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The Impact of Bicycling Facilities on Commute Mode Share

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A 2005 study by Barnes, Thompson, and Krizek examined how the addition of bicycling facilities during the 1990s influenced localized bicycle commuting rates in the Twin Cities. They found that new facilities had a small but consistent and statistically significant impact on increased rates of bicycle commuting in areas immediately surrounding these facilities. This study expands on these findings by applying the same methodology to six other cities that experienced new facility construction during the 1990s. The purpose is to determine whether results from the Twin Cities are consistent elsewhere and to identify possible contextual factors influencing facilities' impact on bicycle commuting rates in a given city. We conclude that the "build it and they will come" theory is not universally applicable; context factors are an important element in determining the effectiveness of new commuting facilities. Among the key factors we identified were the level of publicity surrounding new facilities, the utility of routes to commuters, and the overall connectivity of the city's bicycling network. This evidence will aid in the evaluation of bicycle facility investment as a congestion reduction strategy.

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The Impact of Bicycling Facilities on Commute Mode Share

Final Report

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Executive Summary

A 2005 study by Barnes, Thompson, and Krizek examined how the addition of bicycling facilities during the 1990s influenced localized bicycle commuting rates in the Twin Cities. They found that new facilities had a small but consistent and statistically significant impact on increased rates of bicycle commuting in areas immediately surrounding these facilities. This study expands on these findings by applying the same methodology to six other cities that experienced new facility construction during the 1990s: Austin, TX, Chicago, IL, Colorado Springs, CO, Salt Lake City, UT, Madison WI, and Orlando, FL. The purpose is to determine whether results from the Twin Cities are consistent elsewhere and to identify possible contextual factors influencing facilities' impact on bicycle commuting rates in a given city.

We conclude that the "build it and they will come" theory is not universally applicable; context factors are an important element in determining the effectiveness of new commuting facilities. Specifically, we identify three key themes that were present in cities whose bicycling commute mode share increased around new bicycling facilities. The first theme is *location of facilities along usable commuting routes*, best illustrated by the city of Chicago. Bicycling facilities lead from distant parts of the city and converge in the downtown employment hub. In Austin, facilities are also oriented toward the central city and connect the city's densely-settled residential neighborhoods with this location. In contrast, the new bicycling facilities in Orlando do not converge on any central location. A message that can be drawn from this comparison is that bicycling facilities are most effective in highly-accessible urban areas where a large number of commute trips can take place across short distances. In locations where bicycling facilities could provide viable commuting routes between residential and employment concentrations, increases in bicycle commuting rates were likely to occur.

The second key theme is *overall network connectivity*. In both Austin and Madison, the network of bicycling facilities covers a large part of the central city. Numerous intersections among these trails allow a bicyclist to easily navigate from one section of the city to another. The connectivity of Austin's facility network contrasts with the single trail constructed during the 1990s in Colorado Springs. In Austin, a potential bike commuter could reside in a variety of locations and still ride to an employment location in most parts of the central city. In Colorado Springs, a bicycle commuter would have to both live and work along the length of the Pikes Peak Greenway Trail for this to be a viable new commuting option.

The final key theme is the *amount of publicity and promotion* dedicated to new bicycling facilities. The contrast between the change in commute rates in Chicago and Salt Lake City best illustrates this idea. In Chicago, new bicycling facilities were added in combination with a multitude of other efforts by city planners and advocates to advertise their presence and promote bicycle commuting among city residents. This combination of efforts was simply not present in a similar magnitude in Salt Lake City during the 1990s. A bicycling facility can only be adopted by commuters if they are aware of its existence and excited to adopt bicycles as their commute mode.

Our findings raise several questions for further study. One of the most obvious questions is how bicycle commute mode will change around facilities constructed between 2000 and 2010. Many of the bicycling coordinators we interviewed felt that the popularity of bicycling in their communities reached new levels after the year 2000, and pointed out numerous network expansions since that time. Increasing the study's time span would help uncover trends in commuting rather than snapshots at two particular points in time.

Secondly, although this study did not find off-street facilities to be more beneficial to commuters than on-street trails, these facilities have value as non-work travel routes, recreation destinations, and public amenities. A survey of users' travel purposes is underway in Minnesota; these findings will enhance our understanding of off-street facilities and provide important groundwork for future studies on the subject of travel behavior and the usefulness of bicycling for non-work travel trips.

Lastly, this study identifies several qualitative factors that contribute to the success of city bicycle facilities. A methodology that quantitatively identifies and measures qualitative indicators could provide useful insight and guidance as to how city policy-makers could best address bicycle commuting in their city.

Chapter 1:
Introduction

Federal funding for bicycling infrastructure increased dramatically with the passage of the Intermodal Surface Transportation Equity Act (ISTEA) in 1991 and its successors, the Transportation Equity Act for the 21st Century (TEA 21) in 1998 and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (SAFETEA-LU) in 2005 *(1)*. In 1994, the Federal Highway Administration identified doubling the percentage of trips made by foot or bicycle as a federal goal *(2)*. Given this increased spending and political attention toward multi-modal travel, understanding how implementing bicycling infrastructure affects people's mode choice is an important research objective. Implementing bicycle facilities requires considerable political and economic investment. While construction of off-street facilities generally entails higher implementation costs than designating lanes on existing streets, both types of facilities can provide alternative transportation routes for urban commuters. The purpose of this study is to determine whether the presence of new bicycle facilities correlates with increased bicycle commuting rates in a variety of US cities. We also identify contextual factors that help explain why bicycling facilities were more effective in some locations than others. This information can inform policy-makers of facilities' effectiveness as they leverage federal funds for future projects.

In the following sections of this report, we first review existing literature on bicycle facilities. The next two sections describe the study's methodology and limitations of our data. We then provide a summary of our findings before individually analyzing the six case study cities. The final three sections offer our conclusions, questions for further research, and acknowledgements. See Appendix C for definitions of terms used throughout this report.

Literature Review

Several researchers have attempted to isolate factors that affect people's decision to travel by bicycle. Analyses have examined how distance between a person's residence and a bicycle facility affects travel behavior. Krizek and Johnson found that use of on-street bicycle facilities correlates with the facility's proximity to the user's residence *(3, 4)*. Other studies have explored the question of who uses bicycle facilities. Krizek, Johnson, and Tilahun concluded that men are more likely to ride bicycles to work than women, although women were more likely to ride bicycles to school as students *(5)*. Of particular importance to this study, Dill and Carr concluded that the presence of bicycling infrastructure in a city is a key variable in determining rates of bicycle commuting. They found a significant correlation between higher levels of bicycling infrastructure and higher rates of bicycle commuting in 43 cities. This cross-sectional study compared commuting rates across multiple locations, but did not compare how each city's bicycle commute rate changed over time as new bicycling infrastructure was added to city networks *(6)*. While each of the aforementioned studies has broadened our understanding of how bicycle facilities are used, none have addressed the important question of whether adding new bicycle facilities actually induces commuter bicycling and encourages growth of bicycle commute mode share.

In an attempt to address this dilemma, Barnes, Thompson, and Krizek adopted a longitudinal analysis of Minneapolis and St. Paul, MN to determine whether increased investment in bicycle facilities correlates with increased rates of bicycle commuting in specific areas around the new facilities. The researchers identified bicycle facilities that were constructed during the 1990s and likely to be used for commuting purposes. They then used 1990 and 2000 Census data to determine the change in bicycle commute rates in locations within a given distance of these facilities. The hypothesis was that construction of a new bicycle facility during that time period would correlate with an increase in bicycle commute mode share near the facility. Researchers found a statistically significant correlation between construction of a facility and an increase in localized bicycle commuting rates *(7)*.

Given the study's limited scope of the Twin Cities, it is logical to ask whether these findings are transferable to other locations. The relative level of bicycle commuting varies among cities across the country. With a bicycle commute rate of 1.89%, Minneapolis ranks third-highest among cities with a population over 300,000. In comparison, Memphis, TN ranks lowest with a bicycle commute rate of .11% *(see Table 1).* At the national level, rates of bicycle commuting decreased from .41% to .38% between 1990 and 2000 *(see Table 2)*. The cause of this decline may be attributed to a variety of macro trends: dispersion of jobs and homes throughout metropolitan areas, population aging, and the low cost of gasoline during most of the 1990s. Given the national context of bicycle commuting during this time period, the relative variance in bicycle commute mode share across cities raises questions about its cause. Despite the national trend toward decline in cycling rates, some cities, such as Minneapolis, were able to sustain or increase bicycle commute rates during this time period.

The purpose of this study is to apply the methodology developed by Barnes, et al. to multiple cities and examine the correlation between new bicycle facilities and increased bicycle commute rates during the 1990s. Our goal is to develop a more robust understanding of this relationship and to determine whether results from the Twin Cities are generally applicable or if changes in bicycle commute rates may be attributed to other factors.

Chapter 2:
Data and Methodology

This study follows the established methodology of Barnes, et al. and compares the bicycle commute rate in a particular geographic area before and after construction of a bicycle facility. The first task was to identify cities with relevant facilities and gather spatial data identifying their location.

The cities included in this study are: Austin, TX; Chicago, IL; Colorado Springs, CO; Madison, WI; Salt Lake City, UT; and Orlando, FL. Most of these cities were identified in Bicycling Magazine's list of "Best Cycling Cities and Bike Clubs" *(8)*. To qualify for this list, cities generally had new bicycle facilities, official bicycle planning agencies, and up-to-date maps of their facilities. Our list of case study cities reflects locations where successful contact was made with a city bicycle coordinator. Because bicycling resources are well-established in these cities, our request for data was most fruitful in these locations.

After establishing contact with a city's bicycle coordinator, generally an employee of the city government or a metropolitan planning organization, we collected GIS shapefiles of each city's bicycle facilities. Bicycle coordinators helped us identify which facilities would be most suitable for this study. Suitable facilities are those that:

- Were constructed during the 1990s.
- Are at least one mile in length.
- Enhanced accessibility to employment destinations (as opposed to paths used mainly for recreation)

We asked city bicycle coordinators to identify facilities that met our suitability criteria based on their knowledge of their city's bicycling network. Note that not all of a city's facilities constructed in the 1990s are necessarily included in this study; we selected only those that could be reasonably expected to impact the rate of bicycle commuting due to their magnitude and location. Depending on availability of data, city bicycle coordinators sent us shapefiles of off-street facilities and/or on-street facilities. We define an off-street facility as a trail that is separate from any roadway. While many off-street facilities parallel major roadways, they typically run along creek routes or repaved rail lines. On-street facilities can be either striped bike lanes or designated "bicyclist-friendly" routes marked with signs.

Using shapefiles of suitable bicycle facilities, we determined each city's Bicycle Analysis Zone (BAZ) using GIS. We set a 2.5 kilometer buffer around each city's bicycle facilities and marked Census-defined block groups whose geographic center fell within these buffered zones. This set of block groups comprises the BAZ. The 2.5 km measurement was determined as the likely catchment area of bicycle facilities (area where we would expect to see users of the bicycle facility to live) based on the finding of Barnes, et al. that "…more than half of the users cycled less than 2,500 meters to reach the trail and there was a sharp decline [in the distance trail users cycled to use the trail] thereafter *(7)*."

We established BAZs for both 1990 and 2000 block groups in order to measure change in localized bicycle commuting rates over this time period. When data was available, we separated a city's on-street and off-street facilities into two BAZs. This allowed us to compare how these two types of facilities induced bicycle commute rates in a given city.

Addressing Data Quality Concerns
We acknowledge that Census data introduces several possibilities for error to our analysis. The block group level is the smallest aggregation that means of transportation to work is recorded by the US Census Bureau. Over the 10 year period of study, its total population can vary. Despite this possibility, a block group is still more comparable to itself at different points in time than the population elsewhere in the city or in a different city.

In addition to population variation, a block group's specific boundaries may change from one Census to the next. We were able to reduce the impact of individual block group boundary changes by selecting block groups whose geometric center fell within the buffered area, versus selecting block groups whose physical boundaries fall entirely within the buffered area. As Figure 2.1 demonstrates, this sometimes means that the boundaries of the BAZ do not match up with a city's political boundaries. Even though some block groups may have a large geographic area outside of the city boundaries, these areas are generally not densely populated and therefore the population outside of the city boundaries would not greatly affect recorded commute mode share.

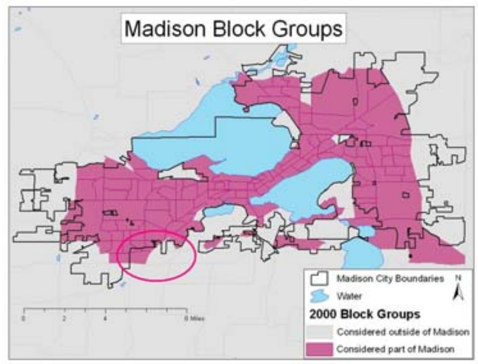

Figure 2.1: Block Groups Considered part of the city of Madison for this study.

In addition to geographic discrepancy, the Census' sampling technique introduces possibility for statistical error. The Census only records means of transportation to work for a sample of the total US population. These numbers are then extrapolated to determine the means of transportation to work for the total working population of any given geographic area. Barnes and Krizek addressed this issue in a previous study, concluding that "using the scaled-up numbers will not introduce any major errors" *(3).* See Appendix C for further definition of sample statistics.

Another concern with Census data is the specific question used to determine an individual's commute mode, "How did this person usually get to work last week?" Respondents may check only one box for the mode of transportation they most frequently employ *(9)*. This means that multi-modal commuters who include bicycling may not be captured in this sample. The Census is taken on April 1, a time when many cities could typically experience inclement weather. Since the question only asks commute mode for the previous week, the bicycle commute rates recorded by the Census may differ from actual rates during warmer months. Because the question's specific wording asks how the respondent got to *work*, university students and others who use bicycle facilities for non-work trips may not have responded to this question. Finally, an underlying assumption of this study is that bicycle commuters use the facility closest to their homes; however, Census data does not actually indicate which routes people choose. Despite these limitations, the Census remains the most comprehensive and consistent source available for recording commuting rates across time and different geographic locations.

Statistical Correlation Testing
After establishing the BAZ for both 1990 and 2000 block groups, we used SPSS to identify appropriate descriptive statistics for each variable. We calculated:

total sample size
total number of workers over age 16
total number of bicycle commuters

These statistics were calculated among block groups inside the BAZ and for a city's block groups outside the BAZ to serve as a control. As an additional control, we included calculations for the total number of block groups within each city's county.

We then transferred these descriptors into Microsoft Excel to perform a statistical significance test on the changing rates of bicycle commuters between 1990 and 2000. In this test,

R_{90} = Bicycle Commute Rate in 1990
R_{00} = Bicycle Commute Rate in 2000
N_{90} = Sample Size in 1990
N_{00} = Sample Size in 2000
σ_{90-00} = Standard Deviation of the Sampling Distributions of the Differences in Sample Proportions

The Null Hypothesis states that the rate of bicycle commuting remained constant from 1990 to 2000:

$$H_0: R_{90} = R_{00}$$

The Alternate Hypothesis states that the rate of bicycle commuting changed between 1990 and 2000:

$$H_1: R_{90} \neq R_{00}$$

To test these hypotheses, we first calculated the average rate of bicycling between 1990 and 2000, denoted R_μ.

$$R_\mu = (N_{90} * R_{90} + N_{00} * R_{00})/(N_{90} + N_{00})$$

We then calculated the standard deviation of the sampling distributions of the differences in sample proportions using the formula:

$$\sigma_{90-00} = \sqrt{(R_\mu * (1 - R_\mu))} * \sqrt{((N_{90} + N_{00}) / N_{90} + N_{00})}$$

The Z score obtained from this standard deviation was calculated with the formula:

$$Z(obtained) = (R_{90} - R_{00}) / \sigma_{90-00}$$

If $|Z(obtained)| > \pm 1.96$, we rejected the Null Hypothesis that bicycle commute rate remained constant between 1990 and 2000. In other words, we felt reasonably confident stating that the change in bicycle commuting rate was statistically significant during this time period.

Whether or not our tests proved that changes in an area's bicycle commute rate were statistically significant, our findings still have practical significance to those trying to understand trends in bicycle commute rates. By itself, a statistical significance test does not fully explain bicycle commuting trends within these cities. It should be noted that this study calculates change in commute *rates*, not the change in total number of bicycle commuters during the study's time period. Therefore, a change that fails a statistical significance test could still represent a sizeable increase in the total number of bicycle commuters.

Qualitative Analysis

After performing our statistical analysis, we solicited qualitative information to provide contextual background for these results. We conducted interviews with city bicycle coordinators from the case study cities to learn how factors such as political culture, housing density, employment patterns, and publicity efforts may have influenced the success of bicycle facilities built during the 1990s. The results of these interviews are discussed with analyses of each case study city. See Appendix B for a list of interviewees and interview questions.

Chapter 3:
Summary of Findings

The results of this study indicate that contextual factors promoting bicycle commuting were an important component to the success of bicycling facilities constructed during the 1990s. The previous findings of Barnes, et al. suggest that construction of new bicycle facilities correlates with a statistically significant increase in localized bicycle commuting rates. While this trend occurred in some cities, the findings were not consistent throughout our case studies. Overall, the results from the six case study cities do not support the hypothesis that the implementation of new facilities has a stand-alone effect on commuters' decision to bicycle. Variation across the six cities is best explained by our qualitative findings identifying complementary factors that were present (or absent) in cities that added bicycle facilities.

In three cities, Austin, Chicago, and Colorado Springs, bicycle commute mode share increased around new bicycle facilities. In Austin and Chicago, this change was statistically significant. In Colorado Springs, the increase in bicyclist commute mode was statistically insignificant. Interestingly, all three of these cities also experienced increased rates of bicycle commuting city-wide.

In Salt Lake City, Madison, and Orlando, bicycle commute mode share declined overall and within BAZs. In Madison and Salt Lake City, decreases both city-wide and within BAZs were statistically insignificant. Although bicycle commute rates declined in these two cities, the total number of bicycle commuters increased both overall and within BAZs. Orlando experienced a statistically significant decrease in city-wide bicycle commute mode share and an insignificant decrease within its BAZ. Total number of bicycle commuters dropped as well during this time period. See Table 4 for specific bicycle commute data in each city.

Because quantitative findings among these six cities were inconsistent, interviews with local bicycle coordinators helped contextualize results from each city and provide insight as to why implementing bicycle facilities was more effective in some locations than others. Among the key themes we identified were location of facilities along usable commuting routes and the overall connectivity of the facility network. For example, the bicycling network in Austin is well-connected throughout the downtown core, resulting in a system that is easy to use and bicyclist-friendly. In contrast, Orlando's routes are fragmented throughout the metro area among primarily middle to high-income neighborhoods. According to Orlando's metro bicycle planner, the city's bicycle commuters are primarily low-income groups that live in different locations than those served by the trails. As a result, the accessibility of the trails was limited and the facilities were less likely to be taken advantage of by those most likely to adopt them as commute routes.

Demographic Profiles of Block Groups with High Numbers of Bicycle Commuters

To help understand different areas' potential to induce bicycle commuting, we created a demographic profile of the block groups from each case study city that contained the highest total number of bicycle commuters. The specific locations of these block groups within each city are highlighted in the figures below. While these statistics are not meant to be considered representative of bicycle commuters or bicycle commute origin locations nationwide, they offer some insight into the character of locations where bicycle commuting is a popular option. Table 5 *(Appendix A)* summarizes selected socioeconomic variables for these six block groups.

As our qualitative findings suggest, locations with the highest number of bicycle commuters have noticeably high population densities compared to their respective cities. These are frequently located in or near the central business district. Exceptions to this location pattern are in Chicago, where high-density block groups exist throughout the city, and Orlando, where population density is consistently dispersed. Interestingly, most of these block groups also contain high percentages of individuals who walk to work, an indication that non-motorized accessibility is generally high in these areas.

Across this sample, the median age of the population is typically in the early twenties and median household income is considerably below respective city median incomes. The exception to this trend is in Chicago, where the median age is 30 and the median household income is above the city-wide median.

Of this sample, Austin and Chicago block groups represented both the lowest and the highest median income group. These two cities had the highest increases in bicycle commuting throughout the 1990s. The median income characteristics of these block groups provides some indication that the popularity of bicycling is not limited to people of a specific income category. While this data cannot provide specific information about the identity of bicycle commuters, it is a starting point for those wishing to understand the dynamics of bicycle commuting in specific areas.

Another key theme we identified was the level of increased visibility and local political support for bicycle commuting during the 1990s. In Chicago, the increase in bicycle commuting was accompanied by multiple city-wide bicycle campaigns. “Bike to Work Week” became officially sponsored by the Mayor’s Office of Special Events. In contrast, new bicycle facilities in Salt Lake City were implemented at the same time as massive infrastructure changes to the city’s highway and transit systems in preparation for the 2002 Olympics. Consequently, little fanfare was devoted to new bicycle facilities and their impact on commuting rates was less effective.

A final element of our findings was that implementation of off-street facilities did not seem to have a greater impact on bicycle commuting rates than on-street facilities. This may be a function of various factors. Many off-street facilities are constructed on former rail lines and along creek beds. As a result, they can be less obvious to users and may be less connected to major commuting destinations. This does not mean that off-street facilities are without value to bicyclists. They provide recreational opportunities, public amenities, and routes for non-work travel trips. Unfortunately, these uses are beyond the scope of this study. In the following sections, we discuss each of these key themes with our findings and individual analysis of each city.

Chapter 4:
Analysis

While the level of bicycle commuting decreased nationwide during the 1990s, our results show that new bicycling facilities helped reverse this trend in some locations. This raises important questions about the kinds of policies that are necessary to best promote bicycle commuting. Since the "build it and they will come" effect does not seem to be universally applicable, the purpose of this analysis is to identify characteristics of successful facilities that could be tested in future studies and ultimately applied by city policy-makers.

Austin, TX

The city of Austin experienced a statistically significant increase in bicycle commuting rates between 1990 and 2000, with an overall increase from .76% to .95%. In all categories, Austin supported our hypothesis that bicycle commute mode share would increase significantly in BAZs and decrease or remain the same everywhere else. The BAZ around on-street routes experienced a statistically significant increase from .87% to 1.19% in bicycle commute mode share. The control area experienced a statistically significant decrease from .31% to .14%. The BAZ around Austin's two eligible off-street facilities experienced a statistically significant increase in bicycle commute mode of 2.64% to 3.52% and a statistically insignificant increase in the control area. It should be noted that the BAZ around off-street facilities is entirely contained within the larger BAZ around on-street facilities, making it difficult to precisely determine which type of facility bicyclists are using in this area. Although it is tempting to attribute increased rates to Austin's high student population, it should once again be noted that the Census only counts journeys to work and students are unlikely to be included in these figures.

Austin city bicycling planners offered some context for the overall improvement in bicycle commute rates. The city re-established its bicycling program in 1992, a sign that increased political momentum may have generated new interest in bicycling during the 1990s. In addition, Austin developed a procedure for determining route locations that differs from typical planning processes. Many cities choose routes based on the geometry of existing roads, efficiency of routes, and connectivity to additional networks. In Austin, planners also work with bicyclists to identify routes already being used for commuting before officially designating them with signs. Consequently, these routes are bicyclist-friendly, using residential roads that run parallel to major arterials in order to help bicyclists avoid dangerous traffic. While planners admit that these routes are less visible to those who do not already know they exist, our findings indicate that this system may be considered a factor of Austin's success in increasing bicycle commute mode.

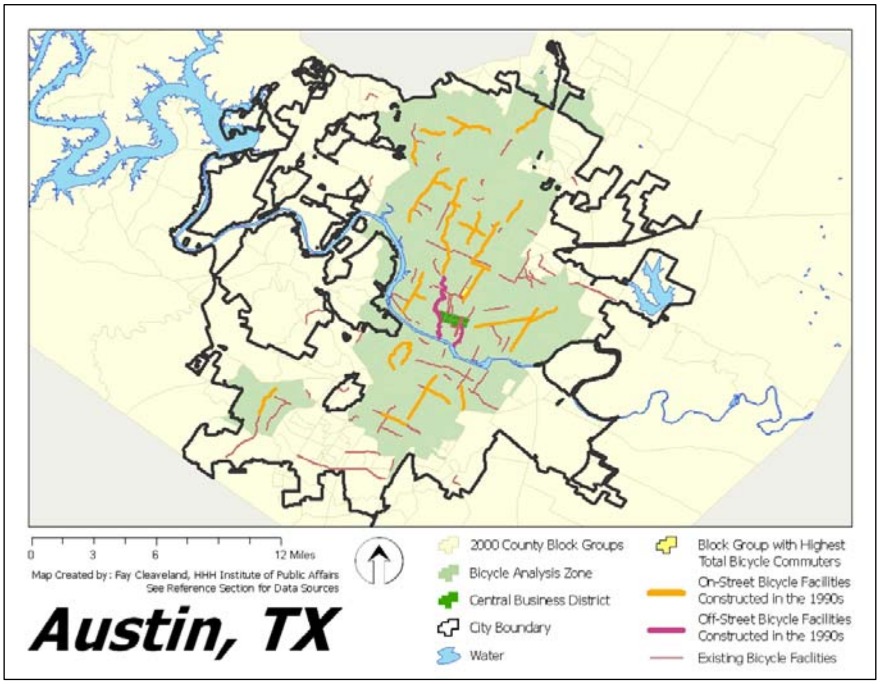

Figure 4.1: Austin, TX

The geographic location of the city's bicycling system may also explain high bicycle commute rates. As shown in Figure 4.1, Austin's bicycle system is concentrated around the central business district, where the gridded street design is typically more bicyclist-friendly than the sprawling subdivisions at the urban fringe. People who choose to bicycle to work may be more likely to live in this area, contributing to increased bicycle commute rates here. Not surprisingly, the block group containing the highest total number of Austin's bicycle commuters is close to the central business district and well connected by several bicycle facilities.

Chicago, IL

Chicago experienced a statistically significant increase in bicycle commute mode share during the ten-year period of study. Bicycling rates grew from .28% to .50% overall and from .35% to .67% within the BAZ. The facilities used in this study were striped bike lanes. Chicago has not experienced significant construction of off-street facilities due to lack of available development space. As shown in Figure 4.2, bike lanes typically lead from outer districts into the downtown Loop.

Chicago had very few bicycle facilities in place prior to the 1990s. Their implementation may have had such a great effect during this study's time interval because they provided a new transportation alternative that had not been previously available to commuters. The city's high degree of residential density, traffic congestion, and traditional grid-like street pattern contributes to the attractiveness of this transportation option.

Figure 4.2: Chicago, IL

In addition, the implementation of new bicycling facilities was accompanied by significant political fanfare that generated visibility and enhanced awareness of the new infrastructure. "Bike to Work Day" was initiated in the late 1980s by the Chicagoland Bicycle Federation, a local bicycle advocacy group. In 1993, the Mayor's Office of Special Events officially adopted this program and expanded the event to "Bike to Work Week." At the same time that bicycle lanes were being created, the city spent approximately $15,000 to install bicycle racks in front of municipal buildings. This both improved parking for bicyclists and increased bicyclist visibility. Many of these changes can be attributed to the presence of a savvy and well-organized bicycle advocacy organization. Cooperation between the Chicagoland Bicycle Federation and city officials is high. The group supports the city's Bike Week by coordinating workplace mentorships among seasoned and first-time bicycle commuters. Eight members of the organization are employed by the city government, another sign of strong collaboration between city officials and bicycling advocates.

Although it is impossible to totally separate the effects of facility construction from increased bicycling advocacy and awareness campaigns, it is clear that this combination of factors led to a significant increase in the rate of Chicago's bicycle commuting. Even more promising for this study, the rate of bicycle commuting increase in the BAZ was much greater than in other parts of the city and county. Chicago has achieved measurable success in increasing bicycle commute mode share near its bicycle facilities and our qualitative findings indicate that increased visibility and political support played a large role in this accomplishment.

Colorado Springs, CO

The city of Colorado Springs experienced a statistically insignificant increase from .49% to .55% in bicycle commuting rates. Colorado Springs is a unique example among our case studies because the city only constructed one off-street facility during the 1990s, the Pikes Peak Greenway Trail. On-street facility data was not available for this study. Prior to the 1990s, the Pikes Peak Greenway Trail ran approximately two miles north/south along the western edge of downtown, indicated in Figure 4.3. About four miles were added on both the north and south sections during the 1990s, increasing the trail's total length to about 10 miles.

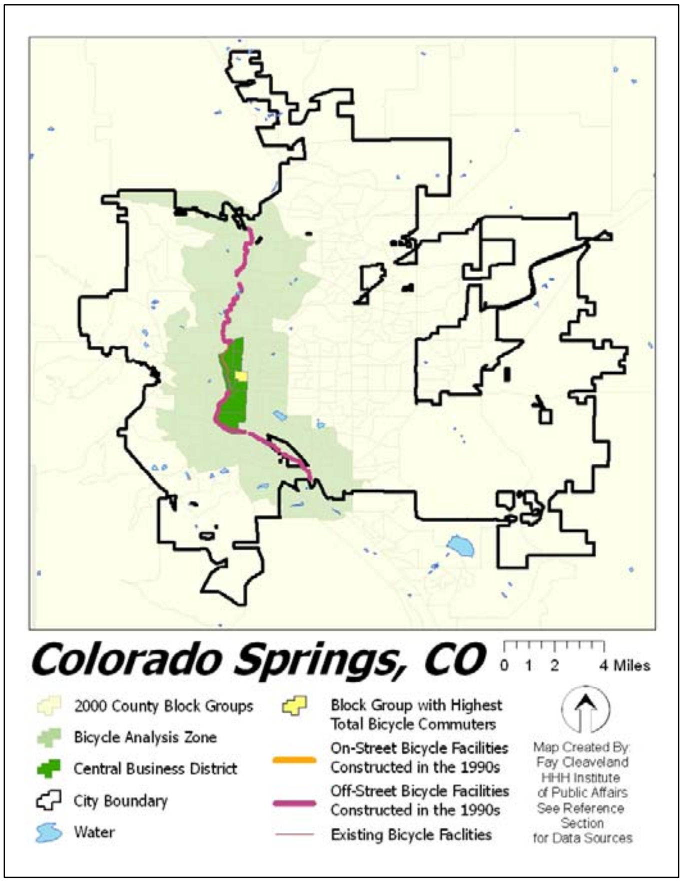

Figure 4.3: Colorado Springs, CO

This situation creates a perfect statistical control area for measuring change in commute rates in Colorado Springs. Within the BAZ, the increase in bicycle commute rate was insignificant, changing from .91% to .95%. Commuting rates in the control area also increased insignificantly from .26% to .34%. Although these changes were not statistically significant, the fact that commute rates in the BAZ were higher than rates in the control area suggests that expansion of the facility during the 1990s provided a needed service for the area. Disaggregating the north and south section of the trail showed that the northern section experienced a greater share of the overall increase. Rates near this portion grew from .23% to .68%, while rates around the southern portion actually decreased from 1.21% to .82%. The northern section of the trail was lengthened after 2000, suggesting that city planners have recognized the need for infrastructure here and continue to construct in areas that are most likely to attract commuters. Although commuting rates in Colorado Springs did not experience a dramatic increase, the higher rate of increase around the Pikes Peak Greenway Trail suggests that this trail is well-situated to improve service to Colorado Springs' bicycle commuters.

Salt Lake City, UT

During the 1990s, Salt Lake City added an extensive amount of bicycling infrastructure to the city network. According to the city bicycle coordinator, existing infrastructure prior to this time was limited and the network's overall connectivity was poor. Given the dramatic increase in infrastructure spending, one might expect to see a corresponding increase in commute rates. However, commuting rates remained virtually the same for both 1990 and 2000. In Salt Lake City overall, bicyclist mode share went from a rate of 1.52% in 1990 to 1.49% in 2000. Within the BAZ, rates were 1.53% both years. When off-street and on-street paths were disaggregated, we found that the BAZs around on-street paths sustained the same commuting rate both years: 1.54% in 1990 and 1.53% in 2000. Rates in BAZs around off-street facilities declined from 1.67% to 1.27%. Because the commute mode share around off-street facilities dropped below the city's overall rate of bicycle commuting, we suggest that off-street facilities were less likely to be used by bicycle commuters than on-street facilities. As Figure 4.4 depicts, many of these facilities are located in low-density areas far from the central business district. Salt Lake City's bicycle coordinator confirmed this hypothesis, stating that off-street facilities are most frequently used for recreational purposes.

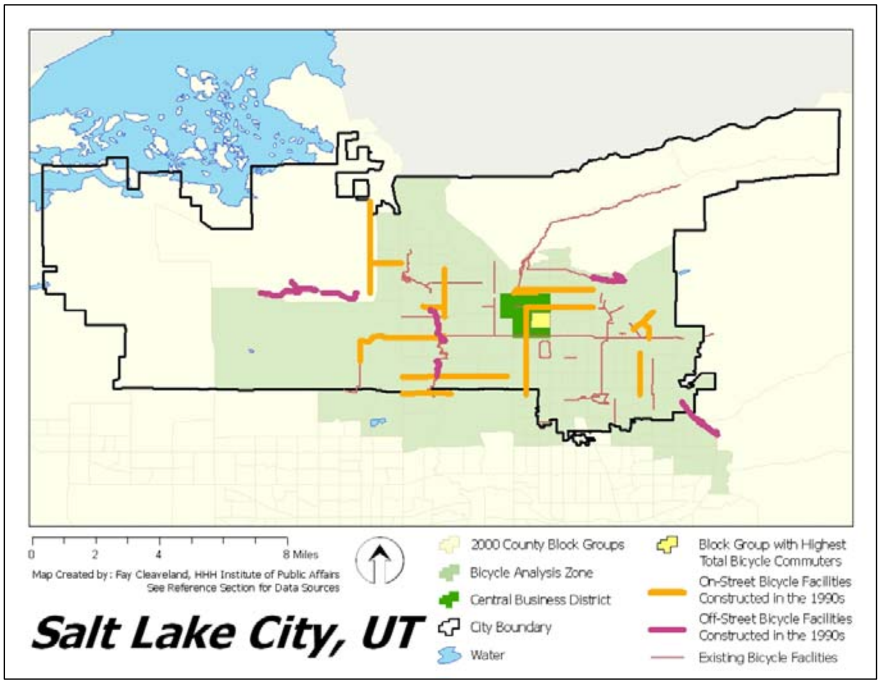

Figure 4.4: Salt Lake City, UT

The case of Salt Lake City may demonstrate the effect increased visibility (or lack thereof) can have on bicycle commute rates. Salt Lake's bicycle facilities were constructed simultaneously with massive infrastructure expansions in preparation for the 2002 Olympics. These included freeway reconstruction and a new light-rail system. Bicycle facilities received little individual fanfare amidst other transportation improvements, and the city has yet to sponsor a major campaign to promote bicycle commuting. Although the on-street BAZ in Salt Lake sustained the bicycle commute rate between 1990 and 2000, our findings from Chicago and Austin indicate that programs increasing the visibility of these routes could have a positive effect on increasing ridership.

Madison, WI

With an overall average above 3%, the city of Madison has one of the highest rates of bicycle commuting in the nation. However, bicycle commuting rates in both the city of Madison and the BAZ around off-street facilities experienced a statistically insignificant decrease between 1990 and 2000. Interestingly, bicycle commute mode increased insignificantly from 1.30% to 1.62% in the BAZ around the single on-street facility that qualified for this study.

Three off-street facilities qualified for use in this study: the Wingra Creek Trail, the Stark Weather Creek Trail, and the Isthmus Path. During discussions with the city's bicycle coordinators, we discovered that both the Wingra Creek Trail and the Stark Weather Creek Trail were implemented in areas that already contained well-used bicycle facilities. See Figure 4.5 for reference. The fact that commuting rates did not increase in the BAZ suggests that new trails may serve to relocate existing bicycle commuters without adding new users who would increase the bicycle commute rate.

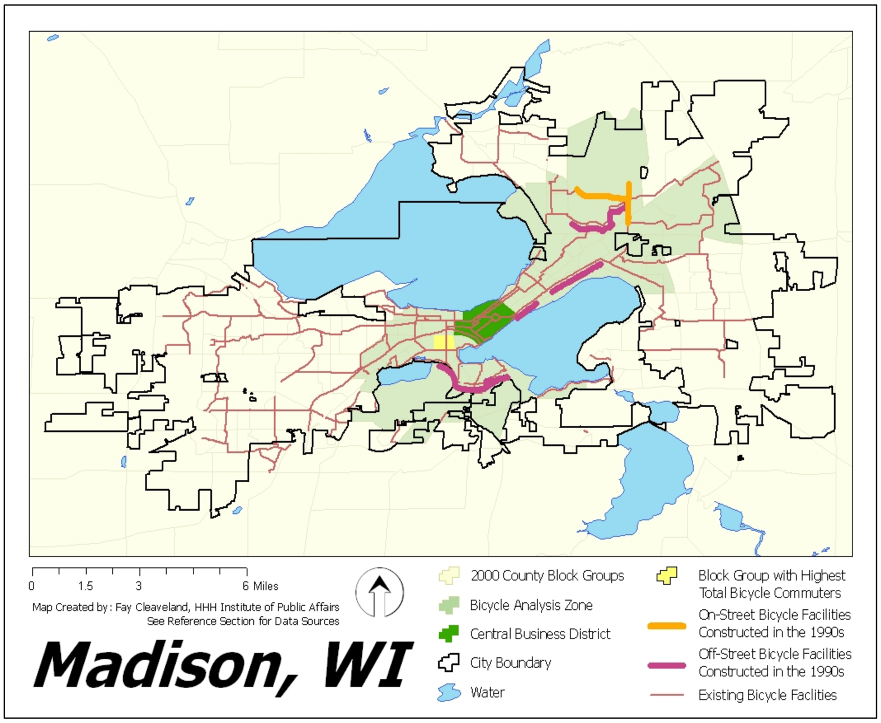

Figure 4.5: Madison, WI

Madison's drop in bicycle commute rates was initially surprising. Many of the BAZs contain high student populations who may commute to school by bicycle. However, the Census does not typically count these journeys as "journeys to work," and any increase in this population is unlikely to have a great affect on recorded bicycle commute rates. The city has well-established bicycling infrastructure that has been in place since the 1970s. Off-street and on-street facilities are well-connected throughout the city network and the system has been consistently improved and expanded over the course of its existence. Because Madison's bicycle facility network had been so firmly in place prior to the 1990s, it is likely that expansions during this time served to sustain existing commute rates rather than generate new interest in bicycling. Furthermore, it should be noted that the total number of bicycle commuters did increase from 3,543 to 3,772 people during this time period. However, because this increase changed at a slower rate than did total workers, bicycle commute mode share decreased.

Orlando, FL

The distinct growth pattern of Orlando, FL is differentiates it from other cities in this study. As shown in Figure 4.6, city boundaries are not contiguous. Unlike older cities dominated by central business districts, population density in Orlando is more evenly distributed throughout the metropolitan area. Because of the discontinuity of city boundaries and the dispersed pattern of population distribution, we include all trails in Orange County instead of using trails only within Orlando city boundaries. Due to data availability, only off-street facilities are included in this study.

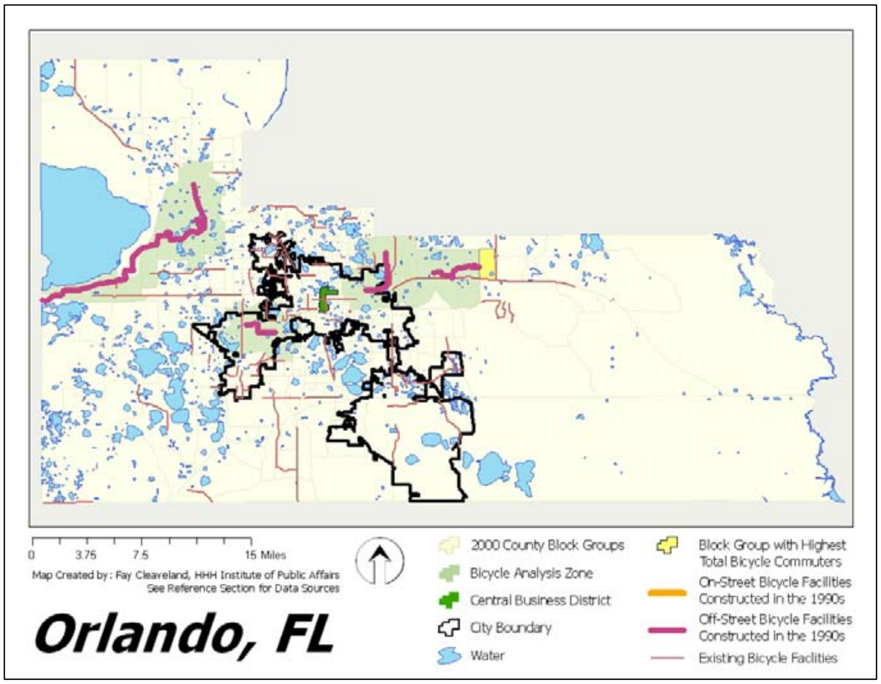

Figure 4.6: Orlando, FL

Orange County experienced a statistically significant decrease in bicycle commuting rates; rates fell from .66% to .46%. Disaggregating this data to the two areas within and outside of Orlando city limits, we find that rates in Orlando experienced a statistically significant drop from .85% to .62%. Within the BAZ, the drop in rates was not statistically significant. Outside of Orlando, the decline was not statistically significant in the BAZ but was significant in the control area. Rates within the BAZ changed from .85% to .69%; in the control area they fell from .50% to .34%. This suggests that bicycle trails outside of Orlando may have helped to sustain existing bicycle commute rates while overall rates declined.

These results were not surprising to Orlando's metro bicycle coordinator. Although both the city and the metro area have established bicycle plans, a strong bicycling advocacy group is not in place. Bicycle trails are generally constructed in middle or high-income areas, and he believes that the majority of Orlando's bicycle commuters are from low-income groups. Additionally, connections between off-street and on-street facilities are fragmented, limiting their transportation potential. Unlike most cities of this study, the sprawling nature of Orlando streets post-date the gridded street patterns typically thought to be most bicyclist-friendly. While Orlando's trails may serve as a recreational amenity, the location of the existing trail network does not seem to enhance commuting viability on these routes.

Chapter 5:
Conclusions

After analyzing our findings, it appears that contextual factors play a significant role in ensuring that new bicycle facilities attract commuters. In Chicago, major campaigns advertised the presence of bike lanes and created excitement about the city's new transportation option. Given the density and congestion of the Chicago metro area, the relative attractiveness of bicycle facilities as an alternative to driving was likely to be high. Salt Lake City experienced a surge in bicycling infrastructure of similar proportion at the same time as Chicago. However, publicity for new facilities was minimal, in part due to the city's preparation for the 2002 Olympic Games. Although facilities in Salt Lake City may have helped sustain existing ridership, construction without city-wide publicity efforts was not enough to encourage increased commuting rates.

Madison and Colorado Springs both reflected very little change in bicycle commute rates during the study's time period. In Madison, rates in both 1990 and 2000 were among the highest in the nation. Although other cities may look to Madison as an example for how to generate high ridership rates, few cities have crossed this threshold and demonstrated how commute rates can be taken to an even higher level. The trails implemented in Madison during the 1990s were frequently placed in areas already served by bicycle facilities, indicating that improvements to this network readjusted ridership but did not attract more users. In Colorado Springs, the implementation of a trail did not bring a significant increase in ridership rates. However, rates around the trail were higher than elsewhere in the city. This indicates that location among underserved riders is an important factor in a bicycle facility's effectiveness.

In Austin, the implementation of facilities had a measurable effect on bicycle commute mode share. Like Chicago, Austin's facilities connect high-density residential areas to the downtown. Neighborhoods built on this pre-WWII grid are typically thought to be bicyclist-friendly in their design and street pattern. A quick glance at Orlando's bicycle facilities shows that the network there is more fragmented and less tightly concentrated around the urban core. In contrast to the changes in Chicago and Austin, ridership rates in Orlando actually decreased. These issues are an indication that overall connectivity between residential neighborhoods, employment centers, and bicycle facilities is a key factor that encourages use.

Our "Summary of Findings" identifies three key themes that were present in cities whose bicycling commute mode share increased around new bicycling facilities. We will revisit them here. The first theme is *location of facilities along usable commuting routes*, best illustrated by the city of Chicago. Bicycling facilities lead from distant parts of the city and converge in the downtown employment hub. In Austin, facilities are also oriented toward the central city and connect the city's densely-settled residential neighborhoods with this location. In contrast, the new bicycling facilities in Orlando do not converge on any central location. Granted, employment opportunities are not equal among the central business districts of these cities. However, a message that can be drawn from this comparison is that bicycling facilities are most effective in highly-accessible urban areas where a large number of commute trips can take place across short distances. In locations where bicycling facilities could provide viable commuting routes between residential and employment concentrations, increases in bicycle commuting rates were likely to occur.

The second key theme is *overall network connectivity*. In both Austin and Madison, the network of bicycling facilities covers a large part of the central city. Numerous intersections among these trails allow a bicyclist to easily navigate from one section of the city to another. In the case of Madison, it is possible that network connectivity was so high in the 1990s that most areas were already connected to the system. The addition of bicycling facilities relocated existing commuters but did not bring new block groups, and therefore commuters, into the network. The connectivity of Austin's facility network contrasts with the single trail constructed during the 1990s in Colorado Springs. In Austin, a potential bike commuter could reside in a variety of locations and still ride to an employment location in most parts of the central city. In Colorado Springs, a bicycle commuter would have to both live and work along the length of the Pikes Peak Greenway Trail for this to be a viable new commuting option.

Network connectivity is one reason why the off-street facilities used in this study may not have shown the same increases in localized commuting rates as on-street trails. As stated earlier, construction of these facilities often depends on the availability of right-of-way, frequently found along creek beds and former rail lines. Because the primary determinant of off-street facility location may not be its relationship to other destinations, these facilities are not always situated to significantly enhance bicycle commute mode share. That is not to say that off-street facilities do not have value; they can attract non-work travel trips or add to a city's recreational amenities. However, these purposes were beyond the scope of this study. A separate effort focused on evaluating the uses of off-street facilities would be highly valuable in discerning their effectiveness at promoting non-motorized travel.

The final key theme is the *amount of publicity and promotion* dedicated to new bicycling facilities. The contrast between the change in commute rates in Chicago and Salt Lake City best illustrates this idea. In Chicago, new bicycling facilities were added in combination with a multitude of other efforts by city planners and advocates to advertise their presence and promote bicycle commuting among city residents. This combination of efforts was simply not present in a similar magnitude in Salt Lake City during the 1990s. A bicycling facility can only be adopted by commuters if they are aware of its existence and excited to adopt bicycles as their commute mode. Promotion by city leaders is a critical component to a bicycle facility's effectiveness.

This study furthers the work of Barnes, et al. by applying their methodology to bicycle facilities in a variety of cities. We conclude that qualitative findings add important texture to the data gathered by this methodology and give meaning to these figures. Our qualitative findings suggest that if the combination of identified factors were present in a city during the 1990s, large increases in the rate of bicycle commuting could occur. In Chicago and Austin, the two cities that experienced significant increases in bicycle commuting, visibility for new facilities was high, routes were implemented in attractive locations for bicycle commuters, and the overall connectivity of the network was well-established. These factors were also present in the Twin Cities at the time of the Barnes, et al. study. In Salt Lake City, Madison, Colorado Springs, and Orlando, the complete combination of all of these factors was not present and the implementation of facilities did not correlate with significant increases in commuting rates. Although the implementation of bicycle infrastructure is an important step toward increasing bicycle commute rates, additional factors must be present to ensure that urban residents take advantage of these facilities.

Chapter 6:
Questions for Further Study

Our findings raise several questions for further study. One of the most obvious questions is how bicycle commute mode will change around facilities constructed between 2000 and 2010. Many of the bicycling coordinators we interviewed felt that the popularity of bicycling in their communities reached new levels after the year 2000, and pointed out numerous network expansions since that time. Publicity efforts that were not present for facilities during the 1990s may have been present the following decade, and it would be interesting to see whether this had any affect on commute rates in specific cities. Furthermore, increasing the study's time span would help uncover trends in commuting rather than snapshots at two particular points in time.

Given the aforementioned shortcomings of Census data, one possible avenue of research is how to improve Census survey questions to more accurately record commute mode share. This could provide meaningful data to researchers as they continue studies on commute mode share and the use of public facilities for transportation.

Although this study did not find off-street facilities to be more beneficial to commuters than on-street trails, these facilities have value as non-work travel routes, recreation destinations, and public amenities. A survey of users' travel purposes is underway in Minnesota; these findings will enhance our understanding of off-street facilities and provide important groundwork for future studies on the subject of travel behavior and the usefulness of bicycling for non-work travel trips.

Lastly, this study identifies several qualitative factors that contribute to the success of city bicycle facilities. A methodology that quantitatively identifies and measures qualitative indicators could provide useful insight and guidance as to how city policy-makers could best address bicycle commuting in their city.

Understanding how bicycle facilities can best serve commuters is an important objective for both researchers and policy-makers. This study identifies several factors that lead to a facility's use, including location, connectivity, and visibility of the network. Although further questions remain, improving understanding of bicycle facilities as commuting routes will help guide policy-makers as they invest in improvements to their local bicycle networks and advocate for viable bicycle commuting routes.

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12. US Census Bureau, American Factfinder. *1990 Decennial Census: Summary file 3.* US Census Bureau. Available http://factfinder.census.gov. Last accessed February 2008.

GIS Data Sources

Austin

Data: US Census Bureau Summary File 3
ESRI ArcData
City of Austin Public Works

City of Austin Parks and Recreation Department
CBD Definition: Austin City Connection. "Downtown Redevelopment." Available < http://www.ci.austin.tx.us/downtown/downloads/demographic_profile.pdf> Accessed 20 Feb 2008.

Chicago
Data: US Census Bureau Summary File 3
ESRI ArcData
Chicago Department of Transportation
CBD Definition: City of Chicago Geographical Information Systems.
Available <http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/Population_Total_1.pdf> Accessed 20 Feb 2008.

Madison
Data: US Census Bureau Summary File 3
ESRI ArcData
Dane County Land Information Office
Madison Area Metropolitan Planning Organization
CBD Definition: City of Madison Parking Utility.
Available < http://www.cityofmadison.com/parking/downtownMap.html> Accessed 21 Feb 2008.

Salt Lake City
Data: US Census Bureau Summary File 3
ESRI ArcData
Salt Lake City Transportation Division
CBD Definition: Salt Lake City.
Available < http://www.slcgov.com/info/area_info/census/ccouncil.htm> Accessed 21 Feb 2008.

Colorado Springs
Data: US Census Bureau Summary File 3
ESRI ArcData
Colorado Springs Utilities Department
Colorado Springs Comprehensive Planning Division
CBD Definition: City of Colorado Springs Online Maps.
Available < http://www.springsgov.com/Page.asp?NavID=1120> Accessed 21 Feb 2008.

Orlando
Data: US Census Bureau Summary File 3
ESRI ArcData
MetroPlan Orlando
CBD Definition: City of Orlando.
Available < http://www.cityoforlando.net/gis/pdf/DowntownDDB.pdf> Accessed 21 Feb 2008.

Appendix A:

Data Tables

Table 1. Bicycle commute rate for cities over 300,000 people in 2000 (10)

Rank	City	Cycle commute rate 2000
1	Tucson city, Arizona	2.21
2	San Francisco city, California	1.98
3	Minneapolis city, Minnesota	1.89
4	Seattle city, Washington	1.88
5	Portland city, Oregon	1.76
6	Sacramento city, California	1.35
7	Honolulu CDP, Hawaii	1.25
8	Mesa city, Arizona	1.23
9	Oakland city, California	1.22
10	Anaheim city, California	1.22
11	Washington city, District of Columbia	1.16
12	New Orleans city, Louisiana	1.16
13	Santa Ana city, California	1.12
14	Albuquerque city, New Mexico	1.12
15	Boston city, Massachusetts	0.97
16	Denver city, Colorado	0.95
17	Austin city, Texas	0.93
18	Tampa city, Florida	0.89
19	Philadelphia city, Pennsylvania	0.86
20	Phoenix city, Arizona	0.86
21	Fresno city, California	0.79
22	Long Beach city, California	0.73
23	San Diego city, California	0.73
24	San Jose city, California	0.62
25	Los Angeles city, California	0.61
26	Miami city, Florida	0.55
27	Colorado Springs city, Colorado	0.52
28	Chicago city, Illinois	0.50
29	New York city, New York	0.47
30	Houston city, Texas	0.46
31	Pittsburgh city, Pennsylvania	0.44
32	Jacksonville city, Florida	0.42
33	Las Vegas city, Nevada	0.39
34	St. Louis city, Missouri	0.35
35	Columbus city, Ohio	0.34
36	Milwaukee city, Wisconsin	0.33
37	Baltimore city, Maryland	0.33
38	Virginia Beach city, Virginia	0.32
39	Atlanta city, Georgia	0.31
40	Toledo city, Ohio	0.22
41	Cleveland city, Ohio	0.22
42	Indianapolis city (balance), Indiana	0.21
43	Tulsa city, Oklahoma	0.21
44	Cincinnati city, Ohio	0.19
45	Wichita city, Kansas	0.18
46	Arlington city, Texas	0.17
47	San Antonio city, Texas	0.16
48	Detroit city, Michigan	0.16
49	Charlotte city, North Carolina	0.15
50	Nashville-Davidson (balance), Tennessee	0.14
51	Omaha city, Nebraska	0.14
52	Dallas city, Texas	0.13
53	Fort Worth city, Texas	0.13
54	Kansas City city, Missouri	0.12
55	El Paso city, Texas	0.12
56	Oklahoma City city, Oklahoma	0.11
57	Memphis city, Tennessee	0.11

Table 2. Bicycle commute rate by state according to the 1990 and 2000 Census (2, 10)

	% Workers 16 years and over: Means of transportation to work; Bicycle		Change in terms of St. Dev.
State	1990	2000	
New York	0.25%	0.30%	1.0
Illinois	0.26%	0.32%	0.8
Kentucky	0.10%	0.15%	0.4
Ohio	0.16%	0.18%	0.3
Indiana	0.24%	0.27%	0.3
Pennsylvania	0.23%	0.25%	0.3
Missouri	0.13%	0.15%	0.2
Rhode Island	0.22%	0.27%	0.2
Iowa	0.33%	0.36%	0.2
Massachusetts	0.38%	0.40%	0.2
Arkansas	0.10%	0.13%	0.2
Montana	0.92%	0.96%	0.2
West Virginia	0.08%	0.11%	0.1
Oregon	1.05%	1.07%	0.1
Washington	0.57%	0.58%	0.1
Tennessee	0.08%	0.09%	0.1
Minnesota	0.39%	0.40%	0.1
Connecticut	0.17%	0.18%	0.0
Maryland	0.19%	0.19%	0.0
New Jersey	0.24%	0.24%	-0.1
Louisiana	0.37%	0.36%	-0.1
Michigan	0.23%	0.22%	-0.1
Oklahoma	0.20%	0.19%	-0.1
Georgia	0.15%	0.15%	-0.1
Texas	0.24%	0.24%	-0.1
North Dakota	0.35%	0.32%	-0.1
Maine	0.25%	0.23%	-0.1
Colorado	0.80%	0.77%	-0.2
Alabama	0.10%	0.07%	-0.2
Vermont	0.38%	0.31%	-0.3
Kansas	0.27%	0.23%	-0.3
Mississippi	0.15%	0.10%	-0.3
Delaware	0.34%	0.23%	-0.4
Alaska	0.65%	0.54%	-0.4
North Carolina	0.22%	0.18%	-0.4
Nebraska	0.36%	0.29%	-0.4
Wyoming	0.72%	0.56%	-0.5
South Carolina	0.28%	0.21%	-0.5
New Hampshire	0.30%	0.19%	-0.5
South Dakota	0.39%	0.25%	-0.5
Virginia	0.29%	0.23%	-0.6
Idaho	0.80%	0.66%	-0.6
New Mexico	0.69%	0.56%	-0.6
Wisconsin	0.50%	0.43%	-0.8
Hawaii	1.07%	0.87%	-0.8
Utah	0.68%	0.51%	-1.0
Nevada	0.74%	0.49%	-1.0
Florida	0.70%	0.57%	-1.7
California	0.94%	0.83%	-2.1
Arizona	1.38%	1.00%	-2.6
US Total	0.41%	0.38%	-1.6

Table 3: Results of Statistical Significance Testing for Correlation between Bicycling Facilities and Bicycle Commute Mode Share			Bicycle commute mode share			
			1990	2000	Significant	St. Dev.
Travis County, Texas			0.64%	0.77%	TRUE	5
	Outside of Austin		0.08%	0.13%	FALSE	2
	Austin		0.76%	0.95%	TRUE	6
		All Paths in buffer	0.87%	1.19%	TRUE	8
		All Paths out of buffer	0.31%	0.14%	TRUE	-4
		On Street in buffer	0.87%	1.19%	TRUE	8
		On Street out of buffer	0.31%	0.14%	TRUE	-4
		Off Street in buffer	2.64%	3.52%	TRUE	6
		Off Street out of buffer	0.34%	0.43%	FALSE	4
Cook County, Illinois			0.25%	0.39%	TRUE	22
	Outside of Chicago		0.22%	0.28%	TRUE	6
	Chicago		0.28%	0.50%	TRUE	24
		On Street in buffer	0.35%	0.67%	TRUE	21
		On Street out of buffer	0.20%	0.30%	TRUE	9
El Paso County, Colorado			0.40%	0.42%	FALSE	1
	Outside of Colordo Springs		0.19%	0.15%	FALSE	-1
	Colorado Springs (Off Street)		0.49%	0.55%	FALSE	2
		Colorado Springs in buffer	0.91%	0.95%	FALSE	0
		Colorado Springs out of buffer	0.26%	0.34%	FALSE	3
		North Trail in buffer	0.23%	0.68%	FALSE	5
		North Trail out of buffer (Includes South Trail)	0.50%	0.54%	FALSE	1
		South Trail in buffer	1.21%	0.82%	FALSE	-2
		South Trail out of buffer (Includes North Trail)	0.43%	0.53%	FALSE	3
		Both Trails in buffer	0.72%	0.76%	FALSE	0
		Both Trails out of buffer	0.40%	0.42%	FALSE	1
Salt Lake County, Utah			0.59%	0.50%	TRUE	-4
	Outside of Salt Lake City		0.31%	0.25%	FALSE	-3
	Salt Lake City		1.52%	1.49%	FALSE	0
		All Paths in buffer	1.53%	1.53%	FALSE	0
		All Paths out of buffer	1.29%	0.00%	TRUE	-2
		On Street in buffer	1.54%	1.53%	FALSE	0
		On Street out of buffer	0.92%	0.00%	FALSE	-2
		Off Street in buffer	1.67%	1.27%	FALSE	-3
		Off Street out of buffer	1.41%	1.66%	FALSE	2
Dane County, Wisconsin			1.94%	1.74%	TRUE	-4
	Outside of Madison		0.43%	0.35%	FALSE	-3
	Madison		3.40%	3.28%	FALSE	-1
		All Paths in buffer	5.39%	5.18%	FALSE	-1
		All Paths out of buffer	1.47%	1.40%	FALSE	-1
		On Street in buffer	1.30%	1.62%	FALSE	2
		On Street out of buffer	3.80%	3.62%	FALSE	-1
		Off Street in buffer	5.83%	5.70%	FALSE	-1
		Off Street out of buffer	1.38%	1.31%	FALSE	-1
	Capital City In buffer (city does not equal 1)		6.05%	5.50%	FALSE	-2
	Wingra Creek		6.63%	7.94%	FALSE	4
	Starkweather Creek		2.51%	2.41%	FALSE	0
Orange County, Florida			0.66%	0.46%	TRUE	-7
	In buffer		0.77%	0.61%	FALSE	-3
	Outside of Orlando		0.59%	0.42%	TRUE	-5
		Off Street in buffer	0.85%	0.69%	FALSE	-5
		Off Street out of buffer	0.50%	0.34%	TRUE	-5
	Orlando		0.85%	0.62%	TRUE	-4
		Off Street in buffer	0.60%	0.37%	FALSE	-2
		Off Street out of buffer	0.96%	0.72%	FALSE	-3

Table 4: Case Study Bicycle Commute Rate Data

	1990				2000			
	Sample	Workers	Bicycle commuters	Rate	Sample	Workers	Bicycle commuters	Rate
Travis County, Texas	82,215	302,909	1,951	0.00644	103,688	433,062	3,340	0.00771
Outside of Austin	19,202	50,007	40	0.00080	26,277	95,910	122	0.00127
Austin	63,013	252,902	1,911	0.00756	77,411	337,152	3,218	0.00954
All Paths In Buffer	49,795	201,666	1,753	0.00869	59,615	261,168	3,115	0.01193
All Paths Out of Buffer	13,218	51,236	158	0.00308	17,796	75,984	103	0.00136
On Street In Buffer	49,795	201,666	1,753	0.00869	59,615	261,168	3,115	0.01193
On Street Out of Buffer	13,218	51,236	158	0.00308	17,796	75,984	103	0.00136
Off Street In Buffer	12,479	45,834	1,210	0.02640	13,800	56,914	2,005	0.03523
Off Street Out of Buffer	50,534	207,068	701	0.00339	63,649	280,240	1,214	0.00433
Cook County, Illinois	645,046	2,369,624	5,923	0.00250	678,484	2,371,161	9,221	0.00389
Outside of Chicago	322,903	1,215,354	2,705	0.00223	337,823	1,179,262	3,254	0.00276
Chicago	322,143	1,154,270	3,218	0.00279	340,661	1,191,899	5,967	0.00501
On Street in Buffer	156,323	588,806	2,078	0.00353	164,687	640,412	4,310	0.00673
On Street Out of Buffer	165,820	565,464	1,140	0.00202	175,974	551,487	1,657	0.00300
El Paso County, Colorado	54,104	197,436	781	0.00396	73,246	263,805	1,114	0.00422
Outside of Colorado Springs	17,894	60,577	117	0.00193	27,302	84,141	123	0.00146
Colorado Springs	36,210	136,859	664	0.00485	45,944	179,664	991	0.00552
Off Street in Buffer	13,854	48,244	438	0.00908	16,871	62,318	590	0.00947
Off Street Out of Buffer	22,356	88,615	226	0.00255	29,073	117,346	401	0.00342
Salt Lake County, Utah	102,436	329,238	1,931	0.00587	117,308	438,627	2,196	0.00501
Salt Lake City	21,466	74,822	1,139	0.01522	24,136	89,101	1,331	0.01494
All Paths in Buffer	21,081	73,659	1,124	0.01526	23,478	86,732	1,331	0.01535
All Paths Out of Buffer	385	1,163	15	0.01290	658	2,369	0	0.00000
On Street in Buffer	20,885	73,195	1,124	0.01536	23,478	86,732	1,331	0.01535
On Street Out of Buffer	581	1,627	15	0.00922	658	2,369	0	0.00000
Off Street in Buffer	9,305	33,128	552	0.01666	10,551	38,757	494	0.01275
Off Street Out of Buffer	12,161	41,694	587	0.01408	13,585	50,344	837	0.01663

Dane County, Wisconsin	75,492	204,399	3,970	0.01942	67,400	242,542	4,216	0.01738
Outside of Madison	47,852	100,159	427	0.00426	41,783	127,659	444	0.00348
Madison	27,640	104,240	3,543	0.03399	25,617	114,883	3,772	0.03283
All Paths In Buffer	12,781	51,255	2,765	0.05395	12,108	57,147	2,961	0.05181
All Paths Out of Buffer	14,859	52,985	778	0.01468	13,509	57,736	811	0.01405
On Street In Buffer	4,351	16,668	217	0.01302	4,103	19,336	313	0.01619
On Street Out of Buffer	23,289	87,572	3,326	0.03798	21,514	95,547	3,459	0.03620
Off Street In Buffer	11,967	47,294	2,759	0.05834	10,908	51,621	2,944	0.05703
Off Street Out of Buffer	15,673	56,946	784	0.01377	14,709	63,262	828	0.01309
Orange County, Florida	84,488	356,271	2,345	0.00658	106,335	439,323	2,038	0.00464
In Buffer	21,151	95,593	735	0.00769	24,392	106,271	651	0.00613
Outside of Orlando	62,531	259,770	1,527	0.00588	84,426	347,294	1,466	0.00422
In Buffer	14,821	65,429	553	0.00845	18,647	79,981	555	0.00694
Out of Buffer	47,710	194,341	974	0.00501	65,779	267,313	911	0.00341
Orlando	21,957	96,501	818	0.00848	21,909	92,029	572	0.00622
Off Street in Buffer	6,330	30,164	182	0.00603	5,745	26,290	96	0.00365
Off Street Out of Buffer	15,627	66,337	636	0.00959	16,164	65,739	476	0.00724

Table 5: Selected Demographics from Block Groups Containing the Highest Total Number of Bicyclist Commuters (2000)												
	Austin		Chicago		Colorado Springs		Salt Lake City		Madison		Orlando	
	Block Group	City Total	Block Group	City Total	Block Group	City Total	Group	City Total	Group	City Total	Group	City Total
Total Population	2,288	656,302	5,295	2,895,964	1,423	360,798	1,502	181,456	2,014	207,525	7,820	185,984
Population Density (persons per square mile)	16,415	2,610	81,026	12,750	9,568	1,943	7,071	1,666	12,524	3,029	3,837	1,989
Median Age	23.9	29.6	30.5	31.5	20.8	33.6	25.5	30.0	22.6	30.6	22.0	32.9
Household Median Income	$18,338	$42,689	$41,460	$38,625	$26,439	$45,081	$26,406	$36,944	$31,616	$41,941	$25,290	$ 35,732
Percent Owner/Renter Occupied Housing Units	6/94	45/55	19/81	44/56	20/80	61/39	13/87	51/49	19/21	48/52	11/89	41/59
Bicycle Commuters												
Total Number	183	3,280	99	5,956	64	964	67	1,331	183	3,814	101	536
Percent	13%	1%	2%	0%	9%	1%	9%	1%	14%	3%	2%	0.0056535
Pedestrian Commuters												
Total Number	250	8,995	185	67,556	253	4,514	115	4,427	325	12,755	127	1,790
Percent	17%	3%	5%	6%	36%	2%	15%	5%	24%	11%	3%	2%
Racial/Ethnic Makeup												
White Alone	71%	65%	79%	42%	85%	81%	41%	79%	89%	84%	64%	61%
Black Alone	<1%	10%	6%	37%	1%	6%	4%	2%	1%	6%	8%	27%
American Indian/Hawaiian/Pacific Islander	<1%	<1%	<1%	<1%	<1%	<1%	<1%	1%	<1%	<1%	<1%	<1%
Asian Alone	16%	5%	7%	4%	1%	3%	<1%	4%	4%	6%	9%	3%
Hispanic or Latino	9%	16%	6%	14%	9%	5%	51%	9%	5%	2%	16%	5%

Data sources: American Factfinder. *2000 Decennial Census: Summary file 3 and Summary file 1*. US Census Bureau. Available http://factfinder.census.gov.
Social Explorer. *Census 2000 Essentials Report*. Available www.socialexplorer.com

Appendix B:

Interviews and Correspondence with Bicycle Coordinators

Annick Beaudet, Project Manager
Eric Dusza, Planner III
City of Austin Public Works: Bicycle and Pedestrian Program
Phone Interview: December 4, 2007

Jenna Neal, Park Planner
City of Austin Parks and Recreation Department
Email Correspondence: October – November 2007

Mike Amsden, Transportation Planner
T.Y. Lin International, Inc.
Chicago Department of Transportation, Bikeways Planner
Phone Interview: December 4, 2007

Randy Neufeld, Healthy Streets Campaign Coordinator
Chicagoland Bicycle Federation
Phone Interview: December 2007

Arthur Ross, Pedestrian-Bicycle Coordinator
City of Madison
Thomas Huber, Bicycle and Pedestrian Coordinator
Wisconsin DOT
Phone Interview: November 20, 2007

Dan Bergenthal, Transportation Engineer
Salt Lake City Transportation Division
Phone Interview: December 13, 2007

Mighk Wilson, Bicycle and Pedestrian Planner
Metroplan Orlando
Email Correspondence: November- December 2007

Sample Interview Questions

1. Does your city have an official bike plan?
2. If so, when was that plan written? Is it an update of an older plan?
3. When did the city create an official bicycle coordinator position?
4. How are the specific locations of bike paths determined?
5. What were the city's goals in implementing these paths?
6. What kind of publicity campaigns or related efforts did the city endorse to generate awareness for new bicycling facilities?
7. What factors contributed to overall biking awareness or facility construction in the 1990s?
8. Did any of the above change significantly during the 1990s?
9. What kind of neighborhoods do the trails connect?
10. How well-connected were the facilities existing in the 1990s?

10. How many facilities were in existence prior to the 1990s?
11. What kind of political attention did bicycling receive in your city during the 1990s?

Appendix C:

Definition of Terms

Bicycle Facilities

We use this term to describe both off-street and on-street facilities. An off-street facility is a trail that is separated from roadways; typical trails include creek routes and repaved rail lines. On-street facilities can be either striped bicycling lanes or designated "bicyclist-friendly" routes marked with signs. This report does not consider other types of bicycle facilities, such as bicycle racks, bicycle lockers, or bicycle repair stations.

Block Group

This is a geographic unit designated by the U.S. Census. This is the smallest unit of aggregation for which most Census data is made available.

Buffer

A buffer demarcates all of the land within a given radius of a particular feature. When we set a 2.5 kilometer buffer around a bicycling facility, we are marking all of the land that falls within a 2.5 kilometer radius, in any direction, of the facility.

Central Business District (CBD)

The downtown core of a city, historically the location of a city's highest employment density.

Commute Mode Share

Commute mode means method of transportation by which people travel to work, eg privately-owned vehicle, public transportation, bicycle, walking, etc. Commute mode share is the percentage of total commuters who travel by a certain mode.

Right-of-Way

Property dedicated to the public for transportation purposes.

Sample

The data in this study comes from Summary File 3 of the U.S. Census Bureau. To obtain data for this file, the Census surveys a sample of the U.S. population, not the population as a whole. Sample statistics for a given geographic location are a record of survey responses from individuals who are included in the sample and live in that location. The Census Bureau then extrapolates these figures when it reports statistics for total population in a geographic area.

Statistical Significance

This measures the likelihood that a figure was determined by chance. If a figure is statistically significant, repeating calculations with a different sample of numbers generated from the same pool is highly likely to produce the same result.

Qualitative Data

Information that is gathered through observations, interviews, or personal experience.

Quantitative Data

Information that can be measured in numbers