While low-income residents generally benefit from the public transit subsidy [their] analysis finds that the benefits

of subsidies disproportionately accrue to those least in need of public assistance. White and Asian transit riders in Los Angeles, on average, are subsidized at higher levels than Blacks, Latinos, or Native Americans. (Iseki and Taylor, 2010). The Title IV of Civil Rights Act of 1964 makes it illegal for federally funded organizations from discriminating against anyone on the basis of race, color, or national identity. In the 1990s the Bus Riders' Union along with other grassroots organizations filed a class action lawsuit against Metro and in 1996 the court ruled in favor of the community. This decision recognized that investments in large mass transit projects such as rail that compromised vital bus lines, most used by the urban poor were discriminatory. "Los Angeles, people who do not have cars struggle to reach their jobs and other basic necessities...To improve the bus system would help make public transportation equitable in that it provides riders with the same efficiency and usefulness as a car" (Delgadillo, 2014, Gotlieb et al, 2006). Research shows that poor people predominantly use busses over other modes of public transportation i.e. rail. Whereas more affluent people tend to ride rail. Yet, transit agencies, including Metro, have invested more money in recent time into rail.

Metro is rapidly growing. Measure M is expected to generate $120 billion over 40 years. Measure M was taxpayer approved, which demonstrates Los Angeles voters want more transit. Benefits to higher income residents come in the form of better amenities for cars, such as street and highway improvement and investment in light rail. Metro's 2017-2018 budget outlines that operating capital for Bus, including safety and security, state of good repair, and capital infrastructure, stands at $99,423 million while rail operating capital is $197, 060 million, almost double that allocated for the bus (Los Angeles Metro, FY18 Adopted Budget, 2018). The contrast between whom bus and rail service is an often-cited example, as it demonstrates a dichotomy that is deepening over time (Taylor and Morris, 2014). As the economy evolves,

transportation agencies including LA Metro are also investing in technologies (i.e. mobile applications, public & private partnerships etc.) to enhance the customer experience. This has the potential to profoundly transform mobility in Los Angeles, thus it is important to consider planning policies that promote equity across all modes of transit.

In a 2015 article titled "Public transportation objectives and rider demographics: are transit's priorities poor public policy?" the authors analyze transit agencies' stated goals, the disparity in the prioritization of different groups, and how spending aligns with stated goals and user needs. They ultimately "contend that efforts to secure popular support for transit subsidies stifle agencies' ability to acknowledge transit's critical social service function and serve the needs of its core demographic." 44% of California's likely voters earn more than $80,000 a year and 28% of likely voters earn less than $40,000, this demonstrates the voting population is does not necessarily match transit riders.

The solution alone is not to just pour more money into subsidies for low-income populations. It has been noted that overall "transit subsidization redistributes income from high-income to low-income classes but that it is not very effective in targeting benefits to the poor." Part of the relevance of looking at the contrasts of bus and rail is that it involves a conversation comparing transit-dependent and choice riders. To consider a pilot micro transit program implies a similar debate. This can possibly be mitigated by targeting low-income populations to benefit from this service. Whereas rail takes years of planning, millions of dollars in construction and displaces, a micro transit program would be less costly and easily integrate with the current system. The similarity is that higher income people would more easily have access to this service considering that smartphone ownership rates tend to be higher with higher-income brackets. However, the nature of a micro transit program lends itself to be nimble and thus making it easier

to target the neediest populations. Another key finding in Taylor and Morris' research is that 'transit dependent riders with lower incomes are highly responsive to service improvements. "Measures including increasing bus frequencies, expanding center-city bus networks, and especially cutting bus fares have been shown to be powerful stimuli for increasing ridership" (Taylor and Morris, 2015). Innovative transportation options such as micro-transit can enhance needed accessibility and alleviate the costs associated with private vehicle ownership.

Disparities in Smartphone Ownership and Usage

There are implications that come with the strides cities and governments are making to leveraging technology. As also outlined in Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services, "the rise of new technology-enabled mobility services concern matters of fairness and equity." As a public, government-funded agency, Metro is prohibited from discriminating against anyone on the basis of race or ethnicity under Title IV of the Civil Rights Act of 1964. Although not directly protected under this law, this book examines "unbanked" populations, workers, people with disabilities, and low-income populations, and people without smartphones as stakeholders in this issue. MicroTransit is a pilot service that will most likely rely heavily on access to smartphones. It is evident that this is the potential barrier to many residents of Los Angeles County.

Nationally, access to smartphones has increased significantly over the last few years, but there is still a still an ownership gap between certain demographics. The U.S. Department of Commerce reports that "when combined with advances in mobile internet connectivity, some form of broadband, whether fixed or mobile, is now available to almost 99 percent of the population." In 2017, the Pew Research Center reported that 95% of Americans now own a cell phone of some kind and 77% of Americans own a smartphone. This is up from 35% in 2011. For

people making under $30,000 a year, the rate of smartphone ownership is 64% (over 70% of Metro riders earn less than $30,000 a year). Smartphone ownership amongst Black and Latinos is 72% and 75%, respectively. People who earn more than $50,000 a year have a smartphone ownership rate of 84% and for people who earn more than $75,000, that number is even larger at 92%. While there exist demographic, social, and geographical gaps across the nation in internet access, low-income Hispanics had the highest proportion of households that relied solely on a handheld device or smartphone to connect to the internet, despite having the lowest overall connectivity (Iriondo, 2017). In a 2016 Metro System Wide Customer Satisfaction Survey, Metro reports 54% of riders own a smartphone and 37% percent own a cell phone (Metro Research, 2016). Smartphone ownership rate amongst current Metro riders is 23% less than the national average. This is a barrier that Metro must consider when planning their program. Given the dramatic increase from 35% to 77% of smartphone ownership amongst U.S. adults, we can assume that this number will continue to rise. These numbers look promising for the possibility of a successful Microtransit program.

Smartphone ownership by itself is not a clear indicator of the digital divide. While access is a necessary component, we must also consider the digital divide that exists in usage patterns. As of 2012, 63% of mobile phone users with incomes of at least $100,000 checked or sent an email with their devices while only 27% of users with family incomes below $25,000 did now. The Web browsing, downloading apps, and social networking saw similar patterns (U.S. Dept. of Commerce, 2014). This national study also revealed that users in the West are statistically significantly more likely to use their internet-based mobile phone for all categories analyzed (email, web, apps, social networking). The model in this study suggests that income and education are the largest predictors of mobile phone use habits, not race and ethnicity. This

comes from a report titled, “Exploring the Digital Nation: Embracing the Mobile Internet” by the United States Department of Commerce. It states that these data can inform further research and policy that strives to eliminate disparities by increasing the availability of affordable broadband. This report uses 2012 and 2013 data and we can expect that existing disparities have narrowed but we cannot be sure to what extent. This information can be very useful for Metro to understand how their constituency uses their smartphones and as they develop creative solutions to mitigate the digital divide when they launch its Microtransit service.

There is not a lot of available research on low-income people’s access to specifically Transportation Network Companies’ services. However, there are some studies which look at low-income people’s use of car-share services, bike-share services, and taxis. Low-income people do not use car-share and bike share as much as higher income people. This is due to cost, access, and cultural differences. For example, bike-share docking stations are seldom in low-income neighborhoods. They often require credit cards and internet access, there is a lack of information on them, and there is also distrust of authority or discomfort with shared mobility services amongst lower-income populations (Kodransky and Lewe, 2014). Metro’s bike share program, similarly to other bike share programs, has faced criticism for not placing their bike share stations in lower-income neighborhoods. Currently, they have docking stations in the Port of LA, Pasadena, Downtown LA, and Venice. A year after its implementation, NPR reported Metro’s system averaged one ride per bike per day, which is far below averages of systems in New York and Washington D.C.’s. In a survey conducted by Portland State University, low-income people who had physical access to bike-share stations were asked why they did not use the bikes. Responses included concern for cost, the need to put down a credit card (either because they didn't have one or feared unexpected fees) (McNeil, et. al 2017). The monthly pass

currently costs $20/month plus $1.75 every 30 minutes after the first 30 minutes. Without a pass, the bike costs $3.50 for every 30 minutes. There are currently no discount programs for low-income people and a credit card or tap card is required. Among low-income respondents of color, there was also discomfort with the program due to concerns over road safety and fear of being harassed while on the bike (Pricing, Metro Bike Share, 2018). This demonstrates that barriers with bike-share are larger than physical access. Although bike-share is a different program than micro transit, there are similar concerns that follow suit because both models are typically not used by lower-income people for reasons that have to be addressed.

Despite existing barriers to low-income people's participation in shared-mobility services, the growth of this industry can address some mobility issues for low-income folks. For car-share stations, the evidence is not conclusive. An analysis of carshare stations in a single city did not find that neighborhood income was a significant factor in predicting use (Stillwater et al 2009), instead, variations exist city to city (Millard-Ball et al, 2006). Information about taxi-trips suggests that "[t]o the extent that TNCs provide services similar to those of taxis for people without automobile access but at a lower cost, TNC services could meaningfully increase accessibility for low-income individuals" (National Academy of Sciences, 2016). (Renne and Bennett, 2014). This fits Metro's intention that Microtransit trips will be shorter than 20 minutes. In a study comparing taxis to Uber in Los Angeles' low-income neighborhoods, it was concluded that TNCs are twice as fast and half as expensive as cabs. This makes it possible for TNCs to provide residents in low-income neighborhoods, who have smartphones and credit cards, with a faster more economical transportation option relative to taxis (BOTEC Analysis Corporation, 2015, National Academy of Sciences, 2016). This is a recognized as a well-designed study, done by BOTEC Analysis led by a Ph.D. candidate at UCLA, but it is important to note that it was

funded by Uber. More studies like this need to be done in other cities' low-income neighborhoods to make generalizable conclusions. These preliminary findings suggest that a micro transit service has the potential to be a highly beneficial asset to Metro's equity goals.

Ride-hailing services are mostly used by wealthier Americans— but that does not have to remain the case. In "Between Public and Private Mobility: Examining the Rise of Technology Enabled Transportation Services, the National Academy of Science, Engineering, and Medicine identified nonprofit car-sharing services in Buffalo, Denver, and Washington D.C. which have implemented measures to target the service in low-income neighborhoods. Buffalo CarShare members were found to have incomes of $25,000 or less (Randall, 2011). Denver and D.C. require carsharing operators to have at least two vehicles in low-income neighborhoods. These examples of carsharing seem to differ from Metro's idea for a micro transit pilot in that 1) these services are primarily run by the private company and subsidized by the government 2) car sharing is essentially a car renting model. In contrast, Microtransit will be a dynamically routed vanpool driven by Metro employees and primarily run by Metro.

There is a potential market out there for ride-hailing services within low-income communities of color. Ride-hailing services such as Uber and Lyft are one of the best examples of our new 'on-demand' economy. In 2016, the Harvard Business Review estimated that on-demand transportation companies have 7.3 million monthly consumers and $5.5 billion in annual spending. They estimate this number to continue to grow. Also, in 2016, the Pew Research Center reported that 15% of American adults have used ride-hailing services and that 3% of all adult Americans use these services on a regular basis (daily or weekly) and 12% of all American adults use these services once a month or less. As popular as these services are, there currently exists an income disparity between users. While 26% of people who make $75,000 or more use

these services, only 10% of people who make $30,000 or less have used this service. However, following that income disparity is a gap in awareness with the amenity. 49% of people who earn $30,000 or less are not familiar with the term “ride-hailing service’. Across racial and gender lines, there are no substantial differences. This information is useful in identifying a potential market. Metro knows there is a market out there and they are figuring out how “these new options (demand-economy services) can be synergistic with public transit models” (Westervelt et al., 2016). Pew also found that 64% of frequent ride-hail service users also own a personal vehicle. This shows that even people who own their car find value in using an alternative transit method. Also, 56% of frequent public transportation users also frequently ride-hailing services, which supports Metro’s goals for synergy throughout their entire system.

There’s also a lot of potential in Metro’s new approach to welcome private-public partnerships. Companies like Uber and Lyft are still not profitable. Despite having large market shares in the transit economy and having a valuation of $69 billion and $7.5 billion, respectively they will probably become profitable until the roll-out of autonomous vehicles. One of the barriers that Metro has a public agency is that they have to adhere to a large set of regulations including the Civil Rights Act, the ADA, amongst others, and face a lot of scrutiny that other corporations are exempt from. However, Uber and Lyft also face their share of scrutiny from both the public and government in regard to issues like fair competition, labor rights, and price surges. As previously discussed, “innovative mobility options have the potential to increase the availability of transportation for many Americans...But they may also leave who are already transportation-disadvantaged further behind, either because they will not be able to take advantage of these new services (making them relatively worse off) or because the rise of these services could reduce some existing services (making them absolutely worse off)” (National

Academies of Sciences, 2016). Partnering with private companies who have the technology, Metro can implement policies and use its funding diminish the barriers that low-income people face in the 'free' market when trying to access services in the sharing economy.

IV. METHODOLOGY

Considering that Los Angeles is one of the nation's cities with the highest income disparities, the city's decision to move towards relying on technology-based apps for an public MicroTransit service has posed difficult challenges in terms of successful implementation. This is largely due to the fact that many Los Angelenos who are dependent on public transportation, do not readily have access to means such as smart phones, which are needed to use technology-based transportation apps (such as Uber and/or Lyft). National statistics have revealed a postiive relationship between smartphone ownership and income (Pew, 2016), however, there is no report of the extent of this relationship specific to LA County. To assess the extent of the disparities within LA Metro's constituency in relation to smartphone ownership, I take a quantitative approach, analyzing cross-tabs and chi-square tests, obtained from Metro's 2016 Customer Satisfation Suvey and by conducting further feasibility analysis leveraging data sets obtained from ARC GIS. In addition to assessment, I created an index of high potential and high need areas to highlight specific areas that are both in need and can benefit from LA's proposed MicroTransit service. This is in line with Metro's Request for Proposal which asks contractors to identify 6 potential service zones to pilot the MicroTransit service, while prioritizing low-income areas.

Analysis of L.A. County Data

It is important to understand the relationship between social demographics, smartphone ownership, and car ownership rates among current Metro Riders in order to equittably invest in

new services. Thus, my primary data analysis is aimed at exploring these variables at the zip code level in Los Angeles County. Considering declining public transit ridership on the Metro system and the cost-burden of private car ownership on low-income populations and the environment as a whole, it is also important to uncover the potential market for this service. Using ARC GIS living atlas layers, I compiled a data set of smartphone ownership rates, median household income, total population, and number of transit stops at the zip code level covering all of Los Angeles . I was then able to run descriptives and correlations on key variables. This was done to analyze the penetration of smartphone ownership across zip codes within LA county, median household income, and transit access.

I created a new dataset by compiling existing data sets from ARC GIS. They include:

1. 2011-2015 ACS Percent of Households with Income Below Poverty Level. (2015). Census Bureau. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk
2. 2017 Median Household Income. (2017). Esri, U.S. Census Bureau. https://demographics7.arcgis.com/arcgis/rest/services/USA_Demographics_and_Boundaries_2017/MapServer
3. 2017 USA Smartphone Ownership. (2017). ArcGIS.http://occidental.maps.arcgis.com/home/item.html?id=e74fc985381c47f0b525bff870466aaa
4. Transit Access. 2017. Esri, HERE. https://atlasmaps.esri.com/arcgis/rest/services/Esri/Transit_Access/MapServer.
5. USA Census Populated Places. (2017). ArcGIS. Esri, TomTom.https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/USA_Census_Populated_Places/FeatureServer

A ‘transit access’ variable was created using data about number of transit stops in a zip code divided by the zip code’s area in square miles. Smartphone ownership percentages were also calculated using the total number of smartphone ownership rate divided by the population size. A present limitation is that this data is analyzed at the zip code level, whereas the data in the

Metro study was at the respondent level. Thus, the relationships found cannot be directly compared. However, there geographical component in the primary data analysis makes sense in determining where a Microtransit Pilot should be located.

Transit Need and Potential Index

In an effort to place into action prioritization of low-income populations in new transit investment, I created Transportation High Need and High Potential index using the variables Percent of Households Under Poverty, Smartphone Ownership Rate, Transit Access, and Total Population. High need was operationalized as zip codes with high poverty rates and low transit access. High potential zip codes were operationalized using high percentages of smartphone ownership penetration and high population size. From a list of 308 zip codes, I focused my analysis on areas that had poverty rates above 15%, which narrowed my scope to 117 zip codes. Then, I created a second filter highlighting the areas with transit access in the lower 60th percentile. This brought my zip code count down to 72. At this point I eliminated zip code 90744 (Wilmington) because it had missing smartphone data. To narrow my focus further, and target lower income areas further, I only looked at the zip codes with poverty rates above 20%. This brought my count to 42.

After narrowing my scope to these 42 zip codes, I created an index using the formula:

$$\frac{\text{Population} * \text{Percentage of Households Under Poverty}^5 * \text{Percentage of Smartphone Owners}^7}{\text{Transit Access}}$$

I made the poverty rate to the power of 5 and smartphone ownership rate to the power of 7 in order to balance out population size. At this point, our sample only households with poverty rates above 20%, so I decided to add more weight to smartphone ownership in order to identify areas that are already more aligned with the needs of this program (smartphone ownership).

Of the 43 zip codes, there were 29 that were adjacent to 2 or more zip codes in this list. This allowed me to identify 8 different possible service zones. These are all of different areas in square miles ranging from 9.85 to 533.49. These service zones encompass cities including Palmdale, Long Beach, and Los Angeles.

Analysis of Metro Survey Data

With the generous assistance from Metro Research, I was able to conduct secondary analysis on their bi-annual "On-Board Customer Satisfaction Survey" from June 2016. This bi-annual survey is conducted, as the title states, on-board of both busses and rail. Although I did not see the survey instrument, I was told that what was reported on their website shows an exhaustive list of the variables asked. On their website, Metro reports percentage frequencies of all variables asked in their survey. I was interested in identifying if there was a relationship between smartphone and income, race, gender, and lastly car ownership.

I asked for the following:

<u>From Metro's On-board Customer Satisfaction Survey June 2016:</u>

Cross-tabs for...	Income	Smartphone/Cell phone ownership
	Race	Smartphone/Cell phone ownership

	Gender	Smartphone /Cell phone ownership

Initially, transit dependability was going to be a new variable I asked them to create. Transit-Dependency was going to be operationalized using the variables income and private automobile. The Federal Transit Administration defines transit dependency as people who are low income, do not own a private vehicle, children and the elderly. However, over 70% of rail riders and over 90% of bus riders earn less than $55,000 household income, which is what the Housing and Urban Development agency recognizes as low income in Los Angeles County. Therefore, to increase variability, we categorized whether or not the respondent had a car available to make the trip as transit-dependent.

Looking at this information to determine who is currently using Metro's busses and trains, what is their level of transit dependability and access, and their level of potential connect-ability to an app-based transit service.

Limitations

Metro does not give out datasets due to the confidentiality of the data, therefore I was limited to ad hoc processed data that their limited staff time allowed them to produce (Appendix 3). This prevented me for exploring the entire data set and limited my insights. A second and very valuable asset of information would have been the data set for the "Unpacking Customer Satisfaction: Customer Satisfaction Survey Results (Summer 2017)" which was an online survey conducted to all of LA County. A particular question that was asked in this survey was, "Have you used a ride-hailing app in the last month?" It is both widely known and contested that ride-hailing apps such as Uber and Lyft do not share their data. Analyzing the results of this question

against demographic variables such as race, gender, and income is an important consideration for future studies. A third limitation of this study is lack of detail in the data provided. Although I received crosstabs requested from the one survey, I did not get counts or chi-square tests for all of cross-tabs. I only received counts and chi-square tests for Smartphone ownership and Income crosstabs.

For the primary data analysis, I had to create a new data set by compiling information from other data sets, the years the data is from varies from 2011-15 to 2017.

Limitations to my new index model is that it does not differentiate types of transit stops in the transit access variable. It only combines the number of transit stops and also reveals areas that are 1/4-mile, 1/2 mile, and 1 km away from the nearest bus, metro or train stop.

V. FINDINGS

Analysis of Metro Survey Data : See Appendix III.

The objective of my secondary data analysis was to learn more about Metro's ridership demographics and their smartphone ownership rates. One of the main features of MicroTransit is that it is a dynamic service. This means that it does not run on a fixed route and like other ride-hail companies, i.e. Uber and Lyft, it naturally depends on internet-connected smartphones. Understanding smartphone ownership rates across different demographics particularly race/ethnicity and income is key in understanding who this program can serve. I am analyzing cross-tabulations from Metro's 2016 On-Board Survey. This survey asked respondents to answer demographic questions including income, gender, and race and whether or not they owned a cellphone, smartphone, or neither. They also asked whether or not the respondent had a car available to make their current trip. Although the Federal Transit Administration defines transit

dependent as somebody who is low-income and/ or does not have a car, the classification of low-income in Los Angeles is now $50,500 (by HUDs standards) which is more than 90% of the people in this survey. This prevents us from having the variability we need to make an analysis. Instead, we cross-tabulated car ownership with key demographics and phone ownership with key demographics. The survey was administered on the bus and on rail and the results are also separated in this analysis.

Bus

Demographics:

The demographic data of Metro bus riders is consistent with the literature. There is an overrepresentation of Latino and African American and of lower income patrons; 66% of bus riders are Latino, 15% are African American, 8% are White, and 7% are Asian or Pacific Islander. Whereas in the county there are 48.5% of Hispanic/Latino and 9.1% of African Americans.

The median total household income for bus riders is $15,620. Over 90% of bus riders earn less than $50,0000. 16% of persons are living in poverty in Los Angeles County. 63% of bus riders live below the Los Angeles County poverty line. These demographics are important to consider because they summarize who despite ridership declines in a car-centric Los Angeles, continues to be Metro patrons.

Car and Smartphone Ownership:

83% of bus riders answered that they did not have a car available to make this trip. The average car ownership in Los Angeles County is 2 cars per household. 51% of bus riders own a smartphone and 27% own a cell phone. Unsurprisingly, income has an effect on smartphone ownership. We found a statistically significant relationship between income and smartphone

ownership at the 99% level. The smartphone ownership rate goes up per income bracket as the income level goes up. For example, 77% of people who earn between $50,000 - $99,999 own a smartphone as opposed to only 39% of people who earn $5,000 - $9,999 and own a smartphone. Of those who earn between $10,000 and $14,999, only 44% own a smartphone.

White bus riders have the highest smartphone ownership rates at 70%. African Americans have a 57% smartphone ownership rate and Latinos have the lowest smartphone ownership rate at 43%. Latinos also have the highest rate (10%) of not owning neither cellphone nor a smartphone. This information points to a racial divide in smartphone ownership amongst current Metro bus riders which demonstrates that amongst current Metro riders, there is a racial divide in who would have access to a MicroTransit service.

In addition to a racial divide, there is also a divide amongst people who did not have a car to make their trip and those who did. Of bus riders who did not have a car available to make this trip, 48% owned a smartphone and 43% owned a cell phone. Of bus riders who did have a car available to make this trip, 65% owned a smartphone and 30% owned a cell phone. As defined by the Federal Transit Administration, lack of private vehicle ownership is also a measure of transit-dependency. The smartphone divide amongst this group means that those who are most transit dependent face a barrier in accessing a service that is smartphone dependent.

Rail

Demographics

Demographics in rail at Metro are consistent with the literature. African Americans are also overrepresented in rail ridership at 17% when only 9% of African Americans make up the Los Angeles County population. 46% of rail riders are Latino, which is close with the county

percentage which is 48.5%. 18% of riders are White, and 12% are Asian or Pacific Islander. The rates for Whites and Asians/Pacific Islanders is almost double of in bus, 8% and 7% respectively.

Over 70% of bus riders earn less than $50,000. The poverty threshold for a family of 4 in United States is $24,563. According to the Census Bureau, 16% of persons are living in poverty in Los Angeles County. 44% of Metro Rail riders live below the Los Angeles poverty line.

Car and Smartphone Ownership:

61% of rail riders had a car available to make this current trip. 61% of rail riders also owned a smart-phone. Similar to the bus results, smartphone ownership rates within income brackets go up as income increases. For example, 82% of people for make $50,000-$99,999 own a smartphone whereas 55% of people who make $5,000 - $9,999 own a smartphone.

Analysis of Los Angeles County Data : See Appendix IV

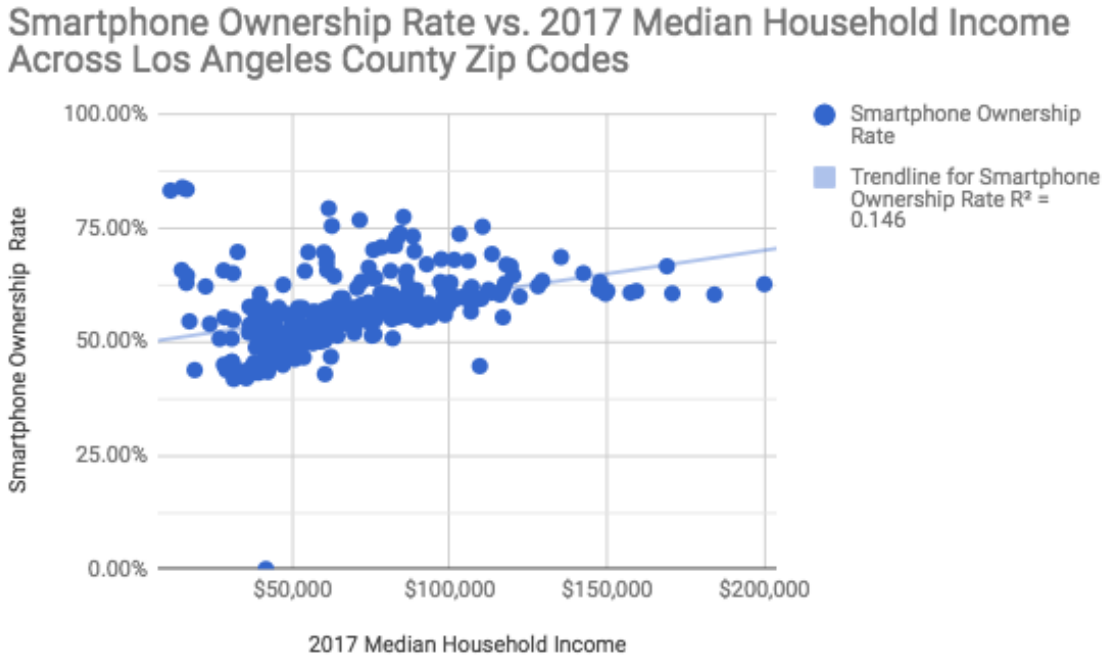
The objective of my primary data analysis is to learn more about what smartphone ownership rates are amongst lower income populations in Los Angeles County. I created a new dataset with 5 variables and an index of zip codes. My secondary data analysis consisted of interpreting processed data I requested from Metro. Another key difference is that my index consists of zip codes whereas Metro's data was at the respondent level. A third difference is that this data is representative of L.A. county residents, transit users or not, whereas Metro's data is only generalizable to Metro riders as the surveys were conducted in transit on busses and on rail.

Smartphone Ownership and Median Household Income

To reiterate, there was a statistically significant relationship between income and smartphone ownership rates amongst Metro riders, and we found a similar relationship across

Los Angeles County zip codes. Across L.A. County zip codes, there is a statistically significant, weak positive relationship between smartphone ownership rates and median household income at the .01 level. 14.6% of the variation in smartphone ownership rates across L.A. county zip codes can be explained by median household income of that zip code (Table 2.1).

Table 2.1

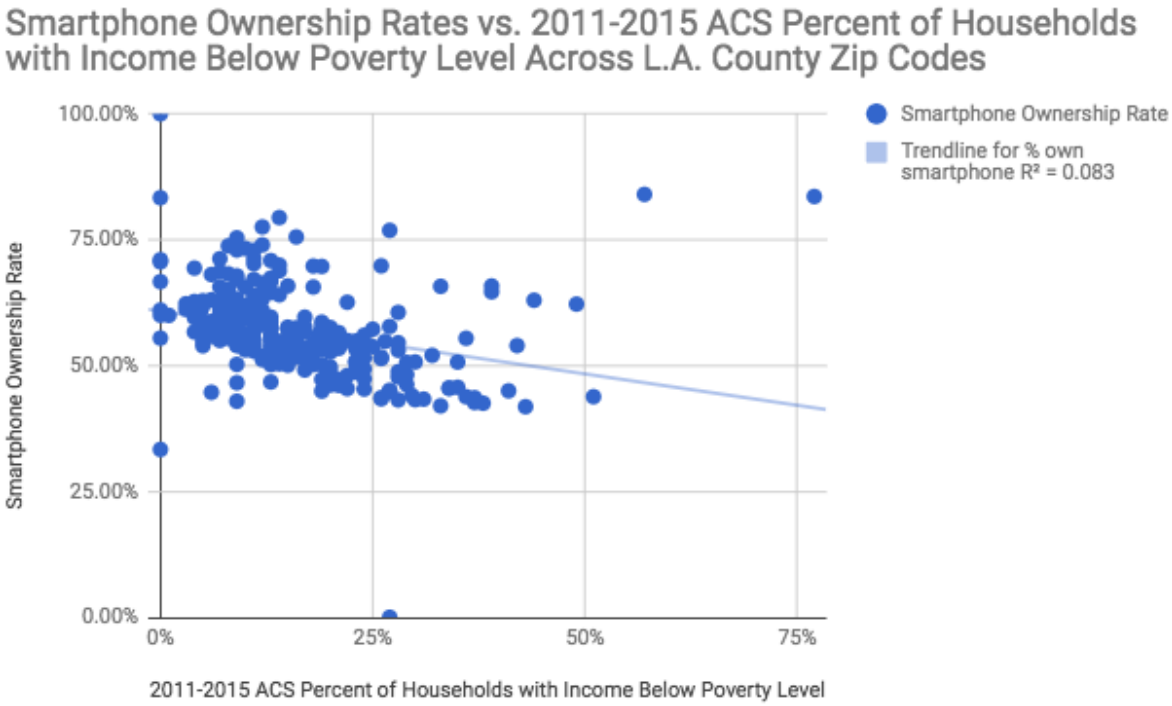


Smartphone Ownership and Percent of Households Under Poverty

Given rapidly changing neighborhoods and housing costs, percentage of households under poverty can be a better index to measure high need areas in Los Angeles County. Still, with this different variable we still find the same trend. Across L.A. County zip codes, there is a statistically significant, very weak negative relationship between smartphone ownership rates and percentage of households under poverty at the .01 level (Table 2.8). 8.3% of the variation in

smartphone ownership rates across L.A. county zip codes can be explained by percentage of households under poverty of that zip code (Table 2.7).

Table 2.7



To understand if there existed meaningful differences between income groups, I initially re-coded Zip Code's 2017 Median Household Income to match the income categories that Metro uses (i.e. $4.999 or less, $5,000 to $9,000, $100,000 or more). Frequencies for median household incomes below $9,999 were nonexistent and very low for the categories up to $24,999. Therefore, I re-coded once more and collapsed all income categories below $24,999 into the lowest category. The frequencies for each income category are still uneven but can be interpreted more meaningful than the first recode.

A one-way Anova demonstrated yet again a statistically significant relationship between smartphone ownership rates and median household incomes. There is a statistically significant

difference between means of 2017 Median Household Income and Smartphone ownership rates across all zip codes at the .001 level. There is a difference between all income brackets except between less than $34,999 and $50,000 - $99,999 (Table 2.2 and Table 2.3).

Transit Stops / Area in Square Miles by 2017 Median Household Income

A second correlation between the ratio of transit stop by area of zip codes and median household income of that zip code showed a statistically significant, weak negative relationship at the .01 level (Table 2.6). 10.2% of the variation in transit stops per square mile across L.A. County zip codes can be explained by median household income of that zip code. As median income goes up, there are less transit stops per area square mile. What may be influencing this relationship is the high number of transit stops in high commercial areas such as Downtown Los Angeles, where median income levels in the periphery are still low. Also, in there are many high-income household in suburban areas with low number of transit stops.

Table 2.4

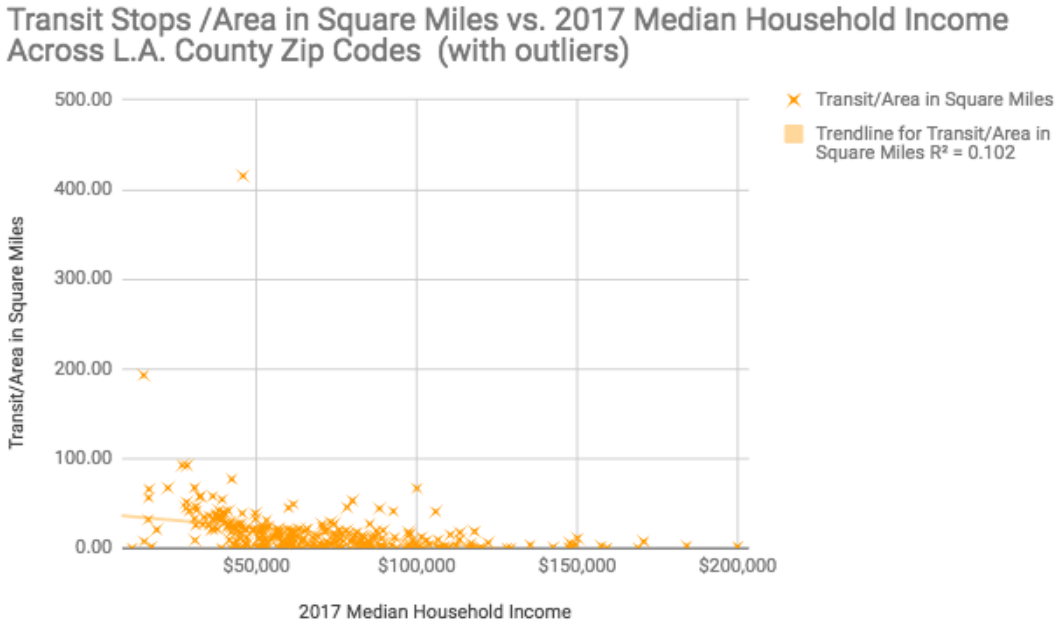
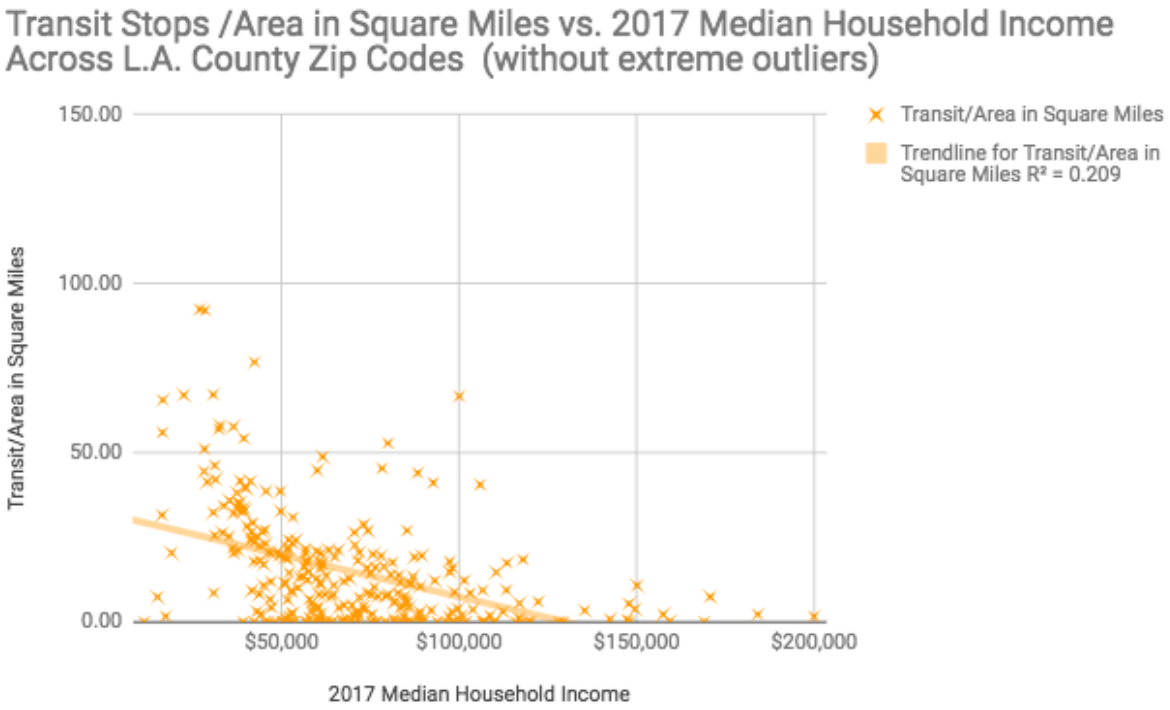


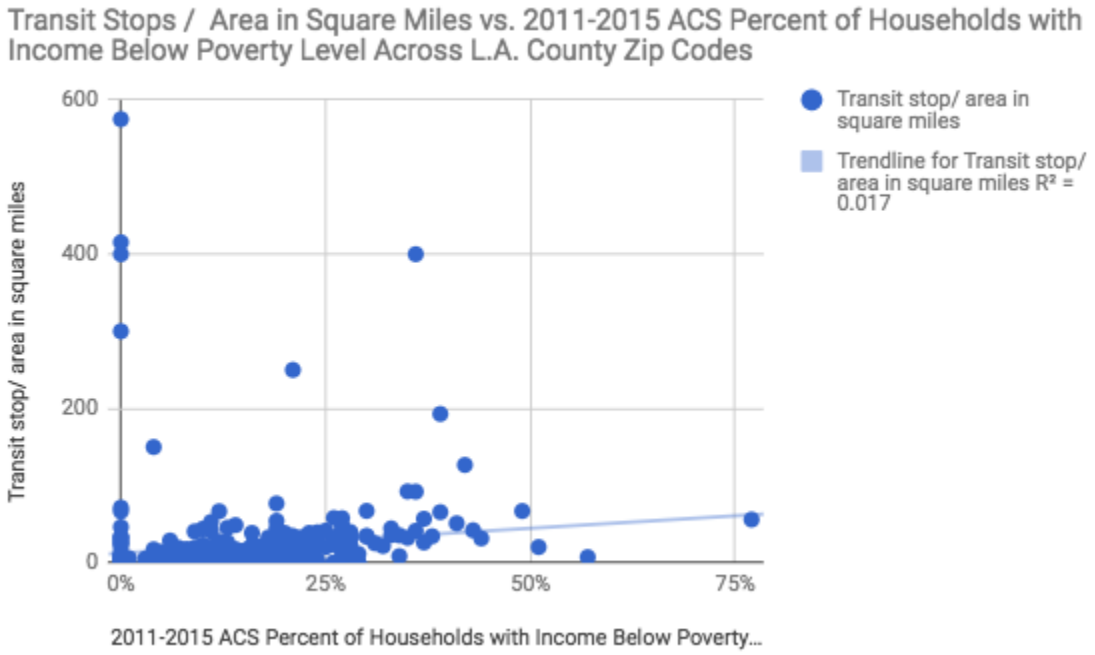
Table 2.5



Transit Stops / Area in Square Miles by Percentage of Households Under Poverty

Across L.A. County zip codes, there is a statistically significant, weak positive relationship between transit stops per area in square miles and percentage of households under poverty at the .01 level. 1.7% of the variation in transit stops per square miles across L.A. county zip codes can be explained by poverty rates in that zip code (Table 2.10). Although statistically significant, the variation that can be explained is very, very low suggesting that percentage of households under poverty is not what determines number of transit stops and that there are other variables missing from this model.

Table 2.9



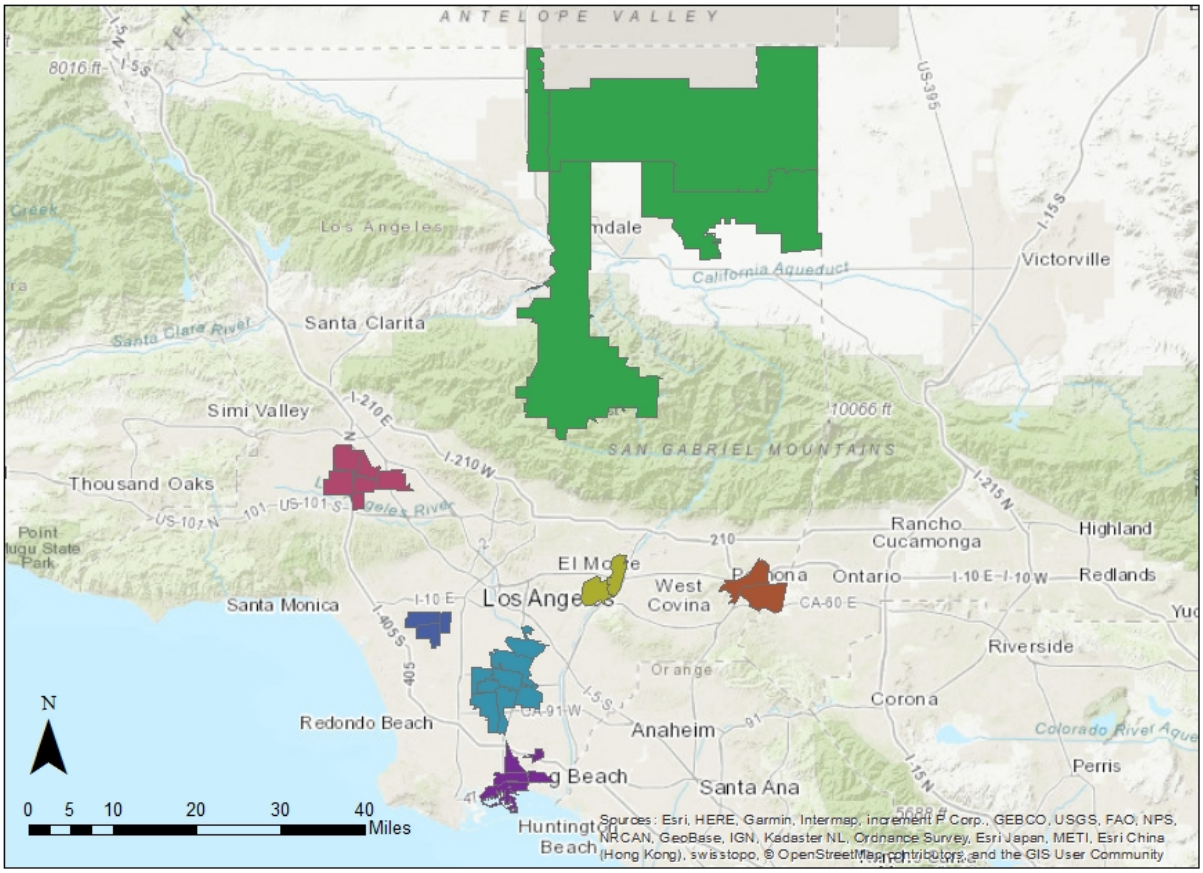
Transit Needs and Potential Index

Metro's Request for Proposals for their MicroTransit Pilot program was issued in the Fall of 2017. The guidelines they issued to vendors include:

The Contractor Team together with LA Metro shall identify up to six service zones ("MTP Zones") with utilization opportunities for short trip types and first/last mile service. MTP Zones should include transit stations and stops as well as places of interest (for example, universities, stadiums, major employers, hospitals, etc.). MTP Zone types could be suburban, urban, university, low-density, high-density areas. Analysis should highlight key corridors and provide justifications for service within each zone. MTP Zones may solve for a specific connection issue.

(MicroTransit Pilot Project, Solicitation Number PS46292, Metro Vendor Portal)

Based on my needs and potential assessment, these are the service zones I identified. There 7 locations are all different sizes in area square miles, but I combined all adjacent zip codes into a zone. All zip codes included have over 43% smartphone ownership rates and over 20% of households under poverty. Metro did not have many outlined guidelines for the service zones. Though not included in this model, selection of service zones should also consider race and ethnicity makeup, type of transit available, and community input in the decision.



Service Zone	Area in Square Miles	Location
Service Zone 1:	533.49	Palmdale-Lancaster
Service Zone 2:	16.10	Long Beach
Service Zone 3:	17.20	Pomona
Service Zone 4:	9.85	South Los Angeles
Service Zone 5:	11.18	El Monte
Service Zone 6:	41.72	Willowbrook-Bell Gardens-Lynwood-South Gate-Paramount-Compton
Service Zone 7:	109.03	Van Nuys-Panorama City-N. Hollywood

VII. CONCLUSION

As L.A. Metro adapts to the ever-changing economy and seeks to serve its constituency in innovative ways, it must prioritize the needs and potential challenges in regard to accessibility of their current ridership, which consists of primarily low-income communities of color. The nature of a dynamically routed Micro-Transit entails the need for a smartphone to access it. I ask, what is the purpose of pushing for a heavily technology reliant service-sector to be embedded in the social fabric of how residents from the city of Los Angeles commute, if the community it sets out to serve does not have the means to partake in the consumer culture of technology-based

transportation apps? National and local county data demonstrated there is a positive relationship between income and smartphone ownership. Individuals with a low-income are less likely to own a smartphone than those with higher incomes, which suggests that an investment in a service that requires a smartphone will be excluding low-income populations, Metro's core ridership.

Despite a significant difference in ownership rates, smartphone ownership rates are still above 40% in all zip codes across L.A. county(2017, USA Smartphone Ownership) This demonstrates promise for a program to succeed, even in the zip codes with the highest poverty rates and lowest transit access in L.A. County. Metro's Micro Transit Program should be launched in lower-income neighborhoods as there lies a large population of Angelenos who are transit dependent. Following Benner and Pastor's Just Growth theory, if this program succeeds in these areas, it is more likely they will also succeed in areas with higher income, and higher smartphone ownership rates (Benner and Pastor, 2012). With Measure M and Micro Transit, Metro has a unique opportunity to leverage technology in advancing transit equity. The high needs, high potential index presented through this research is preliminary. It is a step towards ensuring equity amongst other agency goals, but also setting transit equity for low-income poplations as a main priority. While it is undisputable that technology-enabled companies have revolutionized the market of American consumer populations' expectations for mobility, investing public transportation money into an app-based service can also exacerbatethe disparities in equity and accessibility for low-income populations. Through my preliminary findings, I ague that innovation and equity can coexist. Metro's MicroTransit pilot can serve as a great opportunity to realize such a coexistence.

Bibliography

1. 2011-2015 ACS Percent of Households with Income Below Poverty Level. (2015). Census Bureau. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk
2. 2017 Median Household Income. (2017). Esri, U.S. Census Bureau. https://demographics7.arcgis.com/arcgis/rest/services/USA_Demographics_and_Boundaries_2017/MapServer.
3. 2017 USA Smartphone Ownership. (2017). ArcGIS.http://occidental.maps.arcgis.com/home/item.html?id=e74fc985381c47f0b525bff870466aaa
4. Bernstein, Andrea and N. Soloman. 2014. "Back of the Bus: Mass Transit, Race, and Inequality." Transportation Nation. N.d. Web.
5. Blumenberg, E., Ong, P. 2001. "Cars, Buses, and Jobs: Welfare Participants and Employment Access in Los Angeles." Transportation Research Record 1756: 22–31.
6. BOTEC Analysis Corporation. 2015. *Faster and Cheaper: How Ride-Sourcing Fills a Gap in Low-Income Los Angeles Neighborhoods.* http://botecanalysis.com/portfolio-post/faster-and-cheaper.
7. Delgadillo, Samantha. 2014. "Public Transportation in Los Angeles: Identifying the link between Metro's Services and Social Equity. Senior Comprehensive Project. Urban and Environmental Policy, Occidental College.
8. Federal Highway Administration. *Archived Discussions - Re: Transit Dependent Population*,

collaboration.fhwa.dot.gov/dot/fhwa/ReNepa/Lists/aDiscussions/DispForm.aspx?ID=8891.

9. Gottlieb, Robert et. al. 2005. The Next Los Angeles. Berkeley and Los Angeles: University of California Press. Print.
10. Grengs, J. 2010. "Job Accessibility and the Modal Mismatch in Detroit." Journal of Transport Geography 18 (1): 42–54. Google Scholar, Crossref, ISI
11. Iriondo, Julie. 2017. Younger, Wealthier Households Still Have Greatest Connectivity. U.S. Census Bureau.
12. Iseki, H., & Taylor, B. D. (2010). The Demographics of Public Transit Subsidies: A Case Study of Los Angeles. *UC Berkeley: University of California Transportation Center*. Retrieved from https://escholarship.org/uc/item/9nq526f1
13. John Pucher (1981) Equity in Transit Finance: Distribution of Transit Subsidy Benefits and Costs Among Income Classes, Journal of the American Planning Association, 47:4, 387-407, DOI:10.1080/01944368108976521
14. Kenyon, S., Lyons, G. and Rafferty, J. (2002) Transport and social exclusion: Investigating the possibility of promoting inclusion through virtual mobility. Journal of Transport Geography, 10 (3). pp. 207- 219. ISSN 0966-6923 Available from: http://eprints.uwe.ac.uk/8903
15. Kodransky, M., and G. Lewenstein. 2014. *Connecting Low-Income People to Opportunity with Shared Mobility.* Institute for Transportation and Development Policy and Living Cities
16. Los Angeles Metro. (2018) Fiscal Year 2018 Adopted Budget. https://media.metro.net/about_us/finance/images/fy18_adopted_budget.pdf

17. Martin Wachs (1984) Autos, Transit, and the Sprawl of Los Angeles: The 1920s, Journal of the American Planning Association, 50:3, 297-310, DOI: 10.1080/01944368408976597
18. McNeil, Nathan, Jennifer Dill, John MacArthur, Joseph Broach, Steven Howland. 2017. Breaking Barriers to Bike Share: Insights from Residents of Traditionally Underserved Neighborhoods. NITC-RR-884b. Portland, OR: Transportation Research and Education Center (TREC).
19. Millard-Ball, A., G. Murray, J. ter Schure, C. Fox, and J. Burkhardt. 2005. *TCRP Report 108: Car-Sharing: Where and How It Succeeds.* Transportation Research Board of the National Academies, Washington, D.C.
20. National Academies of Sciences, Engineering, and Medicine. 2016. *Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*. Washington, DC: The National Academies Press. https://doi.org/10.17226/21875.
21. Neighborhood data for social change. 2018. City Rising. KCET. https://www.kcet.org/shows/city-rising/transit-ridership-in-los-angeles-county-is-on-the-decline
22. Renne, J. L., and P. Bennett. 2014. Socioeconomics of Urban Travel: Evidence from the 2009 National Household Travel Survey with Implications for Sustainability. *World Transport Policy & Practice*, Vol. 20, No. 4, pp. 7–27.
23. Shen, Q. 2001. "A Spatial Analysis of Job Openings and Access in a US Metropolitan Area." Journal of the American Planning Association 67 (1): 53–68. Google Scholar, Crossref, ISI

24. Taylor, B., Ong, P. 1995. “Spatial Mismatch or Automobile Mismatch? An Examination of Race, Residence, and Com-muting in U.S. Metropolitan Areas.” Urban Studies 32 (9): 1453–73. Google Scholar, Link, ISI

25. Taylor, B.D. & Morris, E.A. Transportation (2015) 42: 347. https://doi.org/10.1007/s11116-014-9547-0

26. Transit Access. ArcGIS. 2017. .https://atlasmaps.esri.com/arcgis/rest/services/Esri/Transit_Access/MapServer

27. U.S. Department of Transportation. 2016. Transportation Economic Trends. Chapter 6 Household Spending on Transportation, page 71. https://www.bts.gov/sites/bts.dot.gov/files/docs/Transportation_Economic_Trends_2016.pdf

28. USA Census Populated Places. (2017). ArcGIS. Esri, TomTom.https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/USA_Census_Populated_Places/FeatureServer

29. Westervelt, M. et al. 2018. UpRouted: Exploring Microtransit in the United States. Eno Center for Transportation. https://www.enotrans.org/wp-content/uploads/2018/01/UpRouted-18.pdf?x43122

30. Westervelt, Marla, J. Schank,, and E. Huang. 2016. Partnerships with Technology Enabled Mobility Companies: Lessons Learned. http://docs.trb.org/prp/17-05056.pdf/

31. “Pricing.” *Metro Bike Share*, 1 April. 2018, bikeshare.metro.net/pricing/

APPENDIX I. - **DEFINITIONS**

L.A. Metro / Metro

The Los Angeles County Metropolitan Transportation Authority is one of the largest public transportation agencies in the country with a service area of 1,433 square-miles, including i.e. spanning from the San Fernando and San Gabriel Valleys down to the port of Long Beach. It serves 9.6 million people, nearly one-third of California residents (Metro.net, About).

Transportation inequality

Disparity in quality and quantity of services offered between lower income people and higher income people. A prominent example of this is Metro's investment and subsidization of rail which more affluent people ride juxtaposed by the Metro's divestment or lack of investment in the bus system, which many lower-income and transit-dependent people rely on. (Bernstein and Solomon, 2014).

Just Growth

"Just Growth," an economic model developed by Dr. Manuel Pastor (USC) and Dr. Chris Benner (UC Santa Cruz), posits that if investments are targeted towards communities with the fewest resources, the economy will grow stronger for the long haul. Just growth puts equity at the heart of growth — and strategic transportation investments in under resourced communities will make our region more efficient, economically strong, equitable, and sustainable (Investing in Place, 2016).

Transit Equity

Achieving "just growth" requires starting from a shared definition of transportation equity that captures both the responsibility and opportunity for regional agencies to address disparities. An equitable transportation system is one that: 1) Provides equitable access to safe, reliable, and affordable transportation options; 2) Shares the distribution of benefits and burdens of transportation investments; and 3) Includes communities as partners in planning, investment, and implementation processes (Investing in Place, 2016).

Transit-dependent

The Federal Transit Administration defines transit dependent persons as those who are (1) without private transportation, or (2) elderly (over age 65), or (3) youths (under age 18), or 4) below poverty or median income levels as defined by the U.S. Census Bureau. However, in this study, transit-dependent will be narrowed down to two criteria: persons (1) without private transportation or (2) below poverty or median income levels.

Transportation Network Companies

The California Public Utilities Commission, the regulatory agency responsible for regulating essential services, has defined Transportation Network Companies (TNCs) as a company that provides transportation services using an online enabled platform to connect passengers with drivers using their personal vehicles (California Publc Utilities Commision). Two of the most well-known TNCs are Uber and Lyft, although there is a growing number of competitors in the U.S. and abroad.

Micro-Transit

According to the Federal Transit Administration, Micro-transit can be characterized as an IT-enabled private multi-passenger transportation service that serve passengers using dynamically generated routes, and may expect passengers to make their way to and from common pick-up or drop-off points. They provide transit-like service but on a smaller, more flexible scale. Examples of micro-transit providers include services like Bridj, Via, Chariot, or Loup. Micro-transit is not new if we consider other paratransit options offered to people with disabilities; dynamically routed, or crowd sourced routed services. Micro-transit, however, differs from paratransit in that it relies on a sophisticated integration of technology and it operates privately.

APPENDIX II – METRO'S GOALS AND PRIORITIES

Their core business goals are as follows:

- Advance safety and security for our customers, the public and Metro employees.
- Exercise fiscal discipline to ensure financial stability.
- Plan and deliver capital projects on time and on budget while increasing opportunities for small business development and innovation.
- Improve the customer experience and expand access to transportation options
- Increase transit use and ridership.
- Implement an industry-leading state of good repair program.
- Invest in workforce development.
- Promote extraordinary innovation

The goals of Measure M are:

- Ease traffic congestion
- Expand rail and rapid transit system
- Repave local streets, repair potholes, and synchronize signals
- Make public transportation more accessible, convenient, and affordable for seniors, students, and the disabled
- Earthquake-retrofit bridges
- Embrace technology and innovation
- Create jobs, reduce pollution, and generate local economic benefits; increase personal quality time and overall quality of life.
  Provide accountability and transparency; protect and monitor the public's investments through independent audits and oversight.

The goals for MicroTransit are to provide a convenient new travel option in a primarily fixed-route transit network for our current customers while also encouraging new customers to use the transit service. Benefits Metro aims to provide customers with this program include:

- Real-time pick-up and drop-off data
- Demand responsive service
- Managed and reduced overall wait times
- Managed and reduced vehicle time
- Faster trip overall times
- Reduced distance to transit access

- Dynamically to transit access
- Dynamically routed trips
- Reduced routed trips
- Reduced number of transfers
- Improved experience when transferring across metro services
- Point-to-point service to and from Metro’s fixed-route transit system
- Point to point service locally within a predefined service zones
- An alternative to single-occupancy vehicle use for short trips
- Service that meets or exceeds ADA requirements

APPENDIX III – METRO PROCESSED SURVEY DATA FROM JUNE 2016 CUSTOMER SATISFACTION SURVEY : BUS ONLY

Bus Only

Sample Size	
N =	10,546

Do you own a:	Percent
Smart Phone	50%
Cell Phone	41%
Neither	9%
Total	100%

Household's total annual earnings	Percent
Under $5,000	28%
$5,000-$9,999	9%
$10,000-$14,999	10%
$15,000-$19,999	15%
$20,000-$24,999	12%
$25,000-$34,999	7%
$35,000-$49,999	9%
$50,000-$99,999	8%
$100,000 or more	3%
Total	100%

Household's total annual earnings/Do you own a?	Smartphone	Cell Phone	Neither	Total
Under $5,000	38%	51%	11%	100%
$5,000-$9,999	39%	50%	10%	100%
$10,000-$14,999	44%	48%	9%	100%
$15,000-$19,999	56%	38%	7%	100%
$20,000-$24,999	58%	36%	6%	100%
$25,000-$34,999	66%	32%	3%	100%
$35,000-$49,999	70%	27%	3%	100%
$50,000-$99,999	77%	21%	3%	100%
$100,000 or more	81%	14%	5%	100%

Household's total annual earnings?	$$$
Median	$16,218
Mean	$23,138

What is your ethnicity?	Percent
Latino	66%
African American	15%
White	8%
Asian/Pac. Isl.	7%
Native American	1%
Other	4%
Total	100%

What is your ethnicity?/Do you own a?	Smartphone	Cell Phone	Neither	Total
Latino	43%	47%	10%	100%
African American	57%	37%	5%	100%
White	70%	24%	6%	100%
Asian/Pac. Isl.	63%	32%	5%	100%
Native American	62%	29%	10%	100%
Other	61%	28%	11%	100%

What is your gender identity?	Percent
Male	45%
Female	56%
Total	100%

What is your gender identity?/Do you own a?	Smartphone	Cell Phone	Neither	Total
Male	56%	34%	9%	100%
Female	44%	47%	9%	100%

Do you have a car available to make THIS trip?	Percent
Yes	17%
No	83%
Total	100%

Do you have a car available to make THIS trip?/Do you own a?	Smartphone	Cell Phone	Neither	Total
Yes	65%	30%	6%	100%
No	48%	43%	9%	100%

APPENDIX III – METRO PROCESSED SURVEY DATA FROM JUNE 2016 CUSTOMER SATISFACTION SURVEY : RAIL ONLY

Rail Only

Sample Size	
N =	3,909

Do you own a:	Percent
Smart Phone	66%
Cell Phone	29%
Neither	6%
Total	100%

Household's total annual earnings?	Percent
Under $5,000	17%
$5,000-$9,999	6%
$10,000-$14,999	5%
$15,000-$19,999	13%
$20,000-$24,999	11%
$25,000-$34,999	6%
$35,000-$49,999	12%
$50,000-$99,999	19%
$100,000 or more	12%
Total	100%

Household's total annual earnings/Do you own a?	Smartphone	Cell Phone	Neither	Total
Under $5,000	50%	39%	11%	100%
$5,000-$9,999	55%	38%	8%	100%
$10,000-$14,999	57%	36%	8%	100%
$15,000-$19,999	57%	38%	5%	100%
$20,000-$24,999	65%	29%	7%	100%
$25,000-$34,999	67%	29%	4%	100%
$35,000-$49,999	74%	22%	5%	100%
$50,000-$99,999	82%	15%	2%	100%
$100,000 or more	90%	10%	1%	100%

Household's total annual earnings?	$$$
Median	$24,390
Mean	$41,841

What is your ethnicity?	Percent
Latino	46%
African American	17%
White	18%
Asian/Pac. Isl.	12%
Native American	1%
Other	6%
Total	100%

What is your ethnicity?/Do you own a?	Smartphone	Cell Phone	Neither	Total
Latino	60%	33%	8%	100%
African American	60%	35%	5%	100%
White	82%	15%	4%	100%
Asian/Pac. Isl.	73%	24%	3%	100%
Native American	64%	34%	2%	100%
Other	70%	23%	7%	100%

What is your gender identity?	Percent
Male	54%
Female	46%
Total	100%

What is your gender identity?/Do you own a?	Smartphone	Cell Phone	Neither	Total
Male	69%	25%	5%	100%
Female	63%	31%	6%	100%

Do you have a car available to make THIS trip?	Percent
Yes	39%
No	61%
Total	100%

Do you have a car available to make THIS trip?/Do you own a?	Smartphone	Cell Phone	Neither	Total
Yes	77%	20%	3%	100%
No	61%	32%	7%	100%

APPENDIX IV - L.A. COUNTY WIDE SPSS OUTPUT

Table 2.2

ANOVA

% own smartphone

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4263.532	3	1421.177	24.480	.000
Within Groups	16603.363	286	58.054		
Total	20866.894	289			

Table 2.3

Post Hoc Tests

Multiple Comparisons

Dependent Variable: % own smartphone

Tukey HSD

(I) 2017 median income recoded	(J) 2017 median income recoded	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00 less than $34,999	2.00 $35,000-$49,999	7.17571%*	1.83271%	.001	2.4396%	11.9118%
	3.00 $50,000-$99,999	-0.72587%	1.63459%	.971	-4.9500%	3.4982%
	4.00 $100,000 or more	-5.49747%*	1.91631%	.023	-10.4496%	-0.5453%
2.00 $35,000-$49,999	1.00 less than $34,999	-7.17571%*	1.83271%	.001	-11.9118%	-2.4396%
	3.00 $50,000-$99,999	-7.90158%*	1.17745%	.000	-10.9443%	-4.8588%
	4.00 $100,000 or more	-12.6732%*	1.54491%	.000	-16.6655%	-8.6808%
3.00 $50,000-$99,999	1.00 less than $34,999	0.72587%	1.63459%	.971	-3.4982%	4.9500%
	2.00 $35,000-$49,999	7.90158%*	1.17745%	.000	4.8588%	10.9443%
	4.00 $100,000 or more	-4.77160%*	1.30377%	.002	-8.1408%	-1.4024%
4.00 $100,000 or more	1.00 less than $34,999	5.49747%*	1.91631%	.023	0.5453%	10.4496%
	2.00 $35,000-$49,999	12.67318%*	1.54491%	.000	8.6808%	16.6655%
	3.00 $50,000-$99,999	4.77160%*	1.30377%	.002	1.4024%	8.1408%

*. The mean difference is significant at the 0.05 level.

Table 2.6

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
2017 Median Household Income	69539.93	31538.118	290
Transit/Area in Square Miles	16.9825	30.98251	308

Correlations

		2017 Median Household Income	Transit/Area in Square Miles
2017 Median Household Income	Pearson Correlation	1	-.329**
	Sig. (2-tailed)		.000
	N	290	290
Transit/Area in Square Miles	Pearson Correlation	-.329**	1
	Sig. (2-tailed)	.000	
	N	290	308

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2.8

Descriptive Statistics

	Mean	Std. Deviation	N
% own smartphone	56.9046%	8.96375%	296
2011-2015 ACS Percent of Households with Income Below Poverty Level	15.0032%	10.60960%	308

Correlations

		% own smartphone	2011-2015 ACS Percent of Households with Income Below Poverty Level
% own smartphone	Pearson Correlation	1	-.289**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	23702.891	-7914.062
	Covariance	80.349	-26.827
	N	296	296
2011-2015 ACS Percent of Households with Income Below Poverty Level	Pearson Correlation	-.289**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	-7914.062	34556.997
	Covariance	-26.827	112.564
	N	296	308

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2.10

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
2011-2015 ACS Percent of Households with Income Below Poverty Level	15.0032%	10.60960%	308
Transit/Area in Square Miles	16.9825	30.98251	308

Correlations

		2011-2015 ACS Percent of Households with Income Below Poverty Level	Transit/Area in Square Miles
2011-2015 ACS Percent of Households with Income Below Poverty Level	Pearson Correlation	1	.371**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	34556.997	37483.068
	Covariance	112.564	122.095
	N	308	308
Transit/Area in Square Miles	Pearson Correlation	.371**	1
	Sig. (2-tailed)	.000	
	Sum of Squares and Cross-products	37483.068	294694.115
	Covariance	122.095	959.916
	N	308	308

**. Correlation is significant at the 0.01 level (2-tailed).