ANALYZING DEMOGRAPHIC AND GEOGRAPHIC CHARACTERISTICS OF “CYCLE ATLANTA” SMARTPHONE APPLICATION USERS

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by

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ANALYZING DEMOGRAPHIC AND GEOGRAPHIC CHARACTERISTICS OF “CYCLE ATLANTA” SMARTPHONE APPLICATION USERS

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# TABLE OF CONTENTS

LIST OF TABLES ........................................... v

LIST OF FIGURES ........................................ vi

ACKNOWLEDGEMENTS ................................... viii

SUMMARY ................................................... ix

I MOTIVATION AND OBJECTIVE .............................. 1
  1.1 Congestion and air quality .......................... 1
  1.2 The positive health impacts of biking ............. 2
  1.3 The lack of data on active modes of transportation ... 3
  1.4 The impact of the built environment on cycling .... 5
  1.5 Objective ........................................ 10

II BACKGROUND ............................................. 11
  2.1 The state of bicycle facilities in Atlanta ........... 11
  2.2 The importance of public participation in transportation planning .. 12
  2.3 The case for crowdsourcing .......................... 13
  2.4 Developing the Cycle Atlanta smartphone app .......... 15
  2.5 Designing the user interface ........................ 16
  2.6 Equity concerns .................................... 20
    2.6.1 Smartphone ownership .......................... 20
    2.6.2 Demographic characteristics of cyclists .......... 21

III METHODOLOGY .......................................... 23
  3.1 Obtaining external datasets ........................ 23
  3.2 Preliminary data preparation ........................ 25
  3.3 Demographic analysis ................................ 26
  3.4 Geographic analysis ................................ 27

IV RESULTS ............................................... 29
  4.1 Demographic analysis ................................ 29
    4.1.1 Age ........................................ 29
    4.1.2 Sex ......................................... 32
LIST OF TABLES

1 User personal info questions and possible answers. Each category contained a blank choice if users were not comfortable sharing. ........................................... 17
2 Cyclist characteristics and possible choices. .................................................. 17
3 Demographic and socioeconomic characteristics of cyclists based on National Household Travel Survey data [43]. ............................................................ 22
4 Sample sizes used for demographic analysis. .................................................. 29
5 Percent comparisons for age. ........................................................................... 31
6 Percentage comparisons for sex. .................................................................... 33
7 Percentage comparisons for income. ............................................................... 35
8 Percentage comparisons for ethnicity. ............................................................. 36
9 The top six represented ZIP codes for each dataset. ...................................... 40
LIST OF FIGURES

1. An example of a conventional bike lane on Georgia Tech’s campus in Atlanta. Photo credit: Alex Poznanski. ......................................................... 6

2. An example of a two-way cycle track in Brooklyn, NY. Photo credit: Alex Poznanski. ................................................................. 7

3. A rendering from the UBDG showing a bike box. [36] .................. 8

4. An example of a median refuge island from the UBDG. [36] .......... 8

5. An example from the UBDG of a bicycle-detection loop in California. [36]. 9

6. The distribution of bicycle network miles from LOS “A” to LOS “F” in the Atlanta metropolitan area (2007) [9]. ................................. 11

7. A Shareabouts map of suggested bike share locations in Chicago (2012) [18]. 14

8. The “Settings” page of the Cycle Atlanta app. ................................. 16

9. The “Record” page of the Cycle Atlanta app. ................................. 19

10. The “My Trips” page of the Cycle Atlanta app. ............................... 19

11. The percent of American adults within each age group who own a smartphone (2012) [44]. ................................................................. 21

12. ZIP codes that are located completely or partially with the Perimeter (I-285) or City of Atlanta limits. ......................................................... 25

13. Cyclist distributions by age. Note that there were no CATL users in the 65+ age group. ................................................................. 30

14. The percentages of adults by age group who use the internet (left), and the percentage of adults who have home broadband (right). n=2,253 (2012); [65]. 32

15. Cyclist distributions by gender. ..................................................... 33

16. Cyclist distributions by annual household income. ....................... 35

17. Cyclist distributions by ethnicity. .................................................. 36

18. The distribution of Cycle Atlanta users by home ZIP code. .............. 38

19. The distribution of Bike to Work Challenge participants by home ZIP code. ................................................................. 39


21. The most-represented home ZIP codes for the three datasets (top six for each dataset). ......................................................... 40

22. A comparison between the percent of Cycle Atlanta users living in a ZIP code and the percent of non-white, non-Hispanic residents living in that ZIP code. ......................................................... 42
23 A comparison between the percent of Cycle Atlanta users living in a ZIP code and the median income of households in that ZIP code. .......................... 43
24 A comparison between the percent of Cycle Atlanta users living in a ZIP code and the median age of people living in that ZIP code. .......................... 44
25 A comparison between the percent of Cycle Atlanta users living in a ZIP code and the population density of that ZIP code. .......................... 45
26 The distribution of Cycle Atlanta users based on reported rider type. ........ 48
27 The distribution of Cycle Atlanta users based on frequency of biking. ........ 49
28 The distribution of Cycle Atlanta users based on how long they have been biking for. ................................................................. 50
29 The breakdown of Cycle Atlanta users based on gender and rider type. Numbers inside bars indicate actual values, as opposed to percentages. .......... 51
30 The breakdown of Cycle Atlanta users based on ethnicity and rider type. Numbers inside bars indicate actual values, as opposed to percentages. .......... 52
31 A map of 5500 trips logged by Cycle Atlanta users. Thicker lines indicate a more heavily traveled route [5]. ........................................... 54
32 A map of “intown” trips logged by Cycle Atlanta users. Thicker lines indicate a more heavily traveled route. [5]. ........................................... 55
33 A map of strategic corridors that the City of Atlanta wishes to address via the Cycle Atlanta project [20]. ........................................... 59
34 The most-represented home ZIP codes for the three datasets (top six for each dataset). Areas shaded red are within City of Atlanta limits. .............. 62
35 The three phase 1 market service areas for a potential Atlanta bikeshare system [7]. ................................................................. 64
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And of course, I must thank my family, who nurtured my love of transportation from an early age.
This research presents an analysis of the demographic and geographic characteristics of Cycle Atlanta users. Cycle Atlanta is a smartphone application that was developed to collect bicycle route and infrastructure data in Atlanta via crowdsourcing. The data will be used to guide transportation planners and public agencies as they improve and build new bicycle facilities. However, if the data are to be used for equitable urban planning, it is important to ensure that they reflect a wide variety of cyclists with regard to demographic and geographic characteristics. The objective of this research is to analyze how the demographic characteristics and reported home locations of Cycle Atlanta smartphone app users compare to those of cyclists reflected by other datasets.

The findings of this research show that the majority of Cycle Atlanta users are young, white males belonging to either a very high annual income group or a low annual income group, with fewer users belonging to middle-income groups. Most of the app’s users live in east-side, “intown” Atlanta neighborhoods. Other cyclist data for the Atlanta area show similar trends, although less pronounced than the trends exhibited by Cycle Atlanta users.

Because smartphone apps such as Cycle Atlanta are a fairly recent innovation, there is still a great deal of uncertainty as to how equitably they can gather bicycle data. The research presented in this thesis has the potential to empower transportation planners to plan bicycle facilities that will benefit many different facets of the cycling community in Atlanta. This has the potential to increase the mode share of cycling in cities, which will reduce congestion and promote healthier lifestyles.
CHAPTER I

MOTIVATION AND OBJECTIVE

Biking plays an important role as a mode of transportation in urban areas. An increase in the mode share of biking has the potential to address congestion, promote healthy, active lifestyles, and create a sense of community. Biking also can provide mobility to people who cannot drive a car or do not own one. Unfortunately, transportation planners and decision-makers have a tendency to overlook biking as a beneficial, important mode of transportation. A major cause for this oversight is the lack of bicycle data available for planning and decision making. Without adequate data, it is difficult to plan and implement improvements to bicycle networks in urban areas.

1.1 Congestion and air quality

Biking has the potential to address the problem of congestion in urban areas. In 2011, vehicle congestion cost the Atlanta metropolitan area approximately three billion dollars, causing approximately sixty-four million gallons of excess fuel to be consumed [47]. While it is not reasonable to expect an increase in biking to significantly reduce congestion, there is still mitigation potential. According to the 2009 National Household Travel Survey, 53% of trips taken in urban areas are three miles or less; however, only 1.8% of these trips are biked [6]. Promoting cycling has the potential to shift some of these short trips from car to bike, especially in areas where there is infrastructure to support cycling.

Although cycling alone can realistically only address congestion resulting from short trips, the potential for mitigation increases when cycling is combined with transit-use. This has to do with the fact that using transit requires having available access and egress modes to and from transit. While people are usually only willing to walk 400 meters at a time [12], the threshold rises to between two and five kilometers for biking [34]. Krizek and Stonebraker’s research suggests that integrating biking and transit use can increase the catchment area for transit, making it more accessible to more people [33]. Hence, encouraging biking in urban
areas has the potential to encourage transit use. And unlike biking, transit can compete with the automobile for longer trips.

Related to congestion mitigation, promoting cycling has the potential to improve air quality in urban areas. In 2011, auto commuters in Atlanta each produced 462 pounds of CO₂ emissions during congestion [47]. The more bike trips taken instead of auto trips, the fewer greenhouse gas emissions there will be.

1.2 The positive health impacts of biking

Biking provides health and quality of life-related benefits. It provides physical activity, a lack of which has been shown to increase obesity [19]. Obesity has become a major health problem in the United States. As of 2010, over one-third of American adults (37%) and approximately 17% of American youth were obese [39]. Obesity increases one’s risk of hypertension, diabetes, heart disease, cancer, lung disease, and overall mortality [37].

The correlation between physical inactivity and health problems began to surface in the 1970’s. Since then, the amount of research published on physical activity has increased. Generally, public health experts recommend that people engage in at least 30 minutes a day of physical activity. It is very common for people to get this daily physical activity by walking, as walking is feasible for and accessible to most people. Biking is also common [45].

Research has shown that there is a positive correlation between obesity and sprawl in urban areas. Urban sprawl leads to longer commute times, which affects how physically active people are. The more time Americans spend commuting, the less time they have for physical activity, adequate sleep, and for preparing healthy meals [19]. Active transportation modes (such as walking and biking) promote physical activity that is necessary to combat obesity; however, urban sprawl has made it difficult to walk or bike for transportation purposes. In fact, research has demonstrated that three-quarters of trips less than a mile are driven, instead of walked or biked [26].

One could argue that the safety issues associated with biking (such as breathing in air pollution and the risk of traffic incidents) are reasons not to bike, despite the health benefits
that biking provides. However, de Hartog et al. found the opposite to be true. According to their 2010 study, the benefits of cycling out-weigh the risks, especially because the potential risks to cycling could decrease as the prevalence of cycling increases [31]. In fact, according to Jacobsen’s research on cycling safety trends, cyclists are less likely to be involved in accidents with motor vehicles as the amount of biking in that area increases (strength in numbers) [30].

1.3 The lack of data on active modes of transportation

Walking and biking are considered “active” modes of transportation, and are becoming a greater topic of interest to researchers, in both the fields of public health, and urban transportation. In fact, researchers from these fields have realized that they share a common goal in encouraging active modes of transportation. Transportation researchers have historically focused mostly on vehicular travel, and their data-collection endeavors have reflected this. Travel demand models, which have been used by metropolitan planning organizations (MPOs) to plan changes and additions to transportation networks, have also been very auto-focused in the past. Many travel demand models overlook non-motorized forms of transportation such as walking and biking. During the “trip distribution” stage of travel demand modeling where origins and destinations are linked between traffic analysis zones (TAZs), many travel demand models have failed to account for trips taken within one TAZ (referred to as “intra-zonal” trips). Most of these trips are taken using a non-motorized transportation mode, such as walking and biking. Because travel demand models often neglect these intra-zonal trips, walking and biking have not been adequately planned for by MPOs [45].

In fact, it has only been about twenty-five years since MPOs first began including non-motorized forms of transportation into their demand forecasting models. Even today, standards vary between MPOs, and not all of them account for non-motorized forms of transportation the same way in their models. One of the reasons behind is this is the limited amount and quality of data on bicycle and pedestrian trips [48]. Because of the limited data that MPOs have on non-motorized modes, they often make assumptions about trips taken
using these modes, especially for bicycle trips. For example, during the “mode choice” step of many travel demand models, the assumption is made that cyclists will choose the shortest path between origins and destinations, without taking factors such as traffic speed, quality/quantity of bicycle facilities, and topography into consideration. Because these factors are important to cyclists when they decide to bike and plan their trips, excluding them from travel demand models results in cyclists being inadequately planned for [14].

Because so few data are available on walking and biking trips, many MPOs do not distinguish between them in travel demand models. In fact, the Atlanta Regional Commission combines walking and biking into a single mode known as “non-motorized travel” in their travel demand model [11].

Schenider et al. addressed the concern of limited bicycle data availability by doing a case study analysis of places in the United States where bicycle data have been collected, and in what ways these data were collected. They identify manual counts of cyclists, automated counts, surveys of cyclists/the general population, inventories, and spatial analyses as bicycle data collection methods. They found that the cost of collecting bicycle data was often a barrier for local governments/MPOs, especially for methods such as manual counts and surveys. Automating bicycle counting, however, can reduce these costs. Their study also shows that many agencies are reluctant to spend a great deal of time and money on collecting bicycle data, since people who cycle for transportation represent such a small percentage of the population [46]. This poses a challenging conundrum. Cyclists have been neglected in planning procedures because they are few in number; however, it can also be argued that they are few in number because they have not been planned for.

Research has addressed this concern of limited data for demand modeling, showing that traditional travel diaries used to collect transportation data are not adequate, as they do not provide MPOs with the quality and quantity of data necessary. Parlak, et al. studied the potential for enhancing travel demand models using smartphones. They found that the GPS and accelerometer capabilities of smartphones are an asset to demand modeling, especially for mode determination [41].
1.4 The impact of the built environment on cycling

In order to encourage more people to ride bicycles and promote biking as a legitimate mode of transportation, people must be provided with bicycle facilities that they feel comfortable using. Research has shown that people prefer bicycle facilities such as designated lanes and trails over unmarked facilities with no separation from traffic. According to the Institute of Transportation Engineers (ITE), separated bicycle facilities are often built in areas where traffic speeds are high and it is unsafe for bike traffic to be integrated with motor vehicle traffic. These facilities make cyclists feel more comfortable, especially cyclists who are inexperienced [42]. The National Association of City Transportation Officials (NACTO) published the Urban Bikeway Design Guide (UBDG), which goes into detail about the different types of bicycle facilities that have been incorporated into bicycle networks in urban areas. The purpose of this guide is to provide planners and decision makers with best-practice guidelines from around the world for building bicycle infrastructure in urban areas. They classify bicycle facilities as “bike lanes,” “cycle tracks,” and different types of infrastructure that can be found at intersections [36]. The bicycle facilities detailed in the UBDG are the type of infrastructure improvements that could be fueled by Cycle Atlanta data and encourage more people in Atlanta to bike.

The UBDG describes bike lanes as portions of roadways that have been designated for cyclists using various traffic control devices such as striping/marking, and signage. According to the guide, bike lanes enhance cyclist comfort and safety by separating them from vehicle traffic, although not completely separating them from the roadway environment. In addition to the safety and comfort benefits that bike lanes provide, they also increase road capacity for motor vehicles, which sometimes are hindered by slower-moving vehicles such as bicycles. As bicycle planning is very context-sensitive, the guide describes different types of bike lanes to be used in different settings, such as conventional bike lanes, buffered bike lanes, contra-flow bike lanes, and left-side bike lanes [36]. Figure 1 shows an example of a conventional bike lane in Atlanta.
Figure 1: An example of a conventional bike lane on Georgia Tech’s campus in Atlanta. Photo credit: Alex Poznanski.

Another example of bicycle infrastructure that the UBDG provides insight on is cycle tracks. These are similar to bike lanes in that they are still integrated with the road environment; however, they provide cyclists with a greater degree of physical separation than bike lanes do. It is this enhanced physical separation that make cycle tracks sometimes preferable to bike lanes, since cyclists feel more comfortable when they are separated from motor vehicle traffic. The three types of cycle tracks mentioned in the UBDG are one-way protected cycle tracks, raised cycle tracks, and two-way cycle tracks [36]. Figure 2 shows an example of a two-way cycle track.
Figure 2: An example of a two-way cycle track in Brooklyn, NY. Photo credit: Alex Poznanski.

Aside from bike lanes and cycle tracks, the UBDG also describes bicycle infrastructure found at intersections. An example of this type of infrastructure is bike boxes. These are areas positioned before the beginning of an intersection but after the vehicle stop bar. They allow cyclists to get ahead of traffic at intersections, which is especially beneficial for making turns. Bike boxes help to reduce signal delay for cyclists, and also make cyclists more visible to motorists at intersections. In addition, by placing bicycles ahead of idling vehicles, cyclists do not have to breathe as much car exhaust as they would if they were positioned behind vehicles stopped at an intersection [36]. Figure 3 shows an example of a bike box.
Figure 3: A rendering from the UBDG showing a bike box. [36]

Another example of bicycle infrastructure found at intersections are median refuge islands. These are useful at intersections with a high volume of motor vehicle traffic, as they give cyclists a safe area to wait for a gap in traffic and finish crossing a street. Median refuge islands also have traffic-calming benefits, because they cause cars to slow down as they approach an intersection [36]. Figure 4 shows an example of a median refuge island in Belvue, Washington.

Figure 4: An example of a median refuge island from the UBDG. [36]
For intersections that use actuated signal timing, the UBDG recommends installing bicycle-detection equipment, such as loop detectors, which do not require the motorist to dismount in order to activate them. Bicycle-detection equipment informs the traffic signal controller at an intersection that a bicycle is waiting to pass through. This helps to reduce delay for cyclists waiting at intersections [36]. An example of bicycle detection loops embedded in pavement is shown in Figure 5.

![Bicycle detection loop](image)

**Figure 5:** An example from the UBDG of a bicycle-detection loop in California. [36]

Cyclists have different preferences regarding the infrastructure that makes them feel comfortable biking. Tilahun et al. used a stated preference survey to find out what kinds of bicycle facilities participants preferred, with travel time as the “cost” for using a facility. The different kinds of facilities were an off-road trail, a bike lane without on-street parking next to it, a bike lane with on-street parking next to it, a street with no bike lane and no parked cars, and a street with no bike lane with parked cars. They found that participants were willing to add time to their trips if it meant being able to bike in a designated bike facility. Specifically, participants most preferred streets with designated bike lanes [51].

Cyclists' preferences for certain kinds of bike facilities can be further broken down based on demographics. Krizek et al. studied gender differences in cycling with regard to bicycle facilities/infrastructure. Part of their research included an analysis of a survey administered
by the Minnesota Department of Transportation. The survey asked participants to rate the importance of having certain types of bicycle facilities. Krizek et al. found that female survey participants were more likely than male survey participants to rate infrastructure such as paved shoulders and well-lit bike paths as "very important" amenities for commuting by bike. Participants were also asked what made them feel unsafe while biking. Overall, women were more likely than men to report a lack of bike paths and poor road conditions as issues that made them feel unsafe while biking. On the other hand, men were more likely to cite poor road-user behavior (reckless driving or cycling) as issues that made them feel unsafe while biking [32].

1.5 Objective

The objective of this research is to analyze how the demographic characteristics and reported home locations of Cycle Atlanta smartphone application users compare to those of cyclists reflected by other datasets. The external datasets used were the 2009 National Household Travel Survey, recent data from the American Community Survey, and the 2012 Bike to Work Challenge in Atlanta.
CHAPTER II

BACKGROUND

2.1 The state of bicycle facilities in Atlanta

The Atlanta Regional Commission (ARC) evaluated the state of bicycling conditions and the bicycle network in the Atlanta metropolitan area. The results of this evaluation are presented in ARC’s 2007 Bicycle Transportation and Pedestrian Walkways Plan. For this evaluation, the ARC used the Bicycle Level of Service Model, Version 2.0, a common method for evaluating bicycle networks throughout North America. The model classifies bicycle facilities using a level-of-service (LOS) scale ranging from “A” (most accommodating for cycling) to “F” (least accommodating for cycling). This classification considers criteria such as traffic volumes, the speed of traffic through a corridor, road shoulder widths, and the presence of bike lanes. Overall, most bicycle network miles in the Atlanta area (322.2 miles, or approximately 52%) are a LOS “E,” as shown in Figure 6. This is a very poor average LOS compared to other metropolitan areas in the United States [9].

![Chart showing distribution of bicycle network miles from LOS “A” to LOS “F” in the Atlanta metropolitan area (2007) [9].]

Figure 6: The distribution of bicycle network miles from LOS “A” to LOS “F” in the Atlanta metropolitan area (2007) [9].
Because of the poor quality of bicycle infrastructure in the Atlanta area, it is imperative that conditions for biking are improved if it is to become a more utilized mode of transportation. However, in order to improve Atlanta’s bicycle network, it is key that planners, engineers, and public agencies facilitate the participation of ordinary citizens in the planning process to gain an understanding of where the public wants and needs more bicycle facilities or improvements to the currently existing bicycle facilities.

2.2 The importance of public participation in transportation planning

Public involvement is an integral part of the transportation planning process in urban areas. Burby postulates that the planning process must include the input of a diverse group of stakeholders in order to have a significant impact on policy. His findings show that having a large group of stakeholders involved in urban planning contributes to more robust plans that have a greater likelihood of being implemented than planning efforts that sought the influence of a smaller group of stakeholders [16].

Other research argues that ordinary citizens should be included as stakeholders in the urban planning process, as their input and knowledge are valuable resources that should not be overlooked by planners. Van Herzele studied the planning process leading to the design and construction of a park in Belgium. She suggests that planners should consult the general public during the urban planning process in order to gain a non-professional perspective of the situation. Van Herzele emphasizes how citizen input can complement the professional experience and more “academic” knowledge that planners possess by offering a completely different set of viewpoints, as well as local knowledge [63].

Wagner’s research highlights the top three criteria that must be met in order to ensure effective public participation, as shown in transportation literature. He states that the public participation process must (1) be accessible to the public; (2) effectively engage the public, and (3) be outcome-oriented [64]. The research described in this thesis is particularly concerned with the first of these three criteria.
2.3 The case for crowdsourcing

The term “crowdsourcing” was coined by Jeff Howe in a 2006 issue of Wired magazine as a way to describe technological advances resulting from the collective endeavors and contributions of internet-based communities [28]. Brabham’s research shows that for transportation planning, crowdsourcing can be more useful than traditional methods of public participation in several ways. Traditional methods of public participation (such as public meetings and workshops) often lack the breadth that crowdsourcing provides, as they are often attended by a small group of citizens relative to the size of the overall community. Traditional methods also often require citizens to attend a meeting at a specific time and place, which can potentially exclude people for whom that time and place is not convenient. Crowdsourcing, on the other hand, can use the internet to gather input from more people than something such as a public meeting could. Brabham also highlights internet-based public participation as a more “disaggregate” method of gathering public input, as the internet does not facilitate collaboration like face-to-face public meetings do. In addition, using the internet as a medium for public participation allows there to be some degree of anonymity when people are voicing their opinions. People participating in a public meeting might feel the need to censor some of their opinions and ideas due to the prevailing viewpoints of others at the meeting. The same is not the case for public input facilitated by the internet, as individuals do not have to identify themselves [13].

An example of crowdsourcing used for urban planning purposes is Shareabouts. This is an internet-based mapping platform that gathers input from ordinary citizens for various projects [40]. For example, a current Shareabouts project is mapping potential locations for bike share stations in Chicago. Users access the project and then add locations to a map (see Figure 7) where they believe a bike share station should be located, and explain why they believe the station should be located there [18]. Planners can use this map to see which locations in the city are best suited for bike share stations based on citizen preference.
Figure 7: A Shareabouts map of suggested bike share locations in Chicago (2012) [18].

Smartphones have greatly impacted crowdsourcing, as people can now literally carry the internet with them anywhere. Examples of smartphone apps that crowdsource data for urban planning/transportation planning purposes are Tiramisu and Street Bump. Tiramisu is a mobile system that was developed at Carnegie Mellon University to crowdsource public transportation data in Pittsburgh. The app uses the GPS traces from users’ smartphones to make real-time bus arrival predictions. Tiramisu also allows users to provide feedback directly from their phones. In this case, not only is crowdsourcing being used to gather public opinions, but it is also being used to gather data directly from transit riders to help improve service [49].

Street Bump is a smartphone app that uses a smartphone’s accelerometer and GPS capabilities to crowdsource road condition data. The accelerometer can detect the user hitting a pothole while driving. In addition, the app uses GPS to record where that pothole was encountered. This information is being used by public agencies in the Boston area.
to create a street condition inventory to be used for transportation planning [38]. Cycle Atlanta accomplishes a similar goal in the Atlanta metropolitan area for bicycle planning.

2.4 Developing the Cycle Atlanta smartphone app

The Cycle Atlanta smartphone app was developed in September, 2011 by an interdisciplinary team of researchers at Georgia Tech as a way to collect bicycle route and infrastructure data in Atlanta. Cyclists download the app and then use it to record their trips while they are biking. The app uses a smartphone’s GPS capabilities to track cyclists as they are riding. Once recorded, trips are uploaded to a database accessed by researchers at Georgia Tech, and eventually the City of Atlanta. The project is funded in part by the City of Atlanta, which plans to use the data collected from Cycle Atlanta to guide bicycle infrastructure improvements throughout the city [5].

Cycle Atlanta is based on the open source code of Cycle Tracks, an app created in San Francisco. The San Francisco County Transportation Authority (SFCTA) developed Cycle Tracks as a way to crowdsourcing bicycle route data, i.e., collect bicycle route data directly from cyclists in San Francisco. The Cycle Tracks team used the data collected by the app to create a bicycle route choice model to eventually be incorporated into the trip assignment module of SF-CHAMP, San Francisco’s travel demand forecasting tool. The team also used their route choice model to estimate the cost-benefit ratios of bicycle facilities throughout the city [27].

The motivation behind Cycle Tracks was a lack of bicycle route and infrastructure data, especially data provided directly by cyclists [17]. Traditionally, such data would be collected by holding public meetings. Cycle Tracks and apps similar to it address the goal of making public participation more accessible by moving the participation medium from a public meeting to an internet-based platform.

Apps such as Cycle Tracks and Cycle Atlanta have combined crowdsourcing with smartphone technology. This gives them the potential to gather more information on the state of bicycle infrastructure in urban areas than would be possible via other methods. It is rare for public agencies to collect bicycle route and infrastructure data. Agencies that do collect
such data often do not have much of it, as conventional collection methods such as surveys are difficult and expensive to conduct [29]. Apps such as Cycle Tracks and Cycle Atlanta not only elicit public participation in transportation planning, but also benefit public agencies by collecting data that would be difficult and expensive for agencies to collect themselves. There are also direct benefits for the people who use these apps. Cycle Tracks and Cycle Atlanta allow users to keep a record of all of their trips, including a map of the route, the time it took to complete the trip, and the cyclist’s average speed.

2.5 Designing the user interface

In addition to tracking cyclists’ trips, the app prompts users to enter personal information on the “Settings” page, as seen in Figure 8. The information categories are age, email address, gender, ethnicity, home income, ZIP codes (home, work, and school), cycle frequency, rider type, and rider history. Users are not required to enter information into any of the fields, and can still use the app to record trips if they choose not to share their personal information.

![Image of the “Settings” page of the Cycle Atlanta app.](image)

**Figure 8:** The “Settings” page of the Cycle Atlanta app.

The categories and their answer breakdowns are shown in Tables 1 and 2, along with how many users (n) provided data for each category. Also note that the number of users who reported home, work, and school ZIP codes were 295, 249, and 68, respectively. Only fifteen users provided data for every information category, without leaving anything blank.
Table 1: User personal info questions and possible answers. Each category contained a blank choice if users were not comfortable sharing.

<table>
<thead>
<tr>
<th>Age (n=318)</th>
<th>Gender (n=311)</th>
<th>Ethnicity (n=295)</th>
<th>Home income (n=242)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 18</td>
<td>Male</td>
<td>White</td>
<td>Less than $20,000</td>
</tr>
<tr>
<td>18-24</td>
<td>Female</td>
<td>African American</td>
<td>$20,000-$39,999</td>
</tr>
<tr>
<td>25-34</td>
<td></td>
<td>Asian</td>
<td>$40,000-$59,999</td>
</tr>
<tr>
<td>35-44</td>
<td></td>
<td>Native American</td>
<td>$60,000-$74,999</td>
</tr>
<tr>
<td>45-54</td>
<td></td>
<td>Pacific Islander</td>
<td>$75,000-$99,999</td>
</tr>
<tr>
<td>55-64</td>
<td></td>
<td>Multi-racial</td>
<td>$100,000 or greater</td>
</tr>
<tr>
<td>65+</td>
<td></td>
<td>Hispanic/Mexican/Latino</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Cyclist characteristics and possible choices.

<table>
<thead>
<tr>
<th>Cycle Frequency (n=193)</th>
<th>Rider Type (n=313)</th>
<th>Rider History (n=312)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Strong and fearless</td>
<td>Since childhood</td>
</tr>
<tr>
<td>Several times per week</td>
<td>Enthused and confident</td>
<td>Several years</td>
</tr>
<tr>
<td>Several times per month</td>
<td>Comfortable, but cautious</td>
<td>One year or less</td>
</tr>
<tr>
<td>Less than once a month</td>
<td>Interested, but concerned</td>
<td>Just trying it/jus: started</td>
</tr>
</tbody>
</table>

The motivation behind collecting personal information from users after they download the app was to allow the research team to be cognizant of the different types of cyclists using the app with regard to demographics, home/work/school location, and comfort with cycling. This allows the team to tailor its marketing strategies towards attracting a wide variety of cyclists. Having user information available will also allow the research team to examine how user characteristics affect the types of routes users choose to take while cycling. For example, the research team can look at the routes taken by people who identify themselves as “Comfortable, but cautious” and compare them to the routes taken by people who identify themselves as “Strong and fearless.” If we create maps of these routes and make them available to users, then people who identify themselves as “Comfortable, but cautious” can look at routes preferred by others who identify that way to help them select a route they will be comfortable biking on. Overall, the more information that can be gathered on cyclists, the better cyclists can be planned for.
The category answer breakdowns for age, gender, ethnicity, and home income were based on the breakdowns used by the Atlanta Regional Commission (ARC) in their 2011 Regional Travel Survey [10]. The answer breakdowns for the rider type category were based on the four general categories of cyclists created by the City of Portland, Oregon, with some modifications. The City of Portland’s four categories are “Strong and fearless,” “Enthusiastic and confident,” “Interested but concerned,” and “No way, no how.” These categories were created in order to give planners in Portland more and better information on what cyclists in the city are like regarding their cycling comfort and ability. The City of Portland’s intent was for planners to use this information as a way to better estimate the market for bicycle transportation in Portland, as well as the market for specific types of bicycle facilities [25]. Dill and McNeil did a study of 908 adults in Portland to evaluate how effective the city’s “four types of cyclists” categories are at accurately depicting Portland cyclists. They found the categories to be adequate, as the vast majority of the people they surveyed could identify with one of the four categories [22].

For Cycle Atlanta, the “no way, no how” option was removed, as the app is only intended for people who currently cycle. Instead, an option for “Comfortable, but cautious” cyclists was included between “Enthusiastic and confident” and “Interested but concerned,” to distinguish between regular cyclists who maintain caution when choosing their routes and occasional cyclists who are reluctant to bike on city streets.

At the start of a trip, a user navigates to the “Record” screen to begin logging a trip (see Figure 9). After a trip as been logged, users are asked to indicate their trip purpose as a commute, school-related, work-related, exercise, social, shopping, errand, or other. Then, users are asked to enter any comments they might have, such as infrastructure conditions along the route, or app-related technical problems. All of this information is optional for users to share. Users can review previously logged trips by navigating to the “My Trips” section of the app. Figure 10 shows an example of a trip logged from Georgia Tech to Grant Park in Atlanta.
An initial issue encountered when promoting Cycle Atlanta was that cyclists preferred using other biking apps that contain features Cycle Atlanta did not initially have. Hence, the research team wanted to incorporate some of these features to incentivize cyclists to use Cycle Atlanta, as opposed to other apps. These other bicycle-themed smartphone apps were examined during the Cycle Atlanta initial planning process for guidance. Strava [2] and Endomondo [1] are smartphone apps used to track exercise progress, including cycling. After logging a ride, these apps tell users information such as how long the ride was, how
many miles were biked, and how many calories were burned. Like these apps, the next release of Cycle Atlanta will tell users how many calories they burned as a function of the number of miles biked during a trip. This calculation is a rough estimate, which will not take factors such as user weight or height into consideration. The next release of Cycle Atlanta will also tell users how many grams of CO$_2$ they saved by biking instead of driving, using Equation 1. In the future, the research team hopes to provide even more features like this that directly benefit users, and incentivize cyclists to choose Cycle Atlanta over other bicycle apps.

\[
\text{CO}_2 \text{ emissions saved} = (423 \frac{\text{grams}}{\text{mile}}) \times (\# \text{ of miles biked})
\]  

Equation 1 yields an estimate based on information provided by the Environmental Protection Agency (EPA) on passenger vehicle greenhouse gas emissions. According to the EPA, a typical passenger vehicles emits 8,887 grams of CO$_2$ when burning a gallon of gasoline and has a fuel economy of 21 miles per gallon. Hence, 423 grams of CO$_2$ are emitted per mile by the average passenger vehicle [62]. Every mile biked prevents 423 grams of CO$_2$ from being released into the atmosphere.

2.6 Equity concerns

A major concern upon releasing Cycle Atlanta was that cyclists falling into certain demographic groups would not use Cycle Atlanta, or even have access to it. The primary reason for this concern is the fact that Cycle Atlanta is a smartphone app, meaning that non-smartphone users are excluded. While analyzing the demographic characteristics of Cycle Atlanta users, the team also remained cognizant of the fact that the demographic trends of cyclists tend to be different than those of the overall population.

2.6.1 Smartphone ownership

A smartphone is needed to use Cycle Atlanta; however, not everyone owns a smartphone, or even has access to the internet. This is especially true for older people. According to a 2012 survey done by the Pew Research Center, while more than 90% of people surveyed below age
fifty use the internet, this decreases to 77% for people in the 50-64 age group, and to 53% for people sixty-five and over [65]. The percentages are even lower for smartphone ownership. According to another Pew survey, a person’s likelihood of owning a smartphone decreases as a function of increasing age. Figure 11 shows that less than 40% of American adults ages 50-64 surveyed own a smartphone, and that this number decreases to about ten percent for adults age 65 and up. According to the same survey, the likelihood of a respondent owning a smartphone decreased with decreasing income. The trends for smartphone ownership based on gender and ethnicity were less pronounced [44].

![Bar chart showing percentage of smartphone ownership by age group](image)

**Figure 11:** The percent of American adults within each age group who own a smartphone (2012) [44].

### 2.6.2 Demographic characteristics of cyclists

Demographic trends for cyclists are different than those of the general population, and this was something that needed to be considered while analyzing the characteristics of Cycle Atlanta users. Pucher and Buehler compiled socioeconomic and demographic information for cyclists throughout the United States, based on the 2001 and 2009 National Household Travel Surveys (NHTS). The results are shown in Table 3. Based on the 2009 NHTS, 77% of cyclists were male, while 23% of cyclists were female [43]. This is much less balanced than the overall gender ratio in the United States, which was 49.2% male and 50.8% female according
Table 3: Demographic and socioeconomic characteristics of cyclists based on National Household Travel Survey data [43].

<table>
<thead>
<tr>
<th></th>
<th>Bike Share of All Trips</th>
<th>Share of All Bike Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Female</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Age Group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 to 15 years</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>16 to 24 years</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>25 to 39 years</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>40 to 64 years</td>
<td>0.4</td>
<td>0.7</td>
</tr>
<tr>
<td>65 and older</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Automobiles Owned in Household</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No car</td>
<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>One car</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Two cars</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Three and more cars</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Household Income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Quartile</td>
<td>0.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Second Quartile</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Third Quartile</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Highest Quartile</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>African American</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Asian</td>
<td>0.5</td>
<td>0.8</td>
</tr>
</tbody>
</table>

to the 2010 Census [53]. According to the 2009 NHTS, 76% of cyclists in the United States were younger than forty years old [43]. This is indicative that the cycling population is younger than the overall population, as the 2010 Census reported that approximately 54% of Americans were younger than forty years old [53]. Regarding race, the vast majority of cyclists surveyed by the 2009 NHTS were white (79%) [43]. This is not too different from the 2010 Census, which reported that 72.4% of the overall population was white [54].
CHAPTER III

 METHODOLOGY

3.1 Obtaining external datasets

In order to compare the characteristics of Cycle Atlanta users to the characteristics of the overall cycling population in Atlanta, external datasets were needed. Four datasets were considered for analysis. These were the Atlanta Regional Commission’s (ARC) 2011 regional travel survey, the American Community Survey’s (ACS) 2007-2011 5-year estimates, the 2009 National Household Travel Survey, and the 2012 Atlanta Bike to Work Challenge user database and survey results.

The first dataset considered for analysis was ARC’s 2011 regional travel survey. This survey collects transportation data from a sample of households in the Atlanta metropolitan area for planning purposes. Respondents are asked to provide demographic information such as age, ethnicity, income, and gender. Participants are also asked about their travel habits, such as transportation modes used for recent trips. Very few people (approximately 40 in the entire metropolitan area) indicated that they took bicycle trips [10]. It would be very difficult to draw conclusions based on such a small dataset, especially since the survey data reflect participants in twenty counties and are hence very diluted (compared to the Cycle Atlanta study area, which mostly falls into two counties). In addition, the geographic unit used in the ARC travel survey was the traffic analysis zone (TAZ), while Cycle Atlanta uses ZIP codes. This would make it difficult to compare the two datasets based on geographic characteristics of users, as TAZs and ZIP codes do not coincide. Because of the shortcomings of the ARC regional travel survey, it was not used for analysis.

One of the datasets selected for analysis was the American Community Survey’s (ACS) 2007-2011 5-year survey estimates of commuting characteristics by sex, obtained from the United States Census Bureau [57]. When aggregated at the ZIP code level, this dataset provides the number of workers over age 16 in a ZIP code broken down by sex and mode
of transportation used to commute to and from work. For each ZIP code, the percent of workers who used a bike for commuting purposes was provided, as well as the percent of male workers who commute by bike and the percent of female workers who commute by bike in that ZIP code. The research team decided to use this dataset to compare to the Cycle Atlanta data based on home ZIP code distribution, with the ACS database functioning as a “control” group representing the overall cycling population in Atlanta.

Note that other ACS datasets were considered for demographic comparison purposes; however, none of the datasets isolated biking as a mode of transportation as the chosen ACS dataset did. Rather, these datasets grouped biking with other modes of transportation, such as using a taxicab or a motorcycle. Hence, these datasets could not be used for demographic comparison.

Another external dataset that was used was the 2009 National Household Travel Survey (NHTS). The 2009 NHTS contains microdata (not aggregated) on the transportation patterns of 150,147 households in the United States. The survey data are available to the general public, and represent all trips taken by participants over a 24-hour period for all modes of transportation. Questions asked of the participants included their age, ethnicity, household income, gender, and how many bike trips they took in the previous week [61]. This dataset was treated as a “control” group to compared to the Cycle Atlanta data to based on demographic characteristics.

The third dataset selected for comparison with the Cycle Atlanta data was the participant database of The Clean Air Campaign’s 2012 Bike to Work Challenge. This was an event where participants were encouraged to bike to work, and the participants who logged the most bike trips to work won prizes. There were 1,070 people who signed up to participate, and 17,125 bike trips were logged [50]. The database contained the home and work addresses of participants. An external survey of participants (n=309) was also used for comparison. It contained demographic information about participants. Rather than being used to represent the overall cycling population as was the case for the ACS and NHTS datasets, the Bike to Work Challenge dataset reflects cyclists who can be incentivized to start biking or bike more often, as well as cyclists who bike to work.
3.2 Preliminary data preparation

Before analyzing the characteristics of Cycle Atlanta users, the data had to be cleaned. Users who indicated that they lived outside of the Atlanta metropolitan area were purged from the database. This was done by sorting the table of users by the home ZIP code they reported and deleting the records that contained ZIP codes outside of the Atlanta area.

For geographic analysis using ArcGIS, a shapefile of Atlanta ZIP codes was obtained from the ARC. However, ARC’s ZIP code shapefile did not contain all of the ZIP codes reported by Cycle Atlanta users. For example, the ZIP code 30332, which contains part of Georgia Tech’s campus, was not part of the ARC ZIP code shapefile. To rectify this, missing ZIP codes were drawn into the shapefile using Google Maps and a shapefile of city streets for guidance.

The chosen study area comprised of ZIP codes located either completely or partially within Atlanta city limits and/or the Perimeter (I-285), as shown by the red shading in Figure 12.

![Figure 12](image_url) ZIP codes that are located completely or partially with the Perimeter (I-285) or City of Atlanta limits.
The ACS dataset included ZIP codes throughout all of Georgia; however, only data for
ZIP codes in the study area were used. The number of people who commuted to work by
bike in each ZIP code was calculated by multiplying the total number of workers in that
ZIP code by the percent of workers in that ZIP code who reported commuting by bike.

The Bike to Work (BTW) challenge participant database was prepared by selecting all
participants who reported a home ZIP code within the previously described study area
used for analysis. This database was then joined to the ZIP codes shapefile in ArcGIS. The
participant survey did not require preparation for analysis, as the category breakdowns for
age, ethnicity, income, and gender were the same as those used for Cycle Atlanta. Further
aggregation was not necessary.

To prepare the NHTS dataset for analysis, a query was performed to isolate the records
of interest. To be included in the analysis, a record had to reflect a participant who was 18
years of age or older, living in the Atlanta-Sandy Springs-Marietta area, and took between
one and twenty bike trips in the previous week. Anyone who did not take a bike trip in
the previous week was considered to be a non-cyclist. Respondents who reported taking
more than twenty bike trips in the previous week were not included, as it was suspected
that these were erroneous data (this excluded two records). Ninety records qualified for use
in the analysis.

To facilitate comparison with the Cycle Atlanta user data, The ages reported by NHTS
respondents were binned to match the age breakdown used in Cycle Atlanta. The household
incomes reported by NHTS respondents were re-binned to match the income breakdown
used in Cycle Atlanta, as they previously had twice the resolution necessary.

3.3 Demographic analysis

The four demographic metrics that were analyzed were age, income, ethnicity, and sex of
Cycle Atlanta users, NHTS respondents, and BTW challenge participants. For all datasets,
a frequency distribution for each trait was created. A table showing the difference in trait
category percentages between CATL and NHTS, and CATL and BTW was created for each
trait. Note that for all datasets, there were very few people who reported that they were
Asian, Native American/Alaskan Native, Pacific Islander/Native Hawaiian, Multi-racial, or another race not available among the choices. These people were grouped together into a category labeled “Other” for analytical purposes. This reduced the ethnicity categories to “White”, “African American”, “Hispanic/Mexican/Latino”, and “Other”.

3.4 Geographic analysis

The ACS, BTW and CATL datasets were queried to return a list of each discrete home ZIP code in that dataset as well as how many people in the dataset reported that ZIP code as their home ZIP code. The datasets were then joined to the study area ZIP code shapefile using home ZIP code as the common field. This resulted in a data table containing fields for home ZIP code (hzip), number of Cycle Atlanta users living in that ZIP code (CATL_hzip_count), number of ACS respondents residing in that ZIP code (ACS_hzip_count), and the number of BTW challenge participants living in that ZIP code (BTW_hzip_count).

Three maps were created in ArcGIS (one for each dataset) to show the percent of cyclists within the study area who reported each ZIP code as the one they resided in. The maps were shaded in such a way that darker ZIP codes had a greater percentage of the dataset’s cyclists (within the study area). For context, an OpenStreetMap [3] basemap was added to each map.

To analyze the relationships between Cycle Atlanta user home ZIP codes and demographic traits associated with those ZIP codes, four maps were generated using census data. For each map, the shade of the ZIP code polygon represents the demographic variable (ZIP code median age, median annual income, percent of non-white residents, and population density). The size of the black dot over a ZIP code represents the percent of Cycle Atlanta users residing there. The median age and percent non-white data were obtained from American Community Survey table DP05, ”Demographic and Housing, 2007-2011 5-year estimates” [56]. The median income data were obtained from American Community Survey table S1903, ”Median Income in the Past Twelve Months (In 2011 Inflation-Adjusted Dollars), 2007-2011 5-year estimates” [58]. The population density data were obtained
from American Community Survey table B01003, "Total population, 2007-2011 American Community Survey 5-Year Estimates" [59].
CHAPTER IV

RESULTS

4.1 Demographic analysis

The demographic traits that were analyzed were age, income, sex, and ethnicity. The sample sizes for all datasets varied based on the trait being analyzed because not everyone reported an answer for every trait. For example, Table 4 shows that people across all datasets were more reluctant to report their income, compared to other demographic traits.

Table 4: Sample sizes used for demographic analysis.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Age</th>
<th>Gender</th>
<th>Income</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHTS</td>
<td>90</td>
<td>90</td>
<td>89</td>
<td>90</td>
</tr>
<tr>
<td>CATL</td>
<td>318</td>
<td>311</td>
<td>242</td>
<td>295</td>
</tr>
<tr>
<td>BTW</td>
<td>283</td>
<td>282</td>
<td>262</td>
<td>274</td>
</tr>
</tbody>
</table>

4.1.1 Age

Figure 13 shows a comparison between the percent of Cycle Atlanta (CATL) users, National Household Travel Survey (NHTS) respondents, and Bike to Work Challenge (BTW) participants in each age group. Note that no CATL users reported an age of sixty-five or older. For both the CATL and BTW datasets, the greatest percentage of users lie in the 25-34 age group (approximately 50% and 36%, respectively). Generally, the percentage of users that lie in an age group decreases with increasing age for both of these datasets, except for the 18-24 category, which is low for all datasets. For the NHTS dataset, the trend is different. The age group containing the highest percentage of users is 35-44 (approximately 31%), and the decreasing trend that is seen for the CATL and BTW datasets is not present for the NHTS.
Figure 13: Cyclist distributions by age. Note that there were no CATL users in the 65+ age group.

The trends shown in Figure 13 indicate that overall, CATL and the BTW Challenge attracted a younger group of cyclists than the NHTS. This is especially true for CATL users. Table 5 shows the difference in percentages between the CATL and NHTS (CATL % - NHTS %) datasets and the CATL and BTW (CATL % - BTW %) databases for each age category. For age groups 25-34 and 18-24, the CATL dataset has a higher percentage of users within them than the other two datasets, as the values in the last two columns are positive. However, for age groups 35-44 and older, the CATL dataset has a lower percentage of users lying in them than the NHTS and BTW datasets, as the values in the last two columns are negative. This suggests that, compared to other bicycle datasets, the CATL dataset has over-sampled younger cyclists and under-sampled older cyclists.
Table 5: Percent comparisons for age.

<table>
<thead>
<tr>
<th>Age</th>
<th>CATL %</th>
<th>NHTS %</th>
<th>BTW %</th>
<th>CATL % - NHTS %</th>
<th>CATL % - BTW %</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>14.2</td>
<td>6.7</td>
<td>4.2</td>
<td>7.5</td>
<td>9.9</td>
</tr>
<tr>
<td>25-34</td>
<td>49.7</td>
<td>10.0</td>
<td>35.7</td>
<td>39.7</td>
<td>14.0</td>
</tr>
<tr>
<td>35-44</td>
<td>22.0</td>
<td>31.1</td>
<td>28.3</td>
<td>-9.1</td>
<td>-6.3</td>
</tr>
<tr>
<td>45-54</td>
<td>11.0</td>
<td>21.1</td>
<td>19.8</td>
<td>-10.1</td>
<td>-8.8</td>
</tr>
<tr>
<td>55-64</td>
<td>3.1</td>
<td>22.2</td>
<td>11.3</td>
<td>-19.1</td>
<td>-8.2</td>
</tr>
<tr>
<td>65+</td>
<td>0.0</td>
<td>8.9</td>
<td>0.7</td>
<td>-8.9</td>
<td>-0.7</td>
</tr>
</tbody>
</table>

One of the potential reasons why the CATL dataset shows such a bias towards younger cyclists is that the Cycle Atlanta app was developed at a university, and heavily promoted by university students, who tend to be below age 35. In fact, according to the 2010 US Census, in 2009, 84% of college students were 18-34, while only 16% were 35 or older [55]. This bias towards younger users could also potentially be attributed to the fact the data were obtained using a smartphone app, and the literature has shown that the chances of someone using a smartphone decrease with age [44].

It is important for the Cycle Atlanta team to note this bias towards younger cyclists, and attempt to rectify it. More marketing should be done specifically towards older cyclists. It could also be beneficial to collaborate more with other organizations that could help promote the app to older cyclists. Another way to encourage use by more older cyclists would be to include a webapp version of Cycle Atlanta that does not require a smartphone. Figure 14 shows the results of a Pew Research Center survey where adults were asked if they use the internet. Fifty-three percent of adults ages 65+ indicated that they use the internet, and 77% of adults ages 50-64 said they use the internet. However, another survey done by the Pew Research Center found that only 11% of adults ages 65+ own smartphones, and only 34% of adults between ages 50-64 own smartphones [44]. Hence, a non smartphone-based version of Cycle Atlanta could attract older users, since it is much more likely for older people to access the internet without a smartphone than with one.
Figure 14: The percentages of adults by age group who use the internet (left), and the percentage of adults who have home broadband (right). n=2,253 (2012) [65].

It is important for those using Cycle Atlanta data for bicycle planning purposes to be cognizant of this age bias. There still needs to be bicycle infrastructure that accommodates older cyclists, even though they are not well represented by the Cycle Atlanta data and other datasets.

4.1.2 Sex

Figure 15 shows a comparison between the three datasets based on reported sex. For all datasets, the percentage of males was higher than the percentage of females. The NHTS and BTW datasets show almost exactly the same gender breakdown. The CATL dataset shows slightly different breakdown, being more skewed towards males than the other two datasets (by approximately 10%, as shown in Table 6.)
Figure 15: Cyclist distributions by gender.

Table 6: Percentage comparisons for sex.

<table>
<thead>
<tr>
<th>Gender</th>
<th>CATL %</th>
<th>NHTS %</th>
<th>BTW %</th>
<th>CATL % - NHTS %</th>
<th>CATL % - 3TW %</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>74.6</td>
<td>64.4</td>
<td>64.5</td>
<td>10.2</td>
<td>10.1</td>
</tr>
<tr>
<td>female</td>
<td>25.4</td>
<td>35.6</td>
<td>35.5</td>
<td>-10.2</td>
<td>-10.1</td>
</tr>
</tbody>
</table>
The literature show that is much more likely for a cyclist to be male than female, so it makes sense that these three datasets exhibit this trend as well. However, it is unclear why CATL users are more likely to be male than NHTS respondents and BTW participants, and whether or not this is significant. Male and female cyclists have different needs regarding bicycle infrastructure, and women often feel less safe than men while biking [32]. Because of this, it is important that the Cycle Atlanta team concentrate more on attracting female users, and that planners making decisions based on Cycle Atlanta data take the gender bias into consideration when planning new bicycle infrastructure.

The Cycle Atlanta team could reach out to other bicycle-related organizations to attract more female users. The Atlanta Bicycle Coalition sponsors a social bike ride for women called “Heels on Wheels” [8]. In addition, there is a bicycle advocacy group in the Atlanta metropolitan area called Women Bike Atlanta [4]. Collaborating more with organizations such as these could result in more women using Cycle Atlanta.

4.1.3 Income

Figure 16 shows a comparison between the three datasets based on reported income. On the horizontal axis, “K” represents a thousand dollars (for example, “20K” is equal to $20,000). Values following square brackets “[“ are included in that income group, while values preceding rounded brackets “]” are not included in that income group. For example, “[20K - 40K)” should be interpreted as the group representing incomes from $20,000 to $39,999. Table 7 shows the percentage differences for each income category between CATL and NHTS, and CATL and BTW.
Figure 16: Cyclist distributions by annual household income.

Table 7: Percentage comparisons for income.

<table>
<thead>
<tr>
<th>Income ($)</th>
<th>CATL %</th>
<th>NHTS %</th>
<th>BTW %</th>
<th>CATL % - NHTS %</th>
<th>CATL % - BTW %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20K</td>
<td>8.7</td>
<td>7.9</td>
<td>3.4</td>
<td>0.8</td>
<td>5.2</td>
</tr>
<tr>
<td>[20K - 40K)</td>
<td>20.7</td>
<td>15.7</td>
<td>12.6</td>
<td>4.9</td>
<td>8.1</td>
</tr>
<tr>
<td>[40K - 60K)</td>
<td>15.7</td>
<td>14.6</td>
<td>16.4</td>
<td>1.1</td>
<td>-0.7</td>
</tr>
<tr>
<td>[60K - 75K)</td>
<td>12.4</td>
<td>3.4</td>
<td>13.0</td>
<td>9.0</td>
<td>-0.6</td>
</tr>
<tr>
<td>[75K - 100K)</td>
<td>14.0</td>
<td>15.7</td>
<td>19.1</td>
<td>-1.7</td>
<td>-5.0</td>
</tr>
<tr>
<td>&gt;= 100K</td>
<td>28.5</td>
<td>42.7</td>
<td>35.5</td>
<td>-14.2</td>
<td>-7.0</td>
</tr>
</tbody>
</table>

All three datasets show a similar trend for income, with two inflection points: a “peak” at [20K - 40K] (40K - 60K for BTW), and a “valley” at [60K - 75K]. For all datasets, the income group with the greatest representation was >= 100K (yearly household incomes of $100,000 or greater), with the NHTS dataset having the greatest proportion of people in this income group compared to the other two datasets. Among CATL users, another prominent income group was [20K - 40K], with approximately 20% of users falling into this group. This makes sense, since the Cycle Atlanta app was promoted mostly by university students, who tend to fall into lower income groups. It also makes sense that BTW challenge
participants would fall into higher income groups than CATL users, since it is assumed that everyone who participated in the BTW challenge is employed and has an income, which is not necessarily the case for CATL users.

### 4.1.4 Ethnicity

Figure 17 shows a comparison between the three datasets based on reported ethnicity. For this trait, the Cycle Atlanta user base is very similar to the NHTS respondents and BTW challenge participants. All datasets have a very large proportion of cyclists who indicated that they were white—over 80%, with the greatest difference in percentages being only 4.83%, as shown in the right-most column of Table 8.

![Ethnicity Bar Chart](image)

**Figure 17:** Cyclist distributions by ethnicity.

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>CATL %</th>
<th>NHTS %</th>
<th>BTW %</th>
<th>CATL % - NHTS %</th>
<th>CATL % - BTW %</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>82.0</td>
<td>83.3</td>
<td>86.9</td>
<td>-1.3</td>
<td>-4.8</td>
</tr>
<tr>
<td>Af. American</td>
<td>3.4</td>
<td>7.8</td>
<td>2.6</td>
<td>-4.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Hisp/Mex/Lat.</td>
<td>8.8</td>
<td>5.6</td>
<td>2.6</td>
<td>3.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Other</td>
<td>5.8</td>
<td>3.3</td>
<td>8.0</td>
<td>2.4</td>
<td>-2.3</td>
</tr>
</tbody>
</table>
This severely skewed distribution is consistent with other research that has demonstrated that cyclist populations in the United States are overwhelmingly white [43], [35]. However, according to the 2010 Census, only 38% of people living in the City of Atlanta are white. 54% of Atlantans are black [52]. With such a large proportion of Atlantans being non-white, it is concerning to see several datasets that show that minorities in Atlanta are severely underrepresented among cyclists.

There are two possible explanations for this trend. The first is that ethnic minorities really do not cycle very much, and most of the cyclists in Atlanta are indeed white. The second explanation is that there are more ethnic minorities cycling; however, they are not being reflected by various bicycle data sources. The research team is not able to say which of these explanations is correct, or more correct than the other. However, if the latter explanation is indeed the case, then it is very important that the Cycle Atlanta team make an enhanced effort to promote the app among ethnic minority communities in Atlanta.

After Cycle Atlanta was first released, the research team made an effort to raise awareness of the app at the Atlanta University Center (AUC), a consortium of historically black colleges in southwest Atlanta. However, it does not appear that they have any cycling clubs/organizations (or if they do, they do not have a very large presence on the internet). As new versions of Cycle Atlanta are released in the future, it could be beneficial to visit some of the AUC colleges to promote the app. Also, it would be a good idea to reach out to the Metro Atlanta Cycling Club. This is an organization whose mission is to “promote cycling in the black community and build camaraderie among all cyclists” [23]. Reaching out to members of this group could attract more black/African-American Cycle Atlanta users.
4.2 Geographic analysis

A geographic analysis was conducted using the Cycle Atlanta (CATL), American Community Survey (ACS), and Bike to Work Challenge (BTW) datasets. The distribution of cyclists across home ZIP codes within the previously defined study area was mapped for each dataset.

Figures 18, 19, and 20 show a similar trend regarding the home location of cyclists. Overall, cyclists are concentrated in the “intown” part of Atlanta, near the center of the Perimeter. Specifically, ZIP codes east of the Downtown Connector (the north-south running Interstate near the center of the study area) have the highest percentages of cyclists living within them.

![Map of Cycle Atlanta users by home ZIP code.](image)

**Figure 18:** The distribution of Cycle Atlanta users by home ZIP code.
Figure 19: The distribution of Bike to Work Challenge participants by home ZIP code.

Figure 20: The distribution of American Community Survey respondents by home ZIP code (ACS 2007-2011 5-year estimates).
Table 9 shows the top three most represented ZIP codes for each dataset, and Figure 21 identifies these ZIP codes on a map of Atlanta. ZIP codes west of the Downtown Connector are not very well represented, especially those in the southern part of the study area. Of the three datasets, the ACS dataset shows the greatest representation in the southwest part of the study area, with several ZIP codes having between one and two percent of cycling respondents residing within them (compared to the other two datasets, which show these ZIP codes as having one percent or less of the cyclists living in them).

Table 9: The top six represented ZIP codes for each dataset.

<table>
<thead>
<tr>
<th>Rank</th>
<th>CATL</th>
<th>BTW</th>
<th>ACS</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>30308 (13.5 %)</td>
<td>30030 (11.8 %)</td>
<td>30308 (12.9 %)</td>
</tr>
<tr>
<td>Second</td>
<td>30306 &amp; 30316 (11.7 %)</td>
<td>30307 (11.5 %)</td>
<td>30307 (12.5 %)</td>
</tr>
<tr>
<td>Third</td>
<td>30309 (9.6 %)</td>
<td>30306 &amp; 30316 (10.5 %)</td>
<td>30306 (12.3 %)</td>
</tr>
<tr>
<td>Fourth</td>
<td>30307 &amp; 30312 (9.2 %)</td>
<td>30312 (9.3 %)</td>
<td>30318 (9.5 %)</td>
</tr>
<tr>
<td>Fifth</td>
<td>30317 (6.0 %)</td>
<td>30308 (8.6 %)</td>
<td>30316 (8.0 %)</td>
</tr>
<tr>
<td>Sixth</td>
<td>30330 (5.7 %)</td>
<td>30309 (6.8 %)</td>
<td>30330 (6.5 %)</td>
</tr>
</tbody>
</table>

Figure 21: The most-represented home ZIP codes for the three datasets (top six for each dataset).
4.2.1 Correlations between geographic distribution and demographic distributions

There are other possible reasons besides marketing why Cycle Atlanta users are more represented in certain parts of the city than others. This section examines the correlation between the percent of Cycle Atlanta users residing in a ZIP code, and several demographic characteristics of the overall population in that ZIP code—median income, median age, non-white percent of the population, and population density.

Figure 22 shows a comparison between the percent of Cycle Atlanta users living in a ZIP code and the percent of non-white, non-Hispanic residents living in that ZIP code. The darker the ZIP code, the greater of the percentage of non-white residents. The bigger the black dot over a ZIP code, the higher the percentage of Cycle Atlanta users living there. It’s difficult to see a clear relationship between the two variables. Some ZIP codes have a low percentage of non-white residents and a high percent of Cycle Atlanta users living there such as 30306 and 30307 (located between E4 and E5). However, some ZIP codes have a high percentage of non-white residents and a high percentage Cycle Atlanta users, such as 30316 (located between E5 and E6).
Figure 22: A comparison between the percent of Cycle Atlanta users living in a ZIP code and the percent of non-white, non-Hispanic residents living in that ZIP code.
Figure 23 shows a comparison between the percent of Cycle Atlanta users living in a ZIP code and the median income of households in that ZIP code. The darker the ZIP code, the greater the median income of households there. The bigger the black dot over a ZIP code, the higher the percentage of Cycle Atlanta users living there. We could expect ZIP codes with median incomes between $20,000 and $40,000 to have the greatest percentage of Cycle Atlanta users living in them, since Figure 16 shows these income groups as having the two highest percentages of Cycle Atlanta users in them. However, it seems that the opposite is true. ZIP codes with median incomes falling into these groups appear to have some of the lowest percentages of Cycle Atlanta users residing in them. ZIP code 30327, for example, has the highest median income of any ZIP code (between $100,000 and $130,270, which was the income group that had the greatest number of Cycle Atlanta users in it). However, 30327 also has one of the lowest percentages of Cycle Atlanta users residing in it, at less than 0.35%.

**Figure 23:** A comparison between the percent of Cycle Atlanta users living in a ZIP code and the median income of households in that ZIP code.
Figure 24 shows a comparison between the percent of Cycle Atlanta users living in a ZIP code and the median age of people living in that ZIP code. The darker the ZIP code, the greater the median age of people living there. The bigger the black dot over a ZIP code, the higher the percentage of Cycle Atlanta users living there. We could expect ZIP codes with median ages between 25 and 34 to have the greatest percentage of Cycle Atlanta users residing in them, since this was the age category with the greatest percent of Cycle Atlanta users in Figure 13. While this is somewhat true, it appears that ZIP codes with median ages between 35 and 44 have greater percentages of Cycle Atlanta users living in them than ZIP codes with median ages between 25 and 34 (which is the age category that has the second highest percentage of Cycle Atlanta users in it).

Figure 24: A comparison between the percent of Cycle Atlanta users living in a ZIP code and the median age of people living in that ZIP code.
Figure 25 shows a comparison between the percent of Cycle Atlanta users living in a ZIP code and the population density of that ZIP code. The darker the ZIP code, the greater the population density. The bigger the black dot over a ZIP code, the higher the percentage of Cycle Atlanta users living there. Aside from a few outliers, this map suggests that as the population density of a ZIP code increases, so does the percentage of Cycle Atlanta users living in that ZIP code. This makes sense, since high-density urban areas are often the most bikeable. One noteworthy outlier is the ZIP code 30316, located between E5 and E6. This ZIP code contains dense areas such as East Atlanta Village and Reynoldstown in the northern part, but also less dense areas such as Gresham Park in the southern part. It is likely that if this ZIP code were separated into a north part and a south part, the north part would show high density as well as a high percentage of Cycle Atlanta users residing in it, and the south part would show low density and a low percentage of Cycle Atlanta users.

![Map of Cycle Atlanta users and population density](image)

**Figure 25:** A comparison between the percent of Cycle Atlanta users living in a ZIP code and the population density of that ZIP code.
CHAPTER V

DISCUSSION

5.1 Geographic marketing bias

The way the Cycle Atlanta was marketed might account for more users living in certain parts of the city than other, just as marketing is a potential reason for certain demographic groups using the app more than others, as explained in Section 4.1. For example, most of the bike shops that Cycle Atlanta flyers were distributed at are on the east side of the city, which is also where most of the users live.

5.2 Using ZIP codes for analysis

One could argue that ZIP codes are not an adequate geographic unit for analytical purposes. Their boundaries tend to be arbitrary, as do their sizes. In the study area used for this analysis, some ZIP codes were very large, while some were very small. Some followed neighborhood boundaries, while others crossed them. Because of these inconsistencies, it is difficult to draw conclusions from an analysis that uses ZIP codes as the geographic unit (although they do allow general trends to be observed).

The reason that ZIP codes were chosen for this analysis is because that is how Cycle Atlanta users indicate their home, work, and school locations when using the app. A more suitable geographic unit would have been traffic analysis zones (TAZs), since they are smaller and have more logical boundaries than ZIP codes. However, while almost everyone knows their home ZIP code and could recite it from memory, almost nobody knows what TAZ they live in. Even more useful would be knowing the actual home address of Cycle Atlanta users; however, people are reluctant to provide such personal information, and most users would likely not report a specific address.
5.3 The lack of useful bicycle data

It is difficult to draw conclusions on how representative of the overall Atlanta cycling population the user base of Cycle Atlanta is, because there really are no other available datasets that reflect the general cycling population in Atlanta in a non-biased way. The percent mode share for cycling in the United States is so small that it is difficult to collect data on cyclists using large national or regional surveys, such as the NHTS or Census. Even data for other transportation modes can be biased using these data collection methods. Consider race representation by the NHTS. The total sample size for the NHTS for all modes in every part of the country is approximately 150,000 [61]. Approximately 88% of respondents were white [60], compared with the 2010 Census, which reported that approximately 72% of people in the US were white [54]. Hence, the NHTS under-samples minority groups, and cannot be considered “representative” based on race.

The bias of datasets such as the NHTS becomes even more of a problem when limiting the scope of the data to one city such as Atlanta. When the full NHTS dataset was queried to show only respondents who were cyclists in the Atlanta area, 90 records were returned (even less than the number of Cycle Atlanta users). This being the case, we certainly cannot consider the NHTS dataset something that represents the overall cycling population, at least not in Atlanta. All we can do is use it as a reference point.

5.4 The danger of limited/skewed data

The bias in our data towards certain groups of people can be explained in two ways. Either groups of people who are not reflected by Cycle Atlanta data are not cycling, or they are cycling, but not using the app (or some combination of those two reasons). An important future research goal will be figuring out which of these explanations describes why certain groups of people are not well-represented in Cycle Atlanta data. The danger of having limited and/or skewed data is that infrastructure improvements based on these data have the potential to only benefit the cyclists who provided the data.
5.5 Planning for the “Interested, but concerned,” infrequent, and new cyclists

Bicycle planning using skewed/biased data can potentially neglect the needs of people who are new to cycling, do not cycle very often, or are not very comfortable cycling. Figure 26 shows the distribution of Cycle Atlanta users based on how they classified themselves as a cyclist. Most users reported that they were either “Comfortable, but cautious” or “Enthused & confident” (approximately 78% combined). Only 3.1% said they were “Interested, but concerned.” These are the people who are interested in cycling, but are afraid to do so because they are not comfortable using the current bicycle infrastructure in Atlanta. These people may never feel comfortable biking in Atlanta if bicycle infrastructure does not address their needs.

![Bar Chart]

**Figure 26:** The distribution of Cycle Atlanta users based on reported rider type.

Figure 27 shows the distributions of Cycle Atlanta users based on how often they bike. The majority of users (approximately 82%) indicated that they bike several times a week, or daily. The remaining users who answered this question reported that they bike several times a month or less. Although these infrequent cyclists are not a large proportion of the Cycle Atlanta user base, bicycle network/infrastructure improvements should still consider
the needs of these people. This is because a major goal of the Cycle Atlanta project is to encourage people to bike more often. Despite the bias in Cycle Atlanta data towards people who cycle more often, bicycle infrastructure improvements should also target infrequent cyclists, to give them the facilities they need in order to bike more often.

![Bar chart showing the frequency of biking among Cycle Atlanta users.](chart)

**Figure 27:** The distribution of Cycle Atlanta users based on frequency of biking.

Figure 28 shows the distribution of Cycle Atlanta users based on how long they have been biking for. The majority of users (approximately 79%) indicated that they have been biking several years or more. About 21% of users indicated that they have been biking for less than a year, just started cycling, or are just trying cycling. These more-recent additions to the Atlanta cycling population are a strategic group, similar to “interested, but concerned” cyclists and infrequent cyclists. These are the people who perhaps would like to continue cycling and become more frequent cyclists, but are hesitant to do so because the current bicycle network in Atlanta does not support their needs as cyclists.
Figure 28: The distribution of Cycle Atlanta users based on how long they have been biking for.

In order to gain an even more in-depth understanding of who is cycling in Atlanta and how they should be planned for, bicycle planners using Cycle Atlanta data should also consider the intersectionality between reported rider type, and demographic traits. It was already established in Section 4.1.2 that most Cycle Atlanta users are male; however, how does the male-female ratio change for the four different rider types? Figure 29 shows the relationship between reported rider type, and user gender. For the “Enthused & confident,” “Comfortable, but cautious,” and “Interested, but concerned” groups, females represent approximately 30% of the user base, which is similar to the gender ratio for all Cycle Atlanta users, as shown by Figure 15. However, the gender ratio for “Strong & fearless” users is much more skewed towards males, at approximately 95%. This indicates that, overall, female cyclists are somewhat less confident in their cycling ability than male cyclists. This is something that planners should keep in mind when planning bicycle infrastructure.
Figure 29: The breakdown of Cycle Atlanta users based on gender and rider type. Numbers inside bars indicate actual values, as opposed to percentages.

Figure 30 shows the relationship between reported rider type, and whether or not a user identified as white. The “Enthused & confident” and “Comfortable, but cautious” categories show a similar racial breakdown to what is presented in figure 17 for all cycle atlanta users (approximately 80% white). However, for the other two rider type categories (“Strong & fearless” and “Interested, but concerned,” the percentage of white-identified users is about ten percent higher. It is unclear as to why this is the case, or if it is significant. Still, it gives those working with Cycle Atlanta data a better understanding of what sort of cyclists are using the app, and what they are like.
**Figure 30:** The breakdown of Cycle Atlanta users based on ethnicity and rider type. Numbers inside bars indicate actual values, as opposed to percentages.
CHAPTER VI

FUTURE INITIATIVES

6.1 Analyzing trip data

The next logical next step for this research would be to analyze Cycle Atlanta trip data. This will provide insight on user origins and destinations, as well as specific routes that people prefer. Examining user trip data could also give the research team a better understanding of where users live. Although users report the ZIP code they live in, ZIP codes are not an adequate geographic unit for analysis, as explained in Section 5.2. Another way to geographically analyze the home location of users would be to examine origin and destination patterns within the trips they take. For example, if a user’s AM origin points and PM destination points are consistent over the course of an entire week, then we could assume that this is their home location, and check it against the home ZIP code they reported.

It would also be beneficial to do a time-series analysis of Cycle Atlanta trip data. This would allow the research team to analyze changing trends in the types of trips Cycle Atlanta users take, as well as where these trips are taken. Figure 31 shows a map of trips taken by Cycle Atlanta users as of March 28th, 2013. Thicker lines represent more heavily traveled routes. Most trips have been taken in the eastern part of Atlanta’s “intown” neighborhoods (see Figure 32 for a map zoomed in on these trips). Notice that very few trips have been taken in southwest Atlanta. The team could make an enhanced effort to market the app in southwest Atlanta, and then examine how this map changes over time to see if the outreach was effective and encouraged use of the app in previously under-represented parts of the city.
Figure 31: A map of 5500 trips logged by Cycle Atlanta users. Thicker lines indicate a more heavily traveled route [5].
Figure 32: A map of “intown” trips logged by Cycle Atlanta users. Thicker lines indicate a more heavily traveled route. [5].
6.2 Route-choice maps

Something that would greatly benefit Cycle Atlanta users would be the ability to query the map in Figure 31 to only show trips taken by a certain group of cyclists. For example, if “Interested, but concerned” cyclists could see a map of trips taken by others who identify the same way, then perhaps this would encourage them to bike more often. They would be able to select routes that they feel comfortable riding on because other cyclists with similar comfort levels selected those routes as well. The same is true for cyclists who do not bike very often, or have not been riding very long. This map generation tool could also allow users to input more than one trait to search by. For example, a female user who identifies herself as “Comfortable, but cautious” could generate a map showing routes preferred by other comfortable but cautious female cyclists.

6.3 Alternative data-collection media

In order to fill Cycle Atlanta’s goal of collecting the most complete and useful data for bicycle planning, other data-collection media should be incorporated into the project. A webapp version of Cycle Atlanta should be developed at some point in the future so that people who don’t own smartphones can contribute data. Having a webapp version of Cycle Atlanta would also allow users to retroactively upload trips, in case they forgot to turn on the app before their trip. In addition, cyclists who log their rides using another cycling app, or a GPS unit, could upload their trip data to the Cycle Atlanta webapp. This would allow them to contribute to the project without having to use the Cycle Atlanta app, if they prefer to log their trips using some other method.

Further research could involve a comparative analysis between trips logged on the Cycle Atlanta smartphone app and trips logged on the webapp version. This would allow the research team to see if having a webapp version of Cycle Atlanta really does attract users that the smartphone version does not attract, such as older cyclists.

In addition to having a webapp version of Cycle Atlanta, it would also be helpful to have public meetings. The Cycle Atlanta team should collaborate with the City of Atlanta and the Atlanta Regional Commission to hold public meetings for people who are not
comfortable providing data, or do not have access to the internet. This would also allow non-cyclists to provide input. This is important, as Cycle Atlanta data currently do not reflect non-cyclists.

6.4 Integration with public agencies

As the Cycle Atlanta app contributes to a more comprehensive, useful set of data on cyclists in Atlanta, public agencies throughout the metropolitan area will have greater opportunities to use the data to make positive changes to Atlanta’s transportation network.

6.4.1 Atlanta Regional Commission (ARC)

The Atlanta Regional Commission has the potential to benefit from Cycle Atlanta data, as they will be able to use it to plan for cyclists in the Atlanta metropolitan area. This has been difficult for them to do in the past, much like the situations of other MPOs in the United States. The inability to effectively plan for non-motorized modes of transportation is usually attributed to a lack of travel survey data for these modes, as well as a lack of data collection resources for these modes [48]. Recall that ARC’s most recent travel survey only reflected forty people in the entire metropolitan area who indicated they were cyclists [10]. Clearly, ARC could benefit from more bicycle data. Fortunately, research has shown that smartphone data have the potential to enhance travel demand forecasting [41].

The Cycle Atlanta trip data will be very beneficial to ARC and their travel forecasting model. ARC will be able to examine the origin and destination points of Cycle Atlanta trips to gain a better understanding of productions and attractions that they should be accounting for during trip generation and trip distribution. This can be enhanced by the fact that Cycle Atlanta users indicate their trip purpose when uploading a trip, since the trip generation step of demand modeling so heavily depends on trip purposes.

6.4.2 City of Atlanta

The City of Atlanta (“the City”) will play a key role in guiding the future of the Cycle Atlanta project. As the initiators of the project, they are the stewards of the data collected by Cycle Atlanta, and will be integral in determining how to use the data for maximum
positive impact. The Cycle Atlanta app is part of the *Cycle Atlanta: Phase 1.0* study, which was created to fulfill several goals of Atlanta’s regional plan, PLAN 2010. These goals are the following [20].

- Building community
- Growing the economy
- Preserving the environment
- Enhancing mobility
- Serving people

With enhanced bicycle data provided by the Cycle Atlanta app, the City of Atlanta will be able to improve bikeability in the city, which will help to address these goals. In order to build community, the City of Atlanta plans to connect varying land uses with bicycle infrastructure. They are especially concerned with providing accessibility to MARTA transit facilities. They are also focused on enhancing accessibility to housing and employment centers. The bicycle infrastructure improvements they want to make will enhance the sense of community in Atlanta, as the endeavor will involve collaboration between business owners, local residents, cyclists, and the City of Atlanta. The specific corridors that the City of Atlanta wishes to address and enhance using Cycle Atlanta data are shown in Figure 33 [20].

The second goal of the City of Atlanta’s *Cycle Atlanta: Phase 1.0* study is to grow the economy. They believe that enhancing Atlanta’s bicycle network will encourage investments by local communities [20]. According to the League of American Bicyclists, investing in biking does indeed have positive economic benefits. A 2012 report written by the League explains that creating bikeable communities encourages people to shop at local stores. In addition, they explain that, because cyclists save money by driving less, they have more money to spend at local businesses, stimulating the local economy [24].

In order to create bikeable communities to stimulate the local economy, the City of Atlanta needs to use the Cycle Atlanta app data to gain a better understanding of what parts
Figure 33: A map of strategic corridors that the City of Atlanta wishes to address via the Cycle Atlanta project [20].

of the city are most frequented by cyclists, why they choose to ride there, and what their trip purposes are. Close attention should be paid to Cycle Atlanta trips that have “shopping” as their stated trip purpose. The City of Atlanta could examine these trips to see where cyclists are spending money. This will inform the city where there is the most potential for bicycle-based economic development. If the City invests in bicycle infrastructure in these areas, then more cyclists will potentially patronize these commercial establishments, spending money at local businesses and stimulating the local economy.

The third goal that the City of Atlanta wishes to address with the Cycle Atlanta project is preserving the environment. Because biking is a zero-emissions mode of transportation, encouraging more people to cycle has the potential to reduce the amount of transportation-related greenhouse gas emissions that are compromising Atlanta’s air quality and exacerbating climate change. In addition, the strategic corridors identified in Figure 33 provide connections to 64 parks in the city, as well as 592 acres of public green space [20]. With data from the Cycle Atlanta app, the City will be able to determine which areas of Atlanta
are most popular with cyclists, and examine which of these routes coincide with areas that have high congestion. By enhancing the bicycle infrastructure in these areas (especially in a way that accommodates “Interested, but concerned” cyclists), the City can encourage people to bike instead of drive.

The City of Atlanta’s fourth goal of the Cycle Atlanta project is to enhance mobility. They plan to do this by creating safer bicycle routes in the core of the city [20]. Safer bicycle routes will make it possible for more people to become cyclists, and for the people who are already cyclists to be able to bike to more destinations. Enhanced bike infrastructure will be especially beneficial to people who do not own a vehicle, or cannot drive. If the infrastructure is put in place to make these individuals feel comfortable biking, then a whole realm of mobility possibilities will open to them. The City will be able to use the Cycle Atlanta app data to examine routes preferred by infrequent, new, and low-ability (“interested, but concerned”) cyclists. Using this information, infrastructure can be enhanced so that the areas that currently are not hospitable to biking (especially for inexperienced cyclists) become hospitable, and areas that are already hospitable to biking become more hospitable, or at least maintain their convenience to cyclists.

People who do not own a car can be planned for as well using Cycle Atlanta data. Because the likelihood of someone owning a car decreases as their income decreases [21], the City of Atlanta should examine Cycle Atlanta trips taken by low-income individuals. By doing this, planners will be able to infer where individuals who do not own vehicles live and work. Bicycle infrastructure could be enhanced in these areas so that biking becomes a viable transportation option, hence improving the mobility of individuals in these low-income areas.

The City of Atlanta’s final goal in the Cycle Atlanta: Phase 1.0 study is serving people. By this, they mean that they wish to accommodate the needs as many different types of people possible, especially during bicycle planning. They want to be able to improve cycling facilities for people of all ages, as well as people who are not very comfortable cycling. The City plans on using the National Association of Transportation Officials’ (NACTO) Urban Bikeway Design Guide to make this possible, as it is geared toward encouraging people who
are interested, but concerned about biking to bike more. In fact, the city estimates that 60% of Atlantans fall into this category, and would bike more if they felt safe doing so [20]. The City will be able to use Cycle Atlanta to accomplish this goal, as the app encourages users to indicate what type of rider they are, with “Interested, but concerned” being one of the choices. It is really people in this category for whom a lot of planning needs to be done, because they are such a significant portion of the population, and could be encouraged to bike more. Using data provided by the Cycle Atlanta app, the City of Atlanta will be able to fulfill their goal of serving people, and as many different kinds of people as possible.

Aside from using Cycle Atlanta data to fulfill the previously mentioned five goals, the City of Atlanta should consider collaborating with other local governments to provide them with the data as well. Figure 34 (first presented in Section 4.2) shows the ZIP codes with the greatest percentage of Cycle Atlanta users living within them. Notice that several of these ZIP codes (30306, 30307, 30317, 30030, and 30316) are either completely or partially outside of Atlanta city limits. Just because these areas are not officially part of the City of Atlanta does not mean that they should not benefit from Cycle Atlanta data. The City of Atlanta should consider sharing the data with municipalities such as the City of Decatur, as well as DeKalb and Fulton Counties. As these municipalities seek to improve their bicycle facilities, they too will require data on cyclists. The City of Atlanta should ensure that other municipalities have access to the Cycle Atlanta data as well so that they can help to improve the overall bicycle network in the Atlanta area.

6.4.3 Metropolitan Atlanta Rapid Transit Authority (MARTA)

MARTA has the potential to use and benefit from the Cycle Atlanta data. As previously mentioned, integrating biking and transit use results in a synergy that neither mode could provide alone. Bikeability near transit extends transit’s catchment area, by allowing people to access stations by biking, instead of walking. The enhanced access and egress to and from transit that biking provides can benefit transit agencies because it means that there do not have to be as many feeder buses for coverage purposes [15]. While this would not be possible for some of the more “suburban” MARTA rail stations, it can be feasible for
“intown” stations, and stations that already have many people biking to, from, and around them. With Cycle Atlanta trip data, MARTA will be able to see which of their stations are in the most bikeable areas, based on how many trips were taken in specific vicinities. With this information, MARTA could determine which of their facilities they need to make more “bike-friendly.” Some examples of ways that MARTA could improve transit stations for cyclists are by installing bike racks where they are missing, bike gutters to make it easier for cyclists to transport bikes up and down stairs, and even bike lanes near stations. These improvements have the potential to encourage people to bike to MARTA facilities more frequently. These are people who might have not used MARTA very often because they live too far from the nearest station to walk, and did not feel comfortable biking there. With enhanced bicycle facilities at and near MARTA stations, these people might consider biking
to transit, and taking transit more. This could potentially boost MARTA’s ridership, which would increase revenue for the agency.

MARTA could also use Cycle Atlanta data to determine which of their transit stations would best support bike share facilities. The Atlanta Bicycle Coalition (ABC) recently released a report that analyzed the potential for bike share in Atlanta. They examined criteria such as demographics, land use, policies, and existing infrastructure in order to provide recommendations for where bike share facilities should be located. For the first stage of bike share implementation, the report identifies Buckhead, Downtown Decatur, Midtown, Downtown, and West End as strategic areas to locate bike share facilities [7]. Figure 35 shows a map of these areas, as well as MARTA rail stations located within these areas. Each of the three market service areas has one or more MARTA stations within it.

Using the Cycle Atlanta data, MARTA would be able to examine trips taken by cyclists in these three study areas, and provide further recommendations as to which stations would best support bike share facilities. This would benefit the company administering the bike share system, as it would help them locate facilities in the areas that have the most potential for success. Having bike share facilities at transit stations would benefit MARTA because it would give transit riders more access and egress options besides walking or driving. In addition, MARTA riders who wished to bike to transit would not have to own a bicycle or worry about the safety of their bicycle at MARTA stations, because they would be able to use bike share instead.
Figure 35: The three phase 1 market service areas for a potential Atlanta bikeshare system [7].
CHAPTER VII

CONCLUSION

Biking is an active mode of transportation that has many benefits. It is a healthy activity that has the potential to reduce obesity. It also has many transportation-related benefits, such as providing a source of mobility for people who do not own a car, reducing congestion (hence, improving air quality), and serving as an access/egress mode for transit.

In order to encourage biking in urban areas, it is necessary to supply bicycle infrastructure that makes cyclists feel safe while riding. This includes bike lanes, cycle tracks, and bicycle detection equipment at intersections. It is especially important to provide these types of infrastructure to encourage “Interested, but concerned” cyclists to choose cycling as a viable transportation mode more often.

For effective bicycle planning, data on who cyclists are and where they are cycling is necessary. Historically, bicycle data have not been collected nearly as much as motor vehicle data by public agencies for planning purposes. Hence, cyclists have been under-planned for. Cycle Atlanta uses crowdsourcing to address the need for more bicycle data in Atlanta. Although the app has the potential to collect data from many cyclists, there is the potential for the data to be biased. This can mostly be attributed to the fact that Cycle Atlanta is a smartphone app, and not everyone owns a smartphone. Because of these equity concerns, the research team analyzed the demographic and geographic characteristics of Cycle Atlanta users to see how they compared to the overall cycling population in Atlanta.

The results of this research show that the majority of Cycle Atlanta users are young, white males belonging to either a very high annual income group or a low annual income group, with fewer users belonging to middle-income groups. Most of the app’s users live in east-side, intown Atlanta neighborhoods. Other cyclist data for the Atlanta area show similar trends, although less pronounced than the trends exhibited by Cycle Atlanta users.
It is difficult to assess how representative of the overall Atlanta cycling population Cycle Atlanta users are, as very little bicycle data are available. What data are available are usually limited in size or scope, and hence not suitable to draw conclusions from. The Cycle Atlanta project has addressed this concern, and has already surpassed many previous endeavors to gather bicycle data in Atlanta. However, it is imperative that the Cycle Atlanta research team make an enhanced effort to collect more data from a wider variety of cyclists with regard to demographics and home location. The data collected by Cycle Atlanta thus far are a good start, but a lot more needs to be done to address the lack of bicycle network data in Atlanta.

There are several strategies for enhancing the quantity and quality of Cycle Atlanta data. Promoting Cycle Atlanta to a more diverse group of cyclists in Atlanta has the potential to create a much larger, more complete database of cycling route and infrastructure conditions in all of Atlanta, for cyclists from a wide variety of demographic backgrounds. In addition, a webapp version of Cycle Atlanta would benefit cyclists who do not own smartphones, and would let users retroactively upload trips. Route-choice maps created from uploaded trips would allow users to see trips taken by other users who have similar needs and concerns as they do, and plan their routes accordingly. These strategies can contribute to higher-quality data, which will make bicycle planning in Atlanta much more equitable.

Several public agencies will be able to use the Cycle Atlanta data to make positive changes to Atlanta’s transportation network. The Atlanta Regional Commission, The City of Atlanta, and MARTA all can benefit from the data, and use the data to benefit cyclists in the metropolitan area.
REFERENCES


[52] United States Census Bureau, “Atlanta (city) QuickFacts.”


