

# An Equity Analysis of the Scooter Share Program in Seattle, WA

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## **Abstract**

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Micromobility is growing at a rapid pace, and cities have to contend with many issues due to the sudden appearance of shared e-scooters. Much of the current e-scooter research examines safety, however, equity issues are of great importance when considering the potential for accessibility improvements e-scooters can have. This research focuses on the equity analysis of Seattle's shared e-scooter pilot program from September 2020 and June 2021. The City of Seattle established the three Equity Focus Areas (EFA) with a higher concentration of the disadvantaged and/or BIPOC (Black, Indigenous, and People of Color) populations. The scooter vendors are required to allocate 10% of their fleet in EFAs. For the equity analysis, we used the e-scooter trip count data submitted to the Seattle Department of Transportation by vendors. A series of analyses of geographic information systems for scooter deployment and trip destination areas, bicycle infrastructure density, and demographic analysis was used. This study found that bicycle infrastructure does relate to e-scooter usage and that current requirements set by the city do not distribute e-scooters equitably. It finds that the pilot program provides a distribution requirement of 10% of vendor fleets to equity focus areas but does not meet the demand generated by the equity focus areas and does not provide for the equity zones separately (North, Central, South).

This creates an unbalanced distribution towards the Central equity zone compared to the other two equity zones. The research concludes that Seattle needs to improve its requirements for distributions to equity zones and provide a more equitable service by looking at each zone separately. The 10% requirement is not enough, and a more targeted distribution is needed to increase equitable access to shared e-scooter services.

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**Introduction:**

After companies dropped dockless e-scooters onto the streets of cities around the country in 2017, cities have exploded with their growth, staggering their response in policies and usage on their streets. Seattle created a pilot program modeled after its dockless bikeshare program that the city was still in the process of adapting to. Overall, cities needed new policies and regulations quickly to try and create an equitable environment for these dockless e-scooter systems to operate with. To accommodate this new mobility technology, cities had to reassess and build more infrastructure, with safety being of high concern. However, the equity implications that come along with the changes needed to accommodate the implementation of shared e-scooter services are also large. Touted as possible solutions to transportation issues like the “first and last mile”, e-scooters and micromobility solutions such as bikeshare programs are full of potential. However, it will require thoughtful implementation to work in tandem with the larger transportation system and help achieve city goals.

This research examines the approach and considerations that Seattle has taken to create an equitable transportation system using the e-scooter share program. It does so by analyzing aggregated usage data provided by the Seattle Open Data Portal to see where scooters are being used compared to equity requirements set by SDOT for vendor permits. Companies that operate shared e-scooters are referred to as vendors or operators in this research. This paper focuses on the role of e-scooters as a micromobility option and how equitable distribution of services can help address current mobility issues.

With the proliferation of access to smart mobility technology options like e-scooters, cities all around the United States have had challenges adopting policies and regulations to adapt to the changing uses of the roadways. Companies have grown rapidly, and cities have looked at

these devices as possible solutions to the “first/last mile problem” connecting their citizens to more mass transit and increasing accessibility to encourage mode shift. The first and last mile problem is the distance transit riders must travel to and from transit stops to create a “complete trip”, and one that e-scooters are poised to address. But who are these solutions benefiting most? These disruptive transportation modes pose challenges to cities in providing equitable access to services in a variety of ways. And if transportation policies aim to serve the people with the greatest needs, it is important to look at the equity implications that these new technologies and devices come along with.

The purpose of this research is to synthesize the knowledge on the recent adoption of micromobility options in cities through the lens of equity. This study analyzes how Seattle has implemented strategies to meet equity goals and the efficacy of those regulations. It analyzes how and where these devices operate and re-examines if there is a need to change regulation to provide a more equitable service. This could provide information for the city to find opportunities for improvements in providing more accessible and equitable options using micromobility as a solution for things like the first/last mile problem. Using a combination of literature review and GIS Analysis, this study analyzes in what ways Seattle can improve on equity and looks at how data can be used to better support more equitable service.

## Literature Review:

### *Theories of Transportation Equity:*

Equity is a concept that is intrinsic to transportation and especially with transportation planning. The Theory of Justice by John Rawls can be used to frame public goods and infrastructure through an equity lens as Timothy Beatley outlines (Beatley, 1988). Rawls's Two Principles of Justice are:

***First Principle:*** *Each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all.*

***Second Principle:*** *Social and economic inequalities are to be arranged so that they are both (a) to the greatest benefit of the least advantaged, consistent with the just savings principle, and (b) attached to offices and positions open to all under conditions of fair equality of opportunity*

The second principle of providing the greatest benefit to the least advantaged can be applied to transportation infrastructure specifically when trying to provide an equitable public service. This can be taken further to apply towards Michael Walzer's 'Spheres of Justice' theory which Karel Marten continues the conversation when discussing transport good and distributive justice. Marten argues that transport goods need to be considered separately from other key goods as it provides a different service that is linked to an individual's access and freedom (Martens, 2012). He compares transport goods to education or healthcare and states that to understand the social meaning of transport goods, it should be analyzed guided by the benefits related to it and not the burdens it generates. Also, as a good that cannot be conceptualized as one thing but a combination of objects, infrastructure, and less tangible goods, he argues that transport goods should be considered as a separate sphere to distribute to based on its social meaning to a

particular society. Considering the Rawlsian theory of maximizing benefits to the least advantaged, thinking of transport good using a distributive approach makes sense when the social good of transport is valued across the board for whatever service is provided to the public. This paper explores the idea of equitable distribution of resources for transportation goods, specifically the shared micromobility services of e-scooters, using this framework of how infrastructure can support their use providing the most benefit to the least advantaged communities. Creating policies and regulations for equitable transportation systems is necessary with the vital role transportation plays in providing accessibility, mobility, and ultimately choice.

*Focus on E-scooters:*

Early versions of motorized scooters were first created around the early 1900s. Autoped, as they were called, were the first mass-produced motorized scooters in the U.S., and a battery-operated version was made available through Everready Battery Company (Mansky, 2019). During its heyday, these devices and the streets were unregulated and the idea of safety regulations, let alone equity, were yet to be considered. Though like today, with the costs of these devices and their associated costs, these motorized scooters were catered more towards the wealthier class. However, the potential benefits of usage for short-distance trips and recreation were seen early on, with its ability to provide women freedom and mobility like the example of the “Autoped girl” (Mansky, 2019). Though these vehicles provided an innovative means of transportation, they were not profitable, and production was stopped in the 1920s.

The idea and term of micromobility began to emerge around 2017 as new technology enabled the proliferation of shared, dockless vehicles to be introduced to cities by companies around the world and in the States. Horace Dediu is credited for coining the term as startup

companies like Bird, Lime, Lyft, and Jump emerged in cities across the US seemingly overnight after starting in Santa Monica. Piggy backing off the success of the ride-sharing economy created by cars and bikes, e-scooters entered the field and grew at an explosive pace operating in the grey areas of policies on how they could be used. The dockless micromobility options were appearing on city streets for riders to navigate cities in new ways after simply downloading an app.

Technological advancements in the last decade have propelled us forward in an era where we are rethinking how we view the impacts of cars and looking for alternative solutions for carbon consumption. The main enabling technologies that allowed for micromobility include miniature, cheap electric motors, lithium-ion batteries, GPS, smartphones, and market-making software. All these technologies were not initially developed for micromobility, but each plays a key part in creating the infrastructure and potential mobility solutions we are exploring today (Dediu, 2019a). And like how these technologies came together to enable the rise of shared e-scooter technology, the infrastructure and policies that these devices operate in and under can also be adapted to create a more equitable environment that gives better access to everyone.

Promoted as a solution to many transportation issues while creating some of their own, micromobility has rapidly come onto the scene in its dockless form to many city streets. A Populus study measuring equitable access to new mobility found e-scooters have the potential to help cities work toward their transportation equity goals (Clewlow et al., 2018). And as cities look to create policies for e-scooters, they are clarifying terms and definitions and encountering challenges in regulating them. First, the term micromobility itself is used to generally define different modes of transportation like shared docked and dockless bike, electric bike (e-bike), and electric scooter (e-scooter) systems under one umbrella (DuPuis et al., 2019). Horace Dediu

defines it as, "...first and foremost as personal mobility whose utility is to move its occupant. Its purpose is thus to offer maximum freedom of mobility and its minimalism is to do so in the least impactful way" (Dediu, 2019). Although "minimal", the impact of micromobility has been quite large. Cities had to redefine terms like "scooters", which previously referred to motorized scooters used by individuals with mobility needs or disabilities. They also must define where these devices can operate, or even if they are to refer to them as "vehicles" (International Municipal Lawyers Association, 2018). Washington State defined scooters as "Motorized foot scooters" in RCW 46.04.336 referring to "a device with two or three wheels that has handlebars, a floorboard that can be stood upon while riding, and is powered by an internal combustion engine or electric motor that has a maximum speed of no greater than twenty miles per hour on level ground" (RCW 46.04.336, n.d.). Seattle Municipal Code (SMC) identifies e-scooters as motorized foot scooters and regulates them along with the generalized electric personal assistive mobility devices (EPAMDs) which are defined in the SMC as:

- a. "An electric personal assistive mobility device, which is a self-balancing device with two wheels not in tandem designed to transport only one person by an electric propulsion system with an average power of 750 watts (1 horsepower) having a maximum speed on a paved level surface when powered solely by such a propulsion system while ridden by an operator weighing one hundred seventy pounds, of less than 20 miles per hour; or
- b. A self-balancing device with one wheel designed to transport only one person by an electric propulsion system with an average power of 2000 watts (2 2/3 horsepower) having a maximum speed on a paved level surface, when powered solely by such a propulsion system, of less than 20 miles per hour."

(Ord. 124950, § 2, 2015; Ord. 121518 § 1, 2004.)

Another point in terms of definitions surrounding micromobility policy is the need for clarification on whether policies and definitions apply to all devices or only those of the shared system compared to privately owned ones. Also, the many types of form factors of devices or vehicles make regulating micromobility challenging.

For the purposes of this paper, the subject of shared micromobility is focused more on dockless e-scooters. And with the differences in federal, state, and city policies for different definitions or decisions, the variations at the city level are of most interest as cities dictate who are allowed to operate for companies like Lime, Bird, or Jump. The regulations that most states set early on broadly provide guidance for safety, as that is one of the major concerns surrounding shared micromobility. This emphasis on safety has been a dominant area of interest with 169 reports of injuries and even death related to dockless e-scooters between 2017 to 2019 (Yang et al., 2020). Different states have restricted speeds of e-scooters to 15-20 mph and/or set helmet requirements because of these safety concerns. Cities have worked hard to come up with new sets of regulations that can address all concerns that these new mobility options bring.

As city planners, policy makers, and communities adopted and adapted to the growth of micromobility options on the street, different cities created a patchwork of regulations in the early parts of 2019. 44 e-scooter bills were introduced in 26 states, emphasizing different priorities and creating a confusing landscape that e-scooter companies operate in (Glasco, 2020). The National Association of City Transportation Officials (NACTO) created a report for 2018, finding that 38.5 million trips on e-scooters out of 84 million shared micromobility trips total were taken in that year alone (National Association of City Transportation Officials, 2019). And as the dockless technology expanded more rapidly with the introduction of dockless scooters, dockless bikes have largely disappeared across cities in the US, with Seattle being one of the few

exceptions. Along with the physical infrastructure that is needed in cities to accommodate these vehicles, cities must be conscious of the regulation of safety and equity that come along with the deployment of micromobility options in tandem with the terms of data ownership and use (DuPuis et al., 2019).

Cities in the US responded in different ways to the rollout of e-scooters, with some cities enacting bans on e-scooter operations, while some others were allowing them under pilot programs (Glasco, 2020). The National League of Cities (NLC) report “Micromobility in Cities: A History and Policy Overview” details the emergence, opportunities, and challenges of the micromobility solutions in US cities (DuPuis et al., 2019). This report tries to address the concerns of policy makers addressing safety concerns, curb space management, the first and last mile, and pilot programs along with case studies of San Francisco, Washington DC, New York, Kansas City, Norfolk, and Los Angeles. The International Municipal Lawyer’s Association (IMLA) also put out a set of guidelines meant to help cities regulate dockless mobility in 2019 (International Municipal Lawyers Association, 2018). Both overviews mention the need to focus on equity issues in one way or another but are a smaller part of the discussion as safety and use of the right-of-way dominate the conversation.

Generally, the public perception and usage data of micromobility and e-scooters specifically suggest the acceptance of these mobility options as providing a valuable service. A 2020 report looking at surveys on the benefits and barriers of using e-scooters showed that they could potentially fill a niche in providing a fun, fast, and convenient mobility option for transportation in urban settings (Sanders et al., 2020). The report also states the significant barriers to riders as different for race and sex, with women citing safety as one of the major concerns and “African American and Hispanic/Latino non-riders were significantly more likely

to intend to try e-scooters and significantly less likely to be happy with their current transportation options” (Sanders et al., 2020). The demographics of riders who responded to surveys from cities, riders are majority younger, white, male, and wealthier than city and national averages of populations (Johnston et al., 2020). However, these online surveys often struggle with methodological issues of self-selection biases and question design, especially with who has access to it and what the survey wishes to accomplish.

### *Safety and Infrastructure:*

The focus on safety is something that has been a leading area of study for the subject of micromobility, often touching on the need for infrastructure and equity. Information on dangers to lower-income communities or communities of color for bicycling have often shown the inequality they face, like the fact that a 2011 UK study found the risk of injury to children in the lowest social class were 26 times higher for death than compared to their more affluent peers in the highest social class (Christie et al., 2011). This danger translates to the safety of e-scooters as smaller devices that require less road training. Also, the Sanders study found that about 50% of past and occasional riders and even 35% of regular riders said that they worry about being hit or hitting someone while using an e-scooter (Sanders et al., 2020). Thus, the need for infrastructure that provides protected space for the operation of these mobility options.

Where e-scooters can operate in the right-of-way has been a contentious issue concerning safety for both the riders and pedestrians. Cities and states are developing regulations to specify how these new mobility options interact with their streets to certain types of roads or speed-limited areas. Seattle specifically indicates that e-scooters should be ridden in bike lanes or trails when available and that they are not allowed on streets over 25mph, bus lanes, or sidewalks

(Seattle Department of Transportation, 2021b). And from the riders' perspective, a 2021 study on what type of infrastructure riders prefer, route choice modeling showed that riders were willing to travel longer distances to utilize bike lanes, multi-use paths, tertiary roads, and one-way roads (Zhang et al., 2021). This study does show a more specific study area on the Virginia Tech campus but still illustrates the preference of riders for infrastructure that is separated from cars. Then where cities install bicycle infrastructure is something that must be considered if they want to work towards goals of transportation equity and promoting accessibility to shared e-scooter services.

A 2021 study on the inequalities of bicycle facilities by Ferenchak and Marshall assessed 11,010 miles over 10 years since 2010 across 29 cities and found that bicycle facility installation rates were the lowest for People of Color (POC), but bike lane installation was concentrated in lower-income areas (both POC and White) (Ferenchak & Marshall, 2021). Lower-income white communities did receive the most investment in bicycle infrastructure, but the study indicated the need for further research to be done on the demand and distribution. The study showed that what came along with bicycle facility installation was an increase in income rather than an increase in White population. However, the fact that income increases have the strongest relationship with increases in sharrows and trails was a point of interest in terms of equity with the way that either bike facilities are leading to socioeconomic/demographics (SED) changes or planners are prioritizing areas with changing SED characteristics. In the book "Bike Lanes are White Lanes" Hoffman qualifies that "bicycle infrastructure itself is not a form of gentrification because there are numerous examples of bicycle amenities that have not significantly altered the makeup of their surroundings" (Hoffmann, 2017). However, these types of infrastructure are still largely seen by the public as signs of a changing neighborhood. Policy makers must work with

neighborhoods to make sure that bicycle lanes do not just become another example of cities “prioritizing the needs of upwardly mobile white people” (Hoffmann, 2017). Planners and cities must still make investments in such infrastructure to push the bill forward on creating a more equitable transportation system that is safe and accessible for not only bicycles but new micromobility options like e-scoots. There is an opportunity to provide access to the benefits from micromobility solutions and e-scooters in communities of color or lower-income areas. And with its potential as a first and last mile solution to connect riders to transit or provide short to medium-distance trips that would reduce automotive travel, e-scooters could have both positive and negative effects in providing equitable service to cities and the public.

#### *Positive and Negative Effects of E-Scooters:*

The potential for use that e-scooters have with safer and accessible infrastructure in neighborhoods of color or lower-income areas can be emphasized by the study by Sanders. It showed how e-scooters are largely being used as a means of transportation to/from activities and work that replaced some driving trips, which a survey in Portland also found to be true (Portland Bureau of Transportation, 2019; Sanders et al., 2020). With better infrastructure providing safer places to operate micromobility options, cities stand to gain an even greater number of riders, with women largely citing safety as a barrier to using e-scooters in the 2020 paper (Sanders et al., 2020). The benefits that e-scooters can bring are as part of a multimodal model for city transportation systems. With short distance trips under 3 miles making up around 48% of all trips in 25 major cities in the U.S., e-scooters as micromobility solutions provide a fast, efficient alternative to driving (Reed & INRIX, 2019). Aimed at providing the current underserved first and last mile solution for public transit riders, this micromobility solution help supplement mass

transit services as one type of approach for cities in providing “complete” trips (Mohiuddin, 2021). The INRIX study states that the success of e-scooters as a micromobility option is predicated on cities having a clear understanding of where micromobility is best positioned to offset vehicle travel & cities having necessary tolls to engage with and manage these services (Reed & INRIX, 2019). As private automobiles are the current travel mode that makes up the majority of short-distance trips under 2-3 miles, e-scooters provide a new alternative option that can compete and also help decrease parking times (Scott Smith & Schwieterman, 2018). This aim toward providing short-distance trips that are a low share of transit trips does not replace transit trips and creates cost-effective solutions that are incentivized by getting riders cheaper alternatives and minimizing travel times by eliminating parking time and costs (Scott Smith & Schwieterman, 2018). A 2018 study also revealed the increase in access to jobs and employment centers from 16-37% in some areas of Chicago on top of access by walking and transit (Scott Smith & Schwieterman, 2018). The promoted environmental benefits of e-scooters are, however, debatable and depend on the practices and policies of companies and cities when considering the full life cycle of these devices. Hollingsworth et al. conducted a study looking into the environmental impacts of these new mobility solutions finding that e-scooters would need to be in use for two years to decrease average life cycle emissions, while also finding that the redistribution of the devices can largely impact the emission of e-scooter share systems as a whole (Hollingsworth et al., 2019). Having policies in place that can help increase the life cycles of scooters on the street and requiring low emission or more efficient vehicles to be used for the redistribution of these devices could help if cities want to achieve goals of lowering emissions using these mobility options.

The role that these dockless shared e-scooter systems can perform in the larger transportation system suggests that use in conjunction with transit systems sees the highest potential for benefit. A report in 2017 on the demographics of transit ridership shows that 33% of riders earn incomes less than \$24,999 (under the federal poverty line) and 60% of riders are from communities of color (Clark, 2017). And so, investments into a system that can support and benefit transit systems provide ways to address things like first and last mile issues will help create a more equitable transportation system (Clark, 2017). A report in 2020 found that 63% of the e-scooter riders they had surveyed had combined their trips with public transit, giving credence to the notion that they have the potential to address the first and last mile problem (Holm Møller et al., 2020). This in turn can increase access to services and opportunities and potentially change mobility patterns (Holm Møller et al., 2020). As Oeschger et al. indicate in their study, micromobility systems and public transport should be seen “as two interconnected aspects of the same system, in order to fully harness the potential and the synergies of the two modes” (Oeschger et al., 2020). The adoption of planning practices like transit-oriented development (TOD) and emphasis on creating equitable transit connectivity through investments has been an improvement, but solutions are still needed to fill the gaps in making sure communities can take full advantage of what these cities and companies provide. Cities and companies often face challenges in making sure that these potential benefits can be distributed equitably, especially in this digital age. A 2019 Pew Research Study shows that 29% of people in households making below \$30,000 a year do not have access to a smartphone and 44% do not have home broadband service (M. Anderson & Kumar, 2019). And as a service that is primarily operated using app-based technology on smartphones, the micromobility solutions are not convenient for a large number of people (M. Anderson & Kumar, 2019). With this study finding

that lower-income Americans adopt technology slower and have less access to the services associated with this, those who make the least have yet another barrier between them and access to services. These app-based services often rely on banking services to pay for the services they provide, and as an article assessing the barriers to equity in smart mobility systems indicates, digital and banking access is a serious issue for many communities of color and lower-income (Golub et al., 2019). With the potential for cities to move to a larger Mobility as a Service (MaaS) solution that integrates all the different parts of transportation systems in cities into a single service accessible on-demand, this digital divide could create a larger issue of equity in the future (Smith & Hensher, 2020). Some cities have worked with companies to offer solutions through creating alternative payment options like “PayNearMe” that allow for riders a cash payment workaround. However, with the appeal and benefits of e-scooters being that they are fast, convenient, and work as a connecting link, these benefits seem to be lost by needing to add this extra step.

Along with the benefits that these micromobility solutions have brought to cities, cities have had to contend with the problems they have caused. Some of the problems have to do with how these systems were brought to cities with the approach of “ask for forgiveness, not permission”, leaving cities in positions where they had to implement new policies quickly to keep up with the explosive growth of these companies overnight. However, the fact of the matter is that e-scooters do bring along concerns of how space is used in the right of way as well as issues of accessibility with unclear parking policies in many cities leaving them blocking sidewalks (Johnston et al., 2020). Another issue that comes along with the proliferation of micromobility devices on the streets of certain neighborhoods is the issue of bicycle infrastructure discussed before it can be seen as a sign of gentrification. But just like bike lanes,

e-scooters have come to be viewed as signs of neighborhood change that drives out communities of color and lower-income residents (McCarty Carino, 2018). Its association and image with the tech industry along with its ridership demographics from few city surveys showing that about 60-70% of its riders were white males and about 50% making \$75,000 a year or more make for the case that it is a service catering towards a wealthier white population (Johnston et al., 2020; Portland Bureau of Transportation, 2019). However, similar to how bicycle infrastructure investment did not correlate gentrification, the e-scooters have shown favorable adoption rates compared to even bikeshare devices in communities of color, signifying the potential for the benefits that are associated with their integration in our transportation systems to spread (Clewlow et al., 2018). It is up to city planners and companies to work together in creating a solution that can facilitate usage in a way that helps communities grow without creating more disparity or inequity.

Technology has enabled planners and companies to gather more and more data to see not only things like where and how people are moving but use that information to find opportunities for meeting the needs of different communities or potentially changing behavior patterns. With the abundance of data, standardization towards things like Mobility Data Specification (MDS) allows for cities to be able to evaluate trip data and real-time information to better understand trends or analyze usage of different mobility options (A. Anderson, 2020; Clewlow et al., 2018). Using this information, cities can better evaluate where to direct investments to help reach transportation equity goals with better evidence and empirical data. However, with this much data, cities run into the issue of data privacy and must take proper precautions in protecting personally identifiable information (PII) through steps like aggregating data (A. Anderson, 2020). Even though the data that these mobility services can provide is important, cities must

look beyond what is provided to completely assess the impacts of these new mobility options (Clewlow et al., 2018).

*Current Literature on Equity:*

Current literature on dockless micromobility systems and shared e-scooters show that regulation of e-scooters has mostly been focused on safety and the prevention of injuries with equity considerations coming secondary. Many regulations and safety standards for e-scooters are derived from how cities create frameworks for dockless bikeshare systems, but the utilization and impacts of e-scooters are significantly different. Compared to bikeshare and e-bikes, shared e-scooters are smaller but can often go just as fast with studies showing high numbers of injuries with low helmet usage (Kobayashi et al., 2019). Understandably, this type of data drives cities to try to address pressing safety concerns quickly. But it is also important to create an equitable framework for companies to operate in cities that can address these concerns, with the significant impact that they have in shaping mobility and access. Cities are trying to address the structural racism that their transportation systems played role in establishing, and new mobility solutions like e-scooters could become tools in doing so. Strategies that cities are using to provide equitable access to e-scooters include policies for equitable distribution, affordability and discounted pricing plans, alternative payment options, alternative methods of activation, and community engagement (Johnston et al., 2020). A study by the National Bureau of Economic Research (NBER) found that commute times were a significant factor in determining upward mobility, showing how these devices can create a more equitable transportation system (Chetty et al., 2018). However, like the NLC report acknowledges, “the dockless nature of these services may lead to unequal distribution of scooters and bikes throughout the cities” (DuPuis et al.,

2019). Cities must keep their goals clear and keep companies accountable to build up a system that equitably works for its people.

The infrastructure and transportation system of Seattle has a history of having a part or causing inequitable landscapes. Construction of Interstate 5 (I-5) required the demolition and splitting of many communities, often majority communities of color and/or lower-income (Argerious, 2018). Seattle today is facing growing income and racial disparity, with a growing tech industry and increasing housing and living costs. The disparities translate into infrastructure conditions and access for communities of color and lower-income that the city has been trying to address. Washington State has been working towards shifting commuters away from single-occupancy vehicles (SOV), passing its Commute Trip Reduction (CTR) law in 1991 to try and reduce air pollution, congestion, and fuel consumption (King County, 2018). Under the CTR law, employers are required to reduce (SOV) trips in Urban Growth Areas (UGA), with the ability for WSDOT to withhold funding from transportation projects if SOV goals are unmet (Washington State Legislature, 1996). The 2006 “CTR Efficiency Act” updated the 1991 law to create goals of reducing SOV trips to major work areas by 2011 by 10% and led to a Seattle Municipal Code (SMC) update in 2008 that required workplaces with over 100 employees needing to make efforts of reducing vehicle miles traveled (VMT) and SOV trips along with employee commute surveys every 2 years (City of Seattle, 2008). King County also launched its Equity and Social Justice Initiative (ESJ) Initiative in 2008 that led to the establishment of the King County Office of Equity and Social Justice (OESJ) (Caldbeck, 2016). King County codified the language “fair and just” in 2010 and created strategic plans to achieve its goals of advancing “pro-equity policies, systems, and practices in six areas of governance: leadership, operations, and services; plans, policies and budgets; workforce and workplace; community partnerships;

communication and education; and facility and system improvements”, with one of their guiding principles to “pledge to eliminate inequities and promote fairness and opportunity for all.”

(Caldbick, 2016; King County Office of Equity and Social Justice, 2016). The King County Ordinance 16948 stated the need to provide transportation that provides everyone with safe, efficient, affordable, convenient, and reliable mobility options including public transit, walking, carpooling, and biking (Beatty & Foster, 2015). They also established 14 determinants of equity which were defined as the social, environmental, and economic factors which determine equity outcomes, or the level of equity in King County. These determinants are equity of city practices, early childhood development, education, jobs and job training, health and human services, food systems, parks and natural resources, built environment and natural environment, transportation, community economic development, neighborhoods, housing, community and public safety, and law and justice (Beatty & Foster, 2015). Focusing on the measurable determinants of equity, the King County project for identifying indicators to establish a baseline of equity in King County used 13 of those 14 determinants (all except equity of county city practices) to find areas in which they can reduce disparities in the county and help establish goals and priorities. The indicators for the transportation determinant that were studied were:

- Metro Transit Rider Satisfaction with Safety
- Metro Transit Passenger Crowding & Schedule Reliability
- Reliance on Metro Transit
- Proximity to Metro Transit
- Metro Transit On-Time Performance
- Walk Score
- Bike Score
- Transit Score
- Metro Transit Reduced Fare Utilization
- Metro Transit Low-Income Fare Utilization
- Transportation Cost-Burden

These indicators fall under the categories of measuring that the transportation system is safe, efficient/convenient/reliable, and affordable. And the project found that 76% of households in low-income census tracts and 67% of households in minority census tracts were within a quarter-mile of a transit stop, compared to 65% of all households in the county (Beatty & Foster, 2015). With a focus on the goal of transit equity, and the study showing that low-income and minority riders are more likely to depend on Metro for their transportation needs, e-scooters and micromobility solutions can play a huge part in connecting and giving better access to meet the county goal for transportation to connect people with opportunities. By defining structural racism as “the interplay of policies, practices, programs and systems of multiple institutions which leads to adverse outcomes and conditions for communities of color compared to white communities, that occurs within the context of racialized historical and cultural conditions,” the OESJ looks to tackle systemic issues of inequality and set forth a strategic plan for 2016-2022 (King County Office of Equity and Social Justice, 2016). This plan identifies four main strategies for the county to invest resources to tackle problems upstream and where needs are greatest, invest with community partnerships, invest in county employees, and does so with accountable and transparent leadership (Caldbeck, 2016).

As much of public transit in Seattle is managed at the county or regional level through King County Metro, Community Transit, or Sound Transit, these regulations and efforts worked to create equity at a larger transportation system level and the Seattle Department of Transportation (SDOT) created its own measures to work in tandem to guide transportation equity. The growth of new mobility options created a need for SDOT to come up with its own “New Mobility Playbook” in 2017 that works in conjunction with its Bicycle Master Plan,

Pedestrian Master Plan, and Transit Mast Plan (Seattle Department of Transportation, 2017b).

This document outlines five plays:

1. Ensure new mobility delivers a fair and just transportation system for all
2. Enable safer, more active, and people-first uses of public right of way
3. Reorganize and retool SDOT to manage innovation and data
4. Build new information and data infrastructure so new services and “plug-and-play”
5. Anticipate, adapt to, and leverage innovative and disruptive transportation technologies

SDOT focuses on new transportation technologies in a way that can help shape a better transportation system that puts people first using with the changing landscape, acknowledging misguided decisions and plans in the last century (Seattle Department of Transportation, 2017b). Seattle is trying to shift away from being a car-centric city and prioritize its vision of being a city for people through “creating a safe, interconnected, vibrant, affordable, and innovative city for all” (Seattle Department of Transportation, 2017b). Seattle is in a unique position as a city with growing transit ridership and looks at public transit as the backbone of its transportation system in order to fulfill its vision for the city and accommodate for its rapidly increasing population. Safety and reliability can assist Seattle’s transportation system allow for more options and increase affordability through moving away from the reliance on cars, with data showing that owning a car in King County adds about \$12,500 a year to a household’s budget (Seattle Department of Transportation, 2017b). Another issue of equity that these new mobility technologies bring is on the technology side of things. Seattle conducted a Technology Access and Adoption study in 2018 showing that 75% of residents at or below the federal poverty level have internet access, with 79% stating that they access the internet on their smartphone or mobile devices (City of Seattle Information Technology Department, 2018). And with banking services

being the backbone for payment methods for micromobility services, it is important to think about access to payment systems that also allow people who do not have banking services. The potential that new mobility options bring makes for the need to further integrate the layers of assistance from technology, real-time navigation, mobility services, mobility infrastructure, transit stations, and connections in Seattle.

**Methods:**

This study uses GIS analysis to examine the equity of regulations surrounding shared e-scooters to identify necessary changes or gaps in policy that cities should try to address to fit the city's goals for the future. With much of the micromobility regulation adapting docked and dockless bike share legislation to accommodate for e-scooters, explicit equity requirements for underserved neighborhoods are already included in many plans. And with known issues of difficulties of fleet management for dockless mobility options and recommendations by organizations like the NLC for fleet balancing for equitable distribution, different cities have responded differently. This study critically examines the regulations set by the City of Seattle through its New Mobility Program and Scooter Share division to address issues of equity in micromobility. The research takes a quantitative approach by using GIS analysis of Shared Mobility Aggregated Trips that each vendor shares with the city to analyze the distribution of where trips occur, how equity distribution requirements affect usage and explore how to provide a more equitable service.

As an early adopter of dockless micromobility options, Seattle is in a unique position to create a shared e-scooter program that includes equity provisions using the experience and

framework set up previously. (King County, 2016). Seattle, Washington is a focus of this study due to the city's approach to addressing equity concerns at a higher level utilizing a Racial Equity Toolkit under the vision of Seattle's Race and Social Justice Initiative aimed at ending individual, institutional, and structural racism (King County, 2016). Also, the micromobility program in Seattle works to complement the transportation plans and the e-scooter pilot program was able to benefit from the unique position of Seattle being an early adopter of the dockless bikeshare program in the U.S. As one of a few cities that maintained its shared dockless bicycle programs along with e-scooter programs, the micromobility system in Seattle aims to provide multi-modal options that work in conjunction with its public transportation system to tackle citywide transportation and equity goals. And by creating a framework of policies and regulations, Seattle's approach to addressing new mobility options as stated in the New Mobility Playbook allows for the ability of services to "plug and play" into its information and data infrastructure as well as "anticipate, adapt to, and leverage innovative transportation technologies" (Seattle Department of Transportation, 2017b).

Of the six areas of equitable distribution, affordability, pricing plans, payment options, activation methods, and community engagement that Karen Johnston et. al. outline, this study focuses on the distribution aspect of equity (Johnston et al., 2020). To address the affordability, pricing plan, and payment options, the SDOT scooter share permit application establishes an equitable pricing structure by requiring vendors to include "Reduced-Fare Program Element(s)" as pricing is set by vendors (Seattle Department of Transportation, 2021a):

***04.2 Reduced-Fare Program Element.***

*(a) The Vendor shall establish a reduced-fare program element. At a minimum, all persons who qualify for one or more of the following programs shall be eligible for the Vendor's reduced-fare program element:*

- 1. the ORCA Lift reduced-fare program;*

2. *the Regional Reduced Fare Permit (RRFP) program;*
3. *Seattle Public Utility Discount Program;*
4. *Seattle City Light Discount Program;*
5. *Seattle Housing Authority;*
6. *Apple Health (Medicaid);*
7. *Seattle Housing Authority Senior Housing program;*
8. *Seattle Housing Authority Low-income Public Housing;*
9. *Washington Basic Food program;*
10. *Washington State Food Assistant program*

*(b) Unless the Vendor proposes and the Program Manager approves a different price structure, the Vendor shall charge eligible riders no more than \$1.50 per hour*

*(c) The Vendor shall bear any transaction costs associated with a rider's use of the reduced-fare payment method.*

*(d) The Vendor shall prominently display the reduced-fare program information within the smartphone application via pop-up on user's first use, as well as prominently place the link within the smartphone application navigation. The Program Manager shall approve Vendor's display.*

Future studies could further investigate these elements to help provide a more equitable framework for e-scooter usage. For this study, the data on usage focused on location and trip count statistics to analyze where and how usage could be improved.

The GIS analysis uses data provided through Seattle's Open Data Portal showing Shared Mobility Aggregated Trips. Aggregated data is used by SDOT for the trip counts to prevent the disclosure of potentially identifiable information. This data shows quarterly counts of where scooters start and end in Seattle. The start and end coordinates are truncated to 0.01 degrees latitude and longitude since January 2019, along with timestamps that are grouped into five dayparts (Seattle Department of Transportation, 2021b). The time-of-day categories are separated by AM Peak (7-9AM), PM Peak (4-7PM), Mid-Day, Evening, and Weekend. Vendors are required to provide this trip data to SDOT as part of the permit requirements. In compliance with SDOT's disclosure control policy, this aggregated dataset is processed and shows trip information that occurs within an approximate area of 0.17 square miles (2700 ft by 1800 ft)

centered on the truncated coordinates (Seattle Department of Transportation, 2020). This aggregated data allows for approximate information that can show general statistics by area while maintaining the privacy of individual user data. GIS is used to analyze the counts and locations of e-scooter rides, and the distribution of devices in Seattle’s Equity Focus Areas. SDOT’s Scooter Share Permit Requirements outlines an Environmental Justice Communities (EJC) Areas of Focus that require vendors to distribute a minimum of 10% of their fleet to provide an equitable distribution to all areas of need (Figure 1) (Seattle Department of Transportation, 2021a). Vendors charge, change our batteries, rebalance, and redistribute devices regularly as part of their operations, and meeting the 10% requirement is part of those operations.

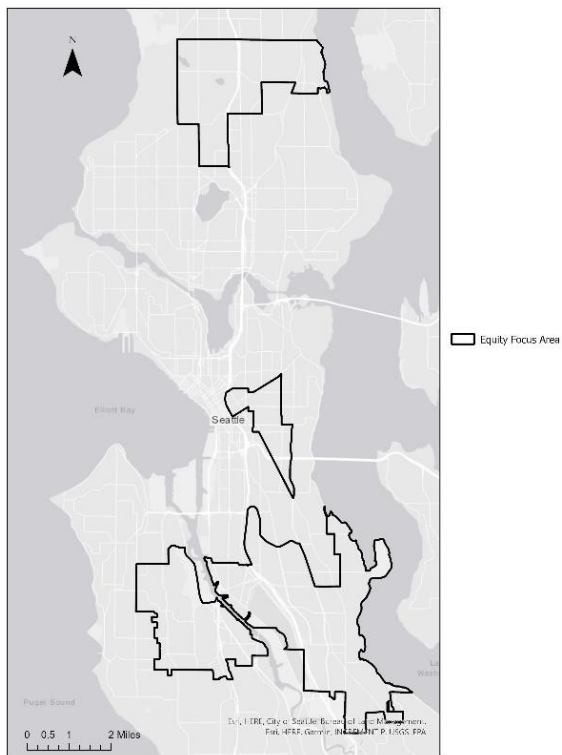


Figure 2: Equity Focus Area  
Source: Author

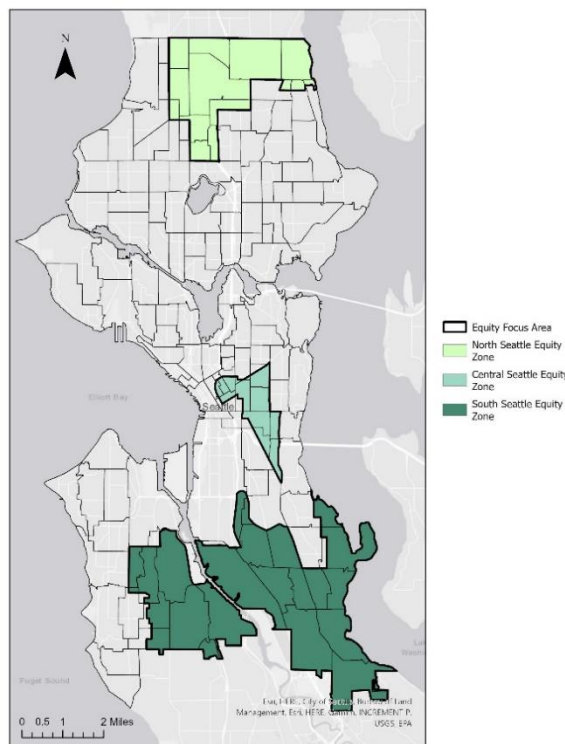


Figure 1: Equity Zones  
Source: Author

The EJC Areas of Focus are analyzed both as a whole and individually and classified by the three subregional areas: North Seattle, Central Seattle, and South Seattle. For the purposes of this study, the Environmental Justice Communities Areas of Focus is referred to as the Equity Focus Areas and separately referred to as zones (Figure 2). A comparison is done to look at the counts of devices in the equity focus area to all of Seattle, and a comparison count of devices between the different zones. The GIS analysis also examines the distribution of bicycle infrastructure in the equity zones, as well as the concentration of trip starts and stops near higher concentration of infrastructure availability. Bicycle infrastructure was used as a measure due to its potential for increasing e-scooter ridership as indicated by previous literature on barriers to usage and rider preferences (Sanders et al., 2020; Zhang et al., 2021). Both current and planned bicycle infrastructure were considered to see if city plans would provide more access in designated equity zones. For the analysis of the density of bicycle facilities, the City of Seattle's GeoData Portal provided GIS layers that typify bicycle infrastructure into five different types: in-street major separation; in-street minor separation; multi-use trail; neighborhood greenway; and sharrows (Figures 3, 4, 5, 6, and 7) (City of Seattle, 2018a). Sharrows makeup about one-third of the city's bicycle infrastructure but provide the least safety for riders, which can be a determining factor for the choice of mobility options when concerning e-scooter usage (Sanders et al., 2020). The methodology for calculating bicycle infrastructure density followed Bryanna Osmonson's graduate thesis on "An Equity Analysis of Bicycle Infrastructure Around Light Rail Stations in Seattle, WA," which was to take bicycle lane miles and divide it by the square miles of each block group (Osmonson, 2017). This was adapted to calculate bicycle infrastructure density (BID) for the census tracts as the tract level information is more compatible with the coordinate

information which is available for the scooter data. A regression analysis is then done to calculate the correlation of BID and trip counts.

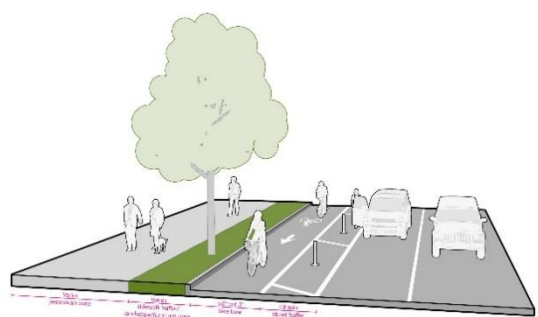


Figure 4: In-Street, Major Separation Bike Lane  
Source: (Seattle Department of Transportation, 2017c)



Figure 3: In-street, Minor Separation Bike Lane  
Source: (Seattle Department of Transportation, 2017a)



Figure 5: Neighborhood Greenway  
Source: (Olsen, 2021)



Figure 6: Multi-Use Trail  
Source: (Hirsch, 2018)

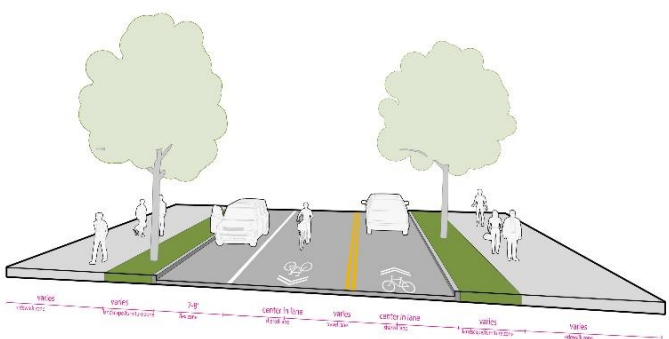


Figure 7: Sharrows  
Source: (Seattle Department of Transportation, 2017d)

This study also critically examines the 10% deployment requirement in equity zones (Figure 1) that e-scooter vendors are required to meet by permit documentation. The concentration and distribution of devices between the different areas of concern are used as well as a comparison between the area defined by SDOT and Census data from the ACS data at the Census Tract level showing where concentrations of minorities and households below the poverty line are. This is also compared to Seattle's own Racial and Social Equity Index (RSEI) calculations at the Census Tract level. These are targeted to inform how well the racial equity zones are equitably providing services to underserved areas of Seattle and meeting mobility needs. The Census Tract shapefiles and profiles are from the Seattle Open Data Portal, showing 5-year (2013-2017) ACS data. This study adopts the five groupings outlined in the RSEI for lowest, second-lowest, middle, second highest, and highest disadvantaged areas to account for indexes including race, socioeconomic, and health disadvantages (City of Seattle, 2021).

**Data:**

Ridership and vehicle data gathered from Seattle's Open Data Portal showing aggregated trips, along with the data shown on the SDOT's New Mobility Program Page for Scooter Share, show the rise of usage and deployment of e-scooters on Seattle's streets between 2020 and 2021 (Seattle Department of Transportation, 2017b). SDOT has developed the Scooter Share pilot program under the New Mobility Program division to address the six major areas for equity that Johnston et. al. outline: *equitable distribution, affordability, pricing plans, payment options, activation methods, and community engagement* (Johnston et al., 2020). The equity focus area defined in the permit application is utilized to quantify and measure how equitable the service is and how well SDOT is doing to meet transportation goals. All five areas for equity are addressed

in the Scooter Share Permit Requirement document under Section O7 “Equity”, with O7.4(a) stating that:

*“The Vendors shall develop and implement an equity programming plan in accordance with Requirement G10 and Appendix F. Generally, the Vendor’s plan shall describe how the Vendor will ensure its services are affordable, accessible, equitably distributed, equitably managed, and engaged with Environmental Justice Communities (described in G2(d)7), people with disabilities, people experiencing homelessness or housing insecurity, LGBTQ people, women and girls, youth, and seniors.”* (Seattle Department of Transportation, 2021a)

The permits that vendors apply for allows for Type 1 (Figure 8) and Type 2 (Figure 9) scooters and leave room for an undefined Type 3 scooter that may be developed in the future as defined below:

**Type 1 Scooter:**

- A standing, electric-scooter share device with a floorboard, dual brakes, front and rear lights, locking cable, and a maximum speed of fifteen (15) miles per hour;

**Type 2 Scooter:**

- A seated electric-scooter share device with a seat, dual brakes, front and rear lights, and a maximum speed of fifteen (15) miles per hour;

**Type 3 Scooter:**

- an electric-scooter share device that does not fit into the category of Type 1 Scooter or Type 2 Scooter, has dual brakes, front and rear lights, and is approved by the Program Manager



Figure 8: Type 1 Shared E-Scooter (Spin)  
Source: (Bergerson, 2021)

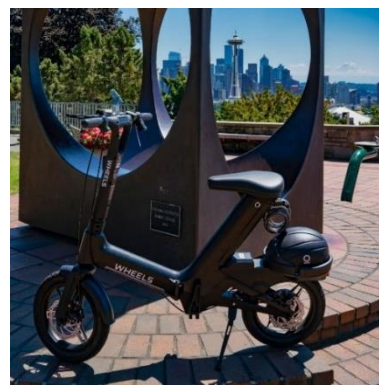


Figure 9: Type 2 Shared E-Scooter (Wheels)  
Source: (SDOT Blog, 2020)

These definitions are used to apply limits in the four types of permits outlined in the application:

#### Permit A

- 1. Within the Initial Application, as described in Requirement AF3.1, SDOT may approve Permit A for the Vendor currently operating at least one thousand (1,000) bicycles within the City and a commitment to two-thousand (2,000) bicycles by October 31, 2020.
- 2. Permit A allows for the operation of up to two-thousand (2,000) Type 1 or Type 2.

#### Permit B

- Within the Initial Application, as described in Requirement AF3.1, SDOT may approve Permit B for the best qualified Vendor that provides a Type 2 Scooter, as defined in G2.18(i). Permit B allows for the operation of up to two thousand (2,000) Type 2 Scooters.

#### Permit C

- Within the Initial Application, as described in Requirement AF3.1, SDOT may approve Permit C for the best qualified Vendor that provides a Type 1, as defined in G2.18(i), or a mixed fleet of both a Type 1 and a Type 2 Scooter, as defined in G2.18(ii). Permit C allows for the operation of up to two thousand (2,000) Type 1 Scooters or two thousand (2,000) Type 1 and Type 2 Scooter mixed fleet.

#### Permit D

- Within the Later Application process, as described in Requirement AF3.2, SDOT may approve Permit D for the operation of up to one-thousand (1,000) scooters. If given, Permit Slot D will be for the best-qualified Vendor that provides a Type 3 Scooter, as defined in G2.18(iii).

The Fee schedule for Scooter Share Permits charges Vendors for three main types of fees: Permit Issuance and Renewal, Permit Review, and Administrative Fee per year (Seattle Department of Transportation, 2021a):

Fee Type	Fee Amount	
Permit Issuance and Renewal	\$232 for issuance or \$176 for renewal as specified in the Street Use Permit Fee Schedule or as subsequently amended	
Permit Review	\$296 per hour of review as specified in the Street Use Permit Fee Schedule or as subsequently amended	
Administrative Fee per year	For Vendors approved during the initial application period:	\$150 per permitted scooter
	For Vendors approved after the initial application period, and no more than 4 total Vendors:	\$150 per permitted scooter or other approved device, prorated by month

Figure 10: SDOT Scooter Share Permit Application Fee Schedule  
Source: (Seattle Department of Transportation, 2021a)

Currently, Seattle has four vendors with permits to operate e-scooter share devices in the city: Lime, Link, Wheels, and most recently added Spin in July 2021. Officially, Lime, Link, and Wheels received their permit for operations in September 2020, while data shows Lime has been operating a number of devices since 2019. And as of November 2021, SDOT recorded that the most scooters deployed on city streets on one day as 5,595 devices (Figure 11).

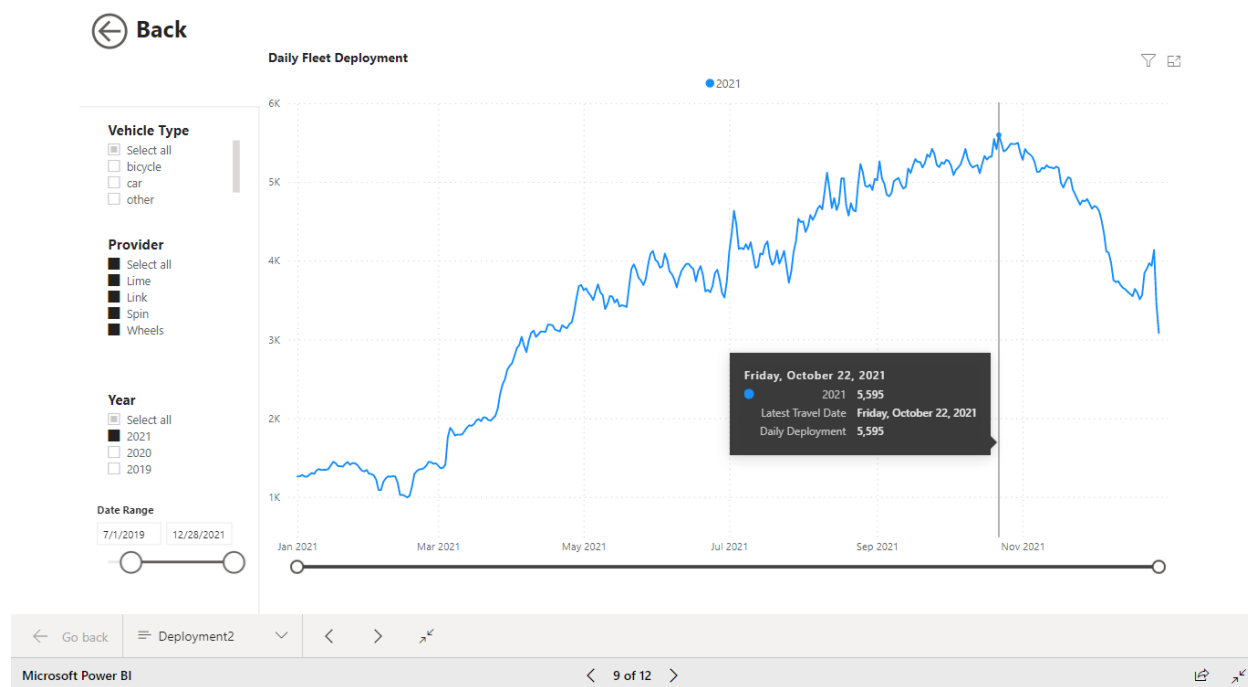


Figure 11: Daily Fleet Deployment in 2021  
Source: (Seattle Department of Transportation, 2021b)

With permits allowing each vendor to operate up to 2,000 total Type 1 and/or Type 2 devices, the vendors have been growing their fleet sizes to meet user demands with over 300,000 trips recorded in August 2021. Both Lime and Link, as the longest operating vendors have approached the upper limit allowed by city permits of 2,000 devices on a few days. And with four vendors approved to operate in the city, Seattle could potentially see up to 8,000 e-scooters on the streets with current permit restrictions. The number of devices on city streets seems to fluctuate with demand and season and are likely managed by the vendors' operations and distribution teams. All

usage statistics are required to be shared with SDOT after being “processed to prevent the disclosure of potentially identifying information according to [SDOT’s] disclosure control policy” (Seattle Department of Transportation, 2021b).

The data used in this study can be categorized into data on (1) ridership, (2) coverage and distribution, and (3) supporting infrastructure. The first section covers statistics of e-scooter usage in Seattle as a whole, compared to usage in equity focus areas. The second section calculates the distribution of e-scooters among the 3 different equity focus areas and looks at how vendors achieve the 10% requirement across all of Seattle. The third section critically evaluates the designation of the equity focus areas by comparing them to the RSEI, census data, and bicycle infrastructure present.

#### *Ridership:*

The aggregated e-scooter ridership data that Seattle is given by the vendors gives a combination of truncated start/end point coordinates, time of day, trip count, trip duration, trip distance, and vehicle type for trip recorded between the two points. The ridership data was mapped using the starting coordinates given for each combination of truncated start/end points to geographically show where trips began (Figure 12). Vendors provided data to SDOT by year, quarter, and daypart, which this study processed and summarized geographically through GIS to show total trip counts by coordinate location as shown in Figure 13.



Figure 12: Map of Aggregated Trip Start Coordinates  
Source: Author, Data from City of Seattle’s Open Data Portal (City of Seattle, 2021b)

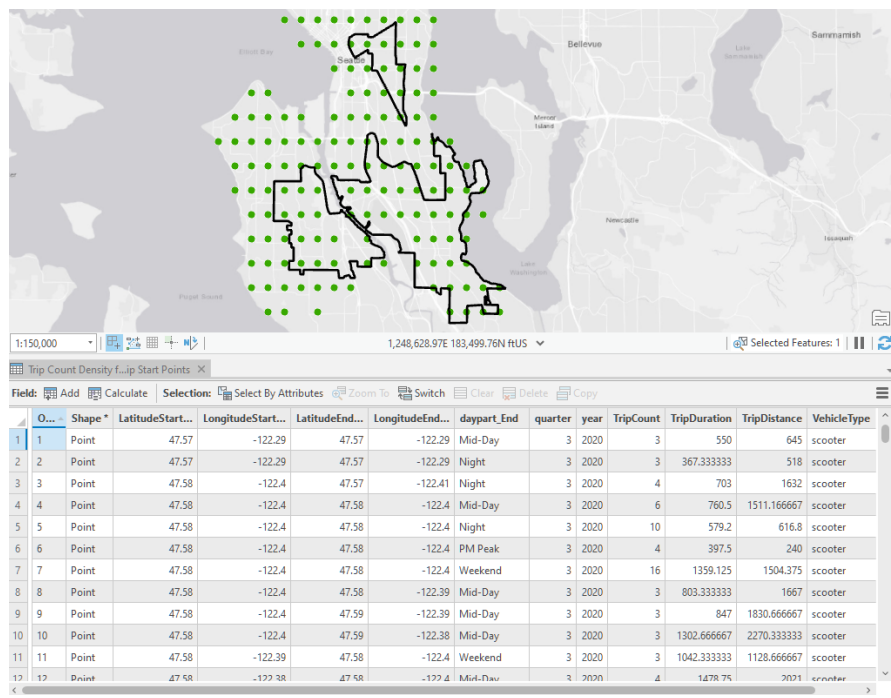


Figure 13: Example of Data for Each Coordinate Pair by Year, Quarter, and Daypart  
Source: Author, Data from City of Seattle’s Open Data Portal (City of Seattle, 2021b)

This study uses the starting coordinates to aggregate all trip counts that originated at each point. Focusing on e-scooters, this study used data from the beginning of Quarter 3 2020 (July) as the pilot program began in September 2020, until June 2021 at the end of Quarter 2. During this period, 576,377 scooter trips were taken with an average trip distance of 1.87 miles and an average trip time of 16.68 minutes (Figure 14). The chart below, Figure 15 shows trip counts by time of day and indicates that most trips, 180,878, were taken during the Mid-Day time. Looking at that same data by time of year and quarter in Figure 16, the ridership numbers climb exponentially for the year that is studied. Over the study period, usage in the equity focus area consistently stayed over 20% of all trips taken in Seattle, with 90% of them occurring in the Central Seattle equity zone. These trip count statistics can be evaluated by comparing usage statistics by land area or population and comparing the numbers for Seattle to numbers for the equity focus areas. Figure 17 gives population statistics of Seattle and the Equity Focus Areas. And as e-scooters can generally only be ridden by riders over 18, statistics for that population are shown in Figure 18. Of Seattle's 595,395 residents over 18, about 48% reside in the equity focus areas. This shows that the equity focus area has less ridership for people able to use e-scooters compared to the non-equity focus area.

	Total Trip	Avg Trip Distance (mi)	Avg Trip Time (min)
Seattle	576,377	1.87	16.68
Equity Focus Area	125,791 (21.82%)	1.65	16.10
North Seattle	48	0.98	14.77
Central Seattle	114,769	1.84	16.68
South Seattle	10,974	1.40	15.27

Figure 14: General E-Scooter Trip Statistics  
Source: City of Seattle (City of Seattle, 2021b)

	AM Peak	Mid-Day	PM Peak	Night	Weekend
Seattle	25,865	180,878	62,256	15,5865	151,513
Equity Focus Area	7,301	38,840	12,927	34,839	31,884
North Seattle	0	6	0	35	7
Central Seattle	6,790	35,172	12,197	31,881	28,729
South Seattle	511	3,662	730	2,923	3,148

Figure 15: Trips by Time-of-Day Statistics, Period (July 2020 – June 2021)  
Source: City of Seattle (City of Seattle, 2021b)

	2020 Q3	2020 Q4	2021 Q1	2021 Q2
Seattle	14,510	74,104	109,206	378,557
Equity Focus Area	3,094 (21.32%)	16,746 (22.6%)	24,303 (22.25%)	81,648 (21.57%)
North Seattle	0	0	0	48
Central Seattle	3,011	14,983	21,762	75,013
South Seattle	83	1,763	2541	6,587

Figure 16: Trips by Time of Year Statistics  
Source: City of Seattle (City of Seattle, 2021b)

	Population	Percentage of Seattle	Land Area (mi <sup>2</sup> )	Percentage of Seattle	Population Density (People / mi <sup>2</sup> )
Seattle	704,520		86.51		8,143.60
Non-Equity Focus Area	361,614	51.33%	37.64	43.51%	9,607.01
Equity Focus Area	342,906	48.67%	48.87	56.49%	7,016.50
North Seattle	98,083	13.92%	11.64	13.46%	8,422.84
Central Seattle	80,256	11.39%	5.96	6.89%	13,456.55
South Seattle	164,567	23.36%	31.26	36.14%	5,264.02

Figure 17: Population Statistics  
Source: U.S. Census Bureau (U.S. Census Bureau, 2018)

	Population	Percentage of Seattle
Seattle	595,395	
Non-Equity Focus Area	311,619	52.34%
Equity Focus Area	283,776	47.66%
North Seattle	82,690	13.89%
Central Seattle	71,099	11.94%
South Seattle	129,987	21.83%

Figure 18: Population of Seattle over 18  
Source: U.S. Census Bureau (U.S. Census Bureau, 2018)

Figure 19 is a heatmap of ridership indicating the density of ridership and the number of trips taken and overlays the equity zones. Figure 20 shows the density of ridership and number of trips taken as a heatmap specifically looking at trips starting within the equity focus area. All ridership statistics shown in previous tables, Figures 14 through 18 are divided to show statistics for the equity focus area as a whole and separately by North, Central, and South Seattle equity zones. These general e-scooter ridership statistics inform where and when riders are using these devices and can be utilized to inform decisions on improvements to creating a more equitable system for all. The significant concentration of trips starting in the Central Seattle equity zone is shown in Figure 20. The trip count totals in Figure 21 are sorted by size and color to indicate the number of trips taken at each coordinate. Of the 5 classes created from this figure, the top two (14855 – 88972) were excluded and a new heatmap was created (Figure 22) to show the density of trip counts outside the most concentrated area in downtown Seattle.

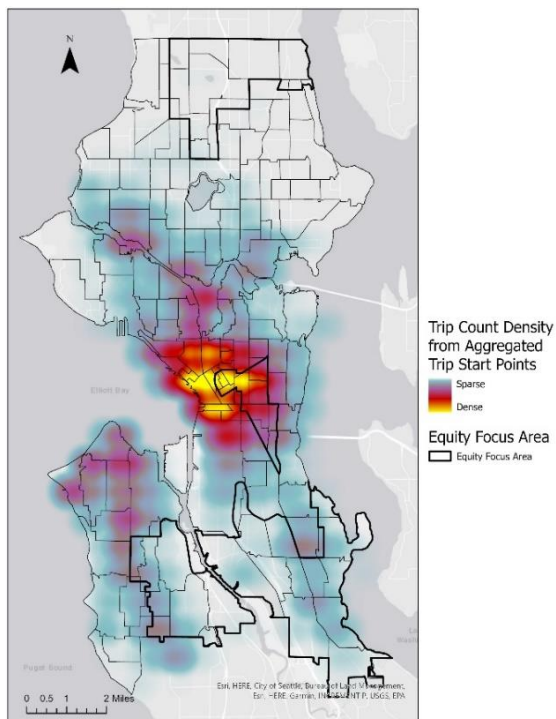


Figure 19: Heatmap of Trip Count Distribution  
Source: Author

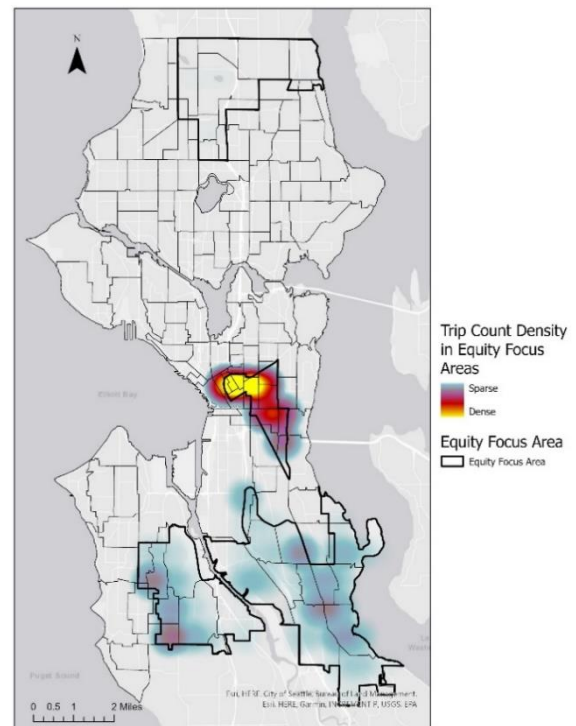


Figure 20: Heatmap of Trip Count Distribution in Equity Focus Areas  
Source: Author

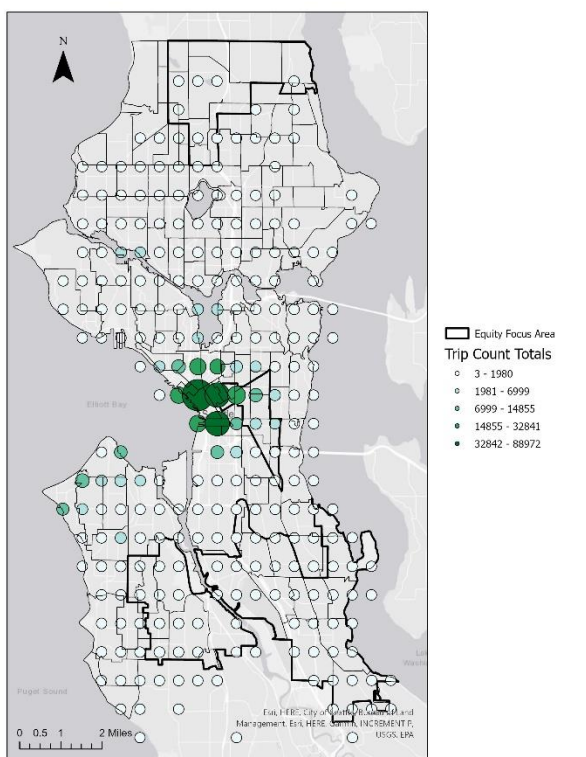


Figure 21: Trip Counts by Coordinate Point  
Source: Author

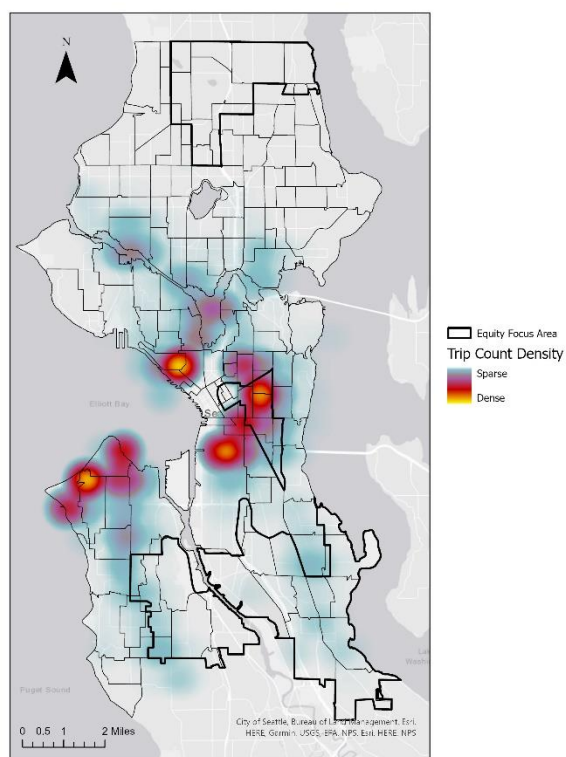


Figure 22: Heatmap of Trip Counts Distributions Excluding Highest Concentration Coordinates  
Source: Author

### Coverage and Distribution:

The amount of scooter trips taken during this period, July 2020 – June 2021, has grown exponentially and has been shown to concentrate around the Pike Place, Downtown, and First Hill area. 21.82% of the trips taken during this time were started in the equity focus area and with a little over 90% of those starting in the Central Seattle focus area. The percentages of total trips by area are shown in Figure 23. Using the time-of-day statistics, Figure 24 provides a calculation by percentage of trips taken from the equity focus area and how many of those trips were started in each area. The following chart, Figure 25 shows similar percentages of total trips. This is supplemented with the next chart, Figure 26, showing the percentage distribution of trips by time of day.

	Total Trip	Percentage
Seattle	576,377	
Equity Focus Area	125,791	21.82%
North Seattle	48	0.04%
Central Seattle	114,769	91.24%
South Seattle	10,974	8.72%

Figure 23: Trip Statistics for Each Area

Source: City of Seattle (City of Seattle, 2021b)

	AM Peak	Mid-Day	PM Peak	Night	Weekend
Seattle	25,865	180,878	62,256	155,865	151,513
Equity Focus Area	7,301	38,840	12,927	34,839	31,884
North Seattle	0	6	0	35	7
Central Seattle	6,790	35,172	12,197	31,881	28,729
South Seattle	511	3,662	730	2,923	3,148

Figure 24: Time-of-Day Statistics

Source: City of Seattle (City of Seattle, 2021b)

	AM Peak	Mid-Day	PM Peak	Night	Weekend
Equity Focus Area	28.23%	21.47%	20.76%	22.35%	21.04%
North Seattle	0.00%	0.02%	0.00%	0.10%	0.02%
Central Seattle	93.00%	90.56%	94.35%	91.51%	90.10%
South Seattle	7.00%	9.43%	5.65%	8.39%	9.87%

Figure 25: Percentage of Time-of-Day Trips by Each Area

Source: City of Seattle (City of Seattle, 2021b)

	AM Peak	Mid-Day	PM Peak	Night	Weekend
Seattle	4.49%	31.38%	10.80%	27.04%	26.29%
Equity Focus Area	5.80%	30.88%	10.28%	27.70%	25.35%
North Seattle	0.00%	12.50%	0.00%	72.92%	14.58%
Central Seattle	5.92%	30.65%	10.63%	27.78%	25.03%
South Seattle	4.66%	33.37%	6.65%	26.64%	28.69%

Figure 26: Percentage of Total Trips During Time of Day in Each Area

Source: City of Seattle (City of Seattle, 2021b)

Of the 86.5 square miles that Seattle covers, the equity focus area covers 48.87 square miles or 56.49% of that area. And of the equity focus area, the Central Seattle zone accounts for 12.2% of the land area. The distribution of devices across Seattle is highly concentrated towards this area during the Mid-Day and Night time periods. West Seattle also shows higher ridership numbers as seen in the previous heatmap (Figure 22). The SDOT Scooter Share Permit Requirements Operations section (O1.6) specifically emphasizes the need to create operational plans for providing services to this area, due to the West Seattle Bridge closure to ensure commuters have connection to transit and ferry:

***O1.6. West Seattle.** (a) On March 23, 2020, the high-level West Seattle Bridge closed for repair and is expected to remain closed through 2022. The low-level Spokane Street Bridge spans the Duwamish River immediately north of the West Seattle Bridge. The Vendor shall cooperate with the Program Manager in providing service for the West Seattle areas.*

*(b) The Vendor shall provide an operational plan for connecting West Seattle to transit and ferry service, as well as connections to the Spokane Street Bridge.*

SDOT's Scooter Share Program page provides statistics of trips, the average number of devices on the streets per day, and the percentage of devices deployed in equity focus areas with the option to separate the information by provider. The Equity Area Deployment statistics shown in Figures 27 and 28 show average provider compliance statistics by month for Quarters 3 and 4 of 2020 and Quarters 1 and 2 of 2021. All vendors are shown to meet the requirement of 10% deployment in the equity focus areas with only a few instances where it falls below. However, observing the overall trends of deployment to the equity focus areas, vendors are distributing less of their overall fleet in the 2021 period to these areas compared to the increasing fleet sizes during the same period as seen in Figure 29. Figure 30 shows a heatmap of deployment in the equity focus areas. It shows a heavier concentration of distribution in the Central equity zone

compared to the medium distribution to the South equity zone and sparse distribution to the North equity zone to meet the 10% requirement by SDOT.

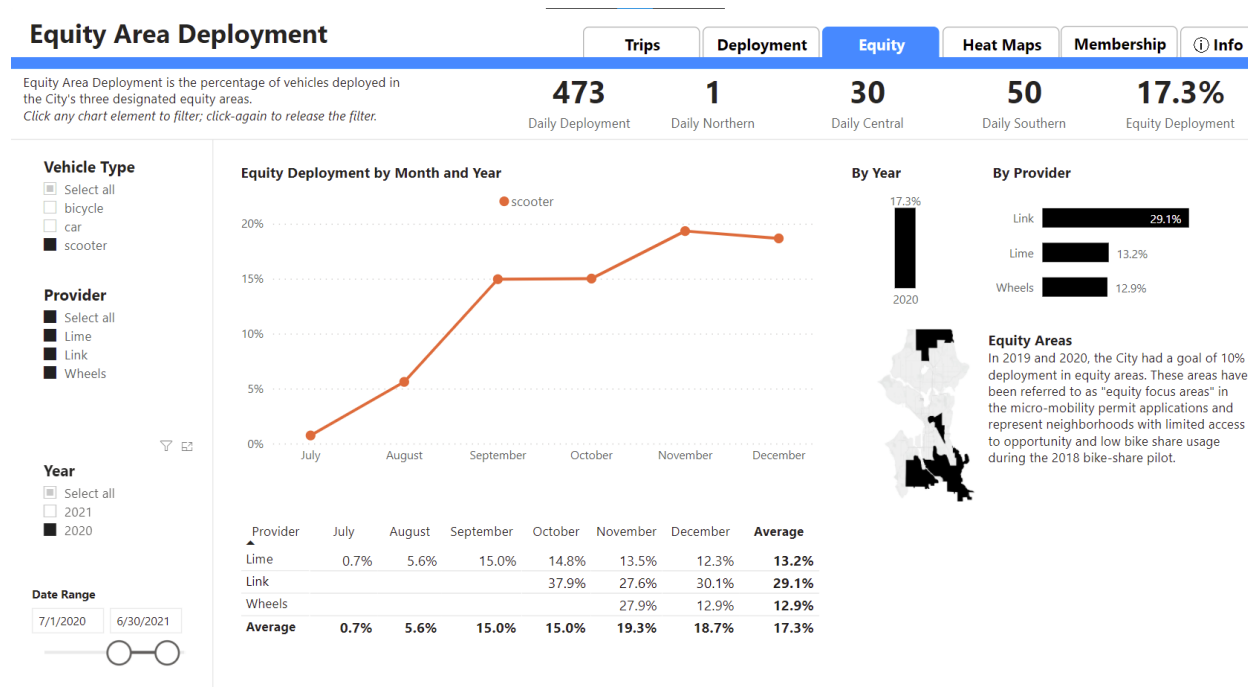


Figure 27: Percentage of Deployment in Equity Focus Areas 2020  
 Source: (Seattle Department of Transportation, 2021b)

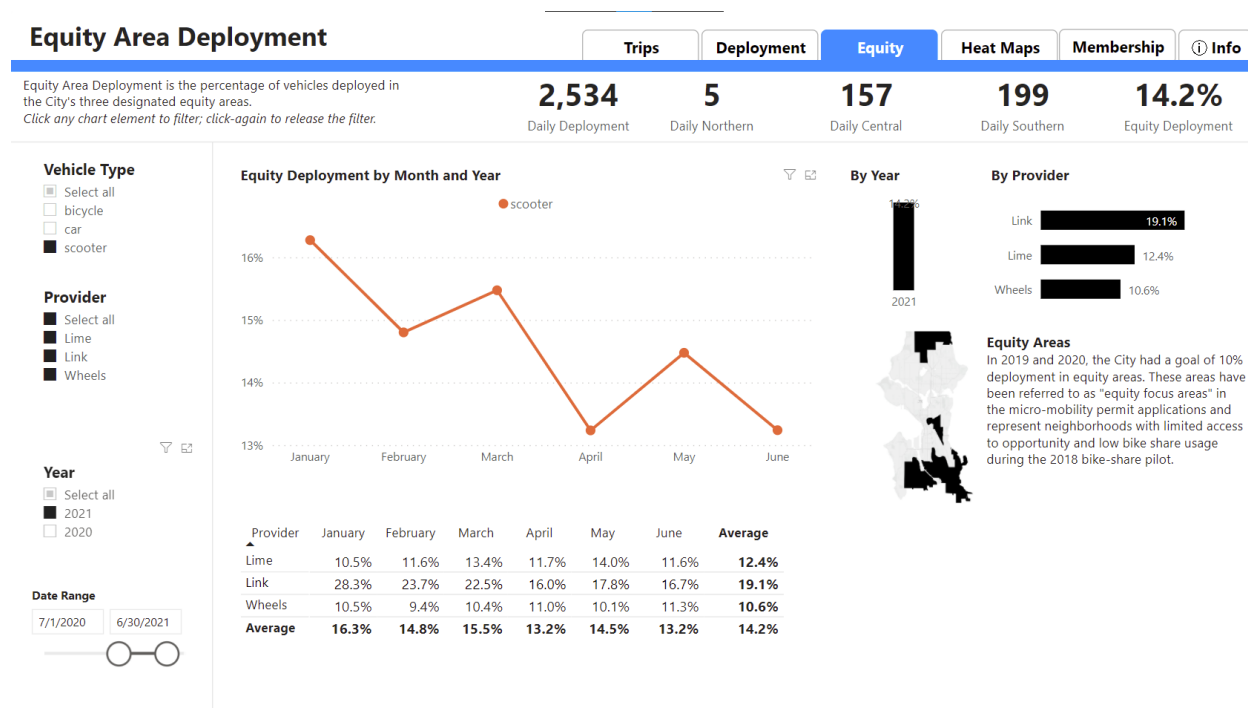


Figure 28: Percentage of Deployment in Equity Focus Areas 2021  
 Source: (Seattle Department of Transportation, 2021b)

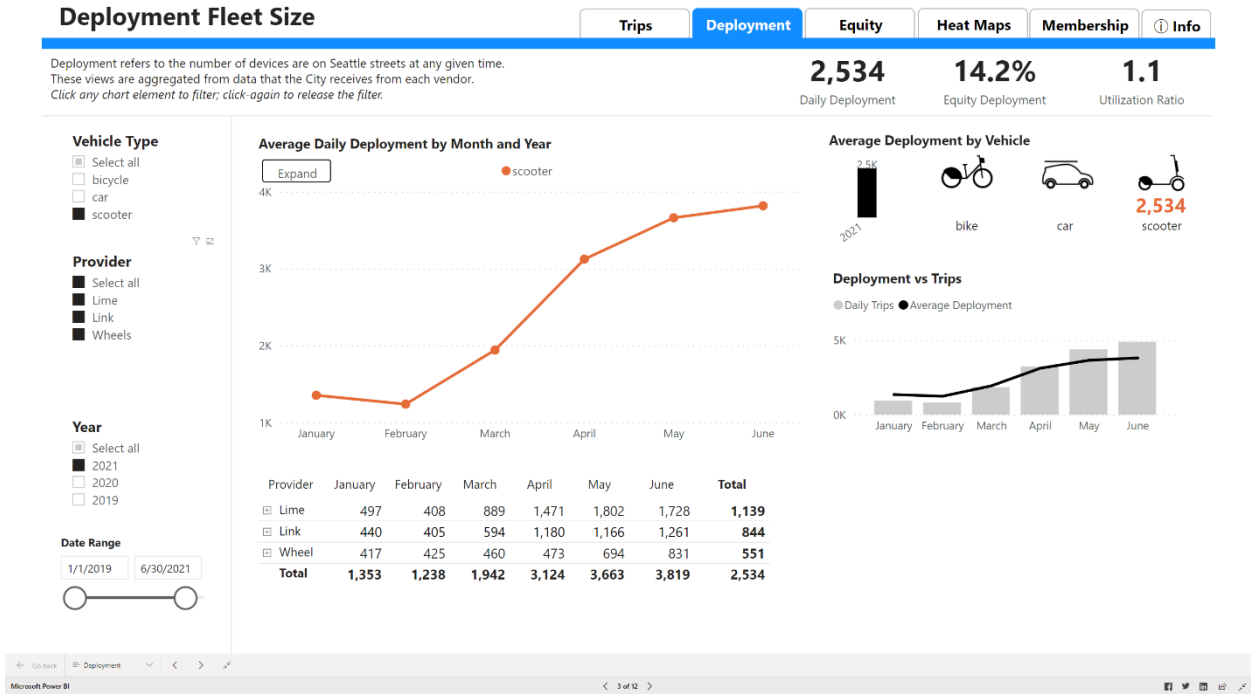


Figure 30: Deployed E-scooter Fleet Size 2021  
Source: (Seattle Department of Transportation, 2021b)

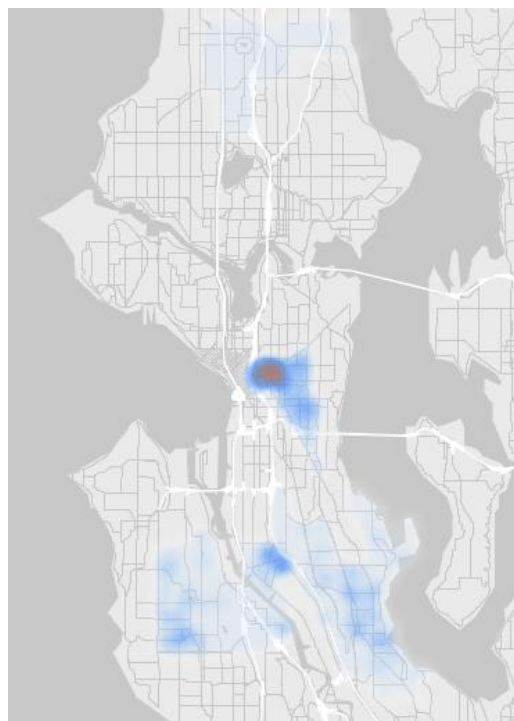


Figure 29: Heatmap of Deployment in Equity Focus Areas  
Source: (Seattle Department of Transportation, 2021b)

Though it does not apply to the calculations for this study due to the time frame and lack of data on usage, Spin’s permit application provides insight into the process and proposal providers make to operate in the city. As the most recent vendor to gain approval for operations in Seattle, Spin put together an application that addresses Seattle’s deployment requirements in four phases. Figure 31 shows the proposed deployment strategy delineated by phases and highlighting equity areas. Each phase aims to expand services “approximately every 30 days, and based on a neighborhood demand metric of 2 rides per scooter per day, [and Spin] expect to expand our deployments to the additional [Phase 2 neighborhoods]” (Spin, 2020).

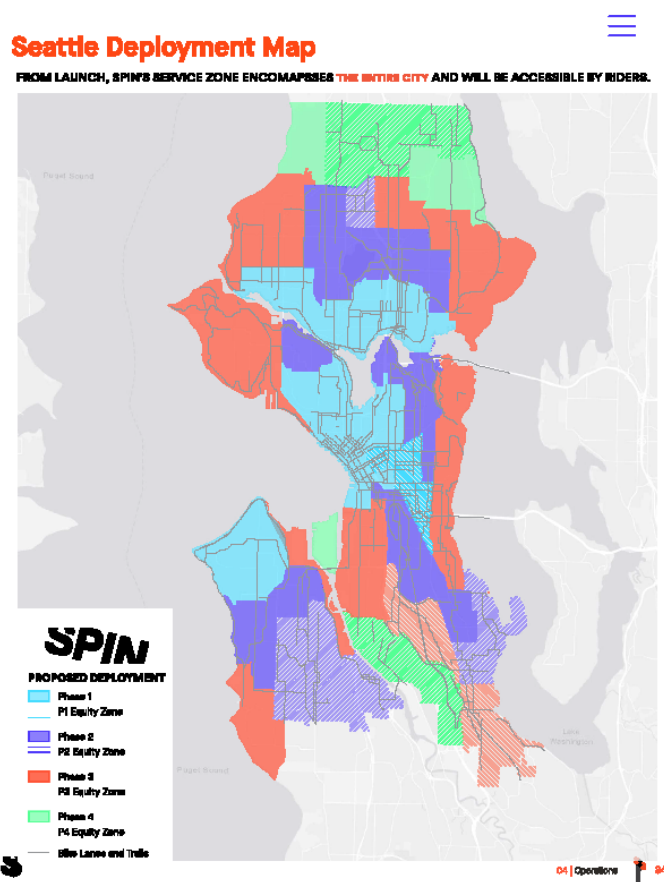


Figure 31: Proposed Deployment Plan for Spin Permit Application  
Source: (Spin, 2020)

### *Supporting Infrastructure:*

Bicycle infrastructure could help facilitate e-scooter usage. The density of bicycle facilities is calculated by the Census Tract level, using the 2013-2017 ACS data into a measure of bicycle infrastructure density (BID). Existing infrastructure in Seattle shows to have 292.9 miles of bicycle facilities for its 86.5 sq mi area. Dividing the miles of bike facilities by the area gives Seattle a BID of 3.4 miles per sq mile as a whole. Of this 292.2 miles, 90.26 miles (30.82%) are sharrows, 76.24 miles (26.03%) are in street with minor separation, 46.93 miles (16.02%) are neighborhood greenways, 32.18 miles (10.99%) are in street with major separation, and 47.29 miles (16.15%) are multi-use trails (Figure 33). The equity focus area that SDOT designated has a BID of 1.69, while separately the North Seattle equity zone has a BID of 1.43, Central Seattle has a BID of 2.78, and South Seattle has a BID of 1.14. Without including sharrows, these numbers drop to 1.02, 1.91, and 1.14 respectively. Compared to the area outside of the equity focus area, which has a BID of 5.58 or 3.82 not counting sharrows, there is a significant difference (Figure 32). Using the measures without sharrows is important to see how much safe infrastructure there is in areas that could encourage more ridership.

	Land Area (mi <sup>2</sup> )	Percentage	Existing Infrastructure (mi)	Infrastructure (without Sharrows)	Infrastructure Density (BID) (mi/ mi <sup>2</sup> )	BID (No Sharrows)
Seattle	86.51		292.9	202.6	3.39	2.342
Non Equity Focus Area	37.64	43.51%	210.2	143.6	5.58	3.815
Equity Focus Area	48.87	56.49%	82.7	59	1.69	1.21
North Seattle	11.64	23.83%	16.6	11.9	1.43	1.02
Central Seattle	5.96	12.20%	16.6	11.4	2.78	1.91
South Seattle	31.26	63.97%	49.5	35.7	1.58	1.14

*Figure 32: Bicycle Infrastructure Statistics*

*Source: Author, Data from U.S. Census Bureau and SDOT (City of Seattle, 2018a; U.S. Census Bureau, 2018)*

	In Street, Major (mi)	In street, Minor (mi)	Multi-use Trail (mi)	Neighborhood Greenways (mi)	Sharrows (mi)
Seattle	32.18	76.24	47.29	46.93	90.26
Equity Focus Area	8.35	20.51	10.61	19.40	23.80
North Seattle	2.74	1.81	2.68	4.62	4.76
Central Seattle	1.85	4.16	1.75	3.61	5.19
South Seattle	3.76	14.54	6.18	11.17	13.84

Figure 33: Amount of Infrastructure by Type in Each Area  
Source: Author, Data from SDOT (City of Seattle, 2018a)

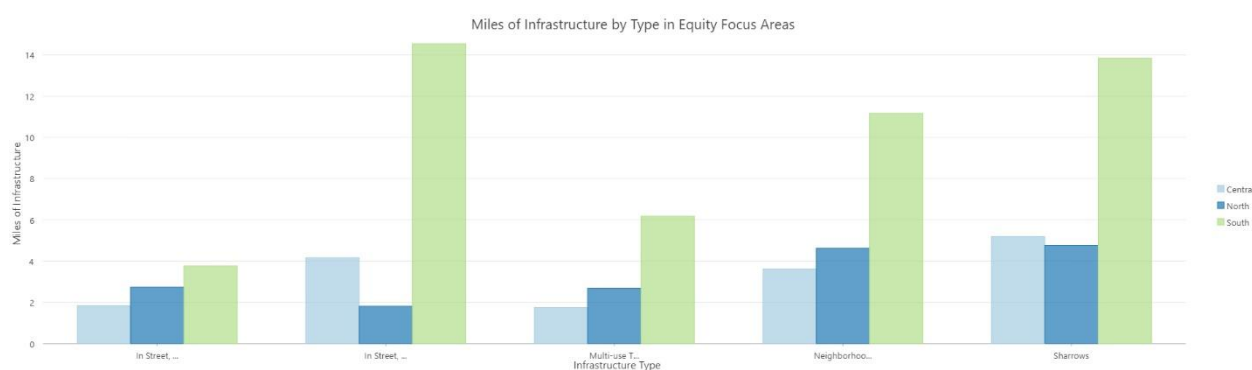


Figure 34: Miles of Infrastructure by Type in Equity Focus Areas  
Source: Author

Seattle has planned for another 447.7 miles of bicycle infrastructure in addition and/or replacing current roads to improve safety and provide a better network for bikers. The equity focus areas are slated for 111.8 miles of those planned bicycle infrastructure additions, of which 12.33 miles are upgrades and 6.9 miles of those are upgrades from sharrows to more protected bicycle infrastructure. The chart below, Figure 35 gives a summary of the current and planned bicycle facilities in the equity focus areas. These numbers show the investment being made to improve Seattle's bicycle infrastructure, especially in South Seattle which could address some of the imbalances in equitable provision of infrastructure to more disadvantaged communities.

	Planned Infrastructure (mi)	Upgrades (mi)	Previously Sharrows (mi)	Percent of Total Being Upgraded from Sharrows	Sharrows Left (mi)	New Additions (mi)	Future Total (mi)	Future BID (mi/mi <sup>2</sup> )
Seattle	447.7	59.7	33.6	37.22%	56.7	388	680.9	7.87
Equity Focus Area	111.8	12.33	6.9	29.00%	16.9	99.47	182.17	3.73
North Seattle	25	2.33	1.4	29.38%	3.4	22.67	39.27	3.37
Central Seattle	14.7	3.5	2.2	42.40%	3.0	11.2	27.8	4.66
South Seattle	72.1	6.5	3.3	23.84%	10.5	65.6	115.1	3.68

*Figure 35: Statistics of Planned Infrastructure*  
*Source: Author, Data from SDOT (City of Seattle, 2018b)*

Figure 36 shows the map of the relative density of bicycle infrastructure by census tract. The results are categorized into their natural break to create 5 classes ranging from 0.00 to 18.85 miles per square mile. The following map, Figure 37 shows BID by census tract without including sharrows using the same scale created in the previous map. The regression analysis is shown in Figures 38 and 39 correlating BID and trip counts indicate the relationship between these two variables. The R-Square value is 0.17 but the P-value of 0.09 indicates that the null hypothesis that there is no relationship between the BID and trip counts is less than 10%.

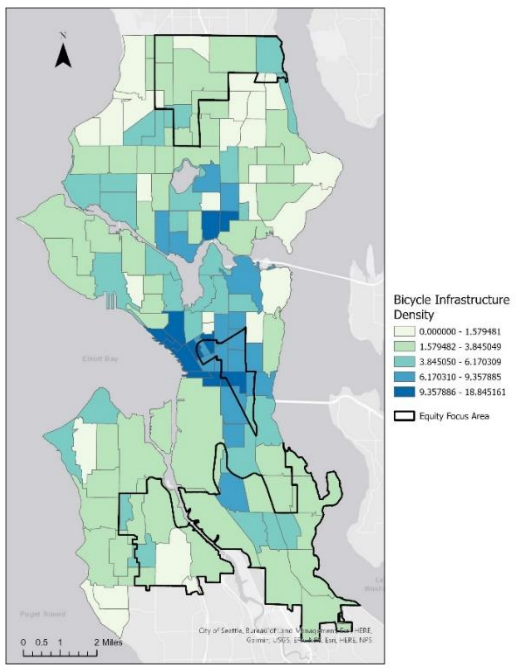


Figure 38: Bicycle Infrastructure Density by Census Tract  
Source: Author

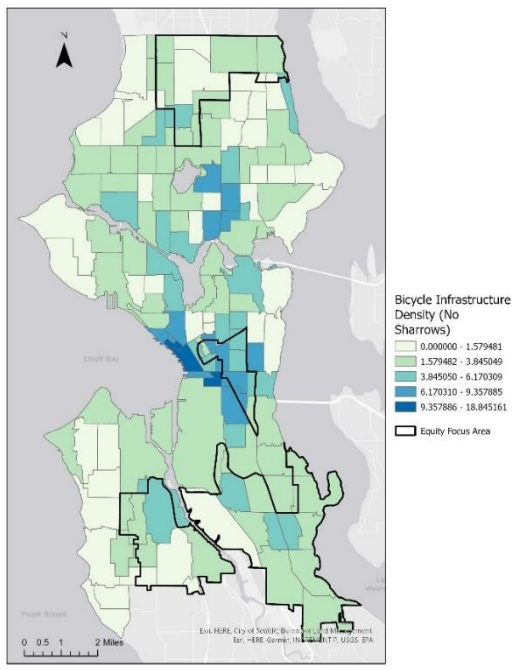


Figure 37: Bicycle Infrastructure Density Without Sharrows by Census Tract  
Source: Author

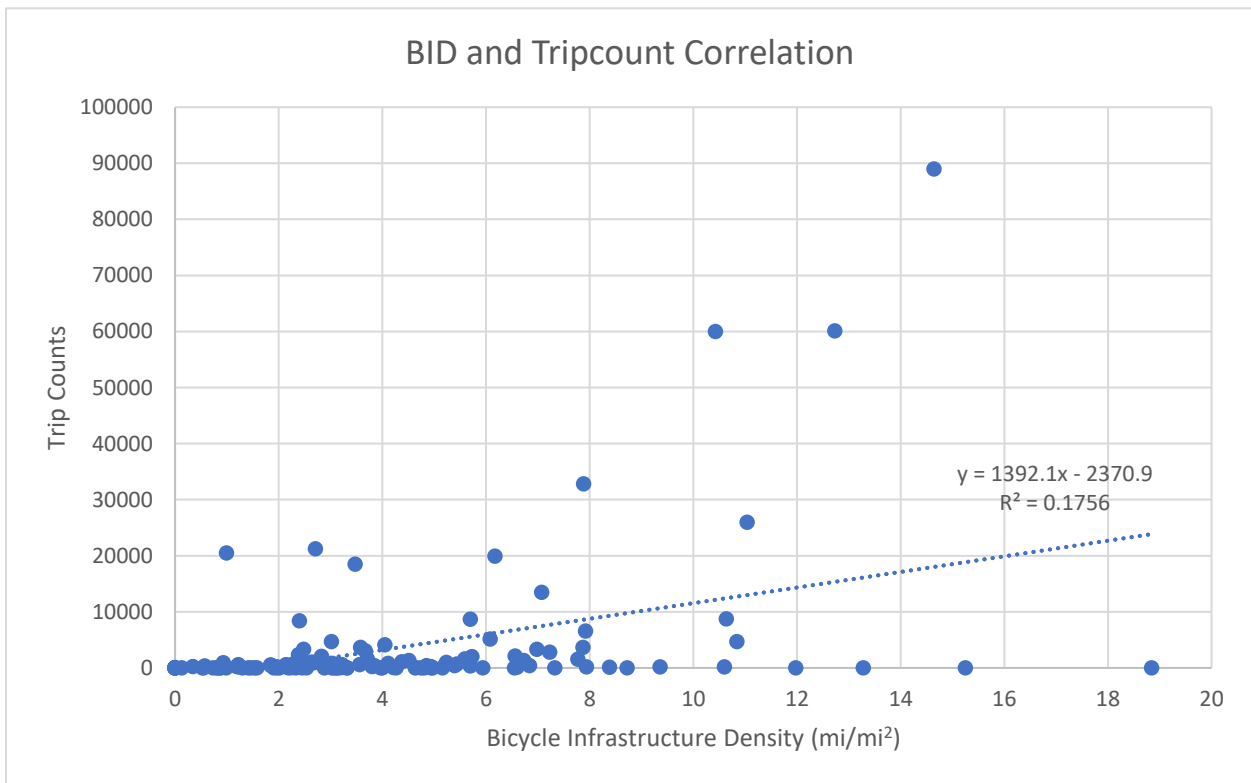


Figure 36: Correlation of BID and Trip Count  
Source: Author

<i>Regression Statistics</i>	
Multiple R	0.42
R Square	0.18
Adjusted R Square	0.17
Standard Error	10411.68
Observations	135

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	3071926899	3.07E+09	28.34	4.2E-07
Residual	133	14417606234	1.08E+08		
Total	134	17489533133			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-2370.95	1419.76	-1.67	0.097	-5179.17	437.27
X Variable 1	1392.08	261.50	5.32	4.21E-07	874.83	1909.32

Figure 39: Regression Analysis  
Source: Author

A comparison map, Figure 40 is shown below of concentration of minority and low-income populations by Census Tract, which is overlaid with areas with the lowest bike lane density. The Highly Disadvantaged Population indicates where the High POC Population layer and High Percent of Population under 200% Poverty Level layer overlap. The equity focus areas are outlined on top to see how these factors relate to SDOT's designation of these zones. The RSEI map, Figure 41 shows the scale from lower to higher disadvantaged and priority for improvements that Seattle uses considering indices of race and origin, socioeconomic factors, and health disadvantages. Figure 42 omits the middle disadvantaged quintile that indicates middle priority for improvements, highlighting the areas of lowest and highest need. These maps show where equity concerns are greater in Seattle and provide a way to focus where resources should go regarding supporting infrastructure that e-scooters may be able to provide. The maroon-colored areas highlighted in Figure 42 are where Seattle currently focuses resources.

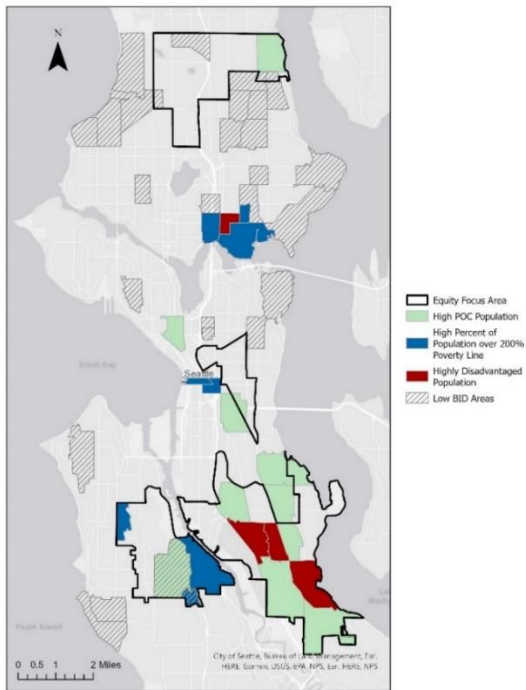


Figure 42: High POC Population vs. High Percentage of Population under 200% Poverty Level vs Low BID Areas  
 Source: Author, (U.S. Census Bureau, 2018)

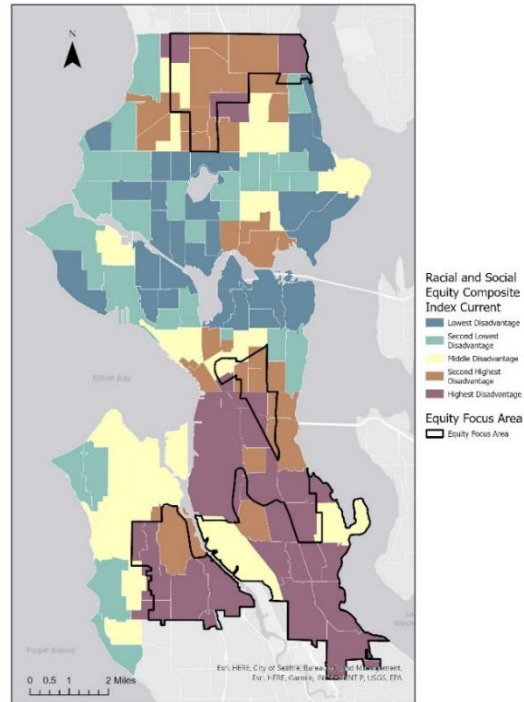


Figure 41: Race and Social Equity Composite Index  
 Source: (City of Seattle, 2021)

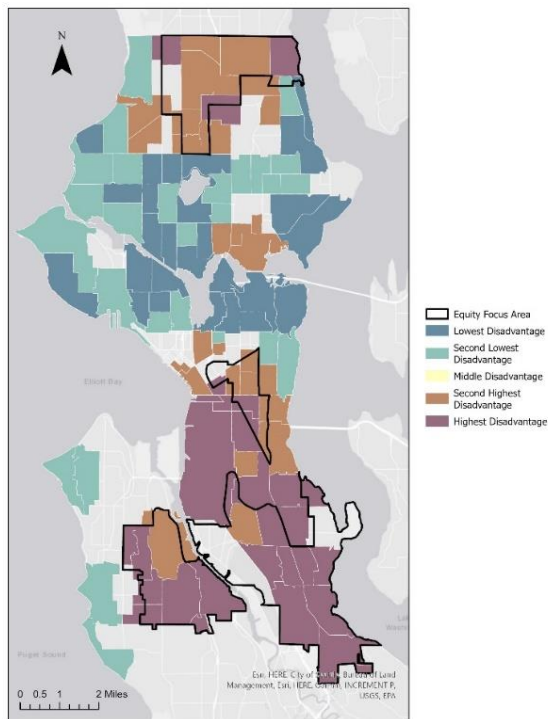


Figure 40: Race and Social Justice Composite Index excluding Middle Disadvantaged  
 Source: (City of Seattle, 2021)

**Discussion:***Distribution of Devices:*

Considering the 86.51 square miles of Seattle, the equity focus area covering 56% of this land area brings to question how appropriate a distribution requirement of 10% is. This is especially so when thinking about the fact that the 10% requirement is for the North, Central, and South Seattle zones combined. The 5-year ACS Census data from 2013-2017 shows that Seattle has a population of over 700,000 people, and the equity focus area contains almost 50% of that population at almost 343,000 (U.S. Census Bureau, 2018). Also, comparing the decreasing Equity Area Deployment by vendors to the rising number of trips being taken in equity zones and increasing fleet sizes causes one to wonder if 10% is sufficient. The fact that equity zones consistently made up over 20% of trips further questions the 10% requirement. And using population statistics, we find that about 48% of Seattle's population who are legally allowed to ride are in the equity focus areas, with almost half of them located in the South Seattle equity zone. And with over 90% of trips in the equity focus area being taken in the Central Seattle zone, the distribution of devices across all zones could possibly be facilitated by requiring minimum deployment obligations for each individual zone that can be adjusted by need. It can later be assessed whether trip counts are caused by the availability of devices in those areas or other factors and adjust requirements on a per-zone basis. Specifically targeting areas like this, instead of simply broad zones, seems to have helped develop scooter usage in West Seattle when a need is emphasized by SDOT. The scooter data shows that during this one-year period, West Seattle observed a significant number of trips with the requirement set by SDOT for vendors to provide "operational plan[s] for connecting West Seattle to transit and ferry service, as well as connections to the Spokane Street Bridge", with concerns over the West Seattle Bridge closure

(Seattle Department of Transportation, 2021a). However, one reason for high numbers in the West Seattle area could be due to the active waterfront and attractions that allow for e-scooter usage around the location. Another reason that could be a contributing factor to high trip count numbers in certain areas is the effects of tourism and the role these devices play in providing mobility options for visitors to move around the city without having to navigate transit or pay for other mobility services. This theory could account for the highest trip count start/stop point is the coordinate for Pike Place Market but could be indicative of this coordinate being near high job concentration or transit options which has yet to be explored. The scooter data shows 173,284 trips starting and ending at this coordinate alone, with 59,285 occurring during the Mid-Day period. However, tourism is only one factor among many that come into play with e-scooter usage. And with the aggregated data being truncated to 0.01 latitude and longitude coordinates for privacy concerns, this data is inconclusive. What can be seen at this level, is aside from the concentration of trips in the downtown area, trip counts in the Central Seattle equity zone would encompass an area with Seattle University and multiple hospitals, along with a high population density. The heatmap excluding the highest trip count coordinates (Figure 22) allows for a clearer picture to be seen of the areas of usage, which still do not include the North or South equity zone significantly.

#### *Distribution of Infrastructure:*

One of the other factors that could contribute to the higher usage of e-scooters in the areas shown in Figure 44 is the density of infrastructure that can be used for safer and more accessible riding. Having safe infrastructure for e-scooter riders in place like West Seattle does with a Multi-Use Trail along the waterfront might promote more utilization of e-scooters in the

area. And with the addition of better infrastructure in the form of an in-street, major separation bicycle lane along the new waterfront development, a further increase of an already high BID area could increase trip counts at the coordinate by Pike Place Market and encourage further usage of safe e-scooter trips (Figure 43). The Zhang study looking at the types of infrastructure e-scooter riders prefer documented riders choosing routes that had car-separated infrastructure, which might factor into increased usage along areas with higher BID found on Figure 45 (Zhang et al., 2021).



Figure 45: Seattle Waterfront Park Promenade + Bike Path Project Plan  
Source: (Waterfront Seattle, 2020)

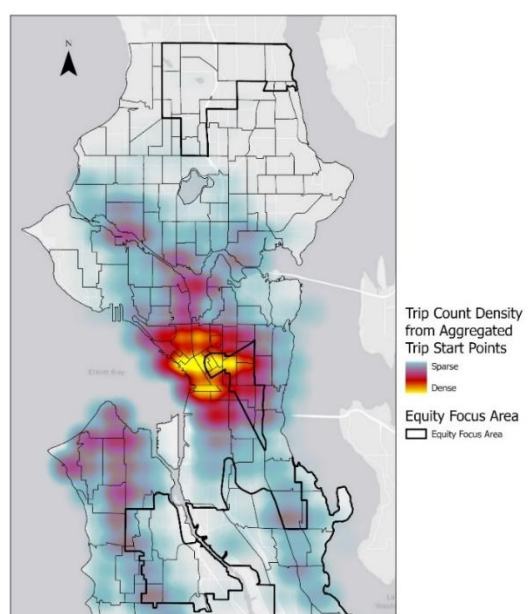


Figure 43: Trip Count Density from Aggregated Trip Start Points  
Source: Author

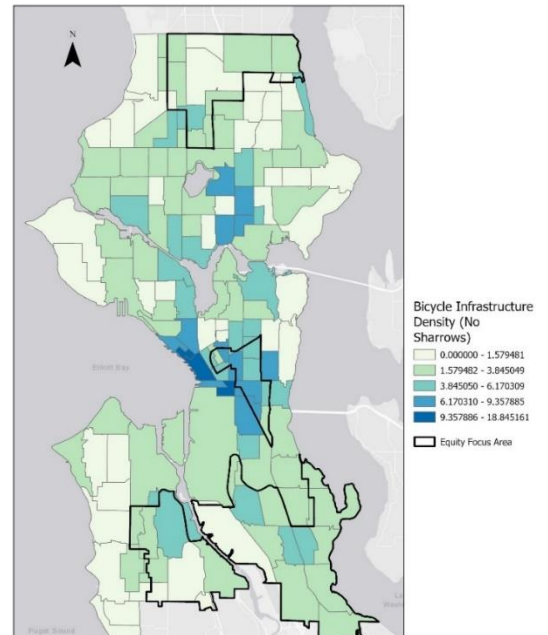


Figure 44: Bicycle Infrastructure Density Without Sharrows  
Source: Author

The distribution of devices on that map shows the need to increase infrastructure around the South Seattle equity focus area and between High Point and White Center area in West Seattle. The calculations for BID without Sharrows give a better idea of safer infrastructure available for use in Seattle and the equity focus areas. And the North and South equity focus area along with the West Seattle area mentioned fall below half the Seattle average of 2.34 miles per square miles (Figure 32). Providing safer infrastructure could not only address current needs but also might encourage more usage. Safer bike lanes could take away some of the barriers to e-scooter ridership with 50% of past and occasional riders feeling unsafe according to Sanders et. al. (Sanders et al., 2020). The regression analysis shown in Figure 38 comparing the number of e-scooter trips to BID gave a P-value of 0.09, meaning that though not statistically significant, there is more than a 90% chance that these two variables are correlated generally showing higher trip counts in areas with higher BID. And creating more infrastructure density could increase trip counts in the North and South equity focus areas and create a more equitable distribution of trips between all three zones. These locations coincide with the areas that the Race and Social Equity Index (RSEI) show as the most disadvantaged with the highest priority for improvement.

The planned improvements that the data shows would upgrade 33.6 miles of sharrows to bicycle infrastructure that offers at least some physical separation. Figures 46 and 47 show existing and planned bicycle infrastructure in the equity focus area. Seattle's equity focus areas will be upgrading 29% of its current sharrows and adding 99.47 miles of new infrastructure. This would bring the BID of the equity focus areas to above 3.73, but this would still be less than half of Seattle's overall BID of 7.87 miles per square mile. Even still, not only could this increase benefit scooter ridership, but it could also increase mode choice options by providing bikers,

walkers, and transit riders a better mobility network. In this way, cities can use improvements aimed at the larger transportation system to meet city goals.

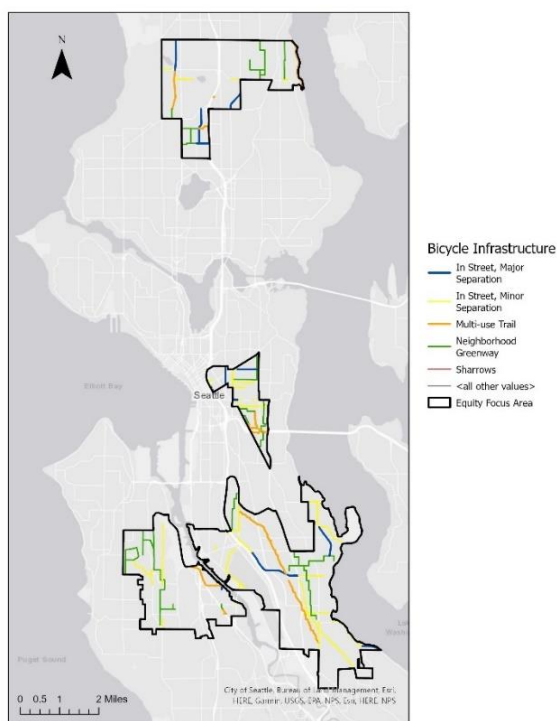


Figure 46: Existing Bicycle Infrastructure in Equity Focus Area  
Source: Author, Data from SDOT (City of Seattle, 2018b)

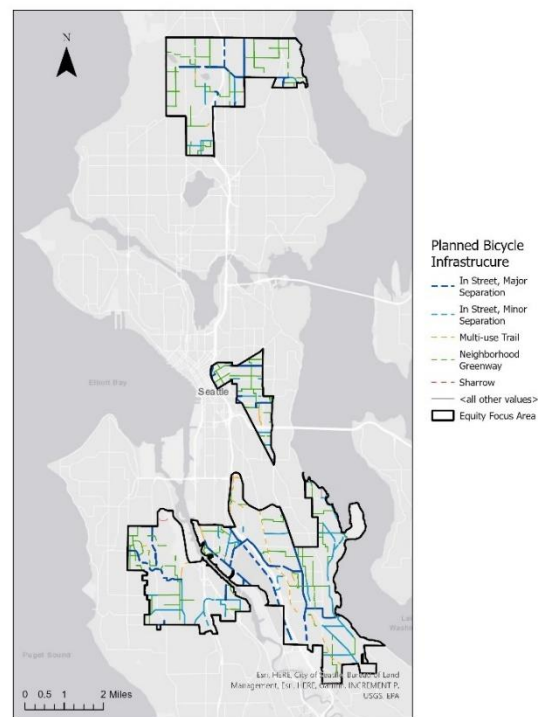


Figure 47: Planned Bicycle Infrastructure in Equity Focus Area  
Source: Author, Data from SDOT (City of Seattle, 2018b)

### Equity:

Increases in bicycle infrastructure come with concerns about gentrification and displacement, as pointed out in *Bike Lanes are White Lanes* by Melody Hoffmann (Hoffmann, 2017). The Ferenchak paper showed that adding bicycle infrastructure did not necessarily cause displacement and could potentially increase area wages (Ferenchak & Marshall, 2021). However, similar to these concerns about bike lanes, the concerns about shared e-scooters are increased with the need to account for the unfamiliarity the public has with these new devices, especially in

the minority communities. The first thing in the equity portion of Seattle’s permit requirements is about community engagement (Seattle Department of Transportation, 2021a):

*“07.1 Community Engagement. The Vendor shall collaborate with SDOT and participate in outreach, education, and other equity programming designed to improve knowledge of and access to mobility and recreation options in the City of Seattle.”*

After evaluating the regulations in Seattle surrounding e-scooters and the supporting data and information that produced the framework the scooter share program operates under, it becomes apparent that Seattle has developed a strong pilot program with a focus on equity that is informed by data and continues to grow. Critically evaluating the 10% Environmental Justice Communities Areas of Focus or equity focus area, the data shows that infrastructure improvements need to be made on top of distribution between the North, Central, and South Seattle zones. And looking at the South Seattle equity focus area with its larger concentration of minority populations, this is particularly of importance. The RSEI map indicates South Seattle as the most disadvantaged with the highest priority for improvement by measure of a: Race, English Language Learners, and Origins Index; Socioeconomic Disadvantage Index; and Health Disadvantage Index (Figure 48).



other areas to meet demand and less is used to service equity focus areas. When vendor and city goals align, like in West Seattle where vendors can gain ridership and the city can better connect people to the transit system to meet the need caused by the bridge closure, growth seems to be easier. However, incentivizing companies to provide services that do not provide as straightforward of benefits is much harder. Cities need to create the supporting infrastructure and environment for companies as an incentive to operate more in areas where the city wishes to see expand or provide transportation solutions using services like e-scooters. The data shows that there is a correlation between the amount of safe infrastructure in an area and the trip counts started. We can infer from this that having safer infrastructure can provide an environment that is more encouraging for riders to utilize this service. However, are the areas with safer infrastructure seeing more ridership due to being areas that are also wealthier? With more ridership data over a longer time, we can observe if trip counts in high BID areas in the equity zones are also high.

*Limitations:*

Information for this study was limited and must be viewed knowing the many factors contributing to the circumstances in which it was gathered. First and foremost, the COVID-19 pandemic has and is still affecting our society in a way and scale which changes how we interact with our surroundings. The methods for this study could be improved upon with further ridership information from surveys that could gather data on demographics of users tied to the trip start locations as well as reasons for trips (ie. commute, leisure, connecting to bus, etc.). The effects of the pandemic significantly reduced mobility needs and changed what normal commuting numbers may look like in the future. Data gathered for this study reflect trip counts for the year

following the lifting of “stay at home” mandates and deployment, ridership, and membership information may give an incomplete picture of how e-scooters are utilized under “normal” circumstances. Quarter 3 and 4 of the 2020 year show the gradual increase in usage as services began again.

Another major factor that contributes to the data present is the fact that the roll-out of the scooter share program is still in its pilot stage while the pandemic spread. It was only in July 2021 that the fourth scooter share provider, Spin, was permitted to operate in Seattle. The impact of the additional vendor operating in Seattle was not included in the study with only data from Q3 of 2020 to Q2 of 2021 provided for analysis at the time of this study. There would need to be an analysis of a full year of scooter share data that is uninterrupted to observe usage patterns and trends that can reflect things like seasonal and weather effects which current data displays to a certain extent.

The e-scooter data available for this study was limited to aggregated trip count data and could not analyze deployment data at a more granular level. This information could have better informed where vendors redistribute devices to in what quantities in compliance to permit requirements to measure needs of different equity focus areas. SDOT’s dashboard showing this information gives a larger scale picture by month, year, and vendor but does not show the information across each zone aside from the heatmap provided of equity deployment (Figure 30). Form factors with Type 1 or Type 2 scooters could also play a role in providing equitable accessibility for riders and could be explored by looking at what types of scooters are available and used more in certain areas or for type of trip.

For further research, an aspect of equity that was not able to be explored is the topic of scooter usage around transit stops in equity areas to see if more users would use this service for

the first and last mile issue discussed previously. With a higher percentage of captive riders that rely on the transit system and have no cars, this would be an interesting data point to see. The data does show that the service is being used to fulfill trips that are on average less than 2 miles and around 16 minutes. Looking further into the effects of e-scooter usage in relation to transit usage going forward would be of interest, especially with cities wanting to encourage mobility mode choice switches by providing alternative options. Targeting areas where communities have less access to cars or are captive transit riders to solve first and last mile issues would be more equitable by distributing resources to where it is needed most. And with transit ridership in decline for most of the COVID-19 pandemic, as shown in Figure 49, the correlation between transit ridership and e-scooter usage is of interest and is an area to be studied further (Washington State Department of Transportation, 2021). Did e-scooters benefit or suffer from this changed behavior? If so, by how much? Will e-scooters help facilitate better transit access as proposed?

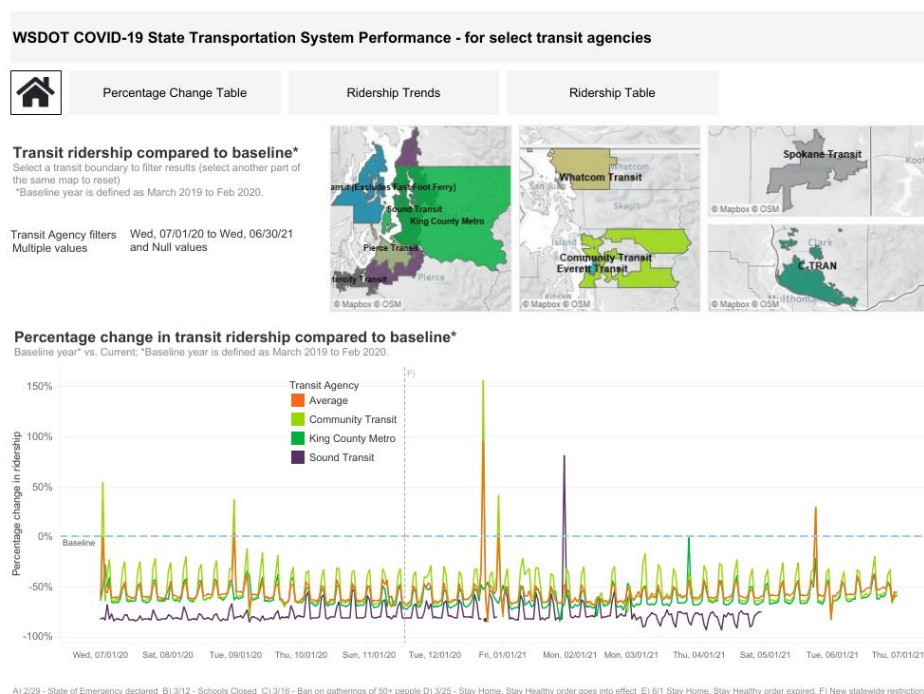


Figure 49: COVID-19 Transit Ridership Percent Changes  
 Source: (Washington State Department of Transportation, 2021)

**Conclusion:**

The purpose of this study was to examine how and where e-scooters operate to determine if current regulations could be adapted to provide more equitable service in Seattle. The goal was to quantify and visually show where e-scooters were being used most, both in the equity focus areas and the city, to help target changes to requirements set by the city. The data showed a concentration of usage around the central Seattle area and an unequal distribution of trips in the Central equity focus area compared to the North and South zones. These equity focus areas cover most of the areas indicated by the Race and Social Equity Index where the highest needs are, but the 10% requirement across all three zones fails to show usage that reflects equal distribution. Following the Rawlsian theory of equity, we should provide more services to areas of highest need, where the 10% requirement fails to do so. The targeted requirements of distribution to West Seattle is an example of how equitable distribution could lead to higher usage through coordination with the city.

For this study, a GIS geospatial analysis was done to find where e-scooters were being utilized and compared with factors that could contribute to equitable usage like bicycle infrastructure density, income, and concentration of minority populations. The data indicates that there seems to be some correlation between bicycle infrastructure density and e-scooters usage. Providing safer infrastructure that these devices can operate in could encourage usage as current literature states one of the main barriers to usage is safety concerns (Sanders et al., 2020). Other literature supports this idea, showing riders prefer to ride on bike lanes and multi-use paths (Zhang et al., 2021). The data from this study can be utilized to target changes to policies and address concerns of equity where usage is low. If Seattle wishes to provide equitable services and solutions for areas where there is a higher need in addressing first and last mile issues, usage

statistics like those found in this study can help break down where to focus development. Also, there is currently no incentive for vendors to distribute across all three equity focus areas, and usage statistics show how they can meet the required 10% distribution to the equity focus areas from just the central zone alone. Seattle needs to adapt this and prioritize giving access to services in all equity zones if it is truly trying to make this service equitable. The ridership data could be utilized to address where the gaps in usages are occurring and where riders could benefit from more community engagement that encourages and educates riders. Planned bicycle infrastructure improvements show Seattle is making good headway in creating a more equitable transportation network for these devices to operate in. And as part of the larger transportation system, these devices can work in tandem with transit services to provide more ways for people to move around the city. Although the data was largely limited due to factors like the COVID-19 pandemic, Seattle can observe the data as the city adopts e-scooters while people change commuting behaviors after the pandemic. Planners and policymakers can adapt its regulations and permit requirements by shaping them to meet the needs of the community as more data is gathered. Also, having different types of data is integral in providing a complete picture of the effects that these services can have, and communication with communities is important to gain feedback on their impact.

Seattle's micromobility regulations have evolved with considerable focus on equity, following the framework laid out by organizations like IMLA and NLC by addressing concerns of distribution, affordability, payment options, methods of activation, and community engagement. As a city that has developed the scooter share pilot program following its bikeshare program, Seattle has been able to adapt to the sudden growth of this industry and has the potential to utilize its services to meet transportation goals. The city has benefitted from its

robust transit system as one of the few cities showing growth in transit ridership. It is important to create infrastructure that can supplement and support this through programs like the scooter share program that can provide potential solutions to increase accessibility and mobility. Future studies could be conducted to explore the relationship of transit and scooter share ridership in Seattle to gain a better understanding of the extent to which e-scooters provide an equitable first and last mile solution. As a pilot program, the scooter share program may take a few years to establish its role in the larger transportation network. Once there is more data and conditions change post-pandemic, further analysis can be conducted to gain a more complete understanding of how we can provide more equitable e-scooter services.

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