ABSTRACT

Transportation plays a vital role in our society and influences every aspect of our lives. It has a hand in shaping how we live, where we work, where we go to school, and where we play. It provides access to both the opportunities and the basic services we rely on each day. However, the benefits of transportation investments have not always been distributed equally among communities (Foth, Manaugh, & El-Geneidy, 2013; Bullard, 2003). This paper develops a means by which equity objectives for bicycle equity may be appraised using geographic information systems (GIS) and demographic information to spatially identify disadvantaged groups in relation to bicycle infrastructure. In order to demonstrate these methods, Chicago, IL is used as a case study in which its bicycle network is analyzed to determine whether the benefits of its bicycle infrastructure are equitably distributed. Methods include the creation of a Bicycle Equity Index (BEI), a composite measure that uses common indicators of disadvantage such as race/ethnicity, class, and travel characteristics and the application of access coverage measures in GIS. Findings demonstrate that in some cases populations in most need of alternative transportation options are receiving less benefit from access to bicycle networks. The methodology proposed in this paper provides planners with additional context regarding social equity in bicycle planning and may serve as the basis for future community discussions related to current and future planning efforts.

Keywords

Access, Access Coverage, Bicycle Equity, Bicycle Equity Index, Environmental Justice Indicators, Equity, Transit Dependent Indicators
1. INTRODUCTION

Throughout the 20th century, transportation policies have been heavily influenced by technological innovation, politics, and environmental concerns. Since the onset of the interstate highway era, transportation planning and policy has been largely dominated by mobility concerns and the provision of auto-dominated infrastructure. While historically, certain segments of society have been better represented in planning decisions and investments, policy objectives have evolved over time in response to significant events and changing social values (Sanchez, Stolz & Jacinta, 2003; Fruin & Sriraj, 2006). Most recently, increased environmental concerns have helped usher in the concept of sustainability—the “3Es” Economy, Environment, and Equity—into transportation planning and policy decision-making (Feitelson, 2002). Equity considerations are increasingly present in many public transportation policies and legislation with the help of the Civil Rights Movement and President Clinton’s 1994 Environmental Justice (EJ) mandate (Fruin & Sriraj, 2006). Clinton’s Executive Order 12898 required all federal agencies to develop an EJ strategy that “identifies and addresses disproportionately high and adverse human health and environmental effects of its program” (Clinton, 1994, Section 1-103). In complying with these mandates, several transportation agencies have conducted analyses to investigate how transportation systems serve different social and economic groups (Sanchez et al., 2003). However, these equity analyses have largely been focused on accessibility to transit, the allocation of transportation funding, and job accessibility (Garret & Taylor, 1999). A growing number of advocates and community organizations such as the League of American Bicyclists, People For Bikes, and Alliance of Walking and Biking, are calling for the consideration of bicycle equity in the conversation about current and future bicycle infrastructure development projects. Similar to overall transportation
equity, bicycle equity seeks fair treatment and meaningful involvement in policy formation and decision-making regardless of race/ethnicity, national origin, or income and it explicitly seeks an equitable distribution of benefits from bicycle facility investments.

In order to answer the question of who is benefiting from bicycling investments, transportation planners must understand the spatial distribution of bicycle infrastructure and whom it is serving (Foth et al., 2013). This paper develops a means by which equity objectives for bicycle equity may be appraised using geographic information systems (GIS) and demographic information to spatially identify disadvantaged groups in relation to bicycle infrastructure.

2. LITERATURE REVIEW

2.1 Definition of equity

In broad terms, equity refers to the fair and impartial treatment towards all concerned. It requires giving as much advantage, consideration, or latitude to one party as is given to another. Although equity is commonly mentioned in transportation planning documents, very few explain how equity is going to be measured and included in performance measures. This is because transportation equity can be hard to evaluate and several interpretations and types of equity exist (Marsh & Schilling, 1993; Litman, 2003; Manaugh & El-Geneidy, 2011; Murray & Davis, 2001; Martens, Golub & Robinson, 2012). Furthermore, equity evaluations are highly susceptible to the values and concerns of stakeholders and to the equity paradigm considered. For example, policies and decisions may seem equitable when evaluated one way but inequitable when evaluated another (Litman, 2003).

At the highest level, equity can be thought of in terms of horizontal equity and vertical equity. Horizontal equity, also called fairness and egalitarianism, is concerned with the fairness and
equal distribution of impacts received between individuals and groups that share the same ability and needs (Litman, 2014a; Litman, 2014b; FWHA 2013). Under horizontal equity, transportation policies are equitable if they are fairly distributed, with all groups receiving similar allocations of resources and bearing equal cost. This implies that the spatial distribution of public facilities be equally accessible to all residents. However, achieving equal distribution in cities is often difficult because the built environment naturally develops centers and peripheries (Martens et al., 2012; Foth et al., 2013; Manaugh & El-Geneidy, 2013).

To account for regional variation, Martens et al. suggests the use of Rawls’ *Theory of Justice* (1971) distributive principles to guide transportation equity evaluations (Foth et al., 2013). Marten’s “maximax” principle, (1) maximizes the average level of access while constraining for the minimum, and (2) maximizes the average level of access while constraining the range. By constraining the minimum level of access and the regional range, this principle ensures that no neighborhood receives the bulk of investment and leave other areas behind (Foth et al., 2013).

Vertical equity or outcome equity is concerned with the distribution of impacts across social groups that differ in their ability and/or need. Under vertical equity, transportation policies are equitable if they are redistributive favoring disadvantaged groups and compensating for overall inequalities (Litman, 2014a; Litman, 2014b; FWHA 2013). This equity principle requires identifying disadvantaged groups that may be in greater need of alternative transportation choices.

**2.2 Equity Indicators**

“Equity evaluations require that people be categorized by demographic and geographic factors” to create indicators of disadvantaged groups who experience inequitable benefits from
transportation systems (Litman, 2014a, pg. 9). These indicators are then measured to provide specific information on the state of something or progress toward a goal.

The transportation disadvantaged can be generally categorized in two ways: 1) Environmental Justice Indicators, and 2) Transit Dependent Indicators. Environmental Justice is an equity framework that suggests that environmental goods are not evenly distributed in society and that access to environmental goods are stratified by race, ethnicity, and social class. Low income and minority populations are less likely to own cars and rely more often on non-motorized forms of transportation (Litman, 2014b; McConville, 2013). Therefore, from a transportation equity standpoint these groups are important to consider as they may possess a greater need of affordable modes of transportation and should be a priority for alternative transportation investment (Zelalem, Glas, Greenlee, Vanik, Bowman & Dieber, 2009). Environmental Justice indicators used in this methodology; Minority (Non-white and/or Hispanic) and Low Income (100% poverty level for the region).

While transportation policies often adopt EJ principles in their equity considerations, the above indicators don’t encompass the entire spectrum of populations that may experience transportation inequality. Transit dependent populations include those without cars or the ability to drive often (Zelalem et al., 2009). Transit dependent populations find mobility within their communities challenging and often rely on public transit and/or non-motorized transportation to gain access to their daily needs. “In addition to facing more difficulties getting around, they face economic inequalities as a result of transportation policies oriented toward travel by car” (Sanchez & Stolz, 2003, pg.10). Therefore, they also have a greater need for infrastructure that provides them a safe, accessible mode of travel. Transit dependent indicators used in this methodology; Elderly (Over 65), Youth (Under 18), and Zero-Car Households.
Equality indicators usually fall on a spectrum of disadvantage as individuals may be characterized by more than one indicator. For example, one can be both low-income, minority, and a zero-car household. Therefore, the degree of disadvantaged is often taken into consideration in equity evaluations (Litman, 2014a).

2.3 Assessing Public Access

The distribution of transportation goods is often measured through the concepts of accessibility and access. Accessibility is commonly defined as a person’s ability to reach desired services and activities. It expresses the ease or “effort” involved in reaching services or activities from a given location using a particular transportation system (Morris, Dumble & Wigan, 1979). This is an important evaluation and useful for assessing the quality of a transportation systems (Murray & Davis, 2001). For example, an accessibility analysis of bicycle infrastructure would allow one to assess the ability to reach services and opportunities using bike lanes.

Access on the other hand, is concerned with the proximity of transportation infrastructure to a person or area (Murray & Davis, 2001). Access to transportation is an origin-destination based measurement based on distance and/or cost (Murray & Davis, 2001; Kwan, 1998). Origin-based access evaluates an individual’s potential to use a transportation system from their starting point, usually the home, while destination-based access looks at one’s ability to use a transportation system from an activity center and/or work (Murray & Davis, 2001).

The operation of measuring access is referred to as “access coverage.” Access coverage is determined through a buffer distance placed around a point of interest creating a catchment zone. This operation allows one to determine if a given area has suitable access based on the proportion of the area that falls within the buffer compared to the area as a whole (Murray, 2003; Murray & Davis, 2001).
3. METHODOLOGY

The method for investigating the equity of access to bicycle infrastructure involved the construction of a regional Bicycle Equity Index (BEI), mapping of the BEI to identify disadvantaged communities, and the mapping and analysis of bicycle facilities to identify access-deprived areas.

3.1 Bicycle Equity Index (BEI) Construction

In order to identify disadvantaged populations that may have greater need of alternative transportation choices and the provision of bicycle infrastructure, the composition of the community living within the area must first be determined. The construction of a Bicycle Equity Index (BEI) was used to determine the relative need of a specific area. While it may be practical for some communities to focus on individual indicators, an index allows one to establish the status of an area that can help guide decisions (Murray & Davis, 2001).

Five indicators were used in the construction of the BEI, percent minority population (non-white and/or Hispanic), and percent low-income population (below the poverty line), percent elderly population (65 or older), percent youth population (under 18), and percent zero-car household population. Five-year estimates, 2008-2013, of the ACS were used in order to obtain the most recent data at the largest geographic resolution available, block groups.

In order to combine several indicators into a single Bicycle Equity Index measurement, values for each indicator were standardized by finding their z-score. Positive z-scores represent higher proportion of an indicator in regards to the regional mean. To calculate the BEI, the z-scores from all 5 indicators were then added together. However, only positive z-scores were used in the index construction and negative scores were converted to zero. This eliminated indicators with negative z-scores (below average values) from diminishing the effect of other indicators. If a negative z-score were used in the index construction it would decrease the overall BEI value,
making the specific region appear less disadvantaged. For example, one would not want a below average percentage of elderly population (negative z-score) within a block group to negate the presence of an above average low income population.

Furthermore, all indicators were given equal weight, meaning that no one indicator was thought to be more important to determining equity than another.

In order to visualize the BEI in ArcGIS, block group census geography data was obtained from the U.S. Census website and joined with the BEI.

3.2 Determining Access

To measure access to bicycle networks, the home is the ideal point from which to measure the separation of people from infrastructure. The home often serves as the “first and last mile,” of one’s commute, both an origin point and a final destination. Importantly, since census data are collected from households it allows one to attribute indicator information to a physical location.

Measuring access to bicycle infrastructure involved five operations; 1) Buffering the bicycle facilities shapefile, 2) Calculating the catchment zone, 3) Calculating areas without coverage, 4) Standardizing the percentage of areas without coverage in each block group to the regional average, and 5) Standardizing the percentage of the area covered by the buffer in each block group to the regional average.

A quarter mile buffer was used to determine whether individuals had access to bicycle infrastructure. Similar analyses used a quarter mile as a reasonable distance to access transportation services and facilities (Murray & Davis, 2001; Murray, 2003; Oregon Metro Metropolitan Transportation Improvement Program, 2015). Furthermore, research suggests that living within a quarter mile of on-street bicycle facilities greatly increases the odds of bicycle use (Krizek & Johnson, 2006).
The portion of the block groups that intersected the buffer represented the portion of the block group that had access to the bicycle network. The bicycle facilities buffer layer was then used to clip the TIGER®/Line Shapefile, resulting in a layer in which the area of the buffer could be calculated for each block group. The measurements of these catchment zones were then compared to the total area of each block group to determine the proportion of block groups with access to bicycle facilities. In order to remain consistent with the construction of the BEI and positive z-scores representing disadvantaged areas, areas of non-coverage were calculated by subtracting each block group’s area of access from the total area of the block group. Z-scores for percent of non-coverage were found to standardize the measure of access and control for variations in block group size. The use of z-scores further allowed for equity to be examined through the lens of Martens’s “maximax” principle, which uses the regional average as a base for acceptable distribution.

Bicycle Equity Index indicators were visualized alongside the BEI for comparison. Equal interval classification was used to symbolize indicators in one standard deviation increments. In order to visualize this information alongside access coverage, map overlays were used. A new shapefile from the access coverage data was created by exporting block groups with z-scores equal to or less than zero to create a layer that represented areas with average or above average access. This new layer was then overlaid on top the BEI and individual equity indicators to elucidate conditions in areas with poor access.
4. CHICAGO CASE STUDY

4.1 Background

Backed by the strong political support of Mayor Rahm Emanuel, Chicago has the goal of becoming the most bike-friendly city in the United States. This goal includes an extensive bike network of traditional bike lanes, buffered bike lanes, protected bike lanes, and neighborhood greenways that will provide Chicagoans of all ages and abilities a bicycle network that is safe and comfortable to use (Chicago Streets for Cycling 2020, 2012).

The city currently boasts more than 200 miles of on-street bikeways and 36 miles of trails. As Chicago moves to create a more comprehensive bicycle network, most of the city will be covered in a dense network of bicycle lanes. This analysis seeks to investigate the equity of access to Chicago’s current bicycle network and identify areas that would benefit from better access.

4.2 Access Coverage

The majority of Chicago’s bicycle network radiates out from its downtown and along the eastern edge of the city. This provides 49% of Chicago’s block groups and 50% of its population, with average

**Figure 1: Chicago’s Access Coverage**
or above average access to bicycle facilities. The bicycle network is increasingly fragmented as one heads to the southwestern edge of the city, lacking connections to the larger network. As a result, there are several neighborhoods along the western and southern edge of the city where Chicago’s residents are underserved by the current network. This not only results in a lack of transportation choices but also lower bike safety and overall health benefits for these communities as these residents are forced to travel in harsh urban conditions. See Figure 1: Chicago’s Access Coverage.

4.3 Bicycle Equity Index (BEI)

4.3.1 Minorities

Figure 2: Chicago’s Minority Population shows the spatial distribution of Chicago’s minority population and highlights the demographic concentration in areas with below average access to bicycle infrastructure. Blue block groups have a greater than average number of minorities with darker blue indicating higher concentrations. There is a clear geographic concentration of minority populations through Figure 2: Chicago’s Minority Population.

Minority is defined as non-white and/or Hispanic/Latino. Areas with higher z-scores have higher concentrations of minority populations.
central and south Chicago that coincides with areas identified with below average access to bicycle lanes.

**Table 1: Chicago’s Minority Indicator Distribution** shows the population characteristics of the minority indicator. While citywide minorities account for 66.3% of Chicago’s population, minorities in areas with below average access account for 71.7% of the population. Furthermore, 54% of Chicago’s minority demographic lives in areas with below average access. This means that a disproportionate number of Chicago’s minorities don’t have access to bicycle facilities.

**Table 1: Chicago’s Minority Indicator Distribution**

<table>
<thead>
<tr>
<th>Minority Indicator</th>
<th>Citywide</th>
<th>Above Average Access</th>
<th>Below Average Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>2,902,246</td>
<td>1,453,798</td>
<td>1,448,448</td>
</tr>
<tr>
<td>Minority Population</td>
<td>1,924,383</td>
<td>886,137</td>
<td>1,038,246</td>
</tr>
<tr>
<td>% of total population</td>
<td>66.3</td>
<td>30.5</td>
<td>35.8</td>
</tr>
<tr>
<td>% of area’s population</td>
<td>n/a</td>
<td>61</td>
<td>71.7*</td>
</tr>
<tr>
<td>% of demographic</td>
<td>100</td>
<td>46</td>
<td>54</td>
</tr>
</tbody>
</table>

*Higher than regional average

**4.3.2 Poverty**

**Figure 3: Chicago’s Low Income Population** shows that the spatial distribution of people living in poverty is fairly uniform, with smaller clusters of poverty in the Far South Side and West Side. The number of low income individuals living in areas with above average access (20.6%) and below average access (21.4%) to bicycle lanes is fairly proportional, with only a slightly higher number of low income individuals living in areas of below average access, see **Table 2: Chicago’s Low Income Indicator Distribution** below. Once again areas with a high concentration of low income individuals and coincide with areas of below average access in the West Side, Southwest Side, and Far Southeast Side.
Figure 3: Chicago’s Low Income Population
Low income is defined as people living at or above the poverty line. Areas with higher z-scores have higher concentrations of poverty.

Table 2: Chicago’s Low Income Indicator Distribution

<table>
<thead>
<tr>
<th>Low Income Indicator</th>
<th>Citywide</th>
<th>Above Average Access</th>
<th>Below Average Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>2,902,246</td>
<td>1,453,798</td>
<td>1,448,448</td>
</tr>
<tr>
<td>Low Income Population</td>
<td>608,961</td>
<td>299,438</td>
<td>309,523</td>
</tr>
<tr>
<td>% of total population</td>
<td>21</td>
<td>10.3</td>
<td>10.7</td>
</tr>
<tr>
<td>% of area’s population</td>
<td>n/a</td>
<td>20.6</td>
<td>21.4*</td>
</tr>
<tr>
<td>% of demographic</td>
<td>100</td>
<td>49.2</td>
<td>50.8</td>
</tr>
</tbody>
</table>

*Higher than regional average
4.3.3. Elderly

**Figure 4: Chicago’s Elderly Population**

*Elderly* is defined as people 65 and older. Areas with higher z-scores have higher concentrations of elderly.

**Table 3: Chicago’s Elderly Indicator Distribution**

<table>
<thead>
<tr>
<th>Elderly Indicator</th>
<th>Citywide</th>
<th>Above Average Access</th>
<th>Below Average Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>2,902,246</td>
<td>1,453,798</td>
<td>1,448,448</td>
</tr>
<tr>
<td>Elderly Population</td>
<td>311,697</td>
<td>146,409</td>
<td>165,288</td>
</tr>
<tr>
<td>% of total population</td>
<td>10.7</td>
<td>5</td>
<td>5.7</td>
</tr>
<tr>
<td>% of area’s population</td>
<td>n/a</td>
<td>10.1</td>
<td>11.4*</td>
</tr>
<tr>
<td>% of demographic</td>
<td>100</td>
<td>47</td>
<td>53</td>
</tr>
</tbody>
</table>

*Higher than regional average*
4.3.4 Youth

Figure 5: Chicago’s Youth Population

Youth is defined as people under the age of 18. Areas with higher z-scores have higher concentrations of youth.

Figure 5: Chicago’s Youth Population

Youth Population shows the spatial distribution of Chicago’s youth population and highlights the demographic concentration in areas with below average access to bicycle infrastructure. Similar to the spatial distribution of people living in poverty, large concentrations of Chicago’s youth are located in the West Side, Southwest Side, and Far Southeast Side. As a result of the limited bicycle infrastructure in these neighborhoods, 56.7% of Chicago’s youth have below average access to bicycle facilities, see Table 4: Chicago’s Youth Indicator Distribution below.

Table 4: Chicago’s Youth Indicator Distribution

<table>
<thead>
<tr>
<th>Youth Indicator</th>
<th>Citywide</th>
<th>Above Average Access</th>
<th>Below Average Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>2,902,246</td>
<td>1,453,798</td>
<td>1,448,448</td>
</tr>
<tr>
<td>Youth Population</td>
<td>669,107</td>
<td>289,909</td>
<td>379,198</td>
</tr>
<tr>
<td>% of total population</td>
<td>23.1</td>
<td>10</td>
<td>13.1</td>
</tr>
<tr>
<td>% of area’s population</td>
<td>n/a</td>
<td>20</td>
<td>26.2*</td>
</tr>
<tr>
<td>% of demographic</td>
<td>100</td>
<td>43.3</td>
<td>56.7</td>
</tr>
</tbody>
</table>

*Higher than regional average
4.3.5 Zero-car households

As one can see in Figure 6:

Chicago’s Zero-car Household Population, zero-car households are the only indicator to have high concentrations of its population along the eastern edge of the city. Most of these neighborhoods along the eastern edge of the city are bisected by bicycle lanes. As a result, 57% of zero-car households have above average access to bicycle infrastructure, see Table 5:

Chicago’s Zero-car Household Indicator Distribution below.

Table 5: Chicago’s Zero-car Household Indicator Distribution

<table>
<thead>
<tr>
<th>Zero-car Indicator</th>
<th>Citywide</th>
<th>Above Average Access</th>
<th>Below Average Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>2,902,246</td>
<td>1,453,798</td>
<td>1,448,448</td>
</tr>
<tr>
<td>Zero-car Population</td>
<td>57,095</td>
<td>32,513</td>
<td>24,582</td>
</tr>
<tr>
<td>% of total population</td>
<td>2</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>% of area’s population</td>
<td>n/a</td>
<td>2.2*</td>
<td>1.7</td>
</tr>
<tr>
<td>% of demographic</td>
<td>100</td>
<td>57</td>
<td>43</td>
</tr>
</tbody>
</table>

*Higher than regional average
4.3.6 BEI

Combining the z-scores of all BEI Indicators allows one to elucidate areas of higher disadvantage that would benefit from investment in bicycle infrastructure. Figure 7: Chicago’s BEI shows the spatial distribution of BEI scores. As the spatial distribution of BEI indicators often coincided with one another, block groups with high BEI scores indicate high concentrations of more than one BEI indicator. Notable neighborhoods are located in the West Side, Southwest Side, and Far Southeast Side.

When areas of above average access to bicycle lanes are compared to the BEI, one can see that a large proportion of Chicago’s underserved neighborhoods coincide with disadvantaged populations identified through the BEI. Neighborhoods with high BEI scores that have limited access to bicycle infrastructure are located in the West Side and the Far Southeast Side. These neighborhoods should be viewed as key locations where increased access could improve the overall equity of Chicago’s bicycle network.

Figure 7: Chicago’s BEI
BEI is a composite score of 5 indicators of transportation disadvantage. Areas with higher percentiles indicate areas with higher concentrations of disadvantaged populations.
5. DISCUSSION OF RESULTS

Through Chicago’s case study, this paper demonstrated methods by which bicycle equity can be examined and the results they can produce. Findings demonstrated not only the utility of the methods for identifying transportation and environmental inequality, but demonstrated how different jurisdictions must consider multiple social determinants of inequality in transportation access.

5.1 Findings relation to equity paradigms

Equity can be an illusive goal subject to varying values and ways of defining what is fair. This paper has examined equity at a high level, through horizontal and vertical equity paradigms. Chicago’s case study revealed that communities with high concentrations of disadvantaged populations often coincided with areas of below average access to bicycle infrastructure. Furthermore, many of Chicago’s BEI indicators (minorities, low-income, elderly, and youth) had less access to its bicycle network.

Finding showed that 50% of Chicago’s population had average or above average access to its bicycle network. As pertaining to horizontal equity, this means that 50% of all indicators should have had average or above average access. However, this was not the case, with minorities receiving the least benefit from the location of bicycle infrastructure. Furthermore, these results were not conducive with the concept of vertical equity. The only BEI indicator to have had a greater than average access to bicycle infrastructure was zero-car households. This finding is interesting because it is the only indicator that was based on transportation characteristics and not sociodemographic attributes. A large proportion of Chicago’s zero-car households coincided with regions of high affluence indicating that individuals able to better position themselves in relation to alternative transportation options are choosing not to own a vehicle. Therefore, further
research may be needed to determine if zero-car households is an appropriate indicator of disadvantage.

5.2 Patterns of inequality

Chicago’s case study revealed interesting spatial patterns in the distribution of their bicycle equity indicators. It was found that high concentrations of bicycle equity indicators often spanned several block groups forming large clusters or communities of shared characteristics. This was most dramatically seen in the large geographic concentrations of minorities in western and southern Chicago. Such residential segregation has long been thought to cause disparate effects in health, education, employment opportunities, and housing (Acevedo-Garcia, Lochner, Osypuk & Sybramanian, 2003; Williams & Collins, 2001). Furthermore, the marginalization of certain groups is thought to led to higher disinvestment in these neighborhoods, including poor infrastructure (Williams & Collins, 2001).

Another interesting finding was that the spatial distribution of BEI indicators often coincided with one another. This supports the notion that equality indicators usually fall on a spectrum of disadvantage (Litman, 2014a). For example, block groups often had high concentrations of both minority populations and people living in poverty. This research also revealed that agglomeration of BEI indicators often coincided with areas with substandard access. This further supports the use of index to examine the degree of disadvantage and prioritize areas in greater need.

5.3 Policy Analysis

Chicago Streets for Cycling Plan 2020 set the framework for how Chicago’s bicycle network will develop in the coming years. The plan outlined key principles, the vision for the full-build
network including route typologies, and how they will be implemented in the near-term. Interestingly, the plan didn’t include policies that articulated how Chicago plans to become the most bicycle-friendly city in the US. The plan’s network map and route typology helped explain their vision for the network, however, the lack of policies made it unclear what the city’s specific goals were and how they were to be meet. While the full-build network appeared to greatly improve access to many disadvantaged neighborhoods found to be lacking access in this research, the phasing information provided didn’t provide clear indication for when those neighborhoods should expect to see significant improvements. Instead, the plan outlined specific projects to be completed by 2015 and remained vague with milestones to be completed by 2020. *Chicago Streets for Cycling Plan 2020* stated that implementation will occur in three stages; 1) The completion of 100 miles of protected bike lanes and 10 miles of neighborhood greenways to be completed by 2015. 2) The completion of 50 additional miles of protected bike lanes, and a stronger focus on Neighborhood Bike Routes, including 30 miles of neighborhood greenways and 40 miles of bike lanes to be implanted by 2020. 3) Fill in the remaining gaps in the network and expand the number of bikeways in neighborhoods that do not currently experience much bicycling. Recommendations for implementation to be made when the plan is updated in 2018 (*Chicago Streets for Cycling Plan 2020, 2012*).

Upon examination of the implementation schedule, projects planned through 2015 appeared to do little for underserved neighborhoods with the majority of improvements identified in areas that already had average or above average access to bicycle infrastructure. Furthermore, the lack of information on their evaluation process left it unclear how projects were and will be prioritized. Overall, the lack of policies, implementation objectives, and project evaluation
BICYCLE EQUITY: THE EQUITY OF ACCESS TO BICYCLE INFRASTRUCTURE

criteria left an unclear picture as to the city’s knowledge of its network shortcomings and plans to improve conditions for all Chicagoans.

6. CONCLUSION

This paper has developed an approach for the evaluation of bicycle equity as it relates to the provision of infrastructure. An advantage of the methods described in this paper is its relative simplicity and flexibility to generate resources to help inform decision-making and advocacy efforts with the goal of promoting equitable infrastructure investment that will help create healthy, dynamic, and livable bicycling communities for all.

Chicago’s case study revealed that in some cases disparities exist in access to bicycle infrastructure as Chicago’s minority, low income, elderly, and youth populations had lower access to bicycle infrastructure than the average Chicagoan.

Based on findings and policy analysis, the author offers the following critique and suggestions. The city of Chicago has ambitious plans for becoming the most bicycle-friendly city in the United States. However, the lack of bicycle facilities in key regions raises important equity concerns. While Chicago’s full-build network provides a promising vision that would provide many of its underserved communities with greater access, it fails to clearly outline how this will be accomplished. Based on the network’s phasing, it appears that Chicago is more concerned with implementing high-profile innovative facilities, such as protected bike lanes, than improving the overall connectivity and reach of its network. Further concerns are related to the low prioritization of networks that currently “don’t experience much bicycling activity” (Chicago Streets for Cycling 2020, 2012). As this could be an issue of latent demand, it seems rather short sighted to assume that these neighborhoods don’t desire or deserve better infrastructure. It is recommended that the city develop a set of policies that clearly address their
vision, purpose, and need. Furthermore, more transparent information should be provided on how the network will be implemented in order to meet policy objectives. Because disparities may be occurring despite the lack of intent or purposeful efforts, planners should examine their own practices to ensure that inappropriate considerations do not affect their judgment. Moreover, the profession in general should increase awareness of inequalities in bicycle planning by engaging in open and broad discussions about the issues. Strategic investment in underserved neighborhoods holds promise for increasing travel options, access to jobs and opportunities, and the equitable distribution of infrastructure. Additionally, bicycling reaches beyond mobility issue; affecting the well-being of communities by providing opportunities to be physically active, protection of the environment, and investments in future generations (Cavill, Kahlmeier & Racioppi, 2006; Dora & Philips, 2000). It is important that communities understand the broader impacts bicycling, as an active mode, has on the well-being of communities and their health. Every community making transportation investments, including bicycling and walking investments, should understand who is and is not benefiting from access to infrastructure, the potential inequities that may result from investments, and use that understanding to ensure more equitable processes and outcomes.
BIBLIOGRAPHY


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