Bicycle Transportation Issues: Describing the Attitudes and Opinions of Cyclists in Austin, Texas

By

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Abstract

Bicycling is an underutilized and marginalized mode of transportation. The neglect of bicycle funding and infrastructure has led to an increasingly unsafe environment for cyclists. Cities are on the forefront of addressing cycling issues and are most likely to encounter and ultimately have to fix the problems facing cyclists. The lack of cycling facilities is a serious issue, but expanding opportunities for cyclists produces many benefits not only for individuals but society as a whole. Austin Texas has been designated a Silver level bicycle friendly city with a favorable bicycling environment when compared to other U.S. cities. Therefore this study describes the attitudes and opinions of cyclists in Austin, Texas regarding the effectiveness of the city of Austin in addressing factors important to increasing bicycle transportation options.

Bicycling issues identified through a literature review resulted in a set of categories that formed the basis of a survey. The survey was distributed electronically to cyclists throughout Austin.

But as the results of this study highlight, in the eyes of its own cyclists, Austin still has a lot of work to do to make cycling a more viable transportation option. Cyclists are most concerned about Austin's improvement in the following areas: bicycle lanes and paths, connecting existing bicycle facilities and bicycles with public transportation, traffic enforcement of motorists, cyclist education, large-scale land use, and finally commuting and utilitarian cycling. In addition to discussing the problems associated with the afore mentioned categories, recommendations for overcoming these barriers will be provided. Addressing these issues has the greatest potential for making a safer and more convenient bicycling environment, thus improving bicycle transportation options for Austinites.

About the Author

Justin William Marlin was born on August 30, 1978 in Morristown, New Jersey. He moved to Texas in 1992 and graduated with a Bachelor of Arts in History and a minor in Geography from the University of Texas at Austin in 2001. Justin is finishing his Masters degree in Public Administration with a focus on Urban and Environmental Planning at Texas State University-San Marcos. He is currently employed with Capital Metropolitan Transportation Authority in Austin, TX. Justin lives with his wife, Amanda and dog, Luci, in Central Austin and has lived in the city for eleven years. He is an avid cyclist and serves on the City of Austin's Bicycle Advisory Council.

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Chapter One: Introduction

Transportation is a complicated issue that not only has major implications for the practice of public administration, but also plays a major role in our daily lives. In America, the automobile dominates the transportation landscape. Unfortunately, many negative externalities are associated with an overdependence on automobiles. Although, the auto has been instrumental in the development and growth of our cities, "It is currently accepted by a growing number of planning scholars and practitioners that current trends in transportation are unsustainable" (Balsas 2002, 93). In light of this emerging realization, many have started to look more seriously at alternative modes of transportation. This paper focuses on a particular mode of non-motorized travel- the bicycle.

Our overdependence on private motor vehicles has prompted the need for more research of non-motorized travel. Artificially low cost of automobile ownership led to this over-reliance on cars. This has been achieved through subsidies, regulations, developments in technology, and planning efforts that have favored the use of private automobiles (Austin Bicycle Plan 1996, Pucher and Dijkstra 2000). Low gasoline taxes, few toll roads, and massive amounts of free parking also highlight some of the factors that reduce the cost of autos, while increasing their externalities (Gardner 1998, Pucher et al. 1999). However, until there are policies and practices that take into account the full cost of automobile usage, little incentive exists for people to choose other forms of travel (Wilkinson 1998).

The over reliance on auto use has not only reduced transportation diversity (Gardner 1998), but has also led to many problems with the environment, public health, and land-use. "Dependency on automobiles has resulted in unbalanced land-use developments that increasingly favor urban sprawl, cause traffic congestion and air pollution, and threaten the safety and comfort of the most unprotected users of urban areas: pedestrians and bicyclists" (Balsas 2002, 91). Serious environmental concerns stemming from the use of automobiles include: exhaustion of fossil fuels, excessive pollution and greenhouse gasses, and the loss and fragmentation of rural lands and wildlife habitats. Finally, the United States faces serious health risks due to physical inactivity, obesity, and cardiovascular disease (Killingsworth et al. 2003; Moudon and Lee 2003). Bicycling has the potential to provide many with the opportunity to partake in doctor recommended physical activity they are missing, while also improving the health of its users.[1] Cycling can also be an effective way, when started in childhood, of promoting life long habits of physical activity.

There is much less bicycling in the United States than in other industrialized countries, and the reasons for the overdependence on autos is directly related to the underutilization of bicycle transportation (U.S. DOT *case 15* 1993). Further, bicycle use is marginalized because it is largely ignored by transportation decision makers and policy experts (U.S. DOT *case 15* 1993). In fact, cycling accounts for only one half of one percent of total person-miles traveled in the United States (Pucher and Dijkstra 2000, 6).

However, more alarming than the small amount of trips actually made by the bicycle is the exceptionally high fatality rate and the overall danger of operating a bicycle

[1] See for example Bo`govic 2001; Killingsworth et al. 2003; Litman 2004; Stinson and Bhat 2004

in the United States. Approximately 16% of all traffic fatalities nationwide and 25% of fatalities in urban areas involve cyclists (Pucher and Dijkstra 2000, 7). In addition, cycling fatalities are 11 times higher than car fatalities when compared on a mileage basis (Pucher and Dijkstra 2000). Thus cycling is among the most hazardous modes of travel (Krizek and Roland 2005). In Austin this year alone, along highway 360, a route popular with cyclists through the hills West of town, two cyclists, Arjun Khanna and Gay Simmons-Posey, have been killed while riding in the paved shoulder outside the motor vehicle lane. With cycling fatalities disproportionably high, compared to the number of trips made by bike, it is easy to see how the danger of current conditions and increasing cycling safety should be major concerns not only for cycling advocates but for the city of Austin and other cities throughout the county.

Surveys and studies not only show statistical data about the danger of cycling, they also reveal cyclists concerns about user safety. Safety is listed as the top concern for cyclists, and unsafe conditions are listed as the main reason people do not ride (Hamilton 2004). Further there is a correlation between the presence of bicycling facilities, safe cycling, and increased ridership. Since safety is a top concern, and the benefits of cycling becoming better known, it is apparent that something has to be done to increase bicycle safety and get more people cycling. John Pucher (2001, 2) notes this relation, "In short those countries and cities with extensive bicycling facilities have the highest cycling modal split share and the lowest fatality rates." Moreover, according to the Department of Transportation, "Experience demonstrates that funded, staffed bicycle programs able to provide bicycle transport infrastructure will boost levels of bicycling. This experience

is supported by a host of studies and surveys that have found suppressed demand for bicycling in areas which lack such infrastructure" (U.S. DOT *case 15* 1993, 71).

Despite problems associated with bicycle safety, bicycles offer significant benefits to individual users and society. Bicycles have the ability to improve the health of the rider, emit zero pollution, are cheap to purchase and maintain, and are ideally situated to urban environments.[2] Bicycle facilities and increased ridership can also mitigate the effects of urban sprawl by increasing transportation options, thus encouraging higher density, more efficient land use, while also decreasing the long distances that all but eliminate the use of a bike as a mode of everyday transportation (U.S. DOT *case 15* 1993). In addition, the cost of providing bicycle facilities is very small when compared to the money spent on other modes of transportation (Bowman and Vecellio 1994). The relatively limited space needed to operate a bicycle, along with a modal shift away from private autos can help reduce congestion, and also improve resource and energy conservation (Litman 2004).

In light of the benefits of increased cycling and the problems associated with an excessive reliance on cars, national and local governments are starting to recognize the need to provide better bicycle facilities and increase bicycling. In 2004, the US Department of Transportation ordered a comprehensive study entitled the "National Bicycling and Walking Study (U.S. DOT 2004)." This study, along with increased funding for cycling needs, demonstrates the Federal governments recognition and promotion of the benefits from cycling, while also showing that they are committed to increasing bicycle transportation options.

[2] See for example, American Association of State Highway Transportation Officials (AASHTO) 1999; Austin Bicycle Plan 1996; Blickstein and Hanson 2001; Gardner 1998; Moudon and Lee 2003

Municipal governments have also taken up an increased interest in bicycle transportation. In particular, this paper will focus on the city of Austin, Texas, and the steps they have taken to increase bicycle use and safety. Austin has demonstrated its commitment to cycling by creating a bicycle program and corresponding bicycle plan. The main goal of the Austin bike plan is to increase bicycle transportation options by making it easier and safer to bicycle (Austin Bicycle Plan 1996). The components of this plan that address this goal, and its implied policies, are also supported by the literature on bicycle transportation. Therefore, my research purpose is to describe the attitudes and opinions of Austin cyclists regarding how well the city of Austin addresses factors important to increasing bicycle transportation options.

Chapter Summary

This chapter touches on the problems associated with our current transportation paradigm and suggests enhancing bicycle transportation options as a possible solution to improving mobility options. The next chapter will provide a short historical perspective of the bicycle and highlight the geographical setting of this study.

Chapter Two: History and Setting

Chapter Purpose

This chapter is examines important developments in the history of the bicycle and cycling policy, and also note the impact of the bicycle on modern society. The city of Austin is introduced and its bicycle policy explored.

History of the Bicycle

The pursuit of a practical human powered vehicle has interested many throughout history. In the early 1800's attempts to design a type of mechanical horse laid the foundation for developments that would later become the bicycle. Improvement of these early models led to a design known as the draisine or velocipede,[3] pictured on the following page in figure 2.1. Several Parisians, including Pierre Michaux, developed a more useful and practical adaptation of these early bicycle models in Paris in the late 1860's (Herlihy 2004).

In *Bicycle: The History*, David Herlihy notes that bicycling in the United States first gained popularity in New York City in 1868 and then quickly spread throughout the rest of the country. The sport was further popularized through increasingly faster and longer bicycle races, which attracted large and excited crowds. Bicycle clubs also helped to popularize the new recreation and increasingly utilitarian tool. But it wasn't until the late 1800's, when popularity increased and the technology developed, that the price of the

[3] This early bicycle model, which lacked pedals and was used more as a type of running machine, was the first to gain any amount of public acceptance (Herlihy 2004).

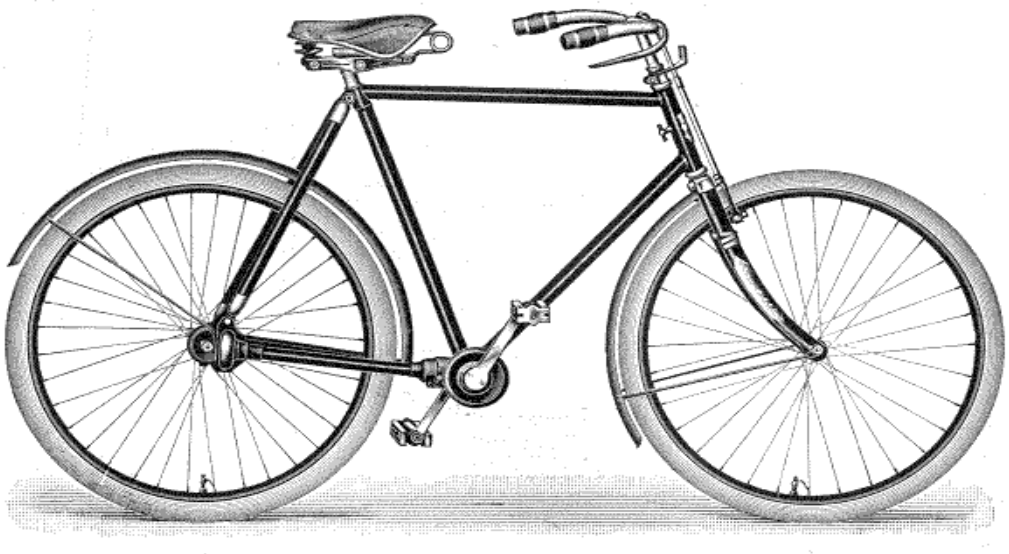
Figure 2.1 Velocipede

Image courtesy of *Bicycle*, by David Herlihy

bicycle fell. The price drop and technological advances allowed the bicycle to "transition form a rich man's toy to a poor man's carriage" (Herlihy 2004, 7). This new machine quickly captured the imagination of the public, as "The bicycle promised two basic but highly prized functions: first, cheap and efficient personal transportation, and, second, a healthy recreational outlet" (Herlihy 1002, 110). Further developments such as pneumatic and replaceable tires, the freewheel, braking advances, and the addition of different gears made the bicycle even more popular (Herlihy 2004). Figure 2.2 on the following page shows a bicycle from 1907 with many of the modern features found on today's bikes such as pneumatic tires, driveshaft, and a modern frame.

The bicycle also had a profound impact on the development of other modes of transportation like the automobile and the airplane. Finally, bicycles provided the need

Figure 2.2 Early 20th Century bicycle



Source: http://tilting.org.za/bok/notnew.html

for better roads that would later form highway networks crucial for the success of the automobile. Bicycle manufacturing technology would also be applied directly to the manufacturing of automobiles, and cycle repair shops would eventually evolve into the first automobile service and filling stations.

> Many of the pioneer automobile makers. Such as Charles Duryea and Henry Ford were themselves former bicycle mechanics. They drew heavily on that experience, adopting numerous cycle innovations to automobiles, including pneumatic tires, wire spokes, steel tubing, differential gears, ball bearings, and chain and shaft drives. And once they undertook large-scale production, they used many of the manufacturing and assembly techniques originally developed for the bicycle industry[4]

The advancement of aviation also owes much to the bicycle. Aviation pioneers like Glenn Curtis were former bicycle mechanics who applied their bicycle knowledge to aviation development (Herlihy 2004). David Herlihy further explains how the Wright brothers operated a bicycle repair shop and used bicycles to test their first wind tunnel experiments. Their metal and woodworking skills, acquired in the fabrication of custom

[4] See Herlihy 2004, 300

bicycle parts, were invaluable to their efforts of developing a manned aircraft. Familiar tools and parts like the ball bearings, chains, and wire wheels were used when the Wright brothers, along with the help of an assistant, assembled their aircraft and motor in their bicycle workshop in 1903 (Herlihy 2004).

The influence of the bicycle went beyond technological and transportation innovation. The bicycle also had a major societal and sociological impact as well. The bicycle was seen as a democratic vehicle as it became affordable to most, thus expanding the mobility of many who lacked wealth or social status (Smith 1972). "More significantly, the old concepts of social morality and proper conduct were undermined by the freedom conferred upon those who rode the wheel (Smith 1972)." Moreover, bicycles provided mobility and freedom from increasingly crowded cities in the late nineteenth century (Strange 2002).

In particular, the bicycle had a profound effect on the identity and role of women in society during the socially restrictive Victorian age. First, cycling challenged the rigid dress code of the times. Garments such as the corset and ankle length dresses restricted movement, and eventually gave way to new female garments more suitable for riding. Lisa Strange in her article *The Bicycle, Women's Rights, and Elizabeth Cady Stanton* tells how popular notions of femininity would be challenged beyond just a rebuke of popular fashions. Leading women's rights activist of the late 1800's believed that the bicycle allowed women to challenge the outdated but encouraged characteristics of weakness and dependency.

> While conservatives feared that cycling would compromise women's femininity, damage their reproductive health, or even corrupt their morals, women's rights activists seized upon the bicycle's liberating potential. Most notably, Elizabeth Cady Stanton sensed that the bicycle had far-

> reaching implications for the status of women in nineteenth-century America. For Stanton, the bicycle was much more than a mode of transportation, recreation, or even escapism. It was a revolutionary social invention that opened new avenues of pragmatic and spiritual independence.[5]

In addition to their newfound mobility and freedom, women no longer had to confine religious worship to the brick and mortar of local churches, but were instead free to experience the glory of god in the surrounding nature to which their access had been previously limited (Strange 2002).

International and Federal Setting

Over time the bicycle has penetrated every corner of the globe and has become an international experience. Currently, there are more than twice as many bicycles in the world as there are automobiles (Worldwatch Institute 2001).

Although cycling is popular in many countries, our international discussion, in the interest of time, will focus on two countries where cycling has really become a significant part of everyday life. Evidence shows that cycling is safer and more popular in countries with favorable bicycling policies and infrastructure (Pucher 2001). Two countries where this is defiantly the case are Germany and the Netherlands. In fact, in the mid 1970's the Dutch were the first to implement a national bicycle policy, which provided municipalities funds for the construction of new bicycle tracts (Rietveld and Daniel 2004).

Cycling infrastructure in these countries includes an expansive and integrated network of bike lanes and trails, and bicycle oriented intersection modifications.

[5] See Strange 2002, 610-611

Favorable bicycling policies include greater education and training for cyclists and motorist, stricter enforcement of traffic laws, regulations more favorable to cyclists and pedestrians, auto free and traffic calmed zones, increased parking and automotive costs, and more compact land use patterns (Pucher and Dijkstra 2000). The point can be summed up by John Pucher and Lewis Dijkstra who state, "In some European countries, fatality rates of pedestrians and cyclists have fallen to less than a fifth the American level. Given the striking success of European efforts, it is essential that American planners and policymakers examine what we can learn from Europe to reduce the serious dangers that Americans face every time they walk or cycle" (Pucher and Dijkstra 2000, 7).

In the United States, federal obligations for the provision of bicycling facilities has been largely ignored. The Federal-Aid Highway Act of 1973 allowed for some highway money to be used for bicycle programs, but few states chose to do so (Pucher et al. 1999). Recently the Intermodal Surface transportation Efficiency Act of 1991 (ISTEA), provided for increased funding for bicycle projects. The act also required states and local governments to appoint bicycle coordinators, while also requiring states and metropolitan planning organizations to include cycling in their transportation plans (Pucher et al. 1999). The bicycling provisions in the ISTEA were further extended by the Transportation Equity Act for the 21st Century (TEA 21). This provision set aside more money for bicycling projects and allowed for bicycle safety and educational activities to qualify for federal funding (Pucher et al. 1999). Unfortunately the funding made available through these acts is still an insignificant amount when compared to total spending on motorized transportation. Moreover, the implementation of these new bicycle provisions is problematic. Many bike plans and bicycle policies use language

that makes the provision of bicycle facilities optional. Additionally, few agencies have turned cycling strategies into specific policies or actions. Therefore many bicycle plans and improvements are in danger of becoming a hypothetical wish list instead of being incorporated into viable transportation improvement solutions (Moe et al. 1997).

Research Setting

Although the federal government provides some funding for bicycle transportation the impetus for a successful bicycle program lies with individual cities. Some cities have proven remarkably successful in promoting the safe use of a bicycle and expanding opportunities for cyclists. Davis, California is generally recognized as the most bicycle friendly city in the United States. Davis has the highest bicycling modal split share, with 22% of all trips made by bicycle and more than 80% of arterial roads being equipped with a parallel path or striped bicycle lane (Rails-to-Trails Conservancy 1998). Major intersections in Davis also have modifications that detect the presence of cyclists, provide designated spaces for bicyclists, and allow cyclists extra time during a bike-only phase in the signal timing (Rails-to-trails Conservancy 1998). Overtime pro-cycling policies and the accommodation of bicycles have been built into the fabric of the city and are now considered the norm rather than the exception. Other cities with supportive bicycle policies and higher than average bicycle ridership include Portland, Seattle, Boulder, and Chicago.

The setting for this study is Austin, Texas.[6] Formal bicycle planning began in Austin in 1972, when the city council adopted the *Proposed Austin Bicycle Plan*, which

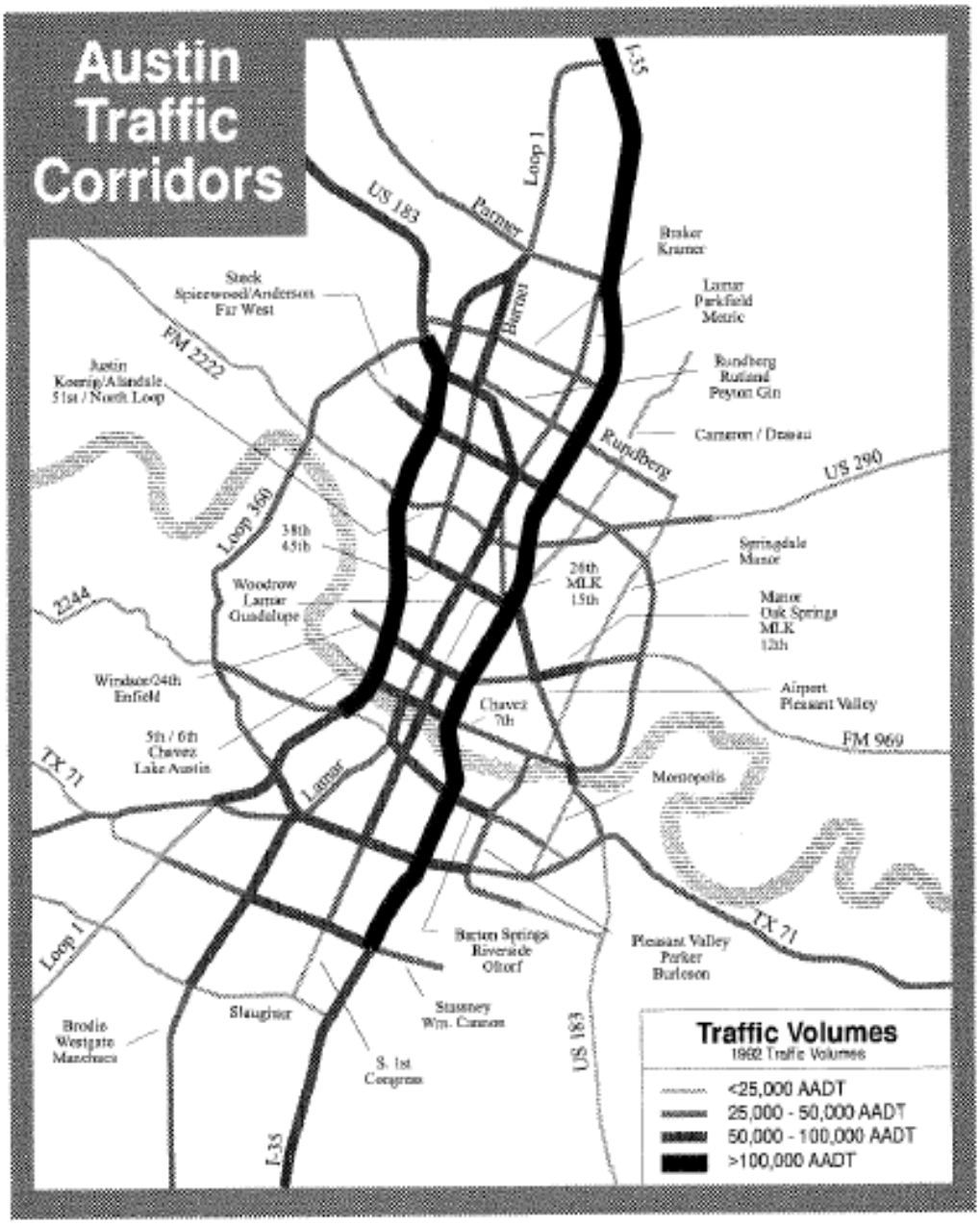
[6] For Additional information on Austin, Texas and transportation policy see the following Applied Research Projects completed by Public Administration graduate students at Texas State University-San

put forth the idea of a area-wide bicycle network linking residential areas and popular destinations (Austin Bicycle Plan 1996). This first attempt at bicycle planning would evolve into the *Austin Bikeway Plan,* adopted in 1980. The bicycle plan has continued to develop and gone through subsequent changes. Additional bicycle developments in Austin include the creation of a "Veloway," the production of a city bicycle map, the creation of a bicycle coordinator position with the city, additional bicycle task forces, and the creation of a citizen's bicycle advisory committee (Austin Bicycle Plan 1996).

Austin, with some exception, is an ideal setting for expanding bicycle transportation opportunities. "Austin meets all the criteria for high bicycle usage, with the exception of presence of bicycle facilities. The weather and climate in Austin, combined with demographics favorable to bicycling, should most likely lead to higher than national average use of bicycles for both recreational and utilitarian purposes" (Austin Bicycle Plan 1996). Additionally, Austin is precariously close to achieving non-attainment status for ozone. The negative economic impact of surpassing this dubious cycling (Austin Bicycle Plan 1996). Furthermore, money spent on bicycle facilities has a substantial impact. When compared to expenses associated with other transportation infrastructure, building bicycle facilities is very inexpensive while producing a significant impact (City of Austin Streets Smarts Task force 2008). Figure 2.3 on the following page shows the general layout of Austin and lists the major travel corridors.

Marcos. These papers include The Downtown Austin Planning Process as a Community of Inquiry: An Exploratory Study, by Timothy Lee Johnson; An Assessment of Smart Growth Policies in Austin, Texas, by Sarah Danse Lewis; Exploring the Barriers to Community Involvement in Public Transportation: The Case of Capital Metro, by Aida Berduo Douglas; Exploring Environmental Policy in Austin, Texas, by Kim Gunn; Is Austin's Transportation Policy Really About Transportation, by James Chandler; Group Dynamics & Power Structures: Toward a Greater Understanding of the Line-Staff Relationship Within the Austin Fire Department, by Kevin L. Baum; The Austin, Texas African-American Quality of Life Initiative as a Community of Inquiry: An Exploratory Study, by Demetria C. Howard-Watkins; and Development Sprawl in Texas, by Rachael Jeffers.

Figure 2.3 Preferred Bicycle Travel Corridors



Source: Austin Bicycle Plan 1996

The current Austin Bicycle Plan seeks to address several important goals. The first goal of the plan is to institutionalize bicycle transportation into all transportation and recreation decision-making, thus increasing the legitimacy of the bicycle and improving its modal share. The second goal is based on the notion that "Bicyclists should not be placed in situations more dangerous than the risk imposed by any other transportation

choice" (Austin Bicycle Plan 1996, 2). The goal thus seeks to improve bicycle safety in all situations. The third goal seeks to increase the amount of commuting and utilitarian cycling. This goal aims to increase the modal split for bicycles to 8 percent by 2015. The fourth goal calls for the creation of an adequate network of bike lanes and trails until all roadways are made safe for cycling. The fifth goal is the development and maintenance of safe standards and guidelines regulating bicycle facilities, programs, and projects. The final goal is the integration of bicycle and public transportation thus creating a more effective multi-modal transportation system (Austin Bicycle Plan 1996).

All of the goals listed above were created with the intention of improving the bicycling environment and creating more and safer opportunities for Austin cyclists. Therefore I thought it appropriate that this study seek to describe the attitudes and opinions of Austin cyclists regarding how well the city of Austin addresses factors important to increasing bicycle transportation options. In doing so, I hope to not only lay a foundation for the evaluation of the city bicycle program but also provide suggestions for how the city can improve the bicycling environment and encourage more people to ride a bike.

Chapter Three: Factors Important to Increasing Bicycle Transportation Options

Chapter Purpose

This chapter reviews the literature used to identify factors important to increasing bicycle transportation options. The factors that emerged were then grouped together into descriptive categories that became the basis for the survey of Austin cyclists. The descriptive categories are bicycle facilities, connectivity, traffic enforcement, education, public participation and representation, land use, and commuting and utilitarian cycling.

Bicycle Facilities

Many studies and surveys show that safety is a top concern for cyclists (U.S. DOT *case 15* 1993) and the expansion of bicycle facilities are the most needed improvements for increasing cycling opportunities.[7] The best way to increase the safety of cyclists is to provide them with bicycle facilities that allow cyclists to arrive safely at any destination. "It appears that the concerns over traffic safety and the lack of ancillary facilities may be most amenable to short-term solutions. Traffic safety is best addressed by improving bicycle facilities, particularly on-road bikeways" (U.S. DOT *case 1* 1993, 68). The correlation between the presence of more bicycle facilities and increased ridership[8] provides justification for including bicycle facilities as a category summarizing ways to

[7] See for example Balsas 2002; Moudon et al. 2005; U.S. DOT *case 1* 1993; Stinson and Bhat 2003; Dill and Carr 2003; U.S. DOT *case 15* 1993; Mayor's Bicycle Advisory Council 2006

[8] Dill and Carr 2003; Morris 2004; U.S. DOT *case 1* 1993; Pucher 2001

increase bicycle transportation. In addition to furthering non-motorized travel, another benefit of bikeways is that compared to other types of transportation infrastructure they are very inexpensive (City of Austin Streets Smarts Task force 2008) and provide benefits to not only the users of bike facilities but potentially to others who would benefit indirectly from decreased pollution and congestion (Krizek et al. 2007).

The bicycle facilities category is composed of the following elements: bicycle lanes and paths, bicycle parking, auxiliary facilities, considerations in the placement and selection of facilities, and maintenance of facilities.

Bike Lanes and Paths

Bicycle lanes and paths are the most common types of bicycle facilities, and are a good way to increase the safety and convenience of bicycle use. There are several types of bicycle lanes and paths. Each type has different advantages and disadvantages, and the selection of the right facility depends on many considerations.[9] The different facilities are on-road bicycle lanes, separated or off-road shared use paths, shared roadways, and paved shoulders.

On-road bicycle lanes

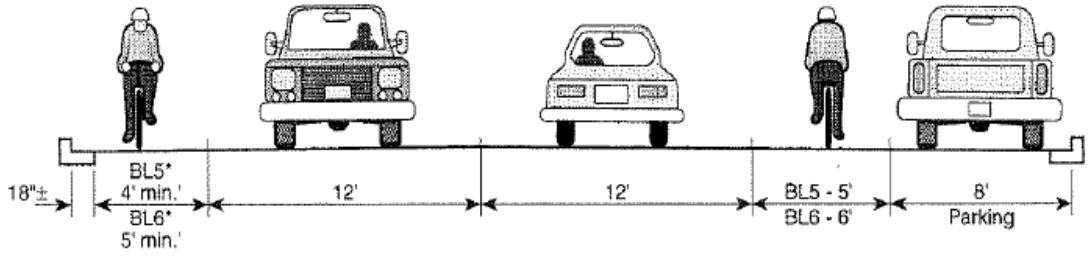
On-road bike lanes have become the preferred facility for bicycle travel as researchers and practitioners have come to realize the danger of earlier attempts to separate bicycle and auto traffic (Ochia 1993). The danger of separate facilities running parallel to traffic is that it places the cyclist out of view of motorists who may be turning and crossing the path of traveling cyclists (Pucher et al. 1999). According to the American Association of State Highway Transportation Officials (Heretofore referred to

[9] The distinctions between the different types of facilities are taken from the Federal Highway Administration, the American Association of State Highway Transportation Officials, and the Austin Bicycle Plan.

as AASHTO) guidelines note (AASHTO 1999, 7-8) "bicycle lanes are intended to delineate the right of way assigned to bicyclists and motorists and to provide for more predictable movement by each. Bike lanes also help to increase the total capacities of highways carrying mixed bicycle and motor vehicle traffic". The Austin Bicycle Plan highlights the importance of bicycle lanes "An on-street bicycle lane network is essential to bring cycling into the transportation mainstream" (Austin Bicycle Plan 1996, 38). Figure 3.1 illustrates the preferred dimensions for roadways with bike lanes, while Figure 3.1a shows examples of various bike lanes in Austin.

Additional on-road bicycle lane features include an optimal width of four to five feet, one-way directionality, and demarcation by the presence of a solid white line (AASHTO 1999). The more orderly flow of mixed-use traffic due to the presence of a bike lane increases the perception of safety for novice and experienced users (Dill and Carr 2003; Pinsof and Musser 1995). While these facilities are appropriate on most urban arterials and collector streets, bike lanes should not be placed between the curb and on-street parked vehicles. This decreases visibility and hinders cyclists' ability to make left turns (City of Portland Office of Transportation 1998; Pinsof and Musser 1995).

Figure 3.1 Typical Roadway Section With Bicycle Lanes



Source: Austin Bicycle Plan 1996

Figure 3.1a Examples of Austin bike lanes

photos courtesy of Justin Marlin

Separated or off-road shared use paths

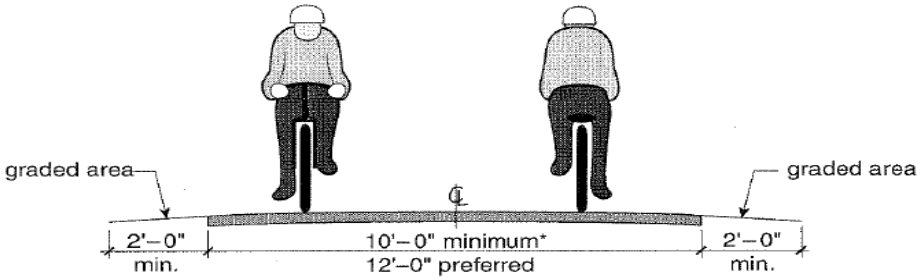
Separated, or off-road shared use paths, are paths physically separated from traffic by open space or a physical barrier (Austin Bicycle Plan 1996). The recommended width for mixed-use paths shared with pedestrians is 10 to 12 feet (AASHTO 1999; Austin Bicycle Plan 1996). While young or inexperienced riders may prefer these paths, they should mostly serve a recreational purpose (Austin Bicycle Plan 1996). Separated and off-road paths should not take the place of on-road facilities, but rather serve as a complementary system of paths where the construction of on-road facilities may not be applicable (AASHTO 1999). See figure 3.2 for an illustration of acceptable bicycle path dimensions and figure 3.2a for pictures of bike paths in Austin.

Off-road, shared use facilities are not particularly suited to convenient travel as their shared use with pedestrians can slow down cyclists,[10] and increase the potential for risk or injury to both cyclists and pedestrians (Austin Bicycle Plan 1996). These separated facilities should not be placed adjacent to roadways because they are two

[10] Clark and Page 2000; Pucher et al. 1999

directional and thus place cyclists against the flow of traffic; but when off-road paths do cross a road, grade separation should be considered to maintain the users continued separation from traffic (City of Portland Office of Transportation 1998).

Figure 3.2 Typical 2-Way Bicycle Path



Source: Austin Bicycle Plan 1996

Figure 3.2a Examples of bike paths in Austin

photos courtesy of Justin Marlin

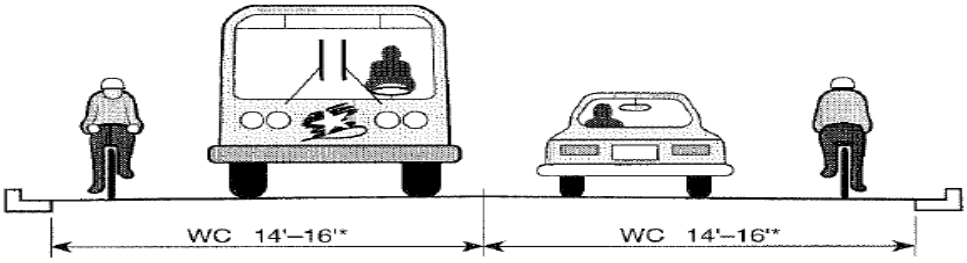
Shared roadways

A shared roadway facility allows for bicycles and vehicles to share the same lane by increasing the width of the outside curb lane. The ideal width for a shared roadway and wide outside curb lane is 14 feet. The extra lane space allows cyclists to be overtaken safely without the need for the vehicle to reduce speed or change lanes, thus providing safe travel for cyclists while not decreasing roadway capacity.[11] The importance of shared roadway facilities led the Austin Bicycle Plan to include an

[11] Austin Bicycle Plan 1996; AASHTO 1999; City of Portland Office of Transportation 1998

objective calling for the provision of wide curb lanes on all arterials and collectors (Austin Bicycle Plan 1996). Shared roadways can also be appropriate for residential streets with low traffic volume (City of Portland Office of Transportation 1998). The benefits of these facilities extend beyond cyclists and include assistance to turning vehicle and better accommodation of wide trucks, busses, and other heavy vehicles (Pinsof and Musser 1995). Figure 3.3 shows bicycle-friendly dimensions for a shared roadway.

Figure 3.3 Typical Roadway Section With Wide Curb Lanes

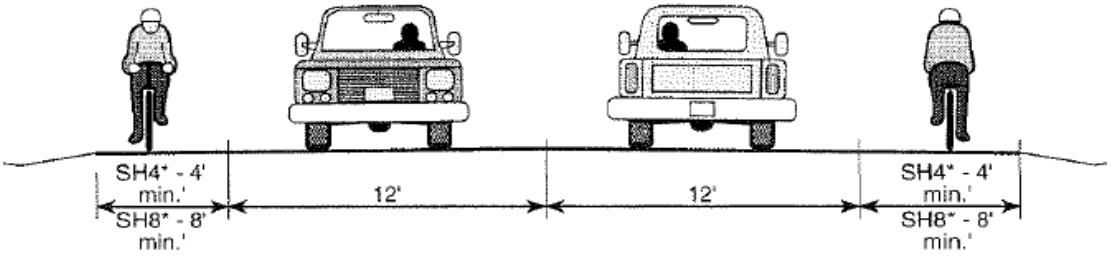


Source: Austin Bicycle Plan 1996

Paved Shoulders

Paved shoulder widths of four to six feet can be an ideal way to accommodate bicycle use in rural areas (Austin Bicycle Plan 1996). Paved shoulders allow for cyclists to be safely overtaken by traffic. Other benefits of having paved shoulders are: the added convenience and safety for motorists, increased road capacity, the reduction of edge deterioration, and reduced maintenance requirements (AASHTO 1999; Litman et al. 2006). As with the other bicycle facilities, providing paved shoulders in rural areas for cyclists is an objective listed in the Austin Bicycle Plan (Austin Bicycle Plan 1996). See figure 3.4 for a depiction of a paved shoulder road designed to accommodate bicyclists.

Figure 3.4 Typical Roadway Section With Shoulders to Accommodate Bicycles



Source: Austin Bicycle Plan 1996

Bicycle Parking

Adequate bicycle parking is an important factor in increasing bicycle use.[12] It benefits existing bicycle users by providing a secure place to park their bikes and may encourage additional ridership from non-cyclists (Ochia 1993; Pucher et al. 1999). Alternatively, a lack of parking may actually discourage bicycle use. Key factors cities should take into account include visibility, security, accessibility, ease of use, durability, and cost of bicycle parking facilities when planning bicycle parking (Litman et al. 2006; Pinsof and Musser 1995). Visibility of the racks advertises their presence, encourages their use, and discourages theft. Secure parking should keep bicycles from being damaged or stolen, and accessibility allows for easy use without undue interference of surrounding areas (Austin Bicycle Plan 1996; Litman et al. 2006).

New bicycle parking locations can be suggested by cyclists and businesses through the use of the Internet, suggestion cards, or any additional methods (Rails-to-Trails Conservancy 1998). Cities can also require bicycle parking through more aggressive bicycle parking ordinances that determine the amount of bicycle parking based on land use or the amount of automobile parking (Pinsof and Musser 1995). Images of various bicycle parking racks are depicted in figure 3.5

[12] Moudon et al. 2005; Mayor's Bicycle Advisory Council 2006; City of Portland Office of Transportation 1998; Pinsof and Musser 1995

Figure 3.5 Bicycle parking racks

photos courtesy of Justin Marlin

Considerations in the placement and selection of facilities

There are two main considerations that planners must account for when determining bicycle facility type and location. One is the skill level of the rider, and the other is the traffic environment surrounding the facility in question.

The skill level of riders generally fits into one of three different categories. The three skill levels, determined by the Federal highway Administration, and used by most planning groups and municipalities (including Austin), are Group A, B, and C. Group A refers to experienced riders, who are comfortable operating in most traffic conditions. Group A riders prefer direct access to destinations, the ability to operate at maximum speeds, sufficient space to operate safely on the roadway or shoulder, and tend to use collector and arterial streets. Group B riders are less confident about their ability to operate in traffic without special provisions to accommodate bicycles. These riders tend to opt for routes with lower vehicle volume and speeds, while also preferring some separation from motor vehicles. Group C riders are children who tend to operate in residential areas with minimal traffic or on separate bicycle trails (Austin Bicycle Plan 1996; AASHTO 1999). Facilities should be designed to adequately meet the needs of all users regardless of cycling ability.

Traffic and the location of bicycle facilities are also important considerations as bicycle planners or city staffs try to select the most proper facility. Traffic volume has a significant impact on the placement and selection of facilities, with many riders preferring lower traffic volumes (Sharples 1999; Stinson and Bhat 2003). Other considerations must include road and lane width, traffic speed, percentage of heavy vehicle use, pavement conditions, vehicle parking, frequency and design of intersections, and geographical barriers.[13]

The location of bicycle facilities as well as the timing of facility construction and repair should also be considered. It is advantageous for facilities to be included during the development phase or as part of the initial construction of roads (Pinsof and Musser 1995). Facilities become much more difficult and expensive to install when roads have to be retrofitted to accommodate bicycle traffic. In addition to the construction of bicycle facilities, facility improvements should be included with road construction projects (Litman et al. 2006). When roads have to be retrofitted to accommodate bikeways there are several available options. These modifications (each applicable only under certain conditions) can include providing a striped lane where there is adequate width, narrowing lane width, reducing the number of traffic lanes, eliminating parking, or widening the shoulder (Ochia 1993; City of Portland Office of Transportation 1998)

Auxiliary Facilities

"Auxiliary facilities" is a catch all term referring to additional modifications that improve existing and future facilities making them more attractive to current and potential users. One example of an auxiliary facility that encourages cycling is adequate

[13] See for example, AASHTO 1999; Austin Bicycle Plan 1996; Pucher et al. 1999; Turner et al. 1997; City of Davis Public Works Department 2006

lighting of bike facilities at night (Moudon et al. 2005). Both bike lanes and off street bike paths should be lit where nighttime riding is anticipated, especially in areas such as underpasses, major intersections, and where security may be an issue. The lighting described above should not occur in isolation but augment acceptable standard city lighting of all bikeways (City of Portland Office of Transportation 1998). Route signing is another feature that notifies cyclists to the advantages of using a particular route, and also indicates to motorists that cyclists are present (AASHTO 1999; Ochia 1993). Hence bicycle route signs should be placed at decision points throughout the route to notify cyclists of direction changes (Pinsof and Musser 1995). Figure 3.6 shows some of the international signage used with bicycle route designation and pavement markings.

Figure 3.6 Bicycle Route Signs and Pavement Markings

Source: Austin Bicycle Plan 1996

Intersections that better accommodate bicyclists is another modification that can improve cycling safety. This can be done with intersections designed to make bicycles more visible to turning vehicles (Wang and Nihan 2004) and bicycle detection devices and actuated traffic signals that allow bikes to pass safely through an intersection (AASHTO 1999; Pucher et al. 1999).

Maintenance

The provision of bicycle facilities cannot be complete without proper maintenance of those facilities. "Proper maintenance of on-street riding surfaces is a key factor in

bicycle safety and an important consideration in people's decision to ride a bicycle" (Austin Bicycle Plan 1996, 69). Adequate maintenance of facilities not only improves the riding experience it also helps to protect the public investment in area roads and bicycle facilities. Proper bicycle facility maintenance also reduces a city's legal liability due to the deterioration of public facilities (City of Portland Office of Transportation 1998). It is essential that road and bicycle facilities be kept clear of debris through regular sweeping. Other problems that can be mitigated with proper maintenance include surface irregularities such as potholes, large cracks or gaps, excessive vegetation, and shoulder deterioration.[14] Attention should also be paid to the orientation of drainage gates, which should be situated so their bars are perpendicular to the direction of bicycle traffic, thus eliminating the possibility of trapping a bicycle tire (Ochia 1993; Bowman et al. 1994).

One final maintenance issues that needs to be addressed is the identification and reporting of maintenance needs. Cities have adopted comment cards, hotlines, or websites to report maintenance needs. A quick response to these maintenance requests, with notification to the reporter that the repair has been completed, is a recommended component of any good maintenance program (Rails-to-Trails Conservancy 1998)

Connectivity

Connectivity refers to the connection of existing bicycle facilities, along with increasing the connection between bicycle and public transportation. These connections are key to enhancing the use and efficiency of both bicycle and public transportation.

[14] See for example AASHTO 1999; Austin Bicycle Plan 1996; Litman et al. 2006; Pinsof and Musser 1995

Connecting Existing Bicycle Facilities

Although some progress has been made establishing safe bicycle lanes and trails, these lanes and trails are often incomplete, circuitous, or inconvenient. According to the National Bicycling and Walking study "Fragmented bikeway systems constitute a serious impediment to utilitarian cycling" (U.S. DOT *case 1* 1993, 11). Further, Ochia (1993, 454) found "bicycle professional tend to agree (93%) that connecting existing bikeways should constitute today's most important (capitol) bicycle program activity". A good bicycle network that connects gaps and overcomes barriers can increase recreational cycling, reduce trip times and encourage cycling for utilitarian purposes (Pucher et al. 1999). Connecting existing facilities with the intention of creating a continuous and integrated bicycle network is also listed as an objective of the Austin Bicycle Plan (Austin Bicycle Plan 1996).

The connecting of fragmented bicycle facilities is an important first step in creating a truly integrated bicycle network. A proper bicycle network not only connects bike lanes and trails, but also integrates bikeways with the entire roadway system. A truly integrated bicycle network that combines bikeways and roadways improves direct access for cyclists (U.S. DOT *case 1* 1993). Developed bicycle networks should also link high use areas and activity centers and should be regional in scope (City of Portland Office of Transportation 1998). The Austin Bicycle Plan proposes a bicycle network where access to a safe and convenient bicycle facility is less than one-half mile from any point (Austin Bicycle Plan 1996). One final development in the advancement of a bicycle network is community acceptance of the notion that all roads should be safe for cycling (Pinsof and Musser 1995). An integrated and connected network of bicycle lanes, trails,

and roads has shown to produce more riders than areas without a connected system of roads, bike lanes and bike trails (U.S. EPA 2001).

Connecting Bicycle Facilities and Public Transportation

The second important aspect of connectivity is connecting bicycle facilities and public transportation. The significance of connecting these two modes of travel is documented by many groups, including the Department of Transportation and the American Association of State Highway Transportation Officials (U.S. DOT 2004; AASHTO 1999). Regional and local level organizations, like the Capitol Area Metropolitan Planning Organization and the Austin Bicycle Plan, list the connection of bikes and public transportation as an important objective (Hamilton 2004; Austin Bicycle Plan 1996). Figure 3.7 shows how buses can be outfitted to accommodate bicycles.

Figure 3.7 Bicycle on a Bus

photo courtesy of Justin Marlin

There are several benefits to increasing the connection between cycling and public transportation. Firstly, increased connections have the ability to also increase the effectiveness of both these modes of travel. The connection of the two modes leads to an increased service distance and increased efficiency for both bicycles and public transportation. Bicycling can increase the service, or catchment area, for each transit stop, as it is easier to draw cyclists from greater distances than those who have to walk to a transit stop (Litman et al. 2006; Austin Bicycle Plan 1996). The ability to draw a larger number of people to each stop can increase ridership of public transportation. Bicyclists benefit from this connection by being able to travel a greater distance than by bicycle alone, and also being able to more easily pass over potential topographical barriers (Austin Bicycle Plan 1996). The potential for traveling greater distances by connecting bicycle and public transportation also allows for the potential to increase bicycle ridership. Additional barriers such as cycling at night or in poor weather can be mitigated by improving the bicycle public transit connection (City of Portland Office of Transportation 1998).

There are several ways to promote the connection between bicycle and public transportation. For example, busses and light rail should be equipped with external bicycle racks that allow cyclists to easily load and unload their bikes. If the racks are insufficient for the number of cyclists wishing to take their bike, then accommodations need to be made that allow bicycles to be brought onboard busses or light rail. There also needs to be safe routes to and from all transit stops that accommodate all cycling abilities. This can be achieved through the provision and maintenance of adequate bikeways or

bike lanes to transit facilities. Lastly, there needs to be enough bicycle parking at all transit stops (Austin Bicycle Plan 1996; City of Portland Office of Transportation 1998).

Traffic Enforcement

It is imperative that cities ensure better enforcement of traffic regulations regarding motorists and cyclists to further develop a safe cycling environment.[15] Increasing the safety of cyclists through better traffic enforcement is a key step to increasing bicycle transportation opportunities (Austin Bicycle Plan 1996).

A connection exists between the strict enforcement of traffic laws and reduced risk of injury or death when cycling (Pucher and Dijkstra 2000). Additionally, more strict enforcement of traffic regulations in countries such as Germany and The Netherlands has yielded significantly more bicycle use due to a safer bicycling environment (Pucher and Dijkstra 2000). The two main elements within the traffic enforcement category are better traffic enforcement for motorists, and better traffic enforcement for cyclists.

Traffic Enforcement for Motorists

Motorists, who operate in an unsafe manner such as aggressive driving, or infringing on cyclists legal rights, must be held responsible for their actions through stricter enforcement of traffic regulations (Pucher et al. 1999; U.S. DOT 2004). Unfortunately, the intimidation of cyclists by motorists or aggressive driving by motorists is rarely ticketed. Research found that aggressive motorist behavior intimidates cyclists, decreases the safety of the cyclist, and discourages people from choosing to ride a bike

[15] See for example, Pucher 2001; U.S. DOT 2004; AASHTO 1999

(Pucher et al. 1999; Austin Bicycle Plan 1996). In fact, in countries such as Germany and the Netherlands, where cycling is safer and more popular, drivers are expected to anticipate unsafe or illegal movements by pedestrians or cyclists. Unfortunately this is often not the case in the United States where motorists are seldom ticketed for accidents with pedestrians or cyclists, even when it is possible to determine that the motorist was at fault (Pucher and Dijkstra 2000).

Traffic Enforcement for Cyclists

The enforcement of traffic laws pertaining to the operation of a bicycle is important to increasing the safety of bicycle use (U.S. DOT 2003; U.S. DOT *case 1* 1993). Better enforcement of traffic regulations can be achieved through more extensive training of police officers to help them better understand bicycle crashes and issues faced by cyclists (Mayor's Bicycle Advisory Council 2006). Many times cyclists operate in an unsafe manner that can endanger themselves and increase the likelihood of an accident with a motorist or pedestrian. The disregard of traffic regulations by cyclists increases the antagonism between bicyclists, even law abiding cyclists, and motorists (Austin Bicycle Plan 1996).

Education

National studies by the Department of Transportation show that respondents have a need for greater bicycle and motorist education (U.S. DOT 2003; U.S. DOT *case 1* 1993). In addition to the need for cyclist and motorist education, the results of providing that education provide a perfect justification for the provision and expansion of educational programs. The Austin Bicycle Plan finds "Most bicycle experts agree that

bicycle training reduces collisions and falls, encourages greater ridership, and makes bicycling safer for bicyclists, pedestrians, and motorists" (Austin Bicycle Plan 1994, 25). These sentiments are further supported by similar findings from additional literature sources.[16] Additional support for cyclist and motorist education is warranted because of the correlation between safe cycling and the presence of cyclist and motorist education programs (Pucher and Dijkstra 2000). The three main components of this education category include cyclist education, motorist education, and public education through promotional activities.

Cyclist Education

Cyclist education has the potential to reduce accidents and encourage additional ridership (Ochia 1993; Forester 1993). There are several distinctions between different types of cyclist education programs including the education of adult and child cyclists.

There is a demonstrated need for educating children cyclists. Many European countries incorporate extensive child cycling education into the school curriculum (Pucher et al. 1999; Pucher and Dijkstra 2000). Children are one of the largest groups of cyclists, and have the highest risk of injury or death (Austin Bicycle Plan 1994). Child cycling education is critical because, while children may have adequate bicycling handling skills they may lack the traffic experience and knowledge of adult riders (AASHTO 1999). Child bicycle safety should stress the importance of wearing a helmet, obeying traffic laws, riding with flow of traffic, and being predictable and visible (City of Portland Office of Transportation 1998). The lack of child cycling education has led the

[16] See for example AASHTO 1999; Litman et al. 2006; Pucher et al. 1999; Mayor's Bicycle Advisory Council 2006; City of Portland Office of Transportation 1998

Austin Bicycle Plan to call for implementation of cycling education into the school curriculum (Austin Bicycle Plan 1996; City of Austin Street Smarts Task Force 2008).

Although schools may seem like a natural place to teach cycling education, they are certainly not the only places where cycling education can take place. Effective cycling education programs can be conducted in many different places by various agencies or groups such as the police, libraries, parks and recreation departments, or bicycle clubs (AASHTO 1999). Additional opportunities for bicycle education can come from local employers or private groups, community cycling centers, or in the form of web or print based educational material.[17]

While adults may have more traffic knowledge and experience than children, adult cycling education opportunities are equally important. Adult cycling education can cover topics including: the importance of adhering to traffic laws; the benefits and proper use of helmets, lights, and hand signals; and courteous bicycle operation. Adult bicycle education can also be helpful for the parents of child riders. Parental education sheds light on the issues faced by children cyclists such as common causes of accidents, age and developmental aspects of child bike safety, the danger of intersections and driveways, the importance of helmets, and the importance of instilling proper riding practices (AASHTO 1999).

Bicycle education opportunities also present themselves when cyclists are ticketed for unsafe operation of their bike. Sources suggest that a bicycle education program can serve as an alternative to ticketing. These bike programs can inform cyclists about safe

[17] See for example, Rails-to-Trails Conservancy 1998; Pinsof and Musser 1995; City of Austin Streets Smarts Task Force 2008

bicycle operation tactics, while diverting them from the court system (Litman et al. 2006; Austin Bicycle Plan 1996)

One final note on cyclist education, it works best in conjunction with adequate bicycle facilities. This is vital because a city can spend all the money in the world on bicycle facilities, but if people are not properly educated about good cycling skills and habits than their dangerous operating practices will negate the safety benefits of the bicycle facilities (Austin Bicycle Plan 1996).

Motorist Education

As noted in the opening paragraph of this section, there is a demonstrated need for additional motorist education about cycling. Bicycle education for motorists should highlight the fact that bicycles have as much of a right to the road as any other vehicle. Skills for sharing the road, proper turning movements in the presence of bikes, and the importance of courtesy towards less protected cyclists should also be part of any motorist education program (AASHTO 1999). Other aspects of motorist education that need to be addressed include being patient, predictable and courteous (City of Portland Office of Transportation 1998). More extensive driver education about bicyclists in Europe informs drivers on the need to pay special attention to cyclists, and tests drivers on their ability to anticipate unsafe moves by cyclists (Pucher and Dijkstra 2000)

One last aspect of motorist education that may improve conditions for cyclists would be to incorporate information about bicycle operation in driver education courses or defensive driving classes. Providing these educational opportunities for motorists is important enough to be included as an objective in the Austin Bicycle Plan (Austin Bicycle Plan 1996).

Public Education Through Promotion

Educating the public through promotional activities helps keep people informed and can be an important step in getting more people to use a bike (Austin Bike Plan 1996). The National Bicycling and Walking Study Update found that there is a need for more promotion and public awareness of bicycle issues (U.S. DOT 2004), while the bicycle plan for the city or Portland states that "Education goes hand-in-hand with encouragement to increase cycling; together they improve skills and raise awareness" (City of Portland Office of Transportation 1998, 65). This has led the Street Smarts task force to recommend, "The city of Austin should create a city sponsored promotion/marketing campaign to increase awareness of the benefits of cycling and the responsibilities of all road and trail users" (City of Austin Streets Smarts Task Force 2008, 18). Special promotions like bike to work week, share the road campaigns, or helmet usage campaigns can improve public awareness and support for bicycle transportation. Public information programs can take the form of public hotlines that inform people about bicycle issues (Austin Bicycle Plan 1996). Bicycle route maps are an excellent way to inform people about safe routes. They can also provide information about the rules of the road, safety tips, and connections with mass transit (AASHTO 1999; Austin Bicycle Plan 1996). Finally, the benefits of bicycling and information pertaining to safely operating your bicycle can be disseminated to locals and tourists alike through radio, television, print, and the Internet (City of Austin Streets Smarts Task Force 2008).

Public Participation/Representation

An active and involved public is an important part of any bicycle transportation plan. The city of Austin requires that an active forum on bicycle transportation issues be open at all times in order to receive public input and better represent the publics' interests (Austin Bicycle Plan 1996). In fact, public participation is critical to the success of any comprehensive bicycle plan, and establishing a safe bicycle environment.[18] There are two components to this category, the first a citizen-based Bicycle Advisory Council should be created to provide a forum for public involvement. The second aspect of this category is the presence of a bicycle coordinator and staff who are responsible for representing the cycling publics' interests.

Public Involvement

The significance of public involvement in bicycle issues is demonstrated by the literature. "Public involvement is an important component of non-motorized planning, it broadens the scope of concerns, solutions and perspectives to be considered in the plan, and can help identify potential problems early in the process. It can also help gain the support for the plans implementation" (Litman et al. 2006, 8).

One major forum for public involvement in Austin is the citizen Bicycle Advisory Council. The purpose of the Council is to solicit input from the cycling public on bicycle issues and the development of city bicycle projects. The council also provides a way for citizens to express concerns or ask questions about bicycle transportation issues (Austin Bicycle Plan 1996).

[18] See for example, Pucher et al. 1999; Wachs 1998; Gardner 1998

Citizen advisory committees may be an effective way of soliciting public participation but they are not the only way. Additional methods of increasing public participation may include public presentations, news releases, informative mailings, public survey questionnaires, telephone hotlines, transportation fairs, focus groups, and public workshops (Litman et al. 2006; Burgess et al. 1994). Some of the hallmarks of effective public participation are adequate notice of involvement activities, early and ongoing opportunities for public involvement, access to information, an adequate process for responding to public input, and review and evaluation of the public involvement process (Burgess et al. 1994).

Bicycle Coordinator and Staff

Creating and maintaining a bicycle coordinator and staff are necessary to representing the interests of the cycling public in the planning process. Effective bicycle programs that accommodate and encourage cycling are not possible without the presence of a bicycle coordinator and staff (U.S. DOT *case 1* 1993). The essential function of a bicycle coordinator and staff allows for the organization of "interdepartmental efforts and integrates bicycle planning objectives into other community activities" (Pinsof and Musser 1995, 4). The Austin Bicycle Plan recognizes the significance of a bicycle coordinator and staff that can effectively implement a bicycle plan. In fact it states that the creation of a coordinator position "is the single most effective and important step to increasing bicycle use for transportation as well as improving safety for existing and future users" (Austin Bicycle Plan 1996, 20). A successful coordinator must be able to deal with all city departments, collect and analyze bicycle data, pursue public and private

funding, and provide advice for policy makers on bicycle issues (Austin Bicycle Plan 1996).

Land Use

Land use is one of the most significant determinants in peoples' decision to use a bicycle (Moe et al. 1997). Land use has a major impact on trip distance, which is often a crucial factor in the decision to use a bike. The low-density sprawl of many American cities makes cycling less feasible and is a major deterrent to increased bicycle use (Pucher et al. 1999; Pucher and Dijkstra 2000). Many sources and studies echo the sentiments of the Austin Bicycle Plan which states that "Reversing the decades old urban sprawl land use pattern is a fundamental problem that must be addressed if bicycling and walking are to become more widespread options" (Austin Bicycle Plan 1996, 6). There is justification for the expansion of mixed-use and denser land use patterns because these types of development correlate with increased bicycle use.[19] Developing land use patterns that better serve bicycles can be accomplished with several measures, economic incentives and disincentives, large-scale traffic management practices, and small-scale traffic management practices.

Incentives and Disincentives

The indirect and external costs posed by automotive transportation are well known. "On overage only 60 percent of roadway construction and maintenance costs are covered directly by user fees from motorists" (Austin Bicycle Plan 1996, 6). Negative externalities of subsidized auto use manifest itself most notably in the form of congestion

[19] See for example, Hamilton 2004, 22; Killingsworth and Schmid 2001; Plaut 2005; Stinson and Bhat 2004; Zhang 2004.

and pollution. Making driving less attractive, through increased pricing that more accurately reflects the total cost of a vehicle, is seen as an option to make bicycling more attractive and driving less attractive (U.S. DOT *case 1* 1993; Rietveld and Daniel 2004). Unfortunately any increase in the price of driving in the United States will likely be seen as, and is thus referred to as a disincentive. But what may be a disincentive for automobile use may be considered an incentive to bicycle use. Common ways of internalizing a higher percentage of automobile costs include higher road and parking pricing, increased toll roads, or congestion pricing.

Large Scale Traffic Management

Large-scale traffic management is the term used to refer to practices and policies that focus less exclusively on the automobile and more on increasing options for non-motorized travel. Large scale traffic management goes by a myriad of names such as: smart growth, mixed use development, mobility management, transportation or travel demand management, and transit oriented development. The main point to these types of developments is that they all attempt to increase the efficiency of land use while decreasing excessive distances that deter bicycle use.[20] These types of development strategies should be encouraged by municipalities as a way of increasing bicycle travel and providing more transportation mode choices (Moe et al. 1997).

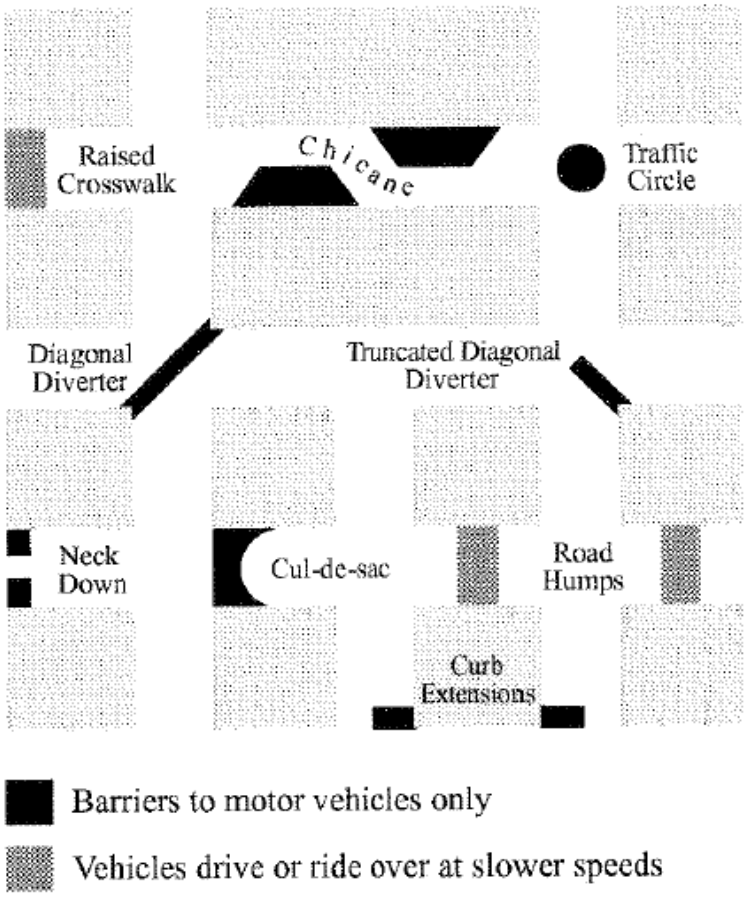
Small-Scale Traffic Management

Small-scale traffic management is the term for techniques used to control traffic and make road conditions more suitable for bicycling. These modifications, more commonly known as traffic calming, are primarily designed to reduce the speeds of vehicles, particularly in residential areas, while increasing the right of way for bicycles

[20] See for example, Hamilton 2004; Litman 2004; Burgess et al. 1994; Pinsof and Musser 1995.

and pedestrians. This allows for a safer and more pleasant cycling environment (Pinsof and Musser 1995). Traffic calming can be achieved with modifications such as raised intersections and speed bumps, traffic circles or artificial dead ends. Other modifications designed to slow vehicles in certain areas include road narrowing, and curved or zigzag routing.[21] Traffic calming greatly impacts children because child riders frequently operate bicycles in residential areas where traffic calming is most likely to occur. Reduced injuries in neighborhoods with traffic calming adjustments provide further explanation for the justification of traffic-calmed streets (Pucher and Dijkstra 2000; Pinsof and Musser 1995). Figure 3.8 illustrates various traffic calming modifications.

Figure 3.8 Sample Traffic Calming Devices



Source: Austin Bicycle Plan 1996

[21] See for example, Pucher and Dijkstra 2000; Pinsof and Musser 1995; Rails-to-Trails Conservancy 1998

Many of these traffic calming techniques can be used on the same street to create what is known as a bicycle boulevard.[22] Bicycle boulevards are streets whose use is limited to bicyclists and pedestrians. These exclusive bicycle facilities can be a good way to provide a safe and comfortable route for cyclists. It is important that a bicycle boulevard not divert excess traffic on to adjacent streets thus creating a hazardous environment for cyclists in other areas (City of Portland Office of Transportation 1998; Rails-to-Trails Conservancy 1998). Hence, ideal locations for bicycle boulevards would be residential streets flanked on both sides by arterial roads (Rails-to-Trails Conservancy 1998).

Finally, the design and technologies involved with intersections should be an important consideration when discussing small-scale traffic management. Research shows that 57% of bicycle motor vehicle collisions involving injuries occur at intersections (Wang and Nihan 2004). The placement of cyclists while waiting at intersections is significant issue. Some type of advanced stop line or area known as a bike box can allow cyclists to safely and visibly move ahead of traffic, thus eliminating potential conflict with turning vehicles (Clark and Page 2000; City of Austin Streets Smarts Task Force 2008). A second critical issue involving intersections is some type of signal modification that caters to cyclists. This can take the form of an advanced green light giving cyclists a head start (Pinsof and Musser 1995; Hamilton 2004). But in order to make use of these bicycle-activated lights there must be a way to detect the presence of cyclists at signalized intersections (Ochia 1993; Clark and Page 2000). The lack of these intersection improvements hinders non-motorized traffic, while their presence can

[22] See for example, Litman et al. 2005; City of Portland Office of Transportation 1998; Rails-to-Trails Conservancy 1998

provide quick and safe travel through busy intersections (City of Davis Public Works Department 2006; Litman et al. 2005).

Commuting and Utilitarian Cycling

The majority of cycling in the U.S. is recreational (Plaut 2005); but in order for bicycles to be a more viable mode of transportation more needs to be done to promote the bicycle for commuting and utilitarian trips. Commuting and utilitarian cycling have added environmental benefits because they are more likely to replace car trips than recreational cycling (Krizek et al. 2007). Austin recognizes this fact and has thus made it a goal of the Austin Bicycle Plan to increase the number of trips made for commuting or utilitarian purposes (Austin Bicycle Plan 1996). Commuting and utilitarian cycling are not only a city goal. The National Bicycling Study cites increasing utilitarian as a federal objective (Dill and Carr 2003).

One particular way to increase commuter bicycle use is to provide facilities that better accommodate those who ride to work. These types of facilities, which can encourage additional commuting bicycle use, can include adequate parking, showers, lockers, and changing rooms (Bowman et al. 1994; U.S. DOT *case 1* 1993). The presence of these end-of-trip facilities cannot increase commuting and utilitarian cycling alone, but must be accompanied with adequate bike lanes and paths (Krizek et al. 2007). Unfortunately even if there are adequate bike lanes, paths and end-of-trip facilities, the final determinant of commuting and utilitarian cycling is distance. Long distances are cited as one of the main reasons for not commuting by bike. While altering this may take a fundamental paradigm shift decreasing the distances that people travel to work would

greatly increase commuting and utilitarian cycling (U.S. DOT *case 1* 1994; Stinson and Bhat 2004).

Conceptual Framework

The conceptual framework, which uses descriptive categories, is linked to the supporting literature in Table 3.1. These categories and the resulting conceptual framework are used to develop the survey that describes the attitudes and opinions of Austin cyclists about the factors important to increasing bicycle transportation options.

Table 3.1 Conceptual Framework

CATEGORY	LITERATURE
Bicycle Facilities	
Bike Lanes and Paths	AASHTO (1999), Austin Bicycle Plan (1996), City of Portland Office of Transportation (1998), Clark and Page (2000), Dill and Carr (2003), Litman et al. (2006), Ochia (1993), Pinsof and Musser (1995), Pucher et al. (1999)
Bike Parking	Austin Bicycle Plan (1996), City of Portland Office of Transportation (1998), Litman et al. (2006), Mayor's Bicycle Advisory Council (2006), Moudon et al. (2005), Ochia (1993), Pinsof and Musser (1995), Pucher et al. (1999), Rails-to-Trails Conservancy (1998)
Considerations in the Placement and Selection of facilities	AASHTO (1999), Austin Bicycle Plan (1996), City of Davis Public Works Department (2006), City of Portland Office of Transportation (1998), Litman et al. (2006), Ochia (1993), Pinsof and Musser (1995), Pucher et al. (1999), Sharples (1999), Stinson and Bhat (2003), Turner et al. (1997)
Auxiliary Facilities	AASHTO (1999), City of Portland Office of Transportation (1998), Moudon et al. (2005), Ochia (1993), Pinsof and Musser (1995), Pucher et al. (1999), Wang and Nihan (2004)
Maintenance	AASHTO (1999), Austin Bicycle Plan (1996), Bowman et al. (1994), City of Portland Office of Transportation (1998), Litman et al. (2006), Ochia (1993), Pinsof and Musser (1995), Rails-to-Trails Conservancy (1998)

Connectivity	
Connecting Existing Bicycle Facilities	Austin Bicycle Plan (1996), City of Portland Office of Transportation (1998), Ochia (1993), Pinsof and Musser (1995), Pucher et al. (1999), U.S. DOT *case 1* (1993), U.S. EPA (2001)
Connecting Bicycles with Public Transportation	AASHTO (1993), Austin Bicycle Plan (1996), City of Portland Office of Transportation (1998), Hamilton (2004), Litman et al. (2006), U.S. DOT (2004)
Traffic Enforcement	
Traffic Enforcement for Motorists	Austin Bicycle Plan (1996), Pucher et al. (1999) Pucher and Dijkstra (2000), U.S. DOT (2004)
Traffic Enforcement of Cyclists	Austin Bicycle Plan (1996), Mayor's Bicycle Advisory Council (2006), U.S. DOT *case 1* (1993), U.S. DOT (2003)
Education	
Cyclist Education	AASHTO (1999), Austin Bicycle Plan (1996), City of Austin Streets Smarts Task Force (2008), City of Portland Office of Transportation (1998), Forester (1993), Litman et al. (2006), Ochia (1993), Pinsof and Musser (1995), Pucher et al. (1999), Pucher and Dijkstra (2000), Rails-to-Trails Conservancy (1998)
Motorist Education	AASHTO (1999), Austin Bicycle Plan (1996), City of Portland Office of Transportation (1998), Pucher and Dijkstra (2000)
Public Education through Promotion	AASHTO (1999), Austin Bicycle Plan (1996), City of Austin Streets Smarts Task Force (2008), City of Portland Office of Transportation (1998), U.S. DOT (2004)
Public Participation/Representation	
Public Involvement	Austin Bicycle Plan (1996), Burgess et al. (1994), Litman et al. (2006)
Bicycle Coordinator and Staff	Austin Bicycle Plan (1996), Pinsof and Musser (1995), U.S. DOT *case 1* (1993)
Land Use	
Incentives and Disincentives	Austin Bicycle Plan (1996), Rietveld and Daniel (2004), U.S. DOT *case 1* (1993)
Large-scale Traffic Management	Burgess et al. (1994), Hamilton (2004), Litman (2004), Moe et al. (1997), Pinsof and Musser (1995),
Small-scale Traffic Management	City of Austin Streets Smarts Task Force (2008), City of Davis Public Works Department (2006), City of Portland Office of Transportation (1998), Clark and Page (2000), Hamilton (2004), Litman et al (2006), Ochia (1993), Pinsof and Musser (1995), Pucher and Dijkstra (2000), Rails-to-Trails Conservancy (1998), Wang and Nihan (2004)
Commuting and Utilitarian Cycling	Austin Bicycle Plan (1996), Bowman et al. (1994), Dill and Carr (2003), Krizek et al (2007), Plaut (2005), Stinson and Bhat (2004), U.S. DOT *case 1* (1993),

Chapter Summary

This chapter has identified the key elements involved with increasing bicycle transportation options. These elements that serve as the descriptive categories are bicycle facilities, connectivity, traffic enforcement, education, public participation and representation, land use, and finally commuting and utilitarian cycling. The chapter further went on to introduce the conceptual framework and detail the literature used to develop each category within the framework.

Chapter Four: Methodology

Chapter Purpose

The purpose of this chapter is to present methodology used to garner the attitudes and opinions of cyclists about Austin's bicycling environment and the cities bicycle policies and facilities. This is accomplished through survey research. The questionnaire is organized using the descriptive categories of the conceptual framework.[23]

The categories used to develop the survey are:

- bicycle facilities
- connectivity
- traffic enforcement
- education
- public participation and representation
- land use
- commuting and utilitarian cycling

This operationalization is depicted in Table 4.1. This chapter also addresses the strengths and weaknesses of survey research, sampling issues, human subject protection, and statistics. The conceptual framework is comprised of descriptive categories, which in turn can contain several subcategories. These subcategories are then explored through the use of survey questions directly pertaining to the framework's subcategories.

[23] Understanding the methodology involved in this study and development of the conceptual framework was accomplished with the help of two important articles: *Pragmatism as philosophy of science: A tool for public administration*, by Patricia Shields, and *Intermediate theory: The missing link in successful student scholarship*, by Patricia Shields and Hassan Tajalli.

Table 4.1 Operationalization of Conceptual Framework

CATEGORY	SURVEY QUESTIONS
Bicycle Facilities	
Bicycle Lanes and Paths	3. Austin has enough on-road bicycle lanes to allow for the safe operation of a bicycle throughout the city.* 4. Austin has enough separated bicycle paths and off-road bicycle trails to allow for the safe operation of a bicycle throughout the city.* 5. Austin has enough shared use roads, such as wide outside curb lanes to allow for the safe operation of a bicycle throughout the city.* 6. Area rural roads are adequately equipped with paved shoulders to allow for the safe operation of a bicycle.* 26. Please rate the following bicycle facilities in the order that you are most likely to use them. *Most likely Somewhat likely Less likely Least likely* On-road bicycle lanes Separated bicycle paths (off-road bicycle trail) Shared use roads (wide outside curb lane) Paved Shoulder (rural conditions)
Bicycle Parking	7. Adequate bicycle parking is provided throughout Austin.*
Considerations in the Placement and Selection of Facilities	27. Please select and rate your TOP 3 factors most likely to affect your use of a bike lane or path. *Most likely Somewhat likely Less likely* Traffic volume Traffic speed Road width Bicycle lane width Percent of heavy vehicle use (trucks and buses) Presence of vehicle parking Road or surface conditions
Auxiliary Facilities	28. Please rate the following factors most likely to increase your bicycle use. *Most likely Somewhat likely Less likely Least likely* Nighttime lighting of bicycle lanes and paths Proper signing of preferred bicycle lanes and routes Improved intersection design more accommodating of bicyclists Bicycle detection and bicycle actuated traffic signals
Maintenance	8. Austin area bicycle facilities such as lanes, paths, and parking are adequately maintained.*
Connectivity	
Connecting Existing Bicycle Facilities	9. Bicycle lanes and paths are frequently interrupted by significant barriers.*
Connecting Bicycles with Public Transportation	10. The accommodation of bicycles on public transportation encourages additional bicycle use.*

Traffic Enforcement	
Traffic Enforcement for Motorists	11. Stricter enforcement of traffic laws will provide a safer bicycling environment.* 12. Austin adequately enforces traffic regulations, citing motorists whose behavior endangers cyclists.*
Traffic Enforcement for Cyclists	13. Austin adequately enforces traffic regulations, citing dangerous or illegal bicycle operation.*
Education	
Cyclist Education	14. There are adequate opportunities for adult cycling education in Austin.* 15. There are adequate opportunities for child cycling education in Austin.* 16. Schools should provide opportunities for educating child cyclists.*
Motorist Education	17. There needs to be more options for educating motorists about the conditions cyclists face.*
Public Education through Promotion	18. Local bicycle information and events are adequately promoted.*
Public Participation/Representation	
Public Involvement	19. There are adequate opportunities for the public to express their opinions and concerns about bicycle issues.*
Bicycle Coordinator and Staff	20. The Austin bicycle coordinator and staff adequately represent cyclists' interests in the development of city bicycle facilities and projects.*
Land Use	
Incentives and Disincentives	21. Increasing the cost of automobile ownership and operation will encourage me to use a bicycle more.*
Large-scale Traffic Management	22. More compact and efficient land use can encourage additional bicycle ridership.*
Small-scale Traffic Management	23. Traffic calming techniques in residential areas, such as speed bumps and traffic circles, provide a safer environment for cyclists.*
Commuting and Utilitarian Cycling	24. The city of Austin does enough to encourage commuting to work by bicycle.* 25. Commuting support facilities, such as showers, changing rooms, and lockers, will encourage me to ride a bike to work more.*

*Response Scale
Strongly Agree, Agree, Unsure, Disagree, Strongly Disagree

Research Technique

The research technique used is survey research. Survey research was chosen for its strengths and was deemed appropriate for this study because it is an effective way of

measuring the attitudes and perceptions of large populations (Babbie 2004). Survey research is a flexible methodology and allows the researcher to ask many questions on any topic, while also allowing for flexible analysis (Babbie 2004). Survey research is anonymous allowing respondents to provide more candid answers.

Although surveys are appropriate for this type of research it must be noted that are weakness associated with survey methodology. Poor participation and a low response rate can decrease the effectiveness of any survey resulting in responses that are unrepresentative of the population (Babbie 2004). While surveys are ideal for collecting information from large populations, it is important that questions not be too broad or overly general. Often times survey research can be inflexible. This is due to surveys not being able to change to issues raised by respondents, or adapt to points that may have surfaced after the development of the survey (Babbie 2004). Finally, misleading or loaded questions can solicit confused or misunderstood responses. Pre-testing the survey instrument is an important part of reducing ambiguous, misleading, or poorly worded questions and getting more accurate responses. The questionnaire was pre-tested by a small group of local cyclists.

Internet Distribution

Convenience and snowball sampling was used to reach Austin cyclists. The survey, containing a short explanation of the research purpose, was distributed to cyclists in several ways. The website www.surveymonkey.com was used to collect data obtained over the Internet. Requests for cyclists to participate in the survey were posted on two local bicycle web forums. Bicycleaustin.info, a compendium of local bicycle information

and the Austin Cycling Association hosted the two forums used to distribute the survey.[24] Surveys were also sent out to members of two local bicycle email lists including those on list for the city of Austin's Bicycle Advisory Committee, and those receiving emails from the Austin Yellow Bike Project. Respondents were allowed several weeks to complete the survey.

Sample

The Austin cycling community is large and diverse. To ensure its resembles the population as a whole and to obtain an adequate sample size a combination of convenience, snowball and quota sampling is used. The correspondence between the quota and the actual population will allow more accurate generalizations to be drawn about Austin cyclists.

The sample for this survey is drawn from the population of Austin cyclists. Reliable data regarding the demographic breakdown of cyclists in Austin does not exist, so an aggregate of National data is used to determine the demographic make up of local cyclists. To make certain the convenience and snowball sampling yielded a sample that represented that Austin population of cyclists at least somewhat quota sampling was also applied. Snowball sampling was used because survey participants were encouraged to share the link with fellow cyclists. The National Bicycling and Walking study states that "two demographic variables appear to be correlated with bicycle usage: Sex and age" (U.S. DOT *case 1* 1993, 14). The data shows that males make up approximately 61% of

[24] The bicycleinfo.org forum can be found at http://bicycleaustin.info/forum/viewforum.php?id=11, while the Austin Cycling Association forum is located at http://www.austincycling.org/forum-smf/

riders, with females comprising the other 39%[25], and that about two-thirds of all riders are under the age of 45 (U.S. DOT *case 1* 1993). Based on the preceding information the control characteristics are broken into male and female groups, and then divided into several age categories: 16-30, 31-45, and 45+.

Statistics

This study uses descriptive statistics such as mode and survey respondent percentages. Descriptive statistics are ideal for this study because of the descriptive nature of the research problem. The statistics used also demonstrate the range of opinions among Austin cyclists, and may also prove valuable in future research. Descriptive statistics provide for the reduction of large amounts of data into manageable summaries (Babbie 2004).

Human Subject Protection

This Applied Research Project was submitted for review and declared exempt by the Institutional Review Board at Texas State University – San Marcos. To ensure anonymity of the respondents no identifiable information was included in the survey. Anonymity improves the quality of the responses, as people typically feel freer to express their opinions in an anonymous setting. Finally, all participants were notified that participation was completely voluntary and respondents were free to stop taking the survey at any time.

[25] This data is based on studies conducted by the Harris Poll, the Bicycle Institute of America, the National Personal Transportation Study, and the Federal Highway Administration.

Chapter Five: Results

Chapter Purpose

The purpose of this chapter is to present and analyze the results of the bicycle survey issued to cyclists in Austin, Texas. This data addresses the research purpose of describing the attitudes and opinions of local cyclists regarding how well the city of Austin addresses factors important to increasing bicycle transportation options.

Respondent Information

Responses were solicited from local cyclists by posting the survey on two local bicycle web forums and message boards. Surveys were also sent out to members of two local bicycle email lists including those on list for the city of Austin Bicycle Advisory Committee, and those receiving emails from the Austin Yellow Bike Project. A total of 284 cyclists completed the survey. The demographic makeup of the sample is similar to the population of Austin cyclists, thus strengthening the validity of the survey results. Men make up 63.1 percent of respondents, with women composing the remaining 36.9 percent. Those between the ages 16-30 make up 25.4 percent of participants, ages 31-45 make up 48.6 percent, and those 46 and over make up 26.1 percent. The following tables give the means and modes for each survey question. Table 5.1 compares local and national cycling demographics. A complete set of results for all survey information can be found in Appendix A

Table 5.1 Bicycle Demographics

	Population of cyclists	Austin Survey n = 284
Sex		
Men	61%	63%
Women	39%	37%
Age		
45 and under	66%	74%
46 and over	33%	26%

In order to increase bicycle opportunities in Austin it is important to look at the individual factors that determine the quality of the bicycle environment. These factors have been incorporated into the conceptual framework and form the basis of the survey. Austin cyclists' responses to these categories are described in the following sections. A complete set of results for all survey information can be found in Appendix A.

Bicycle Facilities

When a city seeks to increase bicycle transportation options it is of primary importance to provide bicycle facilities. Bicycle facilities are comprised of several subcategories including bicycle lanes and paths, bicycle parking, considerations in the placement and selection of facilities, auxiliary facilities, and finally facilities maintenance issues. Tables 5.2a through 5.11 summarize respondents' attitudes and opinions regarding bicycle facilities.

Bicycle Lanes and Paths

An extremely small percentage of survey participants (5%) strongly agreed or agreed that Austin has enough on-road bicycle lanes to allow for the safe operation of a bicycle. An equally small percentage of cyclists (4.6%) strongly agreed or agreed that Austin has enough separated bicycle paths or off-road bicycle trails to allow for the safe

operation of a bicycle. Slightly more cyclists (7.2%) strongly agreed or agreed that Austin has enough shared use roads and wide outside curblanes, and even less (4.3%) strongly agreed of agreed that area rural roads are adequately equipped with paved shoulders permitting safe operation of a bicycle (See table 5.2a). The mode for all four questions in this subcategory showed disagreement. Finally, respondents indicated On-road bicycle lanes as the bicycle facility most likely to be used, while paved shoulders are the least desirable of the facilities listed (See table 5.2b). These results suggest Austin should give provision of bicycle facilities, most notably on-road bicycle lanes top priority. These findings can be interpreted as the existence of latent demand for more bicycle facilities, and suggests at the least that locals are extremely dissatisfied with the amount of bicycle facilities. At the most, it can be extrapolated from these findings that providing these facilities will encourage additional riderhsip. Thus lending credibility to similar studies that show increased bicycle mode split among cities with more bicycle lanes.[26] Furthermore, since bicycle lanes are cited as the key facility, the provision of bicycle lanes should be seen as the primary way to enhance the bicycle environment and create additional opportunities for bicycling.

Table 5.2a Bicycle Lanes and Paths

Survey question	N	% Strongly Agree and Agree	Mode
3. Austin has enough on-road bicycle lanes to allow for the safe operation of a bicycle throughout the city.	282	5%	Disagree
4. Austin has enough separated bicycle paths and off-road bicycle trails to allow for the safe operation of a bicycle throughout the city.	282	4.6%	Disagree
5. Austin has enough shared use roads, such as wide outside curb lanes to allow for the safe operation of a bicycle throughout the city.	279	7.2%	Disagree
6. Area rural roads are adequately equipped with paved shoulders to allow for the safe operation of a bicycle.	281	4.3%	Disagree

[26] Dill and Carr 2003; Morris 2004; U.S. DOT *case 1* 1993; and Pucher 2001 all refrence studies that show greater bicycle use in cities where there is a higher percentage of roads with bicycle lanes.

Table 5.2b Bicycle Lanes and Paths

Survey Question	N	Most Likely	Least Likely
26. Please rate the following bicycle facilities in the order that you are most likely to use them. *Most likely Somewhat likely Less likely Least likely* On-road bicycle lanes Separated bicycle paths (off-road bicycle trail) Shared use roads (wide outside curb lane) Paved Shoulder (rural conditions)	283	On-road bicycle lanes 64.6%	Paved Shoulder (rural conditions) 51.6%

Bicycle Parking and Bicycle Facility Maintenance

Survey results report that only one-fifth of cyclists strongly agree or agree that there is enough bicycle parking throughout Austin. The mode for this question was disagreement. The big picture is that Austinites feel there is insufficient bicycle parking. Given the modest expense of bicycle parking and the opportunities to defray costs by involving private business where parking is needed, the provision of additional bicycle parking should be considered another top priority. Moreover, a lack of bicycle parking can be a deterrent to increased use and needs to be improved in order to increase cycling as a viable transportation mode. Table 5.3 shows local cyclists' attitudes about the amount of bicycle parking and adequacy of bicycle facility maintenance.

To protect the investment made in the previously mentioned bicycle facilities a proper maintenance regimen is required. More than one quarter of the research subjects (28.8%) strongly agree or agree that bikeways and parking are not properly maintained. Hence, if Austin is able to improve its maintenance of bicycle facilities it can increase opportunities for cyclists and extend the life of existing facilities.

Table 5.3 Bicycle Parking and Bicycle Facility Maintenance

Survey Question	N	% Strongly Agree and Agree	Mode
7. Adequate bicycle parking is provided throughout Austin.	283	20.2%	Disagree
8. Austin area bicycle facilities such as lanes, paths, and parking are adequately maintained.	282	28.8%	Disagree

Placement and Selection of Facilities

There are many considerations that must be accounted for when determining the placement and selection of bicycle facilities. Traffic volume, speed, road and bicycle lane width, the presence of heavy vehicles and on-street parking, along with road surface conditions all affect the type of bicycle facility to be used, along with the comfort and safety of the rider. Austin riders assert the width of the bicycle lane is of prime importance and the factor most likely to affect their use of a particular facility. The factor least likely to discourage their use of a bicycle lane or path is the presence of vehicle parking (See table 5.4). These responses suggest cyclists are willing to travel on heavily traveled routes and are not bothered by traffic, providing there is adequate space to ensure their safety while riding.

Table 5.4 Consideration in the Placement and Selection of Facilities

Survey Question	N	Most Likely	Less Likely
27. Please select and rate your TOP 3 factors most likely to affect your use of a bike lane or path. *Most likely* *Somewhat likely* *Less likely* Traffic volume Traffic speed Road width Bicycle lane width Percent of heavy vehicle use (trucks and buses) Presence of vehicle parking Road or surface conditions	283	Bicycle Lane Width 49.1%	Presence of Vehicle Parking 50.8%

Auxiliary Faclities

The term "auxiliary facilities" refers to bicycle amenities other than bicycle lanes, trails and parking. It refers to things such as the lighting and signage of bikeways, and also includes bicycle friendly intersection modifications. The respondents rated intersection designs more accommodating of bicycles as the amenity most likely to increase their bicycle use. Of the other choices listed, less than half said that nighttime lighting of bikeways would be the least likely thing to increase their bicycle use (See table 5.5). Cyclists' opinions of intersection design suggest that their safety of can be improved with intersection modifications. Therefore the city should modify high use or dangerous intersections to make them more bicycle friendly, thus encouraging additional riders and improving the cycling environment for existing and future users.

Table 5.5 Auxiliary Facilities

Survey Question	N	Most Likely	Least Likely
28. Please rate the following factors most likely to increase your bicycle use. *Most likely Somewhat likely Less likely Least likely* Nighttime lighting of bicycle lanes and paths Proper signing of preferred bicycle lanes and routes Improved intersection design more accommodating of bicyclists Bicycle detection and bicycle actuated traffic signals	281	Improved intersection design more accommodating of bicyclists 51.8%	Nighttime lighting of bicycle lanes and paths 42.7%

According to cyclists the current state of bicycle facilities in Austin is insufficient. Most cyclists feel very strongly that Austin is lacking such facilities as adequate bike lanes and paths, sufficient parking and proper maintenance of existing facilities. To bring the discussion of bicycle facilities to a conclusion it is useful to note the most significant results from this category and their implication for increasing bicycle transportation options. The strongest sentiments came in response to bicycle lanes and paths. The lack of bicycle lanes and paths is cited as a significant problem. Not having these facilities

can make cycling dangerous and is a deterrent to the establishment of a safe bicycle environment. This is an area that needs to be addressed first if Austin is to increase bicycle transportation options for current and potential cyclists and the quality of life for all residents.

Connectivity

Connecting existing bicycle facilities and bicycles with public transportation capitalizes on a city's investment in existing infrastructure by enhancing opportunities for both cyclists and public transportation users. Connecting bicycle facilities and public transportation increases opportunities for cyclists by extending the potential distance covered by a cyclists while also giving cyclists the ability to overcome significant geographical barriers. Connecting bicycles with buses also increases the catchment area for bus stops and can provide bus riders with greater flexibility in route choice. Table 5.6 shows survey responses support connecting bicycles and public transportation. Seventy percent of cyclists strongly agree or agree that significant barriers exist in the bicycle network and that improving the connection between bicycles and public transportation will improve bicycle opportunities. The most frequent answer both questions is agreement. Both of the survey results and literature support the elimination of these connectivity barriers. Furthermore eliminating the gaps in the bicycle network by connecting bicycle lanes and paths should constitute a significant portion of capital bicycle expenses (Ochia 1993).

Table 5.6 Connecting Existing Bicycle Facilities and Bicycles with Public Transportation

Survey Question	N	% Strongly Agree and Agree	Mode
9. Bicycle lanes and paths are frequently interrupted by significant barriers.	281	70.5%	Agree
10. The accommodation of bicycles on public transportation encourages additional bicycle use.	284	70.4%	Agree

Traffic Enforcement

The lack of traffic enforcement regarding cyclists and motorists was cited as a barrier to use of the bicycle as a mode of transportation. Table 5.7 reveals that 65 percent of Austin cyclists strongly agree or agree that better enforcement of traffic laws with produce a safer environment for bicyclists. The mode for this question is agreement. For adequate enforcement of traffic regulations regarding motorists the mode is disagreement. An overwhelming minority (less than 3%) of those surveyed strongly agreed or agreed that Austin does a good job of citing motorists for driving that endangers cyclists. Only 12.8 percent of respondents strongly agreed or agreed that Austin adequately enforces traffic regulations regarding cyclists. Although there is a low level of agreement the most popular answer for this question is "Unsure." This can mean that cyclists have not had enough experience to judge the statement, are ambivalent about the statement, or do not understand the meaning of the question. The area that stands out the most in this category is the overwhelming need for better enforcement citing motorists whose behavior endangers cyclists.

Austin cyclists are unhappy with the state of traffic enforcement. They believe stricter enforcement would enhance safety (65% agree or strongly agree). In addition regulations directed at motorists and cyclists need to be more adequately enforced. This

is an especially important finding because these are regulations that are already on the books, the enforcement of which will require little extra expenses. It is crucial that traffic enforcement be more vigilant with motorists and not just cyclists because a lack of regard for traffic regulations by either endangers both. Considering that better enforcement of these regulations would cost little money to fix and cyclists are still very unhappy about the results of enforcement, suggests that the policy governing the enforcement of motorist and bicycle traffic regulations should be reevaluated by the city for improved effectiveness. This should be one of the top priorities for any city looking to promote a more friendly bicycling environment.

Table 5.7 Traffic Enforcement for Motorists and Cyclists

Survey Question	N	% Strongly Agree and Agree	Mode
11. Stricter enforcement of traffic laws will provide a safer bicycling environment.	282	64.9%	Agree
12. Austin adequately enforces traffic regulations, citing motorists whose behavior endangers cyclists.	282	2.8%	Disagree
13. Austin adequately enforces traffic regulations, citing dangerous or illegal bicycle operation.	283	12.8%	Unsure

Education

The responses to the education related questions were more tempered. Although the respondents believed adult and child cycling education was inadequate the strengths of this opinion was relatively mild (e.g. the mode response was unsure). The Austin cyclist also maintains that children should receive bicycle education in school and that there should be more opportunities for motorist education. The most striking result from this section is that an overwhelming majority (94%) believe that motorists are unaware of the conditions cyclists face. This high amount of agreement shows that the lack of awareness on the part of motorists is seen as a significant danger to cyclists and is in need

of improvement through education. This will not only make cycling safer but open additional opportunities for bicyclists. They were mixed about the adequacies of bicycle event promotion (See table 5.8).

Table 5.8 Cyclist Educations, Motorist Education and Public Education through Promotion

Survey Question	N	% Strongly Agree and Agree	Mode
14. There are adequate opportunities for adult cycling education in Austin.	277	39.3%	Unsure
15. There are adequate opportunities for child cycling education in Austin.	283	18.3%	Unsure
16. Schools should provide opportunities for educating child cyclists.	283	85.2%	Agree
17. There needs to be more options for educating motorists about the conditions cyclists face.	284	94%	Strongly Agree
18. Local bicycle information and events are adequately promoted.	280	46.1%	Agree

Public Participation and Representation

Public participation and representation are important aspects of any well-developed bicycle program. Those surveyed did not have as strong a response to public participation and representation as other categories. The mode response for both questions is unsure. Only a nominal percent of Austin cyclists (see table 5.9) strongly agree or agree that cyclists have adequate opportunities to express their opinions and concerns on bicycle issues, and that the bicycle department appropriately represents cyclists' interests. This result tells us cyclists are either unaware of ways to express their opinion, and unsure of what the bicycle coordinator position does. Correcting this issue and having a more informed bicycling public will lead to greater public participation and a more inclusive bicycle planning process thus producing a safer bicycle environment.

Table 5.9 Public Involvement, Bicycle Coordinator and Staff

Survey Question	N	% Strongly Agree and Agree	Mode
19. There are adequate opportunities for the public to express their opinions and concerns about bicycle issues.	281	24.9%	Unsure
20. The Austin bicycle coordinator and staff adequately represent cyclists' interests in the development of city bicycle facilities and projects.	283	34.3%	Unsure

Land Use

Land Use is a term used to describe a large category encompassing many ideas. Associated with land use are incentives and disincentive, which have a great impact not only on land use but also people transportation choices. One major incentive or disincentive, depending on where you are coming from, is the price of automobile ownership and operation. Greater distances associated with sprawling and less efficient land use limit transportation choices and increase the need for a car. One way to combat overdependence on cars is to have the price more accurately reflect the total cost to society. When asked if increased car costs would encourage more bicycling about two thirds of respondents (64.6%) strongly agreed or agreed. A second question dealt with land use on a larger scale. A large majority of cyclists (80.5%) strongly agree or agree that more compact and efficient land use would encourage additional ridership. Finally, this land use category dealt with smaller scale modifications such as traffic calming. More than half of cyclists surveyed (61.8%) strongly agreed or agreed that traffic calming techniques in residential areas, such as speed bumps and traffic circles produce a safer cycling environment. The mode for all answers in this category is Agreement. These results imply that higher automobile costs, more compact and efficient land use, and traffic calming techniques in residential areas could improve opportunities for bicycling.

The city of Austin should take note of these results when dealing with land use issues and policies. Table 5.10 lists the results related to land use subcategories.

Table 5.10 Incentives and Disincentives, Large- and Small- Scale Traffic Management

Survey Question	N	% Strongly Agree and Agree	Mode
21. Increasing the cost of automobile ownership and operation will encourage me to use a bicycle more.	280	64.6%	Agree
22. More compact and efficient land use can encourage additional bicycle ridership.	282	80.5%	Agree
23. Traffic calming techniques in residential areas, such as speed bumps and traffic circles, provide a safer environment for cyclists.	283	61.8%	Agree

Commuting and Utilitarian Cycling

The final category that must be addressed when trying to expand cycling opportunities is the issue of commuting and utilitarian cycling. The city of Austin has recognized this fact and has thus included increasing the level of commuting and utilitarian bicycling as one of their six main goals. Unfortunately, area cyclists do not feel that the city is accomplishing this goal. Only 8.1% of those surveyed strongly agreed or agreed that Austin does enough to encourage commuting to work via bicycle. The mode for this question was disagreement. To reverse this trend the city should look into ways to encourage employers to provide commuting support facilities such as showers, changing rooms, and lockers. Survey respondents demonstrate that the provision of these amenities would encourage additional cycling to work. In fact, a significant majority (82.2%) of cyclists strongly agree of agree that having these commute support facilities would persuade more to commute by bicycle. The answer most frequently selected for this question was “agree.”

Table 5.11 Commuting and Utilitarian Cycling

Survey Question	N	% Strongly Agree and Agree	Mode
24. The city of Austin does enough to encourage commuting to work by bicycle.	283	8.1%	Disagree
25. Commuting support facilities, such as showers, changing rooms, and lockers, will encourage me to ride a bike to work more.	281	82.2%	Agree

Chapter Summary

This chapter displayed the results of the survey according to the categories that comprise the conceptual framework. The categories reveal respondents' attitudes and opinions about bicycle facilities, connectivity, traffic enforcement, education, public participation and representation, land use, and finally commuting and utilitarian cycling. Enlightening results were found in several categories. Among the more significant results are Austin cyclists' opinions on bicycle lanes. There is strong displeasure with the amount of available bicycle lanes and paths. Austin cyclists are also upset about the lack of traffic enforcement citing motorists whose behavior endangers cyclists. The education category also solicited some strong responses. Almost all those surveyed felt that motorists need to be more aware of sand sensitive to the conditions that cyclists face. Finally, respondents were disappointed with the steps Austin has taken to encourage bicycle commuting to work. All of these areas need to be addressed if Austin is to elevate its status a bicycle friendly city.

Chapter Six: Conclusion

Chapter Purpose

This final chapter provides a summary of key research findings related to the factors important for increasing bicycle transportation opportunities. Austin area cyclists were asked to express their attitudes and opinions regarding these factors. The findings are based on an analysis of the survey questionnaires and a review of the literature. The chapter will also discuss the direction of possible future research.

Summary of Research

The purpose of this research was to describe the attitudes and opinions of Austin cyclists regarding how well the city of Austin addresses factors important to increasing bicycle transportation options. In order to put this research and survey in perspective the paper started with a brief history of the bicycle and also provided an introduction to past bicycle policy efforts in the United States and Austin, Texas.

Using the literature to guide the research key areas in bicycle polities were identified. The first category (bicycle facilities) is composed of bicycle lanes and paths, bicycle parking, considerations in the placement and selection of facilities, auxiliary facilities, and maintenance. Connectivity, a term that refers enhancing the connection between bicycles and public transportation and eliminating the barriers that exist in the bicycle network is the topic of the second category. The third category in the framework (traffic enforcement) deals with traffic enforcement pertaining to motorists and bicyclists.

The education category consists of motorist education, cyclist education, and public education through promotion. Public participation and representation touches on public involvement and also covers the bicycle coordinator and staff. The land use category has three components: incentives and disincentives, small-scale traffic management, and large-scale traffic management. Finally, the last category examines the topic of commuting and utilitarian cycling. These main elements and their subcategories would become the descriptive categories, be used as the basis for the conceptual framework, and also organize the survey research.

The survey questions, organized by descriptive categories seek to describe the attitudes and opinions of Austin cyclists regarding how well the city of Austin addresses factors important to increasing bicycle transportation options. To accomplish this task, surveys were sent out electronically to area cyclists. The 284 people who completed the survey comprise the sample population for this study.

The most striking results occur in several categories. Respondents felt most strongly about the following subtopics: bicycle lanes and paths, connecting existing bicycle facilities and bicycles with public transportation, traffic enforcement of motorists, cyclist education, large-scale land use, and finally commuting and utilitarian cycling. Every question pertaining to bicycle lanes and paths had an extremely small percentage of people (all less than 10%) who strongly agree or agree. To address these sentiments, the city of Austin needs to provide more bicycle lanes and paths, more separated bicycle paths and off-road bicycle trails, more shared use roads such as wide curb lanes, and construct area rural roads to include a paved shoulder. These survey results justify the need for additional bicycle facilities. This combined with the fact that cities with more

bicycle facilities have higher bicycle modal split, provides a powerful incentive to muster the political will to dedicate the appropriate amounts of funding necessary to enhance bicycle transportation opportunities.

Another major finding is illustrated by the survey responses on connectivity, the category comprised of connecting existing bicycle facilities, and also enhancing the connection between bicycles and public transportation. A sizable majority of area cyclists strongly agreed or agreed that the connection of existing bicycle facilities (70.4%) and the connection between bicycle and public transportation (70.5%) needs to be improved. This tells us two things. First, there are significant barriers that decrease the effectiveness of existing bicycle facilities. These barriers can be geographical such as rivers, lakes, and hills, or manmade barriers such as highways, poorly designed intersections, or circuitous and indirect routing.

Regardless of the barrier, bridging them will enhance the value and improve the use of existing facilities, while improving the overall effectiveness and connectivity of the entire bicycle network. It was also noted, with equal emphasis, that improving the connection between bicycle and public transportation will lead to increased bicycle use. Beyond this, improving the connection of these two modes has been shown to improve bus ridership as well. The improved effectiveness and reach of these two modes improves non-automobile options and the transportation system as a whole. Improved transportation options not only benefits bicycle and bus users, but the improved effectiveness of the entire transportation system enhances the quality of life throughout Austin.

One aspect in the traffic enforcement category that really hit home with cyclists was the enforcement of traffic regulations citing motorists whose behavior endangered cyclists. Only 2.8%, the lowest response rate for any question on the survey, strongly agreed or agreed that the city adequately enforced traffic regulations regarding these motorists. The city by improving their enforcement of citing dangerous motorist behavior can improve the bicycling environment of Austin. This increased safety can also lead to increased cycling opportunities, and improve and protect the investment the city has made in bicycle infrastructure.

Those surveyed also felt deeply about the category of cyclist education. Most cyclists (85.2%) strongly agreed or agreed that local schools are an appropriate venue for cycling education and should in fact provide that education to child cyclists. Providing kids with cycling education opportunities not only keeps them safe when operating a bicycle but also promotes active lifestyles helps in the early development of positive lifelong habits. Although it may be difficult for schools to find the time to include new curriculum into an already busy schedule, nothing should be too important that it marginalizes child safety. Additionally, this type of instruction correlates well with the physical activities and education common in P.E. curriculum. The highest response rate for any of the survey questions was about motorist education. Almost all cyclists surveyed (94%) strongly agreed or agreed that there needs to be more options for educating motorists about the conditions cyclists face. Driver education and defensive driving classes are ideal settings for improving driver awareness about the conditions that cyclists face while also promoting more bicycle friendly driving techniques. This will go

a long way not only to promote cyclist safety but also to improve the strained relationship between motorists and cyclists.

The subcategory large-scale land use also drew quite a reaction from local cyclists. Eight out of ten (80.5%) strongly agreed or agreed that more compact and efficient land use can encourage additional bicycle ridership. The long distances associated with low-density urban sprawl make cycling less feasible. Therefore, city policies that encourage more efficient land use, such as higher density or mixed use development, will improve opportunities for more cyclists.

The final category that struck a chord with Austin cyclists is dedicated to commuting and utilitarian cycling. Less than one in ten (8.1%) of those surveyed strongly agreed or agreed that the city of Austin does enough to encourage commuting to work by bicycle. One way to encourage bicycle commuting is to provide the commuting support facilities that cyclists need to make cycling to work more practical, convenient, and pleasurable. This is supported by the survey question where 82.2% of cyclist strongly agreed or agreed that commuting support facilities, such as showers, changing rooms, and lockers, will encourage additional bicycle commuting. If the city can find a way to encourage more employers to provide the necessary commute support facilities than the health of employees not only improves but road congestion is reduced during peak hours.

Recommendations

Once problem areas have been identified steps can be taken to address the barriers that discourage bicycle use and improve conditions for cyclists. Table 6.1 asses the areas

that triggered strong participant reaction and lists recommendations Austin can take to counter deficiencies in bicycle facilities, connectivity, traffic enforcement and education for motorists and cyclists, land use, and bicycle commuting.

Table 6.1 Summary of Survey Results

Bicycle Facilities		
Survey Question	**Assessment**	**Recommendations**
3. Austin has enough on-road bicycle lanes to allow for the safe operation of a bicycle throughout the city.	Unacceptable	▪ Austin needs to increase the amount of roads with bicycle facilities and increase the amount of funding dedicated to the construction of bicycle facilities.
4. Austin has enough separated bicycle paths and off-road bicycle trails to allow for the safe operation of a bicycle throughout the city.	Unacceptable	
5. Austin has enough shared use roads, such as wide outside curb lanes to allow for the safe operation of a bicycle throughout the city.	Unacceptable	
6. Area rural roads are adequately equipped with paved shoulders to allow for the safe operation of a bicycle.	Unacceptable	
Survey Question	**Assessment**	**Recommendations**
26. Please rate the following bicycle facilities in the order that you are most likely to use them. *Most likely to Least likely* On-road bicycle lanes Separated bicycle paths Shared use roads Paved Shoulder	Needs improvement	▪ The construction of bicycle lanes should take priority over other facilities and receive the majority of facility construction funding.
Survey Question	**Assessment**	**Recommendations**
7. Adequate bicycle parking is provided throughout Austin.	Needs improvement	▪ The city needs to install more bicycle parking throughout Austin, especially in areas and centers built before considerations were given to bicycle parking
Survey Question	**Assessment**	**Recommendations**
28. Please rate the following factors most likely to increase your bicycle use. *Most likely to Least likely* Night lighting of bicycle lanes/paths Proper signing of preferred bicycle lanes and routes Improved intersection design more accommodating of bicyclists Bicycle detection and bicycle actuated traffic signals	Needs improvement	▪ The city should identify the intersections most heavily used by bicyclists with the highest bicycle accident numbers. These intersections should then be modified to be more accommodating of bicycles. Bicycle accident rates before and after the intersection modification need to be tracked to determine the effectiveness of the bicycle-friendly intersection design

Survey Question	Assessment	Recommendations
8. Austin area bicycle facilities such as lanes, paths, and parking are adequately maintained.	Needs improvement	▪ Austin needs to improve the process by which maintenance problems are reported and addressed. Any program needs to include a way to confirm with the person who made the complaint that the repair or maintenance issue has been resolved
Connecting Existing Bicycle Facilities and Bicycles with Public Transportation		
Survey Question	**Assessment**	**Recommendations**
9. Bicycle lanes and paths are frequently interrupted by significant barriers.	Needs improvement	▪ When considering the construction of bicycle facilities Austin needs to assign a higher priority to projects that gap geographical barriers or fill in incomplete areas in the existing bicycle network
Traffic Enforcement for Motorists and Cyclists		
Survey Question	**Assessment**	**Recommendations**
12. Austin adequately enforces traffic regulations, citing motorists whose behavior endangers cyclists.	Unacceptable	▪ Austin police need to be more aggressive ticketing motorists and cyclists whose exhibit aggressive or dangerous vehicle operation.
13. Austin adequately enforces traffic regulations, citing dangerous or illegal bicycle operation.	Unacceptable	
Cyclist Education, Motorist Education and Public Education through Promotion		
Survey Question	**Assessment**	**Recommendations**
15. There are adequate opportunities for child cycling education in Austin.	Needs improvement	▪ Austin needs to dedicate more money for child bicycle education and expand educational opportunities for child cyclists. ▪ Austin schools need to address bicycle safety issues and provide bicycle education to area students. ▪ Motorist education needs to address bicycle safety issues. Opportunities for this need to be incorporated into drivers education and defensive driving classes.
16. Schools should provide opportunities for educating child cyclists.	Needs improvement	
17. There needs to be more options for educating motorists about the conditions cyclists face.	Unacceptable	
Incentives and Disincentives, Large- and Small-Scale Traffic Management		
Survey Question	**Assessment**	**Recommendations**
22. More compact and efficient land use can encourage additional bicycle ridership.	Needs improvement	▪ Austin should offer or enhance specific plans to support more pedestrian friendly or transit oriented development, by enhancing and promoting local development and design standards that reduce the need for car travel and promote more efficient land use. Austin should also require developers to adhere to more bicycle-friendly design standards.

Commuting and Utilitarian Cycling		
Survey Question	**Assessment**	**Recommendations**
24. The city of Austin does enough to encourage commuting to work by bicycle.	Unacceptable	▪ Encourage bicycle commuting by providing Austin city employees with commute support facilities. ▪ Encourage area employers to promote bicycle commuting and consider incentives for local employers who provide facilities for bicycle commuters.
25. Commuting support facilities, such as showers, changing rooms, and lockers, will encourage me to ride a bike to work more.	Needs improvement	

In addition to the recommendations listed in the table above there are a few other suggestions that would also help expand safe opportunities for cyclists. The city bicycle plan is a critical element necessary to insure a prosperous bicycle environment. It is important that this plan not be marginalized and incorporated into all city decisions and planning. The bicycle plan should not only be integrated with the whole transportation process but it should also be focused on results and implementation. Beyond the city level the bicycle plan and design specifications need to be included in regional and state road design manuals. Having these specifications in front of road engineers and not just bicycle planners insures that bicycle considerations are taken into account in the development, construction and maintenance of all roads. While it is important integrate bicycle design specifications with road planning and design, it is equally vital to include the costs of bicycle facility construction with the overall costs of highway construction and maintenance.

Future Research

One intention of this study is to add to the scholarly research on bicycle transportation. But this study only examines bicycle issues as it pertains to cyclists in Austin, Texas. There is still much needed research that can increase understanding of

and further develop this vital field of study. This particular study asked cyclists to express their attitudes and opinions on the bicycling environment in Austin. Another potential topic for research would be to survey non-cyclists to find out the conditions, facilities, or policies that would encourage new riders to use a bike. It would also be interesting to conduct this same survey in other cities and compare the results. Multiple cities could participate and cities could be grouped together according to their platinum, gold, silver or bronze bicycle-friendly designations, comparing results between the different tiers. Redistributing this survey in Austin after a certain time period, perhaps five years, would allow the researcher to see how opinions in Austin have changed over time. An examination of the values of non-cyclists and how they differ from cyclists could prove beneficial in uncovering the differences between motorists and cyclists, and what influences each to make their transportation choices (U.S. DOT *case 1* 1993).

The literature also identifies several important areas that would benefit from further inquiry. The scholarship on bicycle transportation needs to improve and develop additional methodologies for conducting travel surveys. Future travel surveys should seek to find answers to questions such as where are people going and how are they getting there? Answers to these questions would help improve the design and selection of bicycle facilities. Current methodologies are not adept at quantitatively valuing the benefits of bicycle facilities, assessing the level of service and current demand for the existing network, or determining the safety impacts of particular bicycle facilities.[27] Future research that improves these methodologies will not only yield interesting results but also help us understand the factors that affect bicycle use. Finally a more accurate

[27] Rails-to-Trails Conservancy 1998, U.S DOT Bureau of Transportation Statistics 2000

and thorough analysis of bicycle crashes needs to be undertaken to better understand the circumstances behind injuries and crashes.[28]

In closing, Austin has been given a Silver rating for bicycle friendliness by the League of American Bicyclists, and is seen as having a favorable bicycling environment when compared to other cities in the United States. But as the results of this study highlight, in the eyes of its own cyclists, Austin still has a lot of work to do to make cycling a more viable transportation option. All of the problems mentioned above are those that resonate the most with Austin cyclists. Addressing these issues has the greatest potential for making a safer and more convenient bicycling environment thus improving bicycle transportation options for Austinites.

[28] Mayor's Bicycle Advisory Council 2006, U.S. DOT Bureau of Transportation Statistics 2000

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Appendix A: Summary of Results

Survey Question	N	Male	Female
1. Gender	282	63.1% (178)	36.9% (104)

Survey Question	N	Age 16-30	Age 31-45	Age 46+
2. Age	284	25.4% (72)	48.6% (136)	26.1% (74)

Survey Question	N	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
3. Austin has enough on-road bicycle lanes to allow for the safe operation of a bicycle throughout the city.	282	1.1% (3)	3.9% (11)	2.8% (8)	52.8% (149)	39.4% (111)
4. Austin has enough separated bicycle paths and off-road bicycle trails to allow for the safe operation of a bicycle throughout the city.	282	1.4% (4)	3.2% (9)	9.2% (26)	48.2% (136)	37.9% (107)
5. Austin has enough shared use roads, such as wide outside curb lanes to allow for the safe operation of a bicycle throughout the city.	279	0.7% (2)	6.5% (18)	6.8% (19)	54.5% (152)	31.5% (88)
6. Area rural roads are adequately equipped with paved shoulders to allow for the safe operation of a bicycle.	281	0.0% (0)	4.3% (12)	18.9% (53)	40.6% (114)	36.3% (102)
7. Adequate bicycle parking is provided throughout Austin.	283	1.1% (3)	19.1% (54)	18.7% (53)	45.6% (129)	15.5% (44)
8. Austin area bicycle facilities such as lanes, paths, and parking are adequately maintained.	282	0.4% (1)	28.4% (80)	17.4% (49)	35.5% (100)	18.4% (52)
9. Bicycle lanes and paths are frequently interrupted by significant barriers.	281	21.0% (59)	49.5% (139)	14.6% (41)	12.1% (34)	2.8% (8)
10. The accommodation of bicycles on public transportation encourages additional bicycle use.	284	20.4% (58)	50.0% (142)	15.5% (44)	10.2% (29)	3.9% (11)
11. Stricter enforcement of traffic laws will provide a safer bicycling environment.	282	20.9% (59)	44.0% (124)	21.6% (61)	12.4% (35)	1.1% (3)
12. Austin adequately enforces traffic regulations, citing motorists whose behavior endangers cyclists.	282	0.0% (0)	2.8% (8)	26.6% (75)	35.5% (100)	35.1% (99)
13. Austin adequately enforces traffic regulations, citing dangerous or illegal bicycle operation.	283	1.8% (5)	11.0% (31)	43.8% (124)	32.5% (92)	11.0% (31)
14. There are adequate opportunities for adult cycling education in Austin.	277	4.3% (12)	35.0% (97)	40.4% (112)	18.4% (51)	1.8% (5)
15. There are adequate opportunities for child cycling education in Austin.	283	2.8% (8)	15.5% (44)	59.7% (169)	17.3% (49)	4.6% (13)

16. Schools should provide opportunities for educating child cyclists.	283	32.9% (93)	52.3% (148)	9.9% (28)	4.6% (13)	0.4% (1)
17. There needs to be more options for educating motorists about the conditions cyclists face.	284	54.9% (156)	39.1% (111)	3.5% (10)	0.7% (2)	1.8% (5)
18. Local bicycle information and events are adequately promoted.	280	1.8% (5)	44.3% (124)	24.6% (69)	26.4% (74)	2.9% (8)
19. There are adequate opportunities for the public to express their opinions and concerns about bicycle issues.	281	1.1% (3)	23.8% (67)	33.1% (93)	32.7% (92)	9.3% (26)
20. The Austin bicycle coordinator and staff adequately represent cyclists' interests in the development of city bicycle facilities and projects.	283	5.3% (15)	29.0% (82)	52.3% (148)	12.0% (34)	1.4% (4)
21. Increasing the cost of automobile ownership and operation will encourage me to use a bicycle more.	280	22.5% (63)	42.1% (118)	8.2% (23)	21.8% (61)	5.4% (15)
22. More compact and efficient land use can encourage additional bicycle ridership.	282	34.4% (97)	46.1% (130)	16.0% (45)	2.5% (7)	1.1% (3)
23. Traffic calming techniques in residential areas, such as speed bumps and traffic circles, provide a safer environment for cyclists.	283	14.1% (40)	47.7% (135)	20.1% (57)	14.8% (42)	3.2% (9)
24. The city of Austin does enough to encourage commuting to work by bicycle.	283	0.7% (2)	7.4% (21)	14.1% (40)	48.4% (137)	29.3% (83)
25. Commuting support facilities, such as showers, changing rooms, and lockers, will encourage me to ride a bike to work more.	281	35.9% (101)	46.3% (130)	7.8% (22)	8.5% (24)	1.4% (4)

Survey Question	N	Most Likely	Somewhat Likely	Less Likely	Least Likely
26. Please rate the following bicycle facilities in the order that you are most likely to use them.					
On-road bicycle lanes	260	64.6% (168)	22.3% (58)	10.8% (28)	2.3% (6)
Separated bicycle paths (off-road bicycle trail)	272	20.2% (55)	26.5% (72)	21.7% (59)	31.6% (86)
Shared use roads (wide outside curb lane)	265	12.5% (33)	37.7% (100)	42.6% (113)	7.2% (19)
Paved Shoulder (rural conditions)	273	9.5% (26)	14.7% (40)	24.2% (66)	51.6% (141)

Survey Question	N	Most Likely	Somewhat Likely	Less Likely
27. Please select and rate your TOP 3 factors most likely to affect your use of a bike lane or path.				
Traffic volume	176	34.3% (61)	42.1% (75)	23.6% (42)
Traffic speed	175	45.7% (80)	36.0% (63)	18.3% (32)

Road width	114	28.9% (33)	32.5% (37)	38.6% (44)
Bicycle lane width	112	49.1% (55)	25.0% (28)	25.9% (29)
Percent of heavy vehicle use (trucks and buses)	83	24.1% (20)	25.3% (21)	50.6% (42)
Presence of vehicle parking	65	20.0% (13)	29.2% (19)	50.8% (33)
Road or surface conditions	111	18.0% (20)	32.4% (36)	49.5% (55)

Survey Question	N	Most Likely	Somewhat Likely	Less Likely	Least Likely
28. Please rate the following factors most likely to increase your bicycle use.					
Nighttime lighting of bicycle lanes and paths	262	13.7% (36)	16.0% (42)	27.5% (72)	42.7% (112)
Proper signing of preferred bicycle lanes and routes	267	22.1% (59)	27.3% (73)	27.7% (74)	22.8% (61)
Improved intersection design more accommodating of bicyclists	272	51.8% (141)	26.8% (73)	18.0% (49)	3.3% (9)
Bicycle detection and bicycle actuated traffic signals	265	15.8% (42)	31.3% (83)	26.8% (71)	26.0% (69)

Appendix B: Survey

Attitudes and Opinions of Austin Cyclists

The purpose of this survey is to determine the attitudes and opinions of Austin cyclists regarding the factors important to increasing bicycle use. This survey should take **less than 10 minutes to complete**. Participation is completely voluntary and all answers will remain confidential. Should you have any questions or comments about the survey please contact me at *justinwilliammarlin@yahoo.com*. Thank you, your participation is greatly appreciated.

1. Gender

◯ Male ◯ Female

2. Age

◯ 16 - 30 ◯ 31 - 45 ◯ 46+

3. Austin has enough on-road bicycle lanes to allow for the safe operation of a bicycle throughout the city.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

4. Austin has enough separated bicycle paths and off-road bicycle trails to allow for the safe operation of a bicycle throughout the city.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

5. Austin has enough shared use roads, such as wide outside curb lanes to allow for the safe operation of a bicycle throughout the city.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

6. Area rural roads are adequately equipped with paved shoulders to allow for the safe operation of a bicycle.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

7. Adequate bicycle parking is provided throughout Austin.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ strongly Agree

8. Austin area bicycle facilities such as lanes, paths, and parking are adequately maintained.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

9. Bicycle lanes and paths are frequently interrupted by significant barriers.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

10. The accommodation of bicycles on public transportation encourages additional bicycle use.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

11. Stricter enforcement of traffic laws will provide a safer bicycling environment.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

12. Austin adequately enforces traffic regulations, citing motorists whose behavior endangers cyclists.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

13. Austin adequately enforces traffic regulations, citing dangerous or illegal bicycle operation.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

14. There are adequate opportunities for adult cycling education in Austin.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

15. There are adequate opportunities for child cycling education in Austin.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

16. Schools should provide opportunities for educating child cyclists.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

17. There needs to be more options for educating motorists about the conditions cyclists face.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

18. Local bicycle information and events are adequately promoted.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

19. There are adequate opportunities for the public to express their opinions and concerns about bicycle issues.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

20. The Austin bicycle coordinator and staff adequately represent cyclists' interests in the development of city bicycle facilities and projects.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

21. Increasing the cost of automobile ownership and operation will encourage me to use a bicycle more.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

22. More compact and efficient land use can encourage additional bicycle ridership.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

23. Traffic calming techniques in residential areas, such as speed bumps and traffic circles, provide a safer environment for cyclists.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

24. The city of Austin does enough to encourage commuting to work by bicycle.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

25. Commuting support facilities, such as showers, changing rooms, and lockers, will encourage me to ride a bike to work more.

◯ Strongly Disagree ◯ Disagree ◯ Unsure ◯ Agree ◯ Strongly Agree

26. Please rate the following bicycle facilities in the order that you are most likely to use them.

	Most likely	Somewhat likely	Less likely	Least likely
On-road bicycle lanes	◯	◯	◯	◯
Separated bicycle paths (off-road bicycle trail)	◯	◯	◯	◯
Shared use roads (wide outside curb lane)	◯	◯	◯	◯
Paved Shoulder (rural conditions)	◯	◯	◯	◯

27. Please select and rate your *TOP 3* factors most likely to affect your use of a bike lane or path.

	Most likely	Somewhat likely	Less likely
Traffic volume	◯	◯	◯
Traffic speed	◯	◯	◯
Road width	◯	◯	◯
Bicycle lane width	◯	◯	◯
Percent of heavy vehicle use (trucks and buses)	◯	◯	◯
Presence of vehicle parking	◯	◯	◯
Road or surface conditions	◯	◯	◯

28. Please rate the following factors most likely to increase your bicycle use.

	Most likely	Somewhat likely	Less likely	Least likely
Nighttime lighting of bicycle lanes and paths	◯	◯	◯	◯
Proper signing of preferred bicycle lanes and routes	◯	◯	◯	◯
Improved intersection design more accommodating of bicyclists	◯	◯	◯	◯
Bicycle detection and bicycle actuated traffic signals	◯	◯	◯	◯