

Successful Bicycle Policy Guidelines and Audit for Midsize Cities

by

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A Thesis in

Civil Engineering

Submitted to the Graduate Faculty
of Texas Tech University in
Partial Fulfillment of
the Requirements for
the Degree of

Master of Science

in

Civil Engineering

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December, 2011

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Acknowledgements

The author would like to acknowledge the Texas Department of Transportation for funding the first part of this research project as part of TxDOT Report #: 0-6582-1. The author would also like to thank TechMRT for facilitating the research and surveymonkey.com for hosting the research survey.

Table of Contents

| | |
|--|-------------|
| Acknowledgements | ii |
| Abstract..... | vii |
| List of Tables | viii |
| List of Figures | ix |
| I. Introduction..... | 1 |
| II. Background and Literature Review..... | 2 |
| Introduction..... | 2 |
| Reasons for Bicycling..... | 2 |
| Environment | 3 |
| Congestion..... | 3 |
| Health | 5 |
| Recreation..... | 7 |
| Bicycle Commuter Profiles..... | 8 |
| Bicyclist Demographics | 8 |
| Number of Bicyclists and Bicycle Trips | 11 |
| Factors Affecting Bicycling | 14 |
| Safety | 15 |
| Community | 16 |
| Facilities | 17 |
| Wide Curb Lanes..... | 18 |
| Signed Shared Roadway..... | 19 |
| Bike Lanes | 20 |
| Paved Shoulders | 22 |
| Bicycle Facility Frequency | 22 |
| Funding | 23 |
| Federal Legislation..... | 23 |
| State Legislation..... | 28 |

| | |
|---|-----------|
| Model Bicycle Communities | 29 |
| Top Ranked States | 30 |
| Platinum Bicycle Friendly Communities | 31 |
| Successful Midsize Bicycle Friendly Communities | 32 |
| BYPAD and the European Model | 33 |
| III. Research Phase 1 | 36 |
| Methodology | 36 |
| Key Findings | 37 |
| Analysis of Success Results | 37 |
| Findings from Questions for Bicycle Users | 37 |
| Safety is the Primary Concern for Bicyclists | 38 |
| Community Size | 38 |
| Other Factors That Lead to Increased Success Rates | 39 |
| Findings from Questions for Government Officials..... | 39 |
| Local Government Agencies Are More Effective at Promoting Bicycling | 39 |
| MPOs Are Most Effective When Making Funding Decisions but Often Ineffective Otherwise | 40 |
| More Successful Communities Are Active in Improving Bicycle Conditions | 40 |
| Other Key Findings..... | 41 |
| Analysis of Community Sizes | 41 |
| Findings from Questions for Bicycle Users | 42 |
| There Are Few Differences between City Sizes for Bicycle Users | 42 |
| There is a Difference in Comfortable Bicycling Distance | 42 |
| Motorist Attitudes are Generally Negative and Seemingly Worsen with Population Increase..... | 42 |
| Findings from Questions for Government Officials..... | 43 |
| There Are Few Differences between City Sizes for Government Officials.... | 43 |
| Level of Service Likely Has Little Effect on Success in Mid-Size Cities | 43 |
| It is Likely That a Bike Plan is Underutilized in Mid-Size Cities | 43 |
| A Dedicated TA Bicycle Advocate May Be an Advantage of a Larger Population..... | 44 |
| Constraints and Limitations..... | 44 |
| Recommendations | 44 |

| | |
|---|-----------|
| Bicycle Plans Should Be Used More Effectively | 45 |
| Local Government Agencies Should be Responsible for Developing a Plan | 45 |
| Local Government Agencies Should be Responsible for Financing | 45 |
| Mid-Size Cities Should Effectively Promote Bicycling | 46 |
| Mid-Size Cities Should Be Vigilant in Following the Plan | 46 |
| IV. Research Phase 2 | 47 |
| Research Phase 2 | 47 |
| Methodology | 47 |
| Guidelines for Establishing Successful Bicycle Implementation | 48 |
| Constraints and Limitations | 50 |
| V. Research Phase 3..... | 51 |
| Methodology | 51 |
| Sample Audit Form | 53 |
| Section 1: General Questions | 53 |
| Section 2: Funding and Policy | 54 |
| Section 3: Engineering and Design..... | 56 |
| Section 4: Education | 58 |
| Section 5: Safety | 59 |
| Advantages and Recommendations..... | 60 |
| Constraints and Limitations | 61 |
| VI. Conclusions..... | 63 |
| Further Research | 63 |
| Distributing the Second Survey to a More Normalized Population..... | 63 |
| Use of Statistical Analysis to Calibrate Weighting Factors..... | 64 |
| Monitoring of Spreadsheet over a Number of Years..... | 64 |
| References | 65 |
| Appendices..... | 67 |
| A. The Original Bicycle Questionnaire | 67 |
| B. Bicycle Audit Questionnaire | 80 |
| C. Incomplete Audit Excel Form | 87 |
| D. TxDOT Report #: 0-6582-1..... | 92 |

E. Bicycle Implementation in Midsize Cities: Using Survey Results to Develop Successful Bicycle Policy Guidelines.....212

Abstract

In the United States, the bicycle has been a historically underutilized mode of transportation. However, recent political and economic trends have enabled the bicycle to become a much more viable means of transportation that should be integrated into multi-modal transportation systems. This thesis is the culmination of research initially conducted on behalf of the Texas Department of Transportation and carried out to further investigate the claims made in that initial report to TxDOT. This research was conducted to determine how bicycling can be effectively integrated into a multi-modal system and what factors lead to successful bicycling.

The research was conducted in three phases. The first was an analysis of bicycling data gathered through an online survey. This produced a series of key findings and recommendations for governments wishing to improve and/or implement bicycling into their transportation systems. The second phase was conducted to further that analysis with statistical methods, including a correlation study. This second phase corroborated the findings of the first phase and produced a set of general guidelines to follow for bicycle policy implementation. The final phase of the research sought to conclude the project by deriving from all the previous findings a usable audit form by which cities can grade their level of bicycle implementation. The goal of this audit is to be a timely addition to current bicycle knowledge; this simple yet powerful tool is easy to use but should be intuitive enough to allow users to see areas in which to improve. This research is a crucial addition to the state of practice for bicycling as a mode of transportation and should provide the foundation for future efforts in promoting bicycling as a vital means of transit.

List of Tables

| | | |
|------|---|-----|
| 1 | Participation in Outdoor Activities, All Americans Ages 6 and Older (Sample Activities) (Source: Outdoor Foundation, 2010)..... | 8 |
| 2 | Highest and Lowest Percentage of Bicycle Commuters by State and Year (Source: Flusche, 2009). | 11 |
| 3 | Sample Funding Resources for Bicycle Projects (Source, FHWA, 2008) | 25 |
| C. 1 | Blank Audit Form | 87 |
| E. 1 | Correlations to Population for Bicycle Users | 233 |

List of Figures

| | |
|--|----|
| 1. Percent of AM Peak Period Vehicle Trips Not Related to a Commute by Purpose (Source: USDOT, 2003) | 4 |
| 2. Comparison of Active Transportation and Obesity Rates in Various Countries (Source: Bassett et al., 2008) | 6 |
| 3. Percentage of Bicyclists with Access to a Bicycle, by Household Income (Source: Royal and Miller-Steiger, 2008)..... | 9 |
| 4. Total Number of Bicycle Trips by Gender and Age (Source: Royal and Miller- Steiger, 2008) | 10 |
| 5. Percentage of Daily Trips by Mode of Transportation (Source: USDOT, 2003) | 12 |
| 6. Percent Change in Bicycle Commuting in the United States by Year (Source, Flusche, 2009) | 13 |
| 7. Bicycle Commuting to Work in the United States (Source: Flusche, 2009)..... | 14 |
| 8. Percent of Bicyclists Who Feel Threatened, by Urbanicity (Source: Royal and Miller-Steiger, 2008) | 15 |
| 9. Top Reasons Bicyclists Feel Unsafe (Source: Royal and Miller-Steiger, 2008)..... | 16 |
| 10. Satisfaction for Community Design for Bicycling (Source: Royal and Miller- Steiger, 2008) | 17 |
| 11. Unmarked Shared Roadway (Source: AASHTO, 1999) | 18 |
| 12. Signed Shared Roadway (Source: AASHTO, 1999)..... | 20 |
| 13. Bike Lanes (Source: PBIC, 2010) | 21 |
| 14. Top Reasons for Not Using Bike Lanes and Bike Paths (Source: Royal and Miller-Steiger, 2008) | 23 |
| 15. Federal Pedestrian and Bicycle Infrastructure Spending by Year (Source: Handy et al., 2009)..... | 26 |
| 16. Federal Spending on Bicycling and Pedestrians by Program (Source: Handy et al., 2009) | 27 |
| 17. Percent Change in Bicycle Commuting and Federal Funding by State (Source: Flusche, 2009) | 29 |
| 18. The BYPAD Spiral of Development for Cities (Source: Vectris, 2008)..... | 34 |
| 19. Flowchart for Successful Bicycling in Midsize Cities | 49 |
| 20. Questionnaire Section 1 | 54 |
| 21. Example Completed Funding and Policy Section, First Four Questions | 55 |

| | |
|--|-----|
| 22. Example Completed Funding and Policy Section, Last Four Questions | 56 |
| 23. Example Completed Engineering and Design Section of Audit | 57 |
| 24. Example Completed Education Section of Audit | 58 |
| 25. Completed Safety Section of Audit, First Four Questions | 59 |
| 26. Completed Safety Section of Audit, Last Four Questions, and Total Score..... | 60 |
| D. 1. Community Size in Communities of Different Comfort Levels | 95 |
| D. 2. Population Size and Communities of Different Comfort Levels | 96 |
| D. 3. Perceived Comfort Level of Bicycling in a Community | 97 |
| D. 4. Important Factors for Bicycling in Communities of Different Comfort Levels | 99 |
| D. 5. Primary Reasons for Bicycling and Community Comfort Level | 100 |
| D. 6. Common Problems Associated with Bicycling in Communities of Different Comfort Levels..... | 101 |
| D. 7. Factors That Encourage Bicycling in Communities of Different Comfort Levels. | 102 |
| D. 8. Factors That Discourage Bicycling in Communities of Different Comfort Levels | 103 |
| D. 9. Comfortable Bicycle Commuting Distance in Communities of Different Comfort Levels..... | 104 |
| D. 10. Comfortable Bicycle Commuting Distance with Improved Conditions in Communities of Different Comfort Levels..... | 105 |
| D. 11. Comfortable Bicycle Commuting Speed Limits in Designated Bike Routes in Communities of Different Comfort Levels..... | 106 |
| D. 12. Comfortable Bicycle Commuting Speed Limits in Shared Lanes in Communities of Different Comfort Levels..... | 107 |
| D. 13. Perceived Safety Level of Existing Roadways in Communities of Different Comfort Levels..... | 109 |
| D. 14. Connectivity Level of Existing Roadways in Communities of Different Comfort Levels..... | 110 |
| D. 15. Efficiency Level of Existing Roadways in Communities of Different Comfort Levels..... | 111 |
| D. 16. Effective Media Use in Communities of Different Comfort Levels | 112 |
| D. 17. Different Bicycling Activities in Communities of Different Comfort Levels | 113 |
| D. 18. Motorists' Attitudes toward Bicyclists in Communities of Different Comfort Levels..... | 115 |
| D. 19. Bicyclist Rights and Responsibilities in Communities of Different Comfort Levels..... | 117 |

| | |
|--|-----|
| D. 20. Safety Concerns for Bicyclists in Communities of Different Comfort Levels | 118 |
| D. 21. Problems with Motorists in Communities of Different Comfort Levels | 119 |
| D. 22. Incidence of Bicycle Related Accidents in Communities of Different Comfort Levels..... | 121 |
| D. 23. Most Observed Bicycle Related Accidents in Communities of Different Comfort Levels..... | 122 |
| D. 24. City's Effort in Terms of Examining Bicycle Related Accidents in Communities of Different Comfort Levels..... | 123 |
| D. 25. Most Dangerous Intersection Maneuvers in Communities of Different Comfort Levels..... | 124 |
| D. 26. Most Dangerous Locations for Bicyclists in Communities of Different Comfort Levels..... | 125 |
| D. 27. Different Government Agencies and Communities of Different Comfort Levels..... | 127 |
| D. 28. Importance Factors for Communities of Different Comfort Levels | 129 |
| D. 29. Primary Funding Decisions Makers for Communities of Different Comfort Levels..... | 130 |
| D. 30. Sub-Allocation Scheme for MPO for Communities of Different Comfort Levels..... | 132 |
| D. 31. Ability of MPO to Reflect Community Intent for Communities of Different Comfort Levels..... | 134 |
| D. 32. Financial Support for Communities of Different Comfort Levels | 135 |
| D. 33. Primary Funding Sources for Communities of Different Comfort Levels | 136 |
| D. 34. Bicycle Structures in Communities of Different Comfort Levels | 137 |
| D. 35. Bicycle Level of Service in Communities of Different Comfort Levels | 138 |
| D. 36. Program to Actively Manage and Maintain Bike Routes in Communities of Different Comfort Levels..... | 139 |
| D. 37. Official Bicycle and Pedestrian Committee in Communities of Different Comfort Levels..... | 141 |
| D. 38. Specific Law Enforcements for Bicyclists in Communities of Different Comfort Levels..... | 142 |
| D. 39. Written Bike Plans in Communities of Different Comfort Levels | 143 |
| D. 40. Updating Written Bike Plans in Communities of Different Comfort Levels..... | 144 |
| D. 41. Written Bike Plans with Measures to Evaluate Implementation Progress in Communities of Different Comfort Levels..... | 145 |

D. 42. Active Bicycle Advocates in Communities of Different Comfort Levels 147

D. 43. Dedicated Transportation Authority Employees in Communities of Different
Comfort Levels..... 149

D. 44. Dual Consideration of Bicycling in Communities of Different Comfort
Levels..... 151

D. 45. Active Plans to Enhance Bicycle Facilities in Communities of Different
Comfort Levels..... 153

D. 46. MPOs Accounting for Bicycling in Demand Forecasting Models in
Communities of Different Comfort Levels..... 155

D. 47. Primary Bicycle Education Resources in Communities of Different Comfort
Levels..... 157

D. 48. Number of Projects Conducted to Improve Bicycling in Communities of
Different Comfort Levels..... 159

D. 49. Success of Bicycle Planning, Implementation, and Maintenance in
Communities of Different Comfort Levels..... 161

D. 50. Sources of Successful Bicycle Planning in Communities of Different
Comfort Levels..... 162

D. 51. Major Barriers Successful Bicycle Planning in Communities of Different
Comfort Levels..... 164

D. 52. Efforts of Local Authority toward Promoting Bicycling in Communities of
Different Comfort Levels..... 165

D. 53. Bicycle Comfort Level in Communities of Different Sizes 167

D. 54. Factors Affecting Bicycling in Communities of Different Sizes..... 168

D. 55. Comfortable Bicycling Distances under Current Roadway Conditions in
Communities of Different Sizes 169

D. 56. Level of Service Ratings in Terms of Safety in Communities of Different
Sizes..... 171

D. 57. Motorist Attitudes toward Bicyclists in Communities of Different Sizes 172

D. 58. Most Common Types of Accidents in Communities of Different Sizes 173

D. 59. Important Factors for a Bicycle Friendly Community in Communities of
Different Sizes..... 175

D. 60. Major Decision-Makers for Spending Federal Funding in Communities of
Different Sizes..... 176

D. 61. Bicycle Level of Service in Communities of Different Sizes 177

D. 62. Frequency of Updates to a Bicycle Plan in Communities of Different Sizes 178

| | |
|---|-----|
| D. 63. Employment by Local Transportation Authority of a Dedicated Bicycle Employee in Communities of Different Sizes | 179 |
| D. 64. Factors That Contribute to Successful Bicycle Planning in Communities of Different Sizes..... | 180 |
| E. 1. Success Rates in Communities of Different Population Values | 224 |
| E. 2. Major Barriers to Bicycling in Communities of Different Population Values | 225 |
| E. 3. Problems Associated with Bicycling in Communities of Different Population Values | 227 |
| E. 4. Motorists' Attitudes toward Bicyclists in Communities of Different Population Values | 229 |
| E. 5. Factors that Encourage Bicycling in Communities of Different Population Values | 231 |
| E. 6. Flowchart for Successful Bicycling in Midsize Cities. | 235 |

Chapter I

Introduction

In the United States, the bicycle has been a historically underutilized mode of transportation. However, recent political and economic trends have enabled the bicycle to become a much more viable means of transportation that should be integrated into multi-modal transportation systems. This thesis is the culmination of research initially conducted on behalf of the Texas Department of Transportation and carried out to further investigate the claims made in that initial report to TxDOT. This research was conducted in three phases to determine how bicycling can be effectively integrated into a multi-modal system and what factors lead to successful bicycling. The main objective was to produce a useful tool for transportation engineers and planners to rate and improve bicycling in their cities.

To present a cohesive picture of bicycling, this paper is organized by the following topics:

1. Introduction
2. Background and Literature Review
3. Phase 1
4. Phase 2
5. Phase 3
6. Conclusions

Chapter II

Background and Literature Review

The following background and literature review is adopted from TxDOT Report #: 0-6582-1 as part of this ongoing research project (Liu et al., 2011). It provides a broad background for bicycling as a means of transportation, highlighting such important factors as funding, facilities, and ridership. This thesis also adds an additional section relating to bicycle questionnaires and audits currently in use. This provides a basis for the techniques developed in Phase 3 of this research.

Introduction

Before developing the bicycle survey and analyzing the data, the research team at TechMRT performed a background and literature review to better understand the current condition of bicycling in the United States. The team reviewed known literature from a wide range of sources to develop a clear understanding of the various aspects of bicycling and bicycling culture. This background and literature review presents the following topics:

1. Introduction
2. Reasons for Bicycling
3. Bicycle Commuter Profiles
4. Factors Affecting Bicycling
5. Model Bicycling Communities

Each section will contain pertinent figures and charts to explain the data provided.

Reasons for Bicycling

There are multiple reasons why Americans choose bicycling as an alternative, or in many cases, primary mode of transportation. According to Moritz (1997), the primary reasons that survey respondents indicated they bicycle are:

- 95% for health and fitness
- 82% for the environment
- 52% to avoid congestion
- 46% to save money on gasoline
- 34% to avoid car-parking costs and availability

This section will address several of these reasons for bicycling, including, the environment, congestion, health, and recreation.

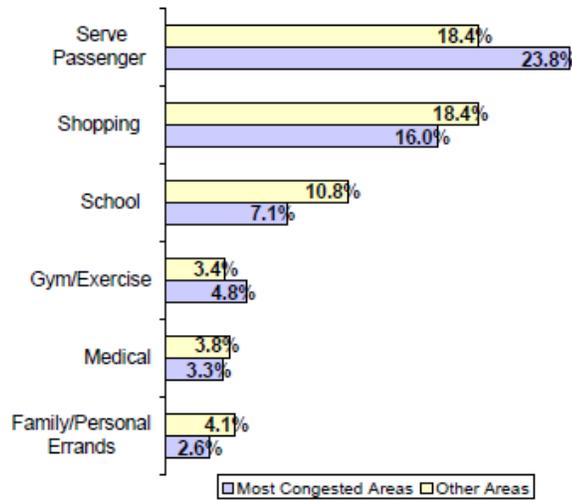
Environment

Many Americans believe that the effects of bicycling on the environment are minimal when compared to other modes of transportation. This is because cycling is essentially pollution-free (Moritz, 1997). Many urban areas, especially those designated as nonattainment areas, suffer from poor air-quality. Pollution-free modes of transportation can be used to significantly reduce the amounts of pollutants in the air and improve air-quality standards. Approximately half of all commuter trips are less than five kilometers (km) in length, so choosing to use a bicycle instead of a personal vehicle for such a short trip can greatly reduce the level of emissions in the air (Moritz, 1997).

Congestion

One of the numerous factors that motivates commuters to bicycle is the growing level of traffic congestion in the nation. One of the U.S. Department of Transportation's (USDOT's) goals is "to improve mobility through outcomes such as decreased congestion and improved accessibility of transportation" (USDOT, 2003). According to Moritz, urban areas in the United States continue to experience increased levels of sprawl, creating heightened levels of congestion (1997). This increased congestion has strained transportation funds and resources. As Moritz states, "The phrase 'we can no longer build our way out of congestion' seems to have become the new mantra of transportation officials across the country" (1997).

To address this increased congestion, government officials have begun to focus on new and alternate modes of transportation to contain urban sprawl and decrease congestion, making roadways more efficient (Moritz, 1997). Providing alternate modes of transportation and supporting infrastructure for those modes increases accessibility for the population, thereby helping to eliminate congestion (USDOT, 2003). The bicycle is one such mode of transportation. Bicyclists can use existing roadways or other support facilities for their trips, decrease the number of motorized vehicles making the same trip, and thereby decrease congestion. Additionally, trips made for most purposes can also be made by bicycles with the necessary accommodations. According to the US Department of Transportation (USDOT), a growing number of peak-time trips are made for non work purposes (2003). Figure 1 demonstrates the percentage of peak AM trips made and for what purpose. Commuters could easily accomplish many of these trip types by bicycle, especially in urban areas and over short distances, thereby eliminating congestion. This ability to improve the current condition of transportation in the United States is another reason many commuters choose bicycling.



Source: National Household Travel Survey Data Series

Figure 1: Percent of AM Peak Period Vehicle Trips Not Related to a Commute by Purpose
(Source: USDOT, 2003)

Health

Health and obesity have become major concerns in the United States in recent years. According to data compiled in a recent study, the United States has an obesity rate between 23.9% (self-reported data) and 34.3% (anthropometric measurements data) (Bassett et al., 2008). The researchers behind this study defined obesity as when a person has a body mass index greater than 30 kilograms per meter squared ($\frac{\text{kg}}{\text{m}^2}$). These rates are significantly higher than the other nations observed in the study. However, it is possible that active transportation can reduce obesity rates. Bassett et al., defined active transportation as “travel-related walking, bicycling, and use of public transit” (2008). Although bicycling is gaining popularity, it is still underutilized in the United States, especially when compared to other countries. According to Bassett et al. in 2008, there are several reasons why active transportation is more prevalent in European countries, including:

- Compact, dense cities with mixed land uses that generate short trips
- Restrictions on car use such as car-free zones, low speed limits, and prohibitions of through traffic
- Extensive, safe, and convenient facilities for walking and bicycling
- Traffic calming of residential neighborhoods
- Coordination of public transit with walking and cycling to transit stations and stops, including bike parking, as well as safe sidewalks and bikeways
- Traffic regulations and enforcement policies that favor pedestrians and cyclists over motorists
- High cost of owning and operating a car resulting from expensive driver licensing, high gasoline prices, and high taxes on car purchases

Although the researchers were incapable of creating a definite link between the data and their conclusions, the data indicate that these high obesity rates in the United States might be connected to less active travel, including bicycling (Bassett et al., 2008). Because of the large impact of bicycling and beneficial bicycling policies on active transportation, it

seems that improving bicycling conditions in the United States could increase the level of active transportation, and thereby decrease obesity rates. Therefore, many cyclists advocate bicycling to improve their health and choose bicycling as their primary mode of transportation. Figure 2 shows a comparison of active travel and obesity in the United States and other nations.

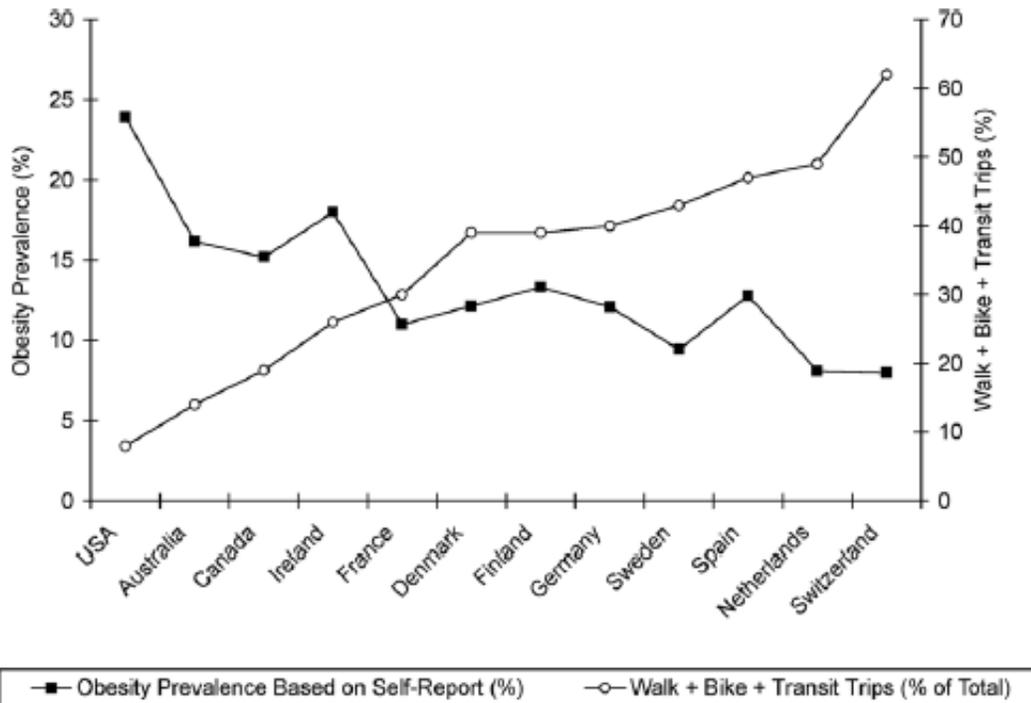


Figure 2: Comparison of Active Transportation and Obesity Rates in Various Countries (Source: Bassett et al., 2008)

Recreation

Another reason many Americans choose to bicycle is because it is considered an enjoyable form of recreation. According to a study by the Outdoor Foundation in 2010, 48.9% of Americans participated in outdoor activities in 2009. This rate was slightly lower in the West South Central Region of the United States (which includes Texas); only 45% of Americans in this area claimed to have participated in outdoor activities. Of the various outdoor activities reported in the study, the second most popular activity reported was bicycling. According to the study, the average bicyclist made 59 outings per year, resulting in a total number of 2.54 billion outings in 2009. In 2009, 40,140,000 Americans participated in some form of bicycling trip. Additionally, 5.8% of all Americans became first-time participants in bicycling in 2009 (Outdoor Foundation, 2010).

The amount of bicycle outings made per year for recreation is also increasing. Bicycling has become the most preferred outdoor activity for children. Another important aspect of the study was that it indicated so-called gateway activities – outdoor activities that lead to other forms of recreation. In 2010, the Outdoor Foundation identified bicycling as a gateway activity and indicated that when more bicycle routes are present, people are more likely to bicycle for recreation or participate in other outdoor activities.

Additionally, outdoor participants often become advocates for increased infrastructure for bicycling. The study showed that 84% of outdoor activities participants indicated that developed parks, biking, and walking trails in their neighborhoods are important (Outdoor Foundation, 2010). Table 1 shows the percentage of Americans who participate in bicycling compared to other outdoor activities. Clearly, bicycling for recreation is a popular activity and is one reason bicycling as a mode of transportation has gained favor in recent years.

Table 1: Participation in Outdoor Activities, All Americans Ages 6 and Older (Sample Activities)

(Source: Outdoor Foundation, 2010)

Participation in Outdoor Activities, All Americans Ages 6 and Older

| | 2006 in 000's | % of Pop. | 2007 in 000's | % of Pop. | 2008 in 000's | % of Pop. | 2009 in 000's | % of Pop. |
|--|------------------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|
| Adventure Racing | 725 | 0.3% | 698 | 0.3% | 920 | 0.3% | 1,089 | 0.4% |
| Backpacking | 7,067 | 2.6% | 6,637 | 2.4% | 7,867 | 2.8% | 7,647 | 2.7% |
| Bicycling (BMX) | 1,655 | 0.6% | 1,887 | 0.7% | 1,904 | 0.7% | 1,811 | 0.6% |
| Bicycling (Mountain/Non-Paved Surface) | 6,751 | 2.5% | 6,892 | 2.5% | 7,592 | 2.7% | 7,142 | 2.5% |
| Bicycling (Road/Paved Surface, Mountain/Non-Paved Surface, BMX) | 39,688 | 14.5% | 42,126 | 15.2% | 41,548 | 14.9% | 43,264 | 15.4% |
| Bicycling (Road/Paved Surface) | 38,457 | 14.0% | 38,940 | 14.1% | 38,114 | 13.6% | 40,140 | 14.3% |
| Birdwatching (More Than 1/4 Mile of Home/Vehicle) | 11,070 | 4.0% | 13,476 | 4.9% | 14,399 | 5.2% | 13,294 | 4.7% |
| Boardsailing/Windsurfing | 938 | 0.3% | 1,118 | 0.4% | 1,307 | 0.5% | 1,128 | 0.4% |
| Camping (Within 1/4 Mile of Vehicle/Home) | 35,618 | 13.0% | 31,375 | 11.3% | 33,686 | 12.0% | 34,338 | 12.2% |
| Camping (Car, Backyard, or RV) | 43,123 | 15.7% | 39,836 | 14.4% | 42,396 | 15.2% | 44,034 | 15.6% |
| Camping (Recreational Vehicle) | 16,946 | 6.2% | 16,168 | 5.8% | 16,517 | 5.9% | 17,436 | 6.2% |
| Canoeing | 9,154 | 3.3% | 9,797 | 3.5% | 9,935 | 3.6% | 10,058 | 3.6% |
| Climbing (Sport/Indoor/Boulder) | 4,728 | 1.7% | 4,514 | 1.6% | 4,769 | 1.7% | 4,313 | 1.5% |
| Climbing (Traditional/Ice/Mountaineering) | 1,586 | 0.6% | 2,084 | 0.8% | 2,288 | 0.8% | 1,835 | 0.7% |
| Fishing (Fly, Freshwater/Other or Saltwater) | 49,696 | 18.1% | 51,836 | 18.7% | 48,206 | 17.2% | 47,973 | 17.0% |
| Fishing (Fly) | 6,071 | 2.2% | 5,756 | 2.1% | 5,941 | 2.1% | 5,568 | 2.0% |
| Fishing (Freshwater/Other) | 43,100 | 15.7% | 43,859 | 15.8% | 40,331 | 14.4% | 40,961 | 14.5% |

Bicycle Commuter Profiles

To better promote and aid bicycling, it is necessary to understand who bicycles, and how often they bicycle. Although bicyclists represent a small percentage of the population, the number of trips made weekly by bicyclists is growing, and many commuters may choose bicycling as a secondary mode of transit to their preferred means of transportation. This section will discuss the demographics of bicyclists, the number of bicyclists in the United States, and how many bicycle trips are made.

Bicyclist Demographics

Although bicycling is not a new hobby, data on bicyclist demographics were relatively scarce until the late 1990's. In his national survey of bicyclists in 1997, Moritz sought to create a coherent picture of who bicycles in the United States. In his study, Moritz found that the average age of bicyclists was 39 years old (1997). In a more recent study, it was

found that Americans with higher incomes tend to have better access to bicycles (Royal and Miller-Steiger, 2008). In the 2001 National Household Travel Survey, it was determined that there are .86 adult-size bicycles per household (USDOT, 2003). This shows that many Americans are likely to have access to a bicycle for commuting. Males are more likely to be bicyclists than females (Royal and Miller-Steiger, 2008). Lastly, white Americans are more likely to bicycle than other ethnicities (Outdoor Foundation, 2010). Figure 3 shows the percentage of Americans with access to a bicycle, by household income. Figure 4 shows the total number of bicycling trips by gender and age.

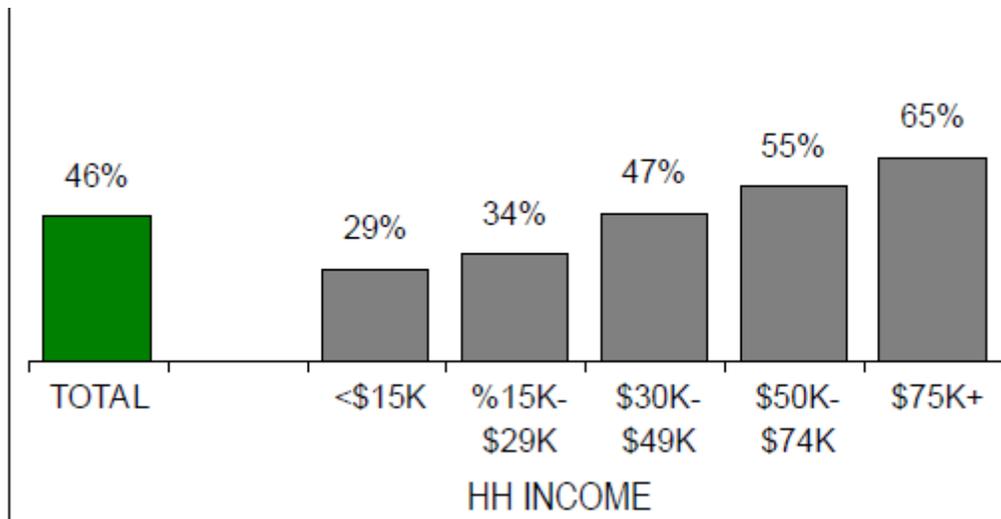


Figure 3: Percentage of Bicyclists with Access to a Bicycle, by Household Income
(Source: Royal and Miller-Steiger, 2008)

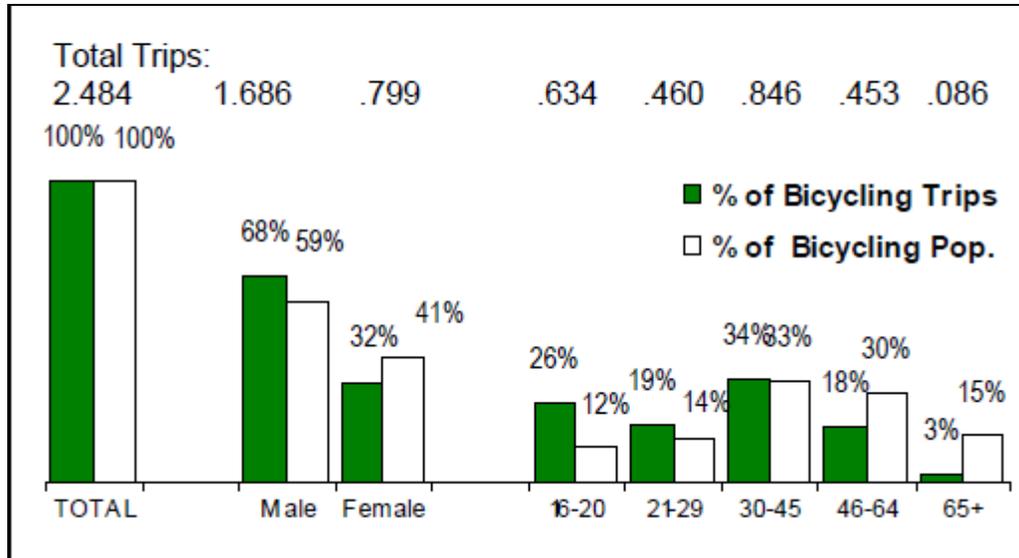


Figure 4: Total Number of Bicycle Trips by Gender and Age
 (Source: Royal and Miller-Steiger, 2008)

Other studies have been conducted to determine the most bicycle-friendly communities and which states are most likely to contain bicyclists who use their bicycles to commute to work. Oregon, Idaho, and Montana contain the largest percentage of bicyclists who commute to work (2.09%, 1.52%, and 1.45%) (Flusche, 2009). The three states with the lowest percentages of bicyclists who commute to work are West Virginia, Arkansas, and Alabama (.16%, .13%, and .13%) (Flusche, 2009). Table 2 lists the top five states with the highest percentage of bicycle commuters and the five states with the lowest percentage of bicycle commuters.

Table 2: Highest and Lowest Percentage of Bicycle Commuters by State and Year
(Source: Flusche, 2009).

| Rank | State | <i>Bike to Work</i> | | | | | <i>Change</i> |
|------------------|---------------|---------------------|-------|-------|-------|-------|---------------|
| | | 2000 | 2005 | 2006 | 2007 | 2008 | 2000 to 2008 |
| 1 | Oregon | 1.07% | 1.53% | 1.68% | 1.88% | 2.09% | 95.09% |
| 2 | Idaho | 0.66% | 1.00% | 0.77% | 1.09% | 1.52% | 128.82% |
| 3 | Montana | 0.96% | 1.60% | 1.33% | 1.42% | 1.45% | 51.17% |
| 4 | Colorado | 0.77% | 0.94% | 1.08% | 1.10% | 1.25% | 62.01% |
| 5 | New Mexico | 0.56% | 0.51% | 0.56% | 0.46% | 1.02% | 80.48% |
| Separator | | | | | | | |
| 46 | Kentucky | 0.15% | 0.12% | 0.13% | 0.22% | 0.19% | 30.04% |
| 47 | Tennessee | 0.24% | 0.23% | 0.23% | 0.12% | 0.16% | -31.64% |
| 48 | West Virginia | 0.43% | 0.64% | 0.72% | 0.22% | 0.16% | -63.54% |
| 49 | Arkansas | 0.13% | 0.17% | 0.16% | 0.12% | 0.13% | -1.26% |
| 50 | Alabama | 0.07% | 0.09% | 0.07% | 0.10% | 0.13% | 72.39% |

Number of Bicyclists and Bicycle Trips

The number of bicyclists has grown steadily in the United States. In the 2001 National Household Travel Survey, it was indicated that approximately 8% of Americans made a trip by bicycle during the week (USDOT, 2003). In 2001, the total number of daily trips made by Americans was 411 billion trips. However, only 1.7% of these trips were made by some mode other than personal vehicle, public transit, school bus, or walking. It can be assumed that bicycling can be included in this small percentage (USDOT, 2003).

Figure 5 shows the percentage of trips made daily by mode of transportation.

Proportion of Trips by Mode

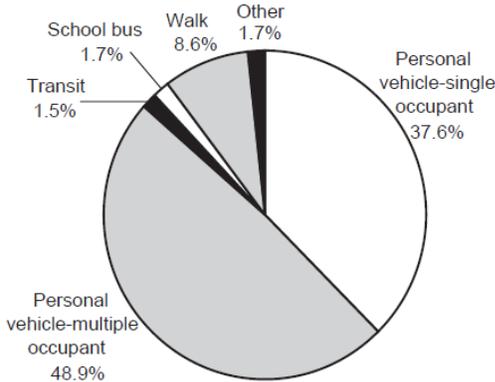


Figure 5: Percentage of Daily Trips by Mode of Transportation
 (Source: USDOT, 2003)

Despite these small numbers, the number of trips by bicycling and the number of bicyclists is growing. Recent data from the 2009 National Household Travel Survey indicates that the total number of bicycle trips has increased from 1.7 billion in 2001 to 4 billion in 2009 (Bikes Belong, 2010). In his 2009 study Flusche found that the number of bicycle commuters increased by 43% from 2000 to 2008. Additionally, he found that .55% of all Americans use bicycling as their primary mode of transportation to work (Flusche, 2009). This number does not account for Americans who use bicycling as a secondary mode of transportation or bicycle irregularly during the year. If these numbers were taken into account, it is likely that number of known bicyclists in the United States would be significantly greater. Approximately 54% of bicyclists commute by bicycle year-round (Moritz, 1997). It is likely that this number would be higher if climate conditions were not a problem in certain seasons in different regions of the United States.

Although many bicyclists commute regularly, a majority of bicycle trips made are less than 1 mile long (Royal and Miller-Steiger, 2008). Interestingly, almost half of all bicycle trips (48%) made are on paved roads (Royal and Miller-Steiger, 2008). This could indicate that bicyclists are using their bicycles for purposes other than just recreation and shows that an increase in bicycle facilities on the existing roadways could prove

beneficial. Figure 6 shows the percentage change in bicycle commuting in the United States by year. Figure 7 represents the percentage of bicycle commuting to work in various types of cities in the United States. “BFC” in both figures refers to the Bicycles Belong Coalition’s designation of “Bicycle Friendly City.” More information on BFCs is given later in this chapter.

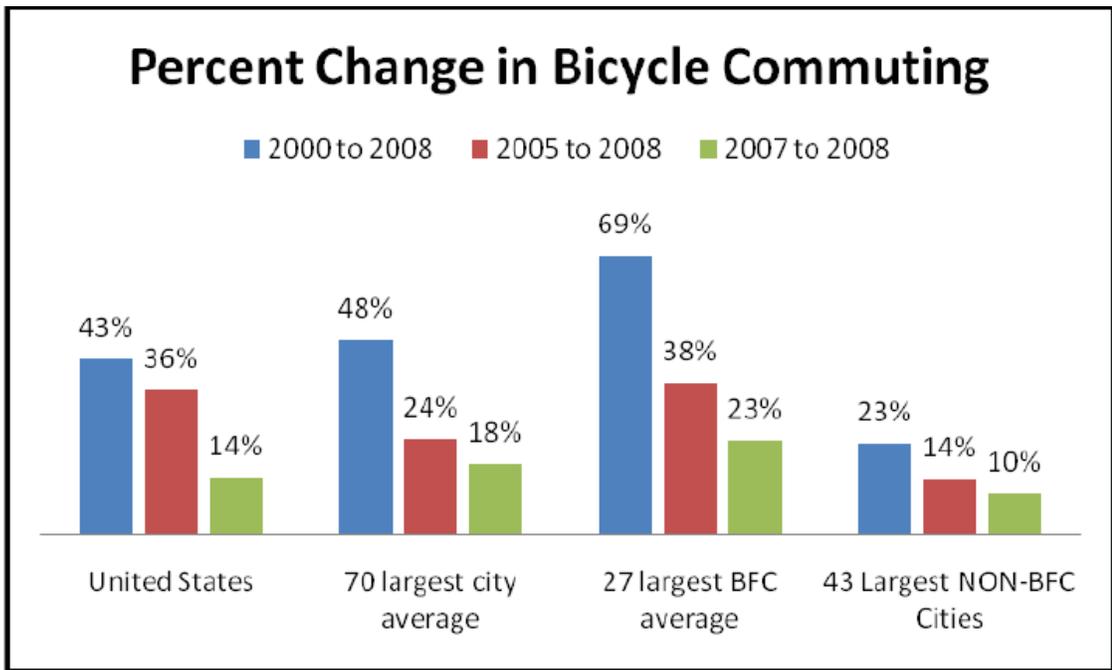


Figure 6: Percent Change in Bicycle Commuting in the United States by Year
(Source, Flusche, 2009)

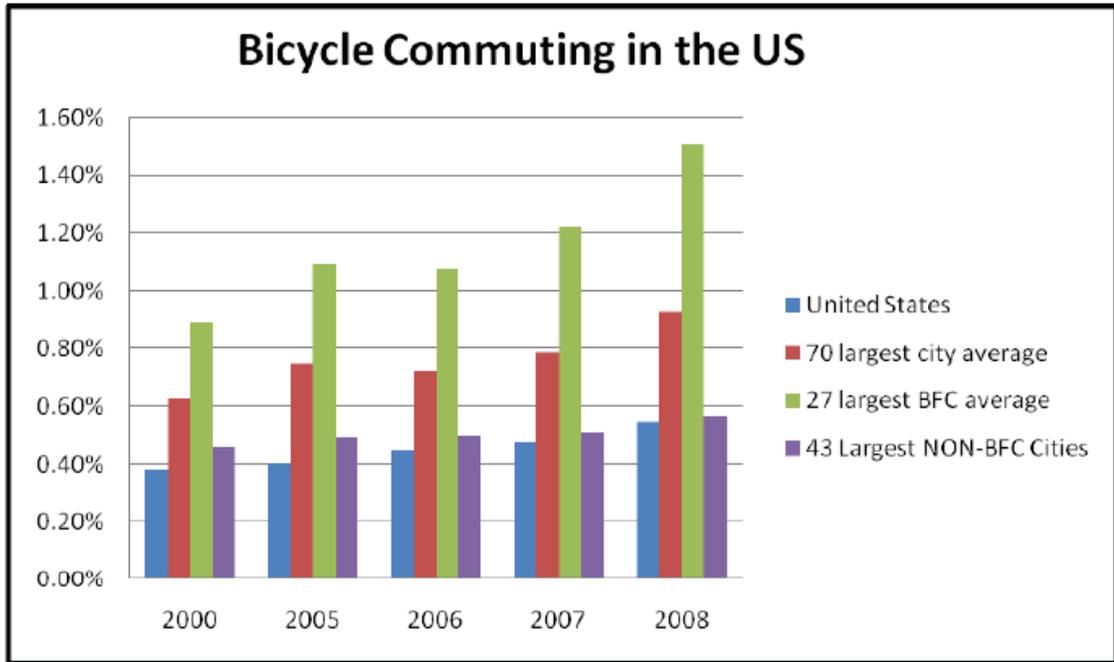


Figure 7: Bicycle Commuting to Work in the United States
(Source: Flusche, 2009).

Factors Affecting Bicycling

Although it has been shown that numerous Americans have access to bicycles, there are several factors that affect whether Americans will bicycle. These reasons include:

- Safety
- Community
- Facilities
- Funding

This section will examine each of these factors and how it affects bicycling. The last two sections will also be used to examine in-depth the different facets of bicycle facilities and bicycle funding.

Safety

Safety is a major concern for many bicyclists. In their 2008 study, Royal and Miller-Steiger found that approximately 13% of bicyclists felt unsafe on their most recent day of bicycling. Studies such as this are the reason the research team chose to focus on safety as an important factor impacting bicycling. Figure 8 shows a comparison of the percentage of bicyclists who felt threatened on the most recent day of bicycling, by urbanicity.

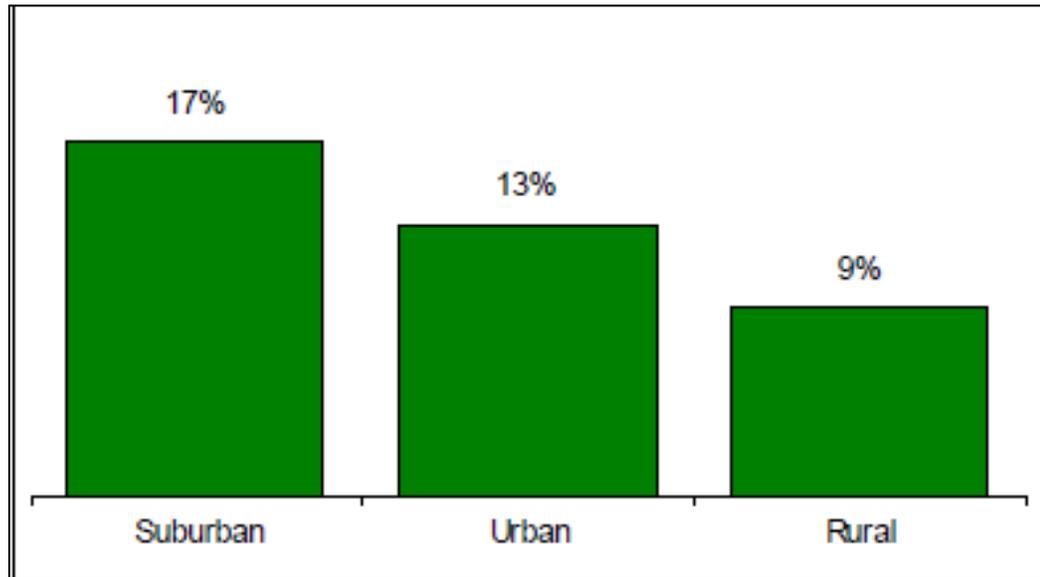


Figure 8: Percent of Bicyclists Who Feel Threatened, by Urbanicity
(Source: Royal and Miller-Steiger, 2008)

Royal and Miller-Steiger's study found that there are numerous factors that made bicyclists feel unsafe (2008), including:

- Motorists
- Uneven walkways or surfaces
- Dogs or other animals
- Potential for crime
- Too much bicycle or pedestrian traffic

Of these multiple reasons for feeling unsafe, an overwhelming majority (89%) of bicyclists felt threatened by motorists (Royal and Miller-Steiger, 2008). Because of this high majority, the original survey distributed for this project addressed several facets of motorist and bicyclist safety. However, all of the factors that affect bicyclist safety are important and should be considered when implementing bicycle policies. Figure 9 shows the main causes of bicyclists feeling unsafe.

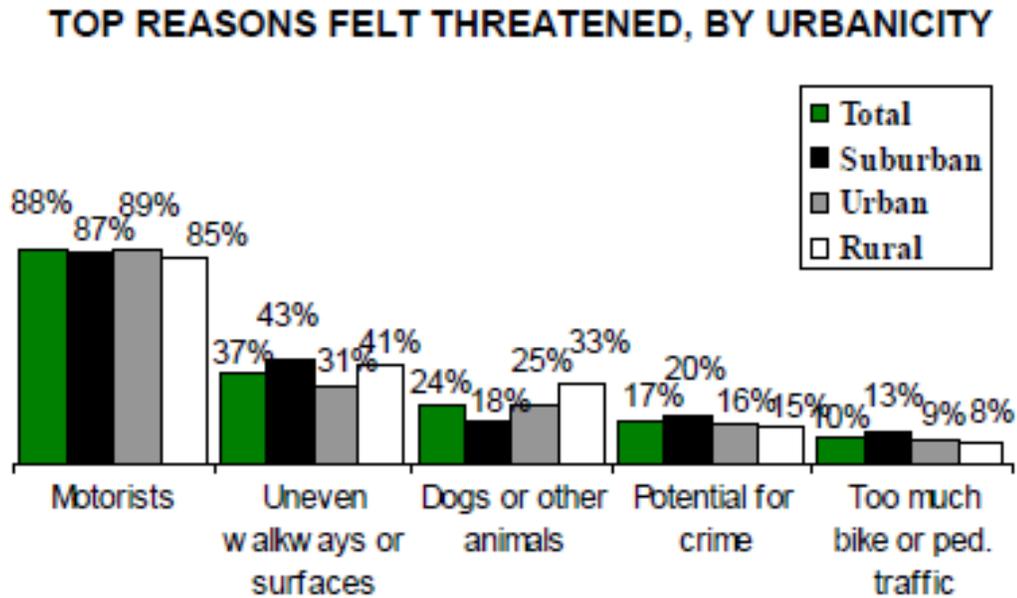


Figure 9: Top Reasons Bicyclists Feel Unsafe
(Source: Royal and Miller-Steiger, 2008).

Community

Many bicyclists feel that community support is an important factor for bicycling. Bicyclists want to live in neighborhoods that support bicycling and provide appropriate facilities that make bicycling more accessible. In their 2008 study, Royal and Miller-Steiger found that almost half of all the bicyclists surveyed (48%) were satisfied with their communities' designs in terms of bicycle safety. Approximately 19% were very satisfied (Royal and Miller-Steiger, 2008). These high percentages show that many modern communities are in fact embracing bicycling as a legitimate and functional mode

of transportation. However, it is obvious that changes and improvements still need to be made. Almost half (47%) of all the urban respondents to Royal and Miller-Steiger’s survey indicated they would like to see some improvements to current bicycling conditions (2008). The top three desired improvements in the 2008 Royal and Miller-Steiger study were:

1. More bike lanes
2. More bike paths
3. More bike trails

If communities took these concerns seriously, bicycling could very likely improve and gain greater popularity in the United States. Figure 10 shows the level of satisfaction with community design.

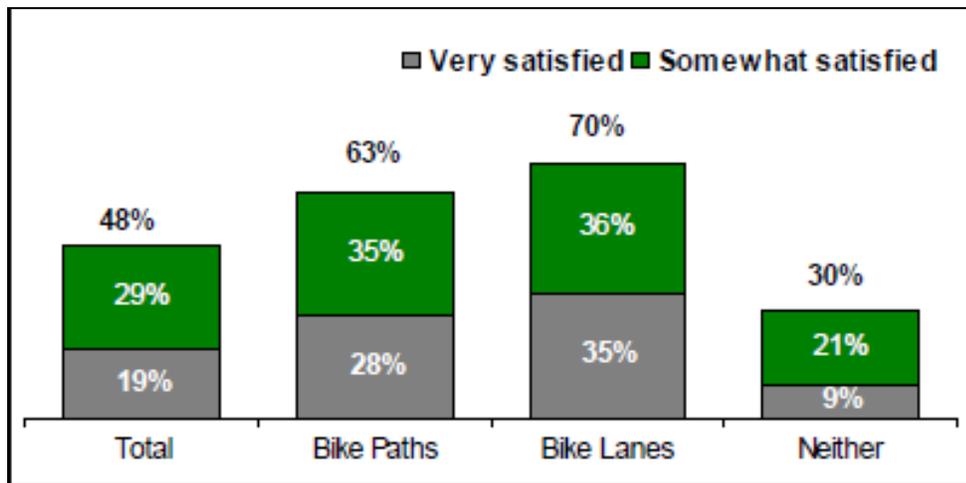


Figure 10: Satisfaction for Community Design for Bicycling
(Source: Royal and Miller-Steiger, 2008)

Facilities

The presence of supporting bicycle facilities is a major influence on the frequency and likelihood of bicycling in a community. There are numerous kinds of bicycle facilities, with some more common than others. These include:

- Wide curb lane (also known as wide outside lane or shared roadway)
- Signed shared roadways
- Bike lanes
- Paved Shoulders

Wide Curb Lanes

A shared roadway, as shown in Figure 11 is a bicycle facility that comprises a roadway wide enough to accommodate both bicyclists and motorists in one lane. Also known as a wide curb lane or wide outside lane, this facility allows motorists and bicyclists to pass each other without changing lanes (Dennison, 2008). The Pedestrian and Bicycle Information Center (PBIC) specifically suggests that a lane width of 14 to 15 feet (exclusive of gutter pan) is ideal to accommodate bicycles without interference from on-street parking (PBIC, 2010).



Figure 11: Unmarked Shared Roadway
(Source: AASHTO, 1999)

According to the New York State Department of Transportation (NYSDOT) in 2006, the advantages of wide curb lanes are that they:

- provide additional maneuvering room for motorists and bicyclists sharing the lane
- normally provide motorists entering the highway with better visibility of bicyclists since the additional space allows bicyclists to ride further from the curb
- accommodate shared bicycle/motor vehicle use with little or no impact on roadway capacity for vehicular traffic
- reduce both the real and perceived operating conflicts between bicycles and motor vehicles.

Dennison (2008) states that a shared lane wider than 14 feet should be avoided because two vehicle streams may form within the wide curb lane, creating an unsafe condition for bicyclists.

Signed Shared Roadway

Signed shared roadways are designated by bike route signs to provide continuity of the bicycle facilities and are designated as preferred routes through high traffic corridors (AASHTO, 1999) An example of such a route is shown in Figure 12. Signing of shared roadways has the advantage of alerting motorists to the presence of bicycles. According to AASHTO (1999), the provisions of signing are subject to the following conditions:

- The route provides through and direct travel
- The route connects discontinuous segments of shared use paths or bike lanes
- Bicyclists are given greater priority on the signed route than on the alternate route
- Street parking has been removed or limited to provide more width
- A smooth surface has been provided
- Regular street sweeping and maintenance is assured
- Wider curb lanes are provided compared to parallel roads
- Shoulders are at least four feet wide



Figure 12: Signed Shared Roadway

(Source: AASHTO, 1999)

Bike Lanes

Bike lanes, as shown in Figure 13, are lanes with appropriate pavement markings and signing specifically designated for bicyclists (Dennison, 2008). Bike lanes can help provide increased comfort and confidence to both bicyclists and motorists (AASHTO, 1999). There are various types of bike lanes in place in the United States, including common delineated bike lanes, contra-flow bike lanes, colored bike lanes, and shared bike and bus lanes (PBIC, 2010).



Figure 13: Bike Lanes
(Source: PBIC, 2010)

The AASHTO Guide Book recommends that bike lanes be installed when there is available space to delineate them for the use of bicyclists (AASHTO, 1999). Many states have specific regulations on bike lanes. For instance, the State of New York does not allow for two-way bicycle lanes on one side of a highway because this often causes bicyclists to ride against the flow of traffic. The state law also forbids locating bicycle lanes at places with angled parking (NYSDOT, 2006). In addition, many state DOTs have policies guiding the length of bicycle lanes. In the California Highway Design Manual (Caltrans, 2006), it is stated that special consideration must be given to the point of conflict between bicyclist and motorist, such as where right-turning motorists must cross a bicyclist's path. The conflict point should be located where there will be the least differential in speed. It also specifies that when bike lanes approach intersections, they should be discontinued at the beginning of a right turn lane. The City of Portland, Oregon found that colored bike lanes were effective in eliminating conflicts between bicyclists and turning motorists (Weigand, 2008).

Paved Shoulders

Paved shoulders are another form of facility designed to improve the accommodation of bicyclists on the roadway. Generally, the PBIC recommends shoulders be at least four feet wide (2010). However, it is recommended that the widths of shoulder be increased if there are higher levels of bicycle usage, if motor vehicle speeds are above 50 mph, or if there are more buses and trucks on the roadway (PBIC, 2010).

According to a study conducted by Benz et al. (1997), it was found that paved shoulders should be designed at least four feet wide to accommodate bicycles. The study suggested that additional shoulder width be provided when motor vehicles travel at speeds above 35 mph or if there is a high volume of trucks (Benz et al., 1997). The usable shoulder width should not include the width of the gutter pan, and a shoulder width of five feet is recommended from the face of a guard rail (AASHTO, 1999).

Bicycle Facility Frequency

As indicated, almost half of all bicyclists would like to see more bicycle facilities in their communities (Royal and Miller-Steiger, 2008). In the 2008 study, Royal and Miller-Steiger found that the leading reason for bicyclists to not use bike paths and bike lanes was a lack of convenience, “meaning they were either not available or did not go where the bicyclist wanted to go.” The study also showed that 50% of bicyclists indicated that bike paths were available in their area, and 32% of bicyclists indicated that bike lanes were available in their area (Royal and Miller-Steiger, 2008). These low numbers indicate that more communities could be better designed with improved bicycle facilities. This would likely result in an increase in bicycling in these communities. Figure 14 shows the top reasons for bicyclists not using bike paths and bike lanes.

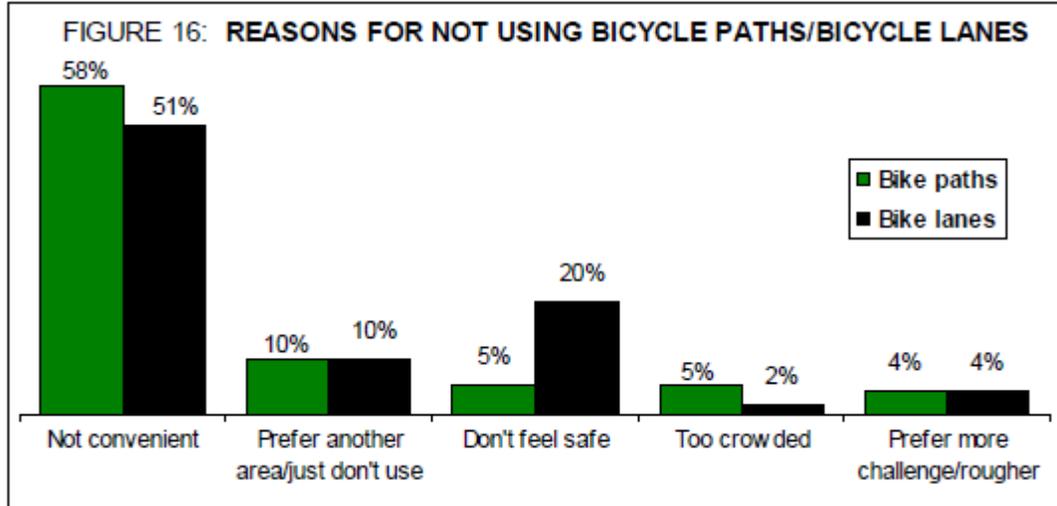


Figure 14: Top Reasons for Not Using Bike Lanes and Bike Paths
 (Source: Royal and Miller-Steiger, 2008)

Funding

A final factor that impacts the frequency of bicycling is funding. Successful planning and implementation of bicycle projects depend largely on the availability of federal, state, and local transportation funds. This section will discuss legislation that deals with bicycle funding on the federal and state levels.

Federal Legislation

Federal legislation has dealt specifically with bicycling since the 1973 Federal-Aid Highway Act (Lipford and Harrison, 2000). Subsequent acts have updated the policies of that influential act, and the most recent transportation bill is the Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (SAFETEA-LU). This act provides great flexibility for states and MPOs to fund bicycle and pedestrian projects from a wide variety of programs, such as providing paved shoulders, restriping roads to provide wider outside lanes, and modifying intersections to include bicycle paths. It further stipulates a number of provisions to improve conditions for bicycling and walking, and increases the safety of these two modes. It requires that safe and convenient

access to jobs, services, and recreational facilities be provided not only to motorized vehicles but also to bicycles. SAFETEA-LU requires that bicycle projects, except for the recreational trails program, be “principally for transportation rather than recreation” purposes (FHWA, 2008). A list of Federal transportation funds for bicycle and pedestrian projects under SAFETEA-LU is provided in Table 3.

Table 3: Sample Funding Resources for Bicycle Projects
(Source, FHWA, 2008)

| | NHS | STP | HSIP | SRTS | TEA | CMAQ | RTP | FTA | TE |
|--------------------------------|-----|-----|------|------|-----|------|-----|-----|----|
| Bicycle and pedestrian plan | | * | | | | * | | | |
| Bicycle lanes on roadway | * | * | * | * | * | * | | * | * |
| Paved Shoulders | * | * | * | * | * | * | | | |
| Signed bike route | * | * | | * | * | * | | | |
| Shared use path/ trail | * | * | | * | * | * | * | | |
| Single track hike/bike trail | | | | | | | * | | |
| Spot improvement program | | * | * | * | * | * | | | |
| Maps | | * | | * | | * | | | |
| Bike racks on buses | | * | | | * | * | | * | * |
| Bicycle parking facilities | | * | | * | * | * | | * | * |
| Trail/highway intersection | * | * | * | * | * | * | | * | * |
| Bicycle storage/service center | | * | | * | * | * | | * | * |
| Sidewalks, new or retrofit | * | * | * | * | * | * | | * | * |
| Crosswalks/new or retrofit | * | * | * | * | * | * | | * | * |
| Signal improvements | * | * | * | * | * | * | | | |
| Curb cuts and ramps | * | * | * | * | * | * | | | |
| Traffic calming | | * | * | * | | | | | |
| Coordinator | | * | | * | | * | | | |
| Safety/education | | * | | * | | * | | | |
| Police patrol | | * | | * | | | | | |
| Helmet protection | | * | | * | * | | | | |
| Safety brochure | | * | | * | * | * | * | | |
| Training | | * | | * | * | * | * | | |

In SAFETEA-LU, the total amount of federal transportation spending on bicycling and walking reached more than \$4 billion over the six year span of the bill (Handy et al, 2009). Figure 15 provides an overview of federal expenditures on bicycle and pedestrian projects during the period of 1992 – 2006.

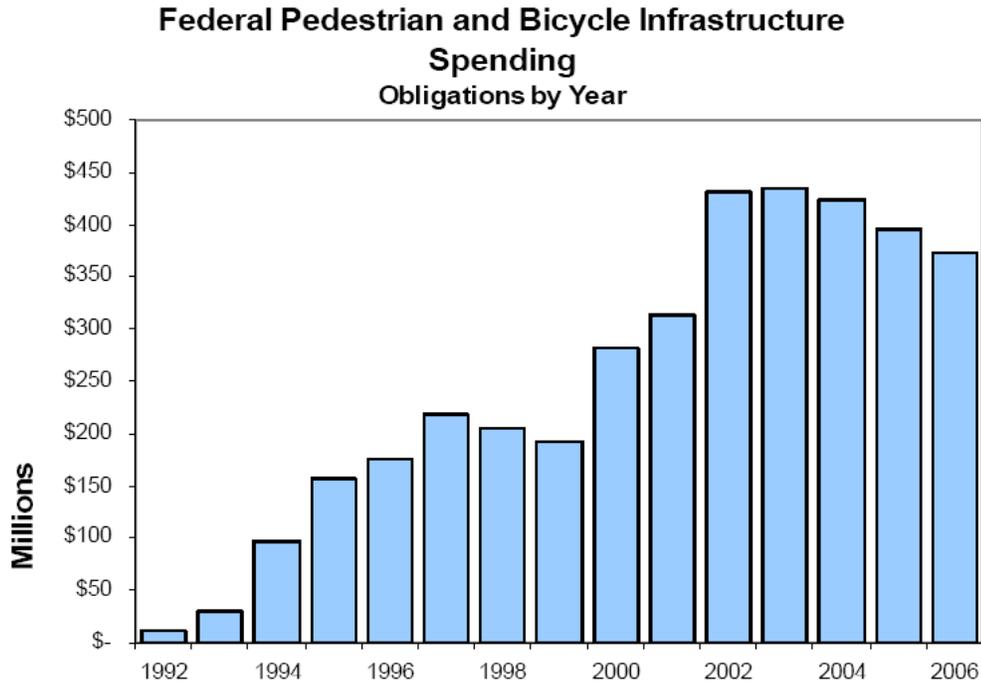


Figure 15: Federal Pedestrian and Bicycle Infrastructure Spending by Year
(Source: Handy et al., 2009)

Federal funding for bicycle and pedestrian projects has been spent primarily through the Transportation Enhancement (TE) program and the Congestion Mitigation and Air Quality Improvement (CMAQ) program. As shown in Figure 16, approximately 75% of bicycle and pedestrian projects were funded through the TE program, while another 10% were funded through the CMAQ program (Handy et al., 2009).

Federal Bicycle/Pedestrian Spending FY1992-FY2006

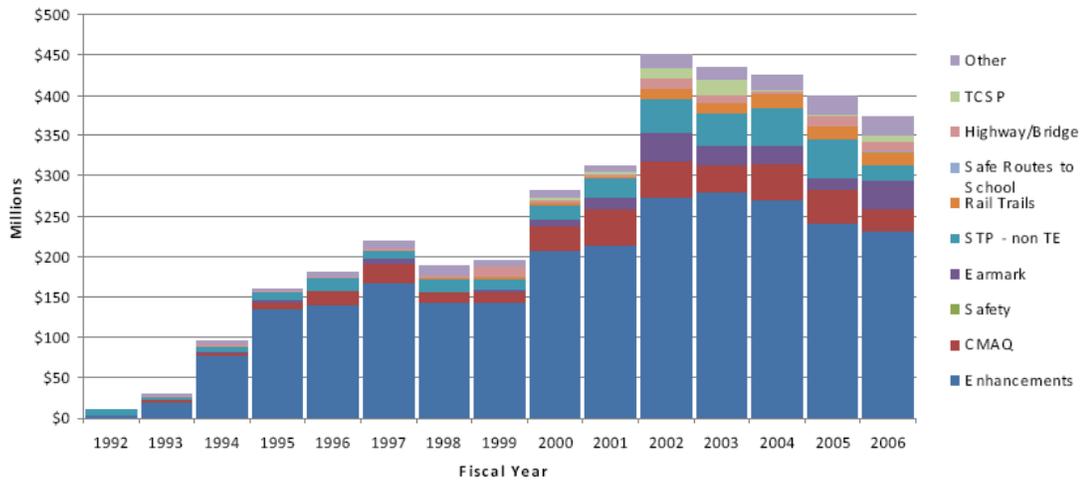


Figure 16: Federal Spending on Bicycling and Pedestrians by Program
(Source: Handy et al., 2009)

These data show that transportation laws and policies require bicyclists and pedestrians be considered an integral part of the state and local long-range transportation plans, as stated in SAFETEA-LU (FHWA, 2008). The FHWA stipulated in 2008 that:

- Bicyclists and pedestrians shall be given due consideration in the comprehensive transportation plans developed by each metropolitan planning organization and state
- Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction, reconstruction, and transportation facilities, except where bicycle and pedestrian use are not permitted
- Transportation plans and projects shall provide due consideration for safety and contiguous routes for bicyclists and pedestrians

State Legislation

Although federal legislations stipulate policies and resources for providing funding on bicycle infrastructure, they do not make decisions as to what amount should be spent on which transportation mode; this flexibility is given to the state DOTs and regional MPOs (Handy et al., 2009). In addition, the federal/state matching requirements, which normally follow an 80/20 percent formula, give the state DOTs and regional MPOs enormous power to decide how to distribute the funding among different transportation modes (FHWA, 2008).

Under current federal policies, state DOTs are responsible for allocating the funds in the TE and the CMAQ programs, the two major programs for bicycling projects. Apart from that, the federal government only distributes a portion of the funds in the Surface Transportation Program (STP) to allow regional MPOs with a population of 200,000 and over to decide how funding is spent. State DOTs have enormous influence on the selection and funding of bicycle projects (Handy et al., 2009).

At the state and regional level, the spending pattern or funding structure plays an essential role in determining how and to what degree the states and MPOs spend federal dollars on bicycle projects. California, for example, has many nationally recognized bicycle friendly communities, and the state has passed significant funding control to regional and local governments, enabling them to create a statewide climate conducive to bicycling (Handy et al., 2009). Giving more flexibility and directing more funding to MPOs, rather than routing it from state DOTs, seems to be a successful experience in terms of promoting bicycle and pedestrian projects.

Studies have shown that spending on the state level does impact bicycle commuting directly. In 2009, Flusche showed that as federal funding for state bicycle and pedestrian programs increases, bicycle commuting increases. Figure 17 represents how state spending impacts bicycle commuting levels. Because of its large impact on increasing ridership, careful administration of federal and state funds should be taken in order to improve bicycling on a state and regional level.

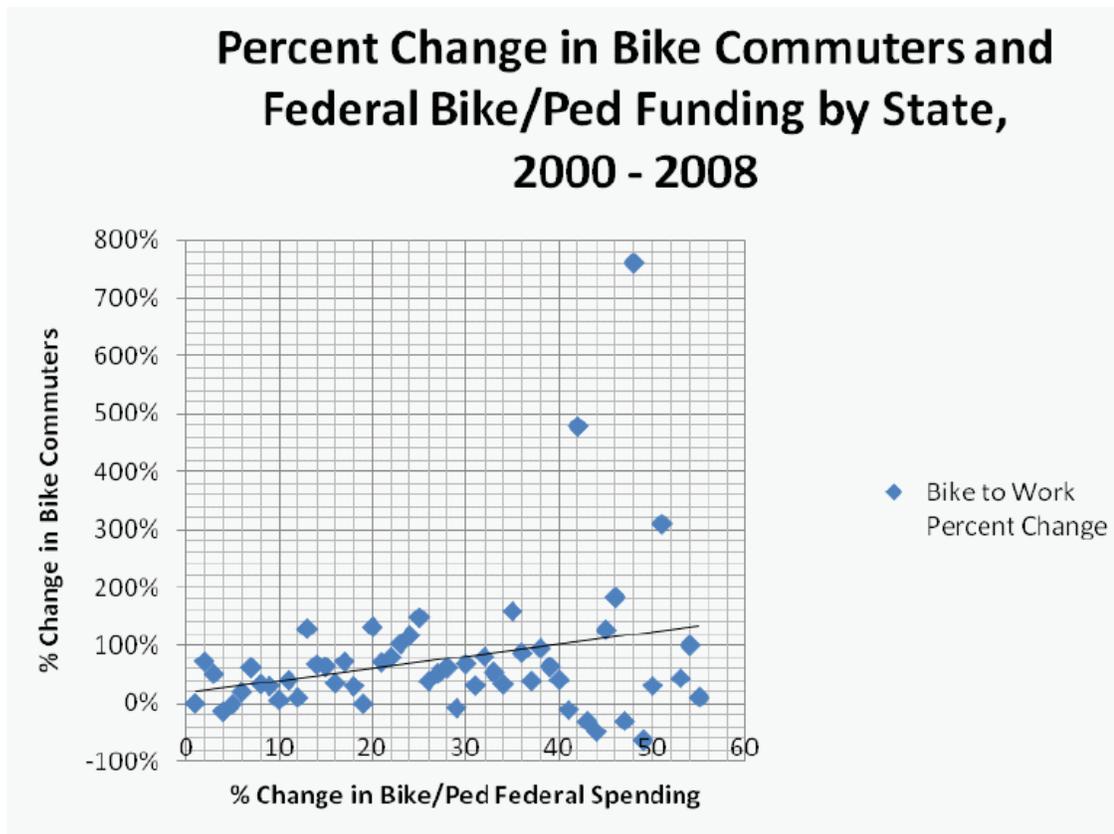


Figure 17: Percent Change in Bicycle Commuting and Federal Funding by State
(Source: Flusche, 2009)

Model Bicycle Communities

To better accomplish the goal of this project and develop a worthwhile analysis of success rates, the research team chose to compare responses from many regions around the United States. Therefore, the team drew information from the 2009 Bicycle Friendly America Yearbook, published by the Bikes Belong Coalition. This group evaluates different states and cities for the success of bicycling in their region, as well as various companies for their contribution to bicycling. States, communities, and companies are awarded in descending order of quality a ranking of platinum, gold, silver, or bronze depending on the quality of bicycling in that community. The process for application and the award sequence challenges communities to improve bicycling, and many communities that fail to be recognized as a BFC in one year often reach an award level in

the subsequent years based off the strength of their improvements. This process creates a clear picture of both successful communities and successful practices to improve bicycling in a community (Nesper, 2009). Due to the strength of this process, the research team felt it could gain valuable information by comparing survey results from Texas with some of these BFCs. Some of the rankings and information that make the represented BFCs effective are presented.

Top Ranked States

The top ten Bicycle Friendly States are:

1. Washington
2. Wisconsin
3. Arizona
4. Oregon
5. Minnesota
6. Maine
7. California
8. Illinois
9. New Jersey
10. New Hampshire

These states were chosen due to their state-wide focus on providing effective bicycling. Specifically, Nesper mentioned that Washington was particularly effective for several reasons (2009). These reasons include:

- Cooperation among local and state agencies, bicycle groups, and health professionals
- Priorities and strategies to improve bicycle connections, increase statewide coordination, and make biking a viable commute option
- Persistent efforts of bicycle advocacy community, and political and governmental leadership

Clearly, there are numerous factors that affect bicycling, and states that draw upon multiple solutions often develop effective bicycling. Texas is ranked number 30 in the state ranking (Nesper, 2009).

Platinum Bicycle Friendly Communities

Platinum BFCs listed in the 2009 Bicycle Friendly America Yearbook are some of the most successful bicycling communities in the country. Among these communities are Boulder, Colorado; Davis, California; and Portland, Oregon (Nesper, 2009). The reasons for these communities' successful bicycling cultures are listed in the following paragraphs.

Davis, California is a small community with a population of 63,722. Despite the small population, bicyclists account for 14% of the population, which is 35 times the national average. The community has achieved great success in bicycling for several reasons. According to Nesper in 2009, these reasons include:

- 40 years of progression, research, planning, and design
- Bike lanes on over 95% of its arterials and collectors
- Special policies to favor bicycling
- A seven-member Bicycle Advisory Commission and two full-time bicycle coordinators
- Consistent funding for bicycle projects and maintenance

Boulder, Colorado is a mid-sized city with a population of 101,500. It too has achieved great success in its bicycle community. According to Nesper (2009) the reasons for this success include:

- Continuous investment and community action
- Comprehensive bicycle planning program
- At least 95% of arterials have bike lanes and trails (Complete Street Program)
- Regular maintenance of 380 miles of bicycle network

- Well-organized bicycle education and promotion program

A third Platinum BFC is Portland, Oregon, with a population of 533,492. This metropolitan city has also achieved great success in bicycling, boasting a 15% ridership level and zero bicycle fatalities in 2008. According to Nesper in 2009, the reasons for this include:

- A seamless bicycle network
- Strong bicycle culture that includes a Community Cycling Center, a Create-a-Commuter program, and a Share the Road safety program
- High-level updating of Bicycle Master Plan
- Safety enhancements, including bike boxes at intersections

All these communities demonstrate effective policies for bicycling, so it is likely that the strategies employed could also be used to improve communities in Texas.

Representatives from all three of these BFCs were contacted to take part in the survey.

Successful Midsize Bicycle Friendly Communities

There are numerous successful bicycle communities in the midsize city range (100,000 to 300,000 citizens) around the country. One of the goals of this survey is to improve bicycling conditions in midsize cities in Texas, so comparisons between different sizes of cities were made to determine what makes communities successful. It may be possible to utilize some of the findings to improve the conditions of bicycling in midsize cities in Texas. Gold, Silver, and Bronze BFCs in the midsize city range are listed as follows.

These cities, as listed by Nesper in 2009, include:

- Billings, MT (Bronze): 100,147
- Arvada, CO (Bronze): 107,050
- Roseville, CA (Bronze): 109,154
- Ann Arbor, MI (Bronze): 114,028
- Columbia, SC (Bronze): 116,278

- Gainesville, FL (Silver): 117,182
- Fort Collins, CO (Gold): 118,652
- Cary, NC (Bronze): 119,745
- Thousand Oaks, CA (Bronze): 127,644
- Sunnyvale, CA (Bronze): 131,760
- Eugene, OR (Silver): 142,681
- Salem, OR (Bronze): 152,239
- Chattanooga, TN (Bronze): 155,554
- Vancouver, WA (Bronze): 156,600
- Tempe, AZ (Silver): 160,676
- Oceanside, CA (Bronze): 174,925
- Santa Clarita, CA (Bronze): 175,314
- Chandler, AZ (Bronze): 176,581
- Salt Lake City, UT (Bronze): 181,743
- Gilbert, AZ (Bronze): 196,000
- Arlington, VA (Silver): 200,226
- Orlando, FL (Bronze): 205,648
- Madison, WI (Gold): 221,551
- Scottsdale, AZ (Silver): 221,792
- Lexington-Fayette Co., KY (Bronze): 246,800
- St. Petersburg, FL (Bronze): 249,090

BYPAD and the European Model

While bicycling efforts in the United States are rated, and often governed, by the Bicycle Friendly America program, many European nations subscribe to the Bicycle Policy Audit (BYPAD) manual and rating system. BYPAD is an audit process created by bicycle enthusiasts in the European Union (EU) as a means to rate communities of different sizes in their efforts to promote bicycling. The BYPAD process recognizes three different community levels: town, city or agglomeration, and region. Each of these different

communities is governed by a system of policies developed by BYPAD in order to promote total quality management in local cycling policy. To accomplish this, representatives from different communities are invited to participate in a questionnaire process that rates them on nine different modules. Each of these different modules are integral to the bicycling process and affect success in a particular community. According to Vectris in 2008, each of these modules is encompassed within one of three overarching policies:

- Planning
- Actions
- Monitoring

The nine modules contained within these three policies are shown in Figure 18.



Figure 18: The BYPAD Spiral of Development for Cities

(Source: Vectris, 2008)

When completing the 30-question questionnaire, respondents indicate how well they think their city performs in each of the nine modules on a scale of one to four (with four

being the best possible rating). An aggregate score is then assigned to the city using the following formula.

$$Score = \sum_i^9 Score_Module_i \times Weightingfactor_i \quad (1)$$

As indicated, each of the modules has an associated weighting factor determined by the BYPAD team. Respondents are able to see an aggregate score for each module, thereby allowing them to see how to improve. This process is a novel approach to rating bicycling in cities and contains similarities to the BFA system (Vectris, 2008). However, this research has revealed that both transportation engineers and planners in the United States could benefit from a simple and intuitive audit system similar to that of BYPAD. This is the result that this research project has attempted to achieve.

Chapter III

Research Phase 1

The author, on behalf of TechMRT, worked together with TxDOT to conduct a survey of successful bicycle policies and practices in the United States. The team developed and released an online survey targeted at various groups, including: Metropolitan Planning Officials (MPOs), government officials, bicycle users, bicycle advocacy groups, TxDOT employees, and members of the Texas District of the Institute of Transportation Engineers (TexITE). The purpose of this survey was to rate various issues of funding, safety, and organization to create a clear picture of how successful bicycling would appear in Texas, particularly in midsize cities. The team used the website www.surveymonkey.com. The link for the survey was <http://www.surveymonkey.com/s/5TB5FXN>. The survey was distributed to approximately 1300 respondents, many of whom disseminated it among other colleagues and posted the link on various websites. A total of 436 respondents took the survey, totaling about 34% of the initial survey population. The high level of responses both lends credibility to the study and indicates the importance and popularity of bicycling as a means of transportation. This chapter is an excerpt from TxDOT Report #: 0-6582-1 coauthored but the author of this thesis (Liu et al., 2011).

Methodology

Research for this phase was essentially conducted in two steps. The first analysis examined the survey with an initial assumption that the perceived comfort level of bicycling correlates to the success rate of a community. Responses to all survey questions were cross-referenced with the question: "Overall, bicycling in your community is?" Cross-referencing other questions with this question allowed the research team to examine results based upon the perceived comfort rate of bicycling in a community, thereby creating a clearer picture of successful bicycling stories. This analysis differentiates between questions aimed at bicycle user groups and government officials.

The second analysis examined the differences between midsize cities and other sized cities. Rather than presenting every question again, this section examined key questions that provided important differences between cities of different sizes. Responses to questions were cross-referenced with the question: “What is the population of your community?” Midsize cities have a population of 100,000 to 300,000, urban cities have a population of 300,000 to 500,000, metropolitan cities have a population greater than 500,000, suburban areas as 50,000 to 100,000, and rural areas have a population less than 50,000.

After these two analyses were conducted, key findings from the survey were derived. Although this process was relatively simple statistically, these key findings still seem accurate and applicable. Trends were found amongst the key findings, especially in regards to midsize cities, and from these trends several recommendations for transportation planners were made. A more-in depth look at the analysis approach can be seen in Appendix D, which contains an excerpt of TxDOT Report #: 0-6582-1.

Key Findings

This section discusses many of the findings of the analysis of this survey. These discussions are split between the two analyses performed and between the sections for bicycle users and government officials. The constraints and limitations of these findings are also discussed.

Analysis of Success Results

This section discusses key findings from the analysis of success rates. The results are split into a section of questions for bicycle users and a section of questions for government officials.

Findings from Questions for Bicycle Users

This section discusses the major findings from the questions for bicycle users. It also lists the corresponding survey questions from which these conclusions were drawn.

Safety is the Primary Concern for Bicyclists

Numerous questions in this section deal directly with safety or other factors with implications on safety. It became apparent during the analysis that safety is the primary concern for bicyclists. The results indicate that safety is a good measure of bicyclist comfort, which in turn indicates the success rate of a community in terms of bicycling. The questions that most directly relate to these conclusions are 6, 7, 8, 9, 10, 11, 12, 13, 14, 19, 21, 22, 23, 24, 25, 26, and 27. The major issues related to safety are:

- Communities with safer bicycling conditions are considered more comfortable, and therefore more successful.
- Unsafe roadway conditions are the primary discouraging factors for most bicyclists. When bicycling conditions become safer, bicyclists are more comfortable traveling greater distances and at higher speeds. Bicyclists who are more comfortable are also more likely to use a bicycle for commuting rather than just recreation.
- Bicycle lanes and designated bicycle paths are typically considered safer than shared use paths, and lead to greater bicyclist comfort.
- Better education of motorists and greater promotion of bicycling can result in safer conditions for bicyclists, increasing their comfort level. The majority of bicycle-related accidents involve collisions with motorists, so cities that perform better at studying and learning from bicycle accidents help create safer conditions and raise the overall comfort level.

Community Size

The size of the community has some effect on the overall comfort level of bicyclists. The questions that most directly relate to these conclusions are 1 and 2. Respondents in mid-size cities and urban areas typically rate their communities as more comfortable. This could be due to a better mix of funding and population size. Metropolitan areas are typically seen as less comfortable because of their large size.

Other Factors That Lead to Increased Success Rates

The following factors also impact the success level of bicycling in a community. The questions that most directly relate to these conclusions are 4, 5, 15, 16, 17, 18, and 20.

- Communities with a higher comfort level rate their communities higher in promoting bicycling.
- Better connectivity leads to higher success and comfort levels.
- More efficient roadway designs lead to higher success and comfort levels.
- Better media use leads to higher success and comfort levels.
- Bicyclists being given more rights and responsibilities correlates to a higher success rate.
- Political support, funding, culture, strong advocacy group, and education are all very important in creating a bicycle friendly community.

Findings from Questions for Government Officials

This section discusses the major findings from the questions for government officials. It also lists the corresponding survey questions from which these conclusions were drawn.

Local Government Agencies Are More Effective at Promoting Bicycling

The results of numerous questions indicate that local government agencies are more effective at supporting bicycling and providing a comfortable and successful environment than are larger or outside government agencies. The questions that most directly relate to these conclusions are 1, 6, 18, 24, and 26. The major issues relating to local agencies are listed below:

- The most successful bicycling communities attribute success to local government support and active promotion of bicycling.
- Regional transportation planning seems to be the most effective source of funding for bicycle projects.

- Bicycling is not usually given dual support in a state's long-term transportation plans, so local government agencies have to provide the necessary support for bicycling.

MPOs Are Most Effective When Making Funding Decisions but Often Ineffective Otherwise

Numerous questions showed that successful communities often rely on MPOs to make critical funding decisions and demonstrate flexibility in spending, but they can count on their MPOs for little else. This could be an indication that MPOs are capable of being effective at supporting bicycling but currently lack the necessary focus or ability to provide direct support. The questions that most directly relate to these conclusions are 3, 4, 5, 13, 14, 15, 16, and 20. The major issues relating to MPOs are listed below:

- MPOs are effective at making funding decisions.
- MPOs either do not have written bicycle plans or do not use them effectively.
- A bicycle advocate in an MPO could lead to success in communities but may not be very effective in current uses.
- MPOs often do not account for bicycling in their travel demand forecasting models.

More Successful Communities Are Active in Improving Bicycle Conditions

Success in bicycling communities often accompanies active maintenance and support in a city. The questions that most directly relate to these conclusions are 10, 19, and 22. The major issues relating to active maintenance include:

- The most successful communities actively maintain and manage their bicycle structures.
- The most successful communities have numerous bicycle projects planned for the future.

Other Key Findings

The following list of findings are important, but cannot be grouped together under one category. The questions that most directly relate to these conclusions are 2, 7, 8, 9, 11, 12, 17, 21, 23, and 25. These miscellaneous findings are listed below:

- Political support, funding, culture, strong advocacy groups, and education are all important for creating a bicycle friendly community.
- Funds from Transportation Enhancements seem to be used most often by the most successful communities.
- Bike lanes are the most frequently used structures in successful communities because of their higher perceived safety.
- A Level of Service for evaluating bicycling is not used very frequently in successful communities, so it may not have much impact on the success of bicycling in a community.
- Successful cities typically have an active bicycle committee.
- Specific law enforcements to protect bicyclists can result in higher success rates.
- Local Transportation Authorities may or may not have dedicated bicycle employees. Therefore, these employees may be largely ineffective at improving bicycle success.
- The most successful communities use media involvement and workshops/courses as the primary means to promote education of bicyclists.
- Funding is the major barrier to successful bicycle implementation.
- There is a direct correlation between perceived comfort level and success rate. This validates the assumption upon which this analysis was performed.

Analysis of Community Sizes

This section discusses key findings from the analysis of success rates. The results are split into a section for questions for bicycle users and a section of questions for

government officials. Many of the findings from this analysis reflected earlier findings from the first analysis, so this section focuses on the key findings from this section.

Findings from Questions for Bicycle Users

This section discusses the major findings from the questions for bicycle user. It also lists the corresponding survey questions from which these conclusions were drawn.

There Are Few Differences between City Sizes for Bicycle Users

The results of this analysis indicate that there is virtually no difference for bicyclists in terms of city size. Most of the issues and solutions pertinent to one city size are still relevant to most of the others. Therefore, it is likely that planners in mid-size cities can apply lessons from other cities, regardless of size, to improve bicycling conditions in mid-size cities. The questions related to this finding are 3, 5, 14, 19, and 24.

There is a Difference in Comfortable Bicycling Distance

The results seem to indicate that bicyclists in larger cities are more comfortable bicycling greater distances. Although this could be for a variety of reasons, it is likely that this is due to either better connectivity or availability of bicycle facilities, or due to different reasons for bicycling, such as commuting. Whatever the cause, it is likely that bicyclists in mid-size cities would be more comfortable bicycling longer distances if conditions improved for them. The question related to this finding is 10.

Motorist Attitudes are Generally Negative and Seemingly Worsen with Population Increase

Except in very small cities, the majority of all bicyclists, regardless of city size, indicated that motorist attitudes towards bicyclists are either neutral or negative. The attitudes also seem to worsen as population increases. This is likely due to a lack of education for motorists in larger cities because of the sheer number of drivers. Therefore, mid-size cities should work harder to improve motorist education. The questions related to this finding are 19 and 24.

Findings from Questions for Government Officials

This section discusses the major findings from the questions for government officials. It also lists the corresponding survey questions from which these conclusions were drawn.

There Are Few Differences between City Sizes for Government Officials

Similarly to the results of the analysis of the questions for bicycle users, the results of the questions for government officials showed that there are very few differences between cities of different sizes in terms of bicycling. As previously asserted, it is likely that planners in mid-size cities could adopt successful strategies from other cities, regardless of size, to improve bicycling conditions. The questions related to this finding are 2, 3, and 24.

Level of Service Likely Has Little Effect on Success in Mid-Size Cities

Although respondents in mid-size cities indicated that they often do use a bicycle Level of Service to measure success, it is likely that this actually has little impact on the success rate. This is because the majority of respondents from the other cities indicated that they do not use one, and yet all the city sizes indicated similar levels of success. Therefore, a bicycle Level of Service should not be relied on to measure or improve success. The question related to this finding is 9.

It is Likely That a Bike Plan is Underutilized in Mid-Size Cities

There were discrepancies between the frequencies of how often a Bike Plan is updated, although it is possible that larger population centers tend to update their plan less often. However, this difference likely indicates that Bike Plans are often underutilized, especially in mid-size cities. Perhaps, if the Bike Plan was updated more often, it could be used more effectively to improve conditions in mid-size cities. The question that relates to this finding is 14.

A Dedicated TA Bicycle Advocate May Be an Advantage of a Larger Population

Although it is unclear whether or not a dedicated bicycle advocate employed by a Transportation Authority can improve bicycling conditions, it does seem that having such an employee is an advantage that larger population centers have over smaller ones. Such an employee could possibly aid the success rate of bicycling in a community, so it may be beneficial for planners in mid-size cities to ensure that they can have the support of such an individual. The question related to this finding is 17.

Constraints and Limitations

This section discusses the constraints on data and limitations of the findings for both analyses. The primary concern with the data is that not all respondents answered every question. Because the cross-referenced question, "Overall, bicycling in your community is?" originally appeared in the bicycle users section, only approximately 10% of the respondents in the government officials section answered this question. Therefore, the number of responses that could be cross-referenced in the government officials section was significantly lower than in the bicycle users section. This could have resulted in a decrease in reliability for the results of the government officials section when compared to the bicycle users section. Similarly, the cross-referenced question "What is the population of your community?" originally appeared in the bicycle users section, so the government officials data had similar shortcomings. Additionally, no respondents to this cross-referenced question indicated that they were a government official from an urban city, so a good comparative analysis of urban areas could not be performed. However, some clear implications could probably still be drawn, so the data and above conclusions should not be ignored.

Recommendations

This section highlights recommendations based on the results gathered from the survey analysis. These recommendations should be integrated implicitly or explicitly with the various sections of the bicycle plan and should help provide a clear direction to meet the

needs of a community. These recommendations are targeted specifically at mid-size cities. Mid-size cities have numerous advantages, including effective sources of funding, a substantial but not excessive population, and local control. Mid-size cities should use these advantages in the following recommendations.

Bicycle Plans Should Be Used More Effectively

The data suggest that mid-size cities underutilize bicycle plans. This could be a result of poorly structured or poorly focused plans. Mid-size cities should carefully develop bicycle plans to access the numerous advantages of their population sizes and focus improvements to bicycling. It is likely that bicycling could be significantly improved if bicycle plans were used more effectively.

Local Government Agencies Should be Responsible for Developing a Plan

The data suggest that local government agencies are the most effective entities for improving bicycling conditions and providing a comfortable bicycling environment in a city. Therefore, mid-size city governments should take advantage of their size and build a focused plan that addresses the needs of bicycling in the community without yielding to external influences. This will provide a more focused and relevant bicycle plan and likely produce tangible results.

Local Government Agencies Should be Responsible for Financing

The data suggest that the most effective source of financing is regional transportation planning. Therefore, mid-size city governments should attempt to effectively use and secure this source of funding, rather than relying on external sources. This will ensure that improvements are relevant to the city's goals for bicycling. It may be beneficial to coordinate efforts with an MPO to make funding decisions. However, influence from the MPO should be limited in order to maintain the local focus on bicycling.

Mid-Size Cities Should Effectively Promote Bicycling

Mid-size cities are capable of effectively using various sources, including the media and workshops, to effectively promote bicycling. The city government should make every effort to promote bicycling, as this will likely increase education levels of both motorists and bicyclists, thereby increasing safety. Safety is the primary concern of bicyclists, so promotion should not be overlooked.

Mid-Size Cities Should Be Vigilant in Following the Plan

The data suggest that cities that actively seek to improve bicycling produce more successful bicycling communities. One way to stay active in implementing bicycling is to adhere to a well-developed bicycle plan. It is likely that as goals and objectives are met, the overall state of bicycling in a community will improve. This in turn will likely bolster efforts to continue improving. Therefore, midsize city governments should follow well-developed plans and constantly seek to improve bicycling conditions.

Chapter IV

Research Phase 2

Research Phase 2

Phase 2 of the research was conducted to examine further the findings of Phase 1 and to use more complex statistical methods, such as correlation of data, to validate the previous assumptions. This section delves further into those findings and provides definitive guidelines that can be used to ensure successful bicycling in a community. The key focus is on promoting safe bicycling in a midsize city.

Methodology

For the first step in this phase, a correlation analysis was performed to test the validity of some of the conclusions from the previous analysis. For this analysis method, all textual responses to every survey question were assigned numerical values in an Excel spreadsheet. For ease of data manipulation, responses to questions asking respondents to choose one answer were typically valued “1,2,3,4, etc.” For questions asking respondents to check all answers that apply, a binary value was assigned to each response, and an aggregate score for each respondent was calculated. For example, the first answer to such a question would be valued 1, and the second answer would be numbered 10. If a respondent chose both of these answers but no other answers, his score was 11. The numeric rankings for each answer on questions asking respondents to rank a series of selections were left as is.

Once all of the responses were collected in numeric format, the data for each question in each section was compared to the data set for one specific question in each section. All of the data in the Bicycle Users section was compared to the results of the question “Overall, bicycling in your community is?” All of the data in the Government Officials section was compared to the results of the question “What is your opinion with respect to bicycle planning, implementation, and maintenance in your community?” Correlations

between the data were determined, and used to verify previous conclusions. A further correlation study was performed by cross-referencing all of the data in the Bicycle Users section with the question “What is the population of your community?” This was performed to determine if any correlations exist between the different community sizes and other factors affecting bicycling.

After performing these analyses, the research team reexamined the data, particularly the city size results, and developed guidelines for success from the data. Four key focus areas relating to bicycle transportation were isolated, and basic guidelines for these focus areas were developed. From these four focus areas, a comprehensive guide to planning and establishing a successful bicycle system is provided. The in depth analysis is contained in Appendix E.

Guidelines for Establishing Successful Bicycle Implementation

Having addressed the key factors affecting bicycling implementation, the team developed guidelines to aid communities in developing a successful bicycle culture. The research team believes that the steps shown in Figure 19 should essentially be followed in order, although several of the processes are continual and can be performed simultaneously. Following this flow chart is likely to produce successful bicycling conditions in a community.

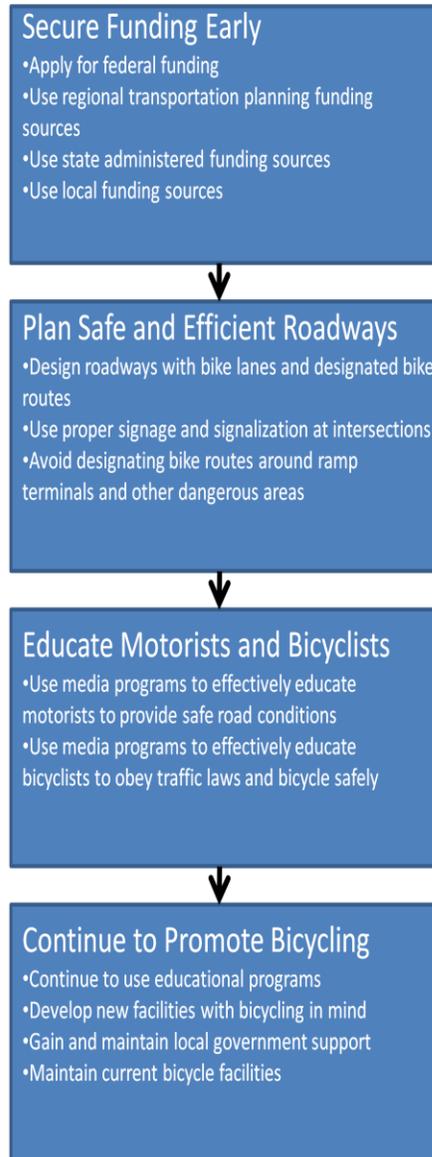


Figure 19: Flowchart for Successful Bicycling in Midsize Cities

The final step in this guide may be the most important. Without proper maintenance and vigilance, a bicycling community will likely suffer. Therefore, transportation planners should be mindful to continually improve bicycling in their communities by acquiring funding, properly designing roadways, using education, and maintaining safe conditions. If these steps are followed, it is likely that bicycling in a community will be successful.

Constraints and Limitations

The primary concern with the data is that not all respondents answered every question. The cross-referenced question “What is the population of your community?” originally appeared in the bicycle users section, so not all of the respondents who answered this question responded to questions in the Government Officials section. It should also be noted that correlation does not mean causality, so although correlations may hint at possible causes, they do not prove that one set of data causes another set. However, some clear implications could probably still be drawn, so the data and above conclusions should not be ignored.

Chapter V

Research Phase 3

The third and final phase of the research was conducted to provide a tangible, effective method for bicyclists and transportation planners in midsize cities alike to evaluate and improve bicycling. Although it has been shown that bicycling, like any mode of transportation, is a complex topic that requires efficient policy and careful planning from a wide variety of perspectives, the previous phases of the research have demonstrated that there are certain key topics that should be addressed to implement successful bicycling. These four topics were derived from the previous research phases and are discussed in Chapter 4 and Appendix E. Using these guidelines, the author developed a spreadsheet questionnaire that can be employed as an audit to aid transportation officials in midsize cities in implementing bicycling. This section discusses the methodology used to create the questionnaire, as well as a discussion of how the questionnaire works.

Methodology

The audit form created on behalf of this research project was developed using similar techniques to the questionnaires employed by BFA and BYPAD. However, there are two key differences between this questionnaire and others. The first difference is that this questionnaire was developed with the direct results of the other two research phases in mind. Although some may argue that some of the measures of success reported in the other phases seem arbitrary, this research project showed that they are effective measures of success for bicycling and should not be rejected. The strength of this questionnaire lies in the fact that its questions were all developed with the results of the previous survey and studies in mind; therefore, this questionnaire is grounded in realistic expectations. The second major advantage of this questionnaire is that it is intuitive and easy to use. This audit by no means represents an all-encompassing final grade for a city as to the success of its bicycling program; it is simply an easy-to-use spreadsheet that provides helpful information and allows respondents to take an in-depth look into bicycling in their cities.

This questionnaire was developed so that it would encompass the primary concerns demonstrated in the four primary focus areas:

- Funding and Policy
- Engineering and Design
- Education
- Safety

Although several questions were adopted from the first survey, new questions were added or old questions reworded in order to directly target the concerns demonstrated by the previous survey. The resulting questionnaire contains 29 questions, each with an associated weight. The questionnaire is broken into five sections, with one section for general questions and each of the four primary concern areas having its own section. Respondents conduct the survey by placing an "x" in the column next to the appropriate answer per question. Some questions may require multiple responses. Every question has a most desirable answer or answers as determined from the previous research phases. For each section except the General Questions and Safety section, the "correct" response carries a weight of 2.5 points. The questions in the Safety section are each worth 3.125 points due to safety being the primary concern for bicyclists. These weights were not arbitrarily chosen, but rather assigned to provide equal weight to each question (except the Safety questions) and to achieve the total weight of each section. Each section has a total weight determined by the relative importance of that topic and the number of questions therein. Equation 2 demonstrated the scoring system of the audit.

$$Score = \sum_i^5 Total\ Section\ Score \quad (2)$$

As respondents complete the survey, they can see the points associated with each response that they select. This was done to show ways in which a community can improve. Therefore, the questionnaire in and of itself is an effective means of providing feedback for how to improve the success level of a city. When the questionnaire is completed, the respondent is assigned a letter grade based off of the total score. The maximum possible score is 100. A score between 90 and 100 receives a Grade A, a score

between 80 and 89 receives a B, a score between 70 and 79 receives a C, a score between 60 and 69 receives a D, and a score less than 60 receives an F. These grades are meant to motivate the respondent to seek ways to improve bicycling in his city.

Sample Audit Form

This section contains a sample completed audit form, broken apart into sections to demonstrate how each question affects the total score.

Section 1: General Questions

This section contains general questions meant to be mostly informative to the auditor. The only question with an associated weight is "What is the modal share of bicycles in your city?" This question was included as a means of correcting one critical error of the previous research efforts. The earlier phases neglected modal share as a measure of bicycling success. However, this is an important measure and is potentially the best indicator of bicycling success in a city. The low percentages provided as choices were selected due to the research of low national average modal shares across the country. This question was assigned a weight of 30 points due to its immense significance on the success level of bicycling in a community. Figure 20 shows a completed section of the audit and demonstrates the points rewarded for a less than optimal answer to the modal share question.

| Question | Response | Score |
|--|-----------|--------------|
| General Questions | | |
| 1. What is the population of your city? | | |
| a. 0 -49,999 | | |
| b. 50,000-99,999 | | |
| c. 100,000-299,999 | x | |
| d. 300,000 or greater | | |
| 2. Are you currently a bicyclist? | | |
| a. Yes | x | |
| b. No | | |
| 3. What is the modal share of bicycles in your city? | | |
| a. 0-0.49% | | |
| b. 0.5-0.9% | x | 15 |
| c. 1.0-1.9% | | |
| d. 2.0% or greater | | |
| Score | | 15 |
| Total Section Score | 15 | of 30 |

Figure 20: Questionnaire Section 1

This example completed section demonstrates that a modal share between 0.5 and 0.9 only awards 15 points. Therefore, a low modal share can lead to a low score and has the single largest impact on a city's grade. However, this is not meant to discourage respondents, but rather to motivate them to promote bicycling and achieve a higher modal share.

Section 2: Funding and Policy

This section contains eight questions relating to funding and governmental policy. Each question has a weight of 2.5 points and are intended to address the key findings of Phase 1. An example of this is that the respondent is asked whether or not he has petitioned for and achieved local government support. Although all of these questions can greatly impact bicycling, there is no single factor that leads to a successful program. Figure 21 shows the first four questions of this section, and figure 22 shows the next four and the total section score.

| Funding and Policy | | |
|--|---|-------|
| 1. In your state, who plays a major role in decision-making as to how federal transportation funds are spent in your city? | | |
| a. State Department of Transportation | | |
| b. Metropolitan Planning Organization | x | 2.5 |
| c. Other/ Unsure | | |
| Score | | 2.5 |
| 2. . In your region, which of the following sources for financial support is used for bicycle projects? | | |
| a. Regional transportation planning | | |
| b. Individual project applications to the state administered transportation program | | |
| c. Both a and b | x | 2.5 |
| d. Other | | |
| e. None of the above | | |
| Score | | 2.5 |
| 3. Which of the following programs are most often used for funding bicycle projects? | | |
| a. Transportation Enhancements | x | 0.625 |
| b. Congestion Mitigation and Air Quality | x | 0.625 |
| c. Safe Route to School | x | 0.625 |
| d. Other | x | 0.625 |
| Score | | 2.5 |
| 4. Does your city have other sources of funding for bicycle projects? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Other/ Unsure | | |
| Score | | 2.5 |

Figure 21: Example Completed Funding and Policy Section, First Four Questions

| | | |
|---|---|-----------------|
| 5. Does your city have a bicycle committee that assists in bicycling planning and advocacy? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Unsure | | |
| Score | | 2.5 |
| 6. Does your city have a bicycle advocate or other representative in the local transportation planning group? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Unsure | | |
| Score | | 2.5 |
| 7. Does your city have a bicycle master plan? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Unsure | | |
| Score | | 2.5 |
| 8. Have transportation officials effectively petitioned for and gained support from your local government? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Unsure | | |
| Score | | 2.5 |
| Total Section Score | | 20 of 20 |

Figure 22: Example Completed Funding and Policy Section, Last Four Questions

As can be seen from Figures 21 and 22, seeking multiple sources of funding and support can provide a very high score. Ideally, if a respondent scores low in this section, he will be motivated to seek ways to improve, such as locating additional sources of funding. This audit is a powerful tool for this reason.

Section 3: Engineering and Design

The third section of the questionnaire is focused on ensuring that respondents are practicing sound engineering in terms of bicycling. Without good engineering practice, roadways become unsafe, and successful bicycling is never achieved. Figure 23 shows a completed form for this section.

| Engineering and Design | | |
|--|---|----------|
| 1. What types of bicycle facilities are present in your city? | | |
| a. Wide curb lanes | x | 0.5 |
| b. Signed shared roadways | x | 0.5 |
| c. Bike lanes | x | 0.8 |
| d. Paved shoulders | x | 0.5 |
| e. Other | x | 0.2 |
| Score | | 2.5 |
| 2. What percentage of roadways feature bicycle facilities? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | x | 2.5 |
| Score | | 2.5 |
| 3. Does your city feature any special intersection treatments for bicycles? | | |
| a. Bike boxes | x | 0.625 |
| b. Loop detectors | x | 0.625 |
| c. Bike signals | x | 0.625 |
| d. Other | x | 0.625 |
| Score | | 2.5 |
| 4. Does your city feature any special interchange treatments for bicycles? | | |
| a. Overpasses or bridges | x | 1 |
| b. Separated bike trails | x | 1 |
| c. Other | x | 0.5 |
| Score | | 2.5 |
| 5. How many roadways are designated bike routes or feature bicycle signage in your city? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | x | 2.5 |
| Score | | 2.5 |
| 6. Does your city actively maintain bike routes and facilities? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Unsure | | |
| Score | | 2.5 |
| Total Section Score | | 15 of 15 |

Figure 23: Example Completed Engineering and Design Section of Audit

Section 4: Education

The education section of the questionnaire is relatively small but still quite important. Without proper methods of education and promotion of bicycling, it is highly unlikely that bicycling will become successful in a city. Figure 24 shows a completed example form for this section.

| Education | | |
|--|---|--------------------|
| 1. Does your city have any bicyclist education programs? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Maybe | | |
| Score | | 2.5 |
| 2. Does your city have any motorist education programs? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Maybe | | |
| Score | | 2.5 |
| 3. Does your city use any of the following media to promote bicycling and bicyclist education? | | |
| a. Bicycle driver's manual | x | 0.357 |
| b. Bicycling specific website | x | 0.357 |
| c. Media involvement | x | 0.357 |
| d. Workshops, courses | x | 0.357 |
| e. Interactive bicycle maps | x | 0.357 |
| f. Social networking communities | x | 0.357 |
| g. Other | x | 0.357 |
| Score | | 2.499 |
| 4. Is media used effectively to promote bicycling and bicycle education in your city? | | |
| a. Yes | x | 2.5 |
| b. No | | |
| c. Maybe | | |
| Score | | 2.5 |
| Total Section Score | | 9.999 of 10 |

Figure 24: Example Completed Education Section of Audit

Section 5: Safety

Although this section does not contain the most questions, it is nevertheless the second most important section of the audit due to the fact that the previous survey revealed that safety is the primary concern for bicyclists. The questions in this section carry more weight than those in the other sections for this reason. This research has shown that without safe conditions, bicycling will likely never become a successful mode of transportation in a midsize city. Figure 25 shows the first half of this section, and Figure 26 shows the second half, in addition to a final score and grade.

| Safety | | |
|---|---|-------|
| 1. What percentage of roadways contain bicycle lanes? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | x | 3.125 |
| Score | | 3.125 |
| 2. What percentage of streets with posted speed limits greater than 30 mph have bike lanes? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | x | 3.125 |
| Score | | 3.125 |
| 3. Is law enforcement used effectively to investigate and learn from bicycle crashes? | | |
| a. Yes | x | 3.125 |
| b. No | | |
| c. Unsure | | |
| Score | | 3.125 |
| 4. Are motorists properly educated on the rights of bicyclists? | | |
| a. Yes | x | 3.125 |
| b. No | | |
| c. Unsure | | |
| Score | | 3.125 |

Figure 25: Completed Safety Section of Audit, First Four Questions

| | | |
|--|----------|----------------------|
| 5. Are bicyclists properly educated on lawful bicycle operation? | | |
| a. Yes | x | 3.125 |
| b. No | | |
| c. Unsure | | |
| Score | | 3.125 |
| 6. Are there any special measures taken to improve bicycling safety in your city? | | |
| a. Yes | x | 3.125 |
| b. No | | |
| c. Unsure | | |
| | | 3.125 |
| 7. Do a high percentage of businesses and recreation areas feature bicycle friendly features (lockers, racks, or showers)? | | |
| a. Yes | x | 3.125 |
| b. No | | |
| c. Unsure | | |
| Score | | 3.125 |
| 8. Are bicycle facilities well lit and secure? | | |
| a. Yes | x | 3.125 |
| b. No | | |
| c. Unsure | | |
| Score | | 3.125 |
| Total Section Score | | 25 of 25 |
| Total Score | | 84.999 of 100 |
| Your grade: | B | |

Figure 26: Completed Safety Section of Audit, Last Four Questions, and Total Score

In this example, the respondent received a B grade. This is due to the relatively low modal share. However, any of these sections can greatly impact the final score. Therefore, this audit and the process of completing it inspires a holistic approach to implementing and improving bicycling not unlike that supported by BYPAD and BFA.

Advantages and Recommendations

This audit form was developed in Microsoft Excel for several reasons. It is the author's hope that this audit could one day be included on the TechMRT homepage, either as a separate website that performs the same function as the Excel sheet, or as a downloadable spreadsheet that a respondent could access directly from the website. The Excel version

has the advantage that it can be easily distributed and downloaded. If need be, the form could also be filled out manually and returned to the auditor.

Although this is not a permanent solution to bicycling issues or a completely comprehensive guide to improving bicycling, this audit form is nonetheless a powerful tool. The simple process of completing it can diagnose problems with bicycle transportation policy and hopefully reveal areas in which a respondent can improve. Filling this form out in consecutive years could be a useful way to monitor progress. Therefore, the author recommends that this form be used in conjunction with other evaluation methods as an engineering tool to help transportation planners improve bicycling conditions in their cities.

Constraints and Limitations

Although this research phase does provide a useful tool to evaluate bicycle policy, further calibration of the audit is recommended. The method used to derive the weighting factors is essentially an empirical method based off of what the past survey results indicated to be important factors for bicycling. These factors were then assigned weights that seemed appropriate. However, advanced statistical analysis methods for assigning weighting factors will be desirable for future versions of the audit form.

One possible way to determine such weighting factors may be to distribute the new survey to a controlled population of survey takers. Once results for the new survey are gathered, it may be possible to normalize the results and evaluate how many respondents indicated which answer. Comparing the population of responses for each question to the previous responses may provide a statistical weight for each response. These weights could then be applied to the spreadsheet to develop a better calibrated audit.

Research into the weighting factors could prove valuable to improving the audit process. However, the usefulness of this tool in its current form should not be ignored. Even the authors of the BYPAD manual indicate that their seemingly empirically derived

weighting factors will be adjusted through future use of their audit (Vectris, 2008).
Therefore, it is highly recommended that further research on this topic be conducted.

Chapter VI

Conclusions

This thesis represents the culmination of three integrated research phases. Each phase produced results upon which the subsequent phase built. Phase 1 provided key findings about bicycling and made general recommendations for bicycle policy makers. Phase 2 validated the conclusions of Phase 1 and subsequently provided more focused guidelines to policymakers in midsize cities for improving bicycling conditions. Phase 3 used many of the findings from Phase 1 and the subsequent guidelines of Phase 2 to develop an audit form that can be used to evaluate bicycling conditions in a city. This audit form comes as a timely and critical tool that engineers and policymakers can both use to ascertain the health of a bicycle transportation program and monitor its development over the years. The audit fills a critical role in the process of successful multi-modal transportation, and the author recommends that transportation planners and engineers adopt, adapt, and implement it to serve the needs of the bicycling public in midsize cities.

Further Research

It is highly recommended that further research projects be conducted to build from and improve upon the research conducted for this thesis. Although there are a wide range of further projects that could be pursued, a suggested list of more immediate research topics is provided below. These topics include:

- Distributing the second survey to a more normalized population
- Use of statistical analysis to calibrate weighting factors
- Monitoring of spreadsheet over a period of years

Distributing the Second Survey to a More Normalized Population

As mentioned in previous chapters, a better understanding of the surveyed population could benefit the research process. A further project could be carried out on a second, more controlled population with normalized survey results. These results may not only be

more statistically valuable but also may provide more conclusive results. One possible way to conduct this research project could be to survey only bicyclists from midsize cities. The data provided by that survey could likely be used to enhance the findings of this thesis.

Use of Statistical Analysis to Calibrate Weighting Factors

This issue was discussed in Chapter 5. As indicated, normalized data could be used to assign more accurate weights to each of the variables included in the audit. This in turn could improve the audit process and provide a more accurate gauge of bicycling success in a city. The method and rationale for this research is discussed in Chapter 5.

Monitoring of Spreadsheet over a Number of Years

This research project could produce many interesting results as to the usefulness and viability of the audit form. This research could be conducted by distributing the audit to various city planners around the state and tracking their scores. The audit could then be distributed to those same planners annually in order to see how their scores change from year to year. It is likely that this data could then be correlated to the usefulness of the audit. Comments from the city planners at the end of the study period could then be used to improve the audit form. This research would require several years to conduct but could produce useful results.

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Appendix A

The Original Bicycle Questionnaire

QUESTIONS FOR THE BICYCLE USERS

1. How would you describe your community?
 - Metropolitan
 - Urban
 - Suburban
 - Rural
 - College-community
2. What is the population of your community?
 - Less than 50,000
 - 50,000-100,000
 - 100,000-300,000
 - 300,000-500,000
 - More than 500,000
3. Overall, Bicycling in your community is
 - Joyful and pleasant
 - Acceptable but need some improvements
 - Not satisfactory and need lots of improvements
 - Extremely dangerous and not acceptable at all
4. On a scale from 0 to 10 (with 10 being the best), how would you rate your community's efforts to promote bicycling?
5. In your opinion, what is the most important factor for creating a bicycle friendly community?
 - Political support
 - Funding

- Culture
 - Strong advocacy group
 - Education
 - All above
 - Other (specify)
6. The most common reason for you to make a trip by bicycle? (check all that apply)
- Commuting to and from work
 - Commute to and from school
 - Shopping
 - Recreation
 - Physical fitness
 - For sport or competition
7. Which of the following problems associated with bicycling have you observed in your community? (check all that apply)
- Roadway design features unfriendly to bicyclists
 - Lack of signs and markings
 - Bicycle paths not properly maintained
 - Insufficient coverage of bike routes
 - Discontinuity of bike paths
 - Lack of bicycle facilities in recreational areas
 - Risky motorist attitude
 - Need for public education
 - Other (specify)
8. Rank the factors that may encourage you to use a bicycle more often.
- Safer road conditions
 - Bicyclist-friendly design of roadways and intersections
 - Better bicycle friendly facilities at destinations (racks, lockers, showers etc.)
 - Less traffic
 - Less heavy vehicles

- Better attitude from motorists
 - Lower motor vehicle speed limits
 - Improved continuity and accessibility of bicycle network
9. Rank the following factors that discourage you from cycling more often in your community.
- Road safety
 - Lack of transit connections
 - Roadway design features not friendly to bicyclists (e.g., lack of bicycle lanes, street lighting, markings and signs etc.)
 - Terrain
 - Distance to destinations
 - Lack of facilities at destinations
 - Climate (wind, rain etc)
10. What is a comfortable distance for you to commute by bicycle under current roadway condition and availability of bicycle facilities in your city?
- Up to 2 miles
 - Up to 5 miles
 - Up to 10 miles
 - Up to 20 miles
 - More than 20 miles
11. What is a comfortable distance for you to commute by bicycle if your city's infrastructure and overall environment is more bicycle friendly?
- Up to 2 miles
 - Up to 5 miles
 - Up to 10 miles
 - Up to 20 miles
 - More than 20 miles
12. If designated/signed bike routes are available, you would consider bicycling on the streets and highways with a posted speed limit of
- 30 mph or lower

- 35 mph
- 40 mph
- 50 mph
- 60 mph
- Any speed limit

13. If shared lanes (wide lanes shared by autos and bicycles) without signs are available, you would consider bicycling on the streets and highways with a posted speed limit of

- 30 mile/hour or lower
- 35 mph
- 40 mph
- 50 mph
- 60 mph
- Any speed limit
- I don't like to use shared lanes for bicycling at any posted vehicle speed limit

14. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of safety?

- Poor
- Acceptable
- Good
- Excellent

15. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of connectivity?

- Poor
- Acceptable
- Good
- Excellent

16. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of efficiency?

- Poor
- Acceptable
- Good
- Excellent

17. Is media effectively used in your community in promoting safe bicycling?

- Yes
- No
- Somewhat
- Don't know

18. Does your community have any of the following activities? (check all that apply)

- Bike month/Bike week
- Bike to work
- Bike to school
- Other (specify)
- None
- Not sure

19. How would you rate the motorists' attitude towards bicyclists in your town?

- Positive
- Acceptable
- Neutral
- Negative
- Extremely Negative

20. As a bicyclist, do you think that you are given the same rights and responsibilities as a motor vehicle operator in your community?

- Yes
- No
- Not sure

21. Rank your concerns with respect to safety when cycling? (Check all that apply)

- Riding at intersection areas
- Volume of surrounding traffic

- Speed of surrounding traffic
- Number of heavy vehicles in surrounding traffic
- Security
- Other

22. Do you encounter any of the following problems with motorists while riding your bicycle? (check all that apply)

- Driving too close to you and pushing you off the road
- Making turns in front of you or cutting you off
- Not seeing you on your bike
- Unfriendly honking

23. Is there high incidence of bicycle related accidents in your city?

- Yes
- No
- Don't know

24. What are the most frequently observed types of bicycle crashes in your city/region?

- Bicyclist losing control
- Bicyclists running into each other
- Motor-vehicle and bicycle crashes
- Opening of parked car doors
- Bicyclists and pedestrian crashes
- Bicyclists and animal crashes
- Other (specify)

25. How would you rate your city's effort in terms of examining and learning from bicycle related crashes and injuries?

- Poor
- Average
- Good
- Excellent

26. Within the intersection area, rank the most risky/dangerous maneuver for bicyclists?

- Through movement
- left-turn
- right-turn
- Sidewalks

27. Based on your experience, rank the most risky/dangerous places for bicyclists?

- Signalized Intersections
- Unsignalized Intersections
- Roundabouts
- Rural highways
- Urban arterials
- Ramp terminals
- Others (specify)

QUESTIONS TO MPO/STATE DOT/LOCAL GOVERNMENT OFFICIALS

General Information

1. Are you employed with
 - State Department of Transportation
 - Metropolitan Planning Organization
 - Transit Agency
 - Local government agency
 - Other (specify)
2. In your opinion, what is the most important factor for creating a bicycle friendly community?
 - Political support
 - Funding
 - Culture
 - Strong advocacy group
 - Education
 - All above
 - Other (specify)
3. In your State, who plays a major role in decision-making as to how federal funds are spent at the regional and local level?
 - State DOT
 - MPO
 - Other (specify)
 - Unsure
4. Does your state have a sub-allocation scheme that gives flexibility to MPOs to control some of the federal transportation funds to address their needs?
 - Yes
 - No
 - Unsure
 - My opinion (specify)

5. Under the existing scheme for allocation of federal transportation funds, is the MPO in your region able to reflect community intent in its approach to bicycle and pedestrian projects?
 - Yes
 - No
 - Unsure
 - My opinion (specify)
6. In your region, financial support for bicycle projects is achieved through?
 - Regional transportation planning
 - Individual project applications to the stated administrated transportation program
 - Other (specify)
7. Which of the following programs are most often used for funding bicycle projects?
 - Transportation Enhancements
 - Congestion Mitigation and Air Quality
 - Safe Route to School
 - Other (specify)

Infrastructure:

1. Which of the following are provided in your region/city? (check all that apply)
 - Bike lanes
 - Wide curb lanes
 - Signed shared roadway
 - Paved shoulders
 - Colored bike lanes
 - Bike boxes
 - None of the above
2. Does your city use a bicycle Level of Service to assess the performance of bicycle facilities?
 - Yes.

- No
 - Unsure
3. Is there a program in your region/city to actively manage and maintain bike routes?
- Yes
 - No
 - Unsure
4. Does your community have an official bicycle and pedestrian interest group that gets involved in enhancement, provision and use of bicycle facilities?
- Yes
 - No
 - Unsure
5. Does your state/city have specific law enforcements to protect the bicyclists?
- Yes
 - No
 - Unsure

Planning:

1. Does the MPO in your region have a written bicycle plan?
- Yes
 - No
 - Unsure
2. If there is a written bicycle plan, how often is the bicycle plan updated?
- Less than 5 years
 - 5-10 years
 - 10-15 years
 - 15-20 years
 - Unsure
3. Does the bicycle plan include any measures to evaluate the progress of plan implementation?
- Yes

- No
 - Unsure
4. Is there anyone who is an active advocate of bicycle/pedestrian programs in the MPO's (local government) policy-making body?
- Yes
 - No
 - Unsure
5. Does the Transportation Authority in your region employ a dedicated employee in charge of bicycle/pedestrian issues?
- Yes
 - No
 - Unsure
6. In your opinion, is bicycling given due consideration in the state or region's long-range transportation plans?
- Yes
 - No
 - Not Sure
7. Does your city/region have any plans to enhance bicycle facilities in the near future?
- Yes
 - No
 - Plan is being implemented
 - Not sure
8. Does the MPO in your region account for bicycling in its travel demand forecasting model?
- Yes
 - No
 - Unsure

Education:

1. Does your city/region have any of the following resources to promote education of bicyclists?
 - Bicycle driver's manual
 - Bicycling-specific website
 - Media involvement
 - Workshops, courses
 - Interactive bicycle maps
 - Social networking communities
 - Other (specify)
2. In the past five years, how many projects have been conducted towards better accommodation of bicycling in your community?
 - Many
 - Some
 - Few
 - None
 - Don't know

Others:

1. What is your opinion with respect to bicycle planning, implementation, and maintenance in your community?
 - Successful
 - Unsuccessful
 - Not sure
2. Would you attribute your city's success in bicycle planning to (check all that apply)
 - Flexible funding policy
 - Strong commitment to bicycling by local government
 - Active outside advocates
 - Active policy makers

- Others
 - I don't consider it a success
 - No bicycle plan
 - Not sure
3. In your opinion, what are the major barriers for planning and implementation of bicycle projects in your community? (check all that apply)
- Lack of funding
 - Culture
 - Lack of government support
 - Lack of public support
 - Insufficient bicycle demand
 - Other (specify)
4. In your opinion, the efforts of your local authority (City/MPO/State) towards promoting bicycling in your community is
- Sufficient
 - Not sufficient
 - No efforts taken
 - Don't know

Appendix B

Bicycle Audit Questionnaire

General Questions

1. What is the population of your city?

- 0-49,999
- 50,00-99,999
- 100,000-299,999
- 30,000 or greater

2. Are you currently a bicyclist?

- Yes
- No

3. What is the modal share of bicyclists in your city?

- 0-0.49%
- 0.5-0.9%
- 1.0-1.9%
- 2.0% or greater

Funding and Policy

1. In your state, who plays a major role in decision-making as to how federal transportation funds are spent in your city?

- State Department of Transportation
- Metropolitan Planning Organization
- Other/ Unsure

2. In your region, which of the following sources for financial support is used for bicycle projects?

- Regional transportation planning
- Individual project applications to the state administered transportation program
- Both a and b
- Other
- Neither
- None of the above

3. Which of the following programs are most often used for funding bicycle projects?

- Transportation Enhancements
- Congestion Mitigation and Air Quality
- Safe Route to School
- Other

4. Does your city have other sources of funding for bicycle projects?

- Yes
- No
- Other/ unsure

5. Does your city have a bicycle committee that assists in bicycling planning and advocacy?

- Yes
- No
- Unsure

6. Does your city have a bicycle advocate or other representative in the local transportation planning group?

- Yes

- No
- Unsure

7. Does your city have a bicycle master plan?

- Yes
- No
- Unsure

8. Have transportation officials effectively petitioned for and gained support from your local government?

- Yes
- No
- Unsure

Engineering and Design

1. What types of bicycle facilities are present in your city?

- Wide curb lanes
- Signed shared roadways
- Bike lanes
- Paved shoulders
- Other

2. What percentage of roadways feature bicycle facilities?

- 0-24%
- 25-49%
- 50-74%
- 75-100%

3. Does your city feature any special intersection treatments for bicycles?

- Bike boxes
- Loop detectors
- Bike signals
- Other

4. Does your city feature any special interchange treatments for bicycles?

- Overpasses/ bridges
- Separated bike trails
- Other

5. How many roadways are designated bike routes or feature bicycle signage in your city?

- 0-24%
- 25-49%
- 50-74%
- 75-100%

6. Does your city actively maintain bike routes and facilities?

- Yes
- No
- Unsure

Education

1. Does your city have any bicyclist education programs?

- Yes
- No
- Maybe

2. Does your city have any motorist education programs?

- Yes
- No
- Maybe

3. Does your city use any of the following media to promote bicycling and bicyclist education?

- Bicycle driver's manual
- Bicycling specific website
- Media involvement
- Workshops, courses
- Interactive bicycle maps
- Social networking communities
- Other

4. Is media used effectively to promote bicycling and bicycle education in your city?

- Yes
- No
- Maybe

Safety

1. What percentage of roadways contain bicycle lanes

- 0-24%
- 25-49%
- 50-74%
- 75-100%

2. What percentage of streets with posted speed limits greater than 50 mph have bike lanes?

- 0-24%

- 25-49%
- 50-74%
- 75-100%

3. Is law enforcement used effectively to investigate and learn from bicycle crashes?

- Yes
- No
- Unsure

4. Are motorists properly educated on the rights of bicyclists?

- Yes
- No
- Unsure

5. Are bicyclists properly educated on lawful bicycle operation?

- Yes
- No
- Unsure

6. 6. Are there any special measures taken to improve bicycling safety in your city?

- Yes
- No
- Unsure

7. Do a high percentage of businesses and recreation areas feature bicycle friendly features (lockers, racks, or showers)?

- Yes
- No
- Unsure

8. Are bicycle facilities well lit and secure?

- Yes
- No
- Unsure

Appendix C

Incomplete Audit Excel Form

This is a blank copy of the Excel spreadsheet used to audit bicycle cities. Instructions are included in Table C.1.

Table C. 1: Blank Audit Form

Bicycle Audit

Instructions: For each response, place a lower case x next to the appropriate response for each question. When applicable, multiple responses may be applied to a certain question. Each response has an associated weight, and each section has a total possible score. When the questionnaire is completed, your city will be assigned a letter grade corresponding to the success level of bicycling implementation in your city.

| Question | Response | Score |
|--|----------|--------------|
| General Questions | | |
| 1. What is the population of your city? | | |
| a. 0 -49,999 | | |
| b. 50,000-99,999 | | |
| c. 100,000-299,999 | | |
| d. 300,000 or greater | | |
| 2. Are you currently a bicyclist? | | |
| a. Yes | | |
| b. No | | |
| 3. What is the modal share of bicycles in your city? | | |
| a. 0-0.49% | | |
| b. 0.5-0.9% | | |
| c. 1.0-1.9% | | |
| d. 2.0% or greater | | |
| Score | 0 | |
| Total Section Score | 0 | of 30 |

Table C. 1. Continued

| Funding and Policy | | |
|--|--|---|
| 1. In your state, who plays a major role in decision-making as to how federal transportation funds are spent in your city? | | |
| a. State Department of Transportation | | |
| b. Metropolitan Planning Organization | | |
| c. Other/ Unsure | | |
| Score | | 0 |
| 2. . In your region, which of the following sources for financial support is used for bicycle projects? | | |
| a. Regional transportation planning | | |
| b. Individual project applications to the state administered transportation program | | |
| c. Both a and b | | |
| d. Other | | |
| e. None of the above | | |
| Score | | 0 |
| 3. Which of the following programs are most often used for funding bicycle projects? | | |
| a. Transportation Enhancements | | |
| b. Congestion Mitigation and Air Quality | | |
| c. Safe Route to School | | |
| d. Other | | |
| Score | | 0 |
| 4. Does your city have other sources of funding for bicycle projects? | | |
| a. Yes | | |
| b. No | | |
| c. Other/ Unsure | | |
| Score | | 0 |

Table C. 1. Continued

| | | |
|---|----------|--------------|
| 5. Does your city have a bicycle committee that assists in bicycling planning and advocacy? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | 0 | |
| 6. Does your city have a bicycle advocate or other representative in the local transportation planning group? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | 0 | |
| 7. Does your city have a bicycle master plan? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | 0 | |
| 8. Have transportation officials effectively petitioned for and gained support from your local government? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | 0 | |
| Total Section Score | | |
| | 0 | of 20 |

Table C. 1. Continued

| Engineering and Design | | |
|--|--|----------------|
| 1. What types of bicycle facilities are present in your city? | | |
| a. Wide curb lanes | | |
| b. Signed shared roadways | | |
| c. Bike lanes | | |
| d. Paved shoulders | | |
| e. Other | | |
| Score | | 0 |
| 2. What percentage of roadways feature bicycle facilities? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | | |
| Score | | 0 |
| 3. Does your city feature any special intersection treatments for bicycles? | | |
| a. Bike boxes | | |
| b. Loop detectors | | |
| c. Bike signals | | |
| d. Other | | |
| Score | | 0 |
| 4. Does your city feature any special interchange treatments for bicycles? | | |
| a. Overpasses or bridges | | |
| b. Separated bike trails | | |
| c. Other | | |
| Score | | 0 |
| 5. How many roadways are designated bike routes or feature bicycle signage in your city? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | | |
| Score | | 0 |
| 6. Does your city actively maintain bike routes and facilities? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | | 0 |
| Total Section Score | | 0 of 15 |

Table C. 1. Continued

| Education | | |
|--|--|----------------|
| 1. Does your city have any bicyclist education programs? | | |
| a. Yes | | |
| b. No | | |
| c. Maybe | | |
| Score | | 0 |
| 2. Does your city have any motorist education programs? | | |
| a. Yes | | |
| b. No | | |
| c. Maybe | | |
| Score | | 0 |
| 3. Does your city use any of the following media to promote bicycling and bicyclist education? | | |
| a. Bicycle driver's manual | | |
| b. Bicycling specific website | | |
| c. Media involvement | | |
| d. Workshops, courses | | |
| e. Interactive bicycle maps | | |
| f. Social networking communities | | |
| g. Other | | |
| Score | | 0 |
| 4. Is media used effectively to promote bicycling and bicycle education in your city? | | |
| a. Yes | | |
| b. No | | |
| c. Maybe | | |
| Score | | 0 |
| Total Section Score | | 0 of 10 |

Table C. 1. Continued

| Safety | | |
|---|---|--|
| 1. What percentage of roadways contain bicycle lanes? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | | |
| Score | 0 | |
| 2. What percentage of streets with posted speed limits greater than 30 mph have bike lanes? | | |
| a. 0-24% | | |
| b. 25-49% | | |
| c. 50-74% | | |
| d. 75-100% | | |
| Score | 0 | |
| 3. Is law enforcement used effectively to investigate and learn from bicycle crashes? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | 0 | |
| 4. Are motorists properly educated on the rights of bicyclists? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | 0 | |

Table C. 1. Continued

| | | |
|--|---|----------|
| 5. Are bicyclists properly educated on lawful bicycle operation? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | | 0 |
| 6. Are there any special measures taken to improve bicycling safety in your city? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | | 0 |
| 7. Do a high percentage of businesses and recreation areas feature bicycle friendly features (lockers, racks, or showers)? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | | 0 |
| 8. Are bicycle facilities well lit and secure? | | |
| a. Yes | | |
| b. No | | |
| c. Unsure | | |
| Score | | 0 |
| Total Section Score | | 0 of 25 |
| Total Score | | 0 of 100 |
| Your grade: | F | |

Appendix D

TxDOT Report #: 0-6582-1

This is an excerpt from TxDOT Report #: 0-6582-1 coauthored by the author of this thesis (Liu et al., 2011). The missing sections are the background and literature review provided earlier in this thesis and the appendices.

Chapter 3: Analysis

TechMRT worked together with TxDOT to conduct a survey of successful bicycle policies and practices in the United States. The team developed and released an online survey targeted at various groups, including: Metropolitan Planning Officials (MPOs), government officials, bicycle users, bicycle advocacy groups, TxDOT employees, and members of the Texas District of the Institute of Transportation Engineers (TexITE). The purpose of this survey was to rate various issues of funding, safety, and organization to create a clear picture of how successful bicycling would appear in Texas, particularly in mid-size cities. The team used the website www.surveymonkey.com. The link for the survey was <http://www.surveymonkey.com/s/5TB5FXN>. The survey was distributed to approximately 1300 respondents, many of whom disseminated it among other colleagues and posted the link on various websites. A total of 436 respondents took the survey, totaling about 34% of the initial survey population. The high level of responses both lends credibility to the study and indicates the importance and popularity of bicycling as a means of transportation.

The first analysis examined the survey with an initial assumption that the perceived comfort level of bicycling correlates to the success rate of a community. Responses to all survey questions are cross-referenced with the question: "Overall, bicycling in your community is?" Cross-referencing other questions with this question allowed the research team to examine results based upon the perceived comfort rate of bicycling in a community, thereby creating a clearer picture of successful bicycling stories. This analysis differentiates between questions aimed at bicycle user groups and government officials.

The second analysis examined the differences between mid-size cities and other sized cities. Rather than presenting every question again, this section will examine key questions that provide important differences between cities of different sizes. Responses to questions are cross-referenced with the question: "What is the population of your community?" Mid-size cities have a population of 100,000 to 300,000, urban cities have

a population of 300,000 to 500,000, metropolitan cities have a population greater than 500,000, suburban areas as 50,000 to 100,000, and rural areas have a population less than 50,000. An analysis for each of the selected questions is presented, followed by the related figure showing responses.

3.1: Analysis of Success

This section analyzes the results of the survey to compare and contrast factors that make bicycling in a community comfortable and successful. This is accomplished by cross-referencing all questions with the main question: "Overall, bicycling in your community is?" The responses to each question are cross-tabbed with four possible responses to the main question: joyful and pleasant, acceptable but needs some improvement, not satisfactory and needs lots of improvements, and extremely dangerous and not acceptable at all. This section includes two sub-sections for bicycle users and government officials. Charts are presented for each question to show the full response statistics.

3.1.1: Questions for Bicycle Users

The following questions are directed at bicycle users and bicycle advocacy groups. The section will list each question with an accompanying analysis and a chart that shows the responses.

1. How would you describe your community?

This question asked respondents to rate the type of community in which they live. Responses included metropolitan, urban, suburban, rural, and college. Unsurprisingly, the highest percentages of respondents for urban communities indicated that bicycling in their community is either joyful and pleasant (34.1%) or acceptable but needs some improvements (43.1%). This indicates that bicycling in urban areas may be more successful thanks to the increased funding, planning, and organization that accompanies larger populations. Interestingly, the majority of respondents in metropolitan communities indicated that bicycling in their community is extremely dangerous and not acceptable at all (28.6%). This could be a result of a much larger population and denser

traffic, resulting in poor bicycling conditions. While a metropolitan area would likely benefit from greater levels of funding, safety may still be the determining factor for the success of bicycling in the community. Figure D.1 illustrates the results of this question.

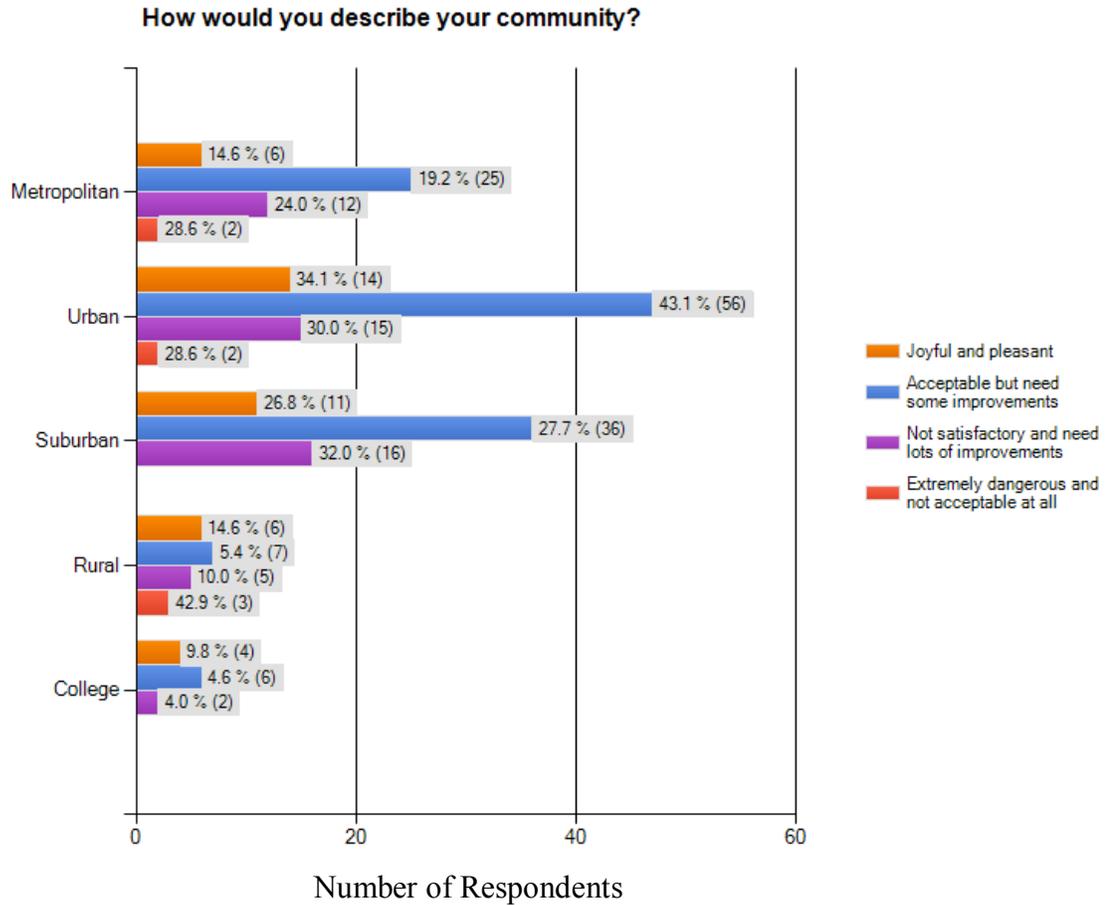


Figure D. 1: Community Size in Communities of Different Comfort Levels

2. What is the population of your community?

This question rates the population of a community compared to the success of bicycling in that community. Similar to the results of the previous question, the majority of respondents in mid-size cities (100,000 to 300,000) indicated that bicycling is joyful and pleasant (29.3%). The majority of respondents (46.2%) in metropolitan communities (more than 500,000) indicated that bicycling in their community is not satisfactory and needs improvement. These results could once again indicate that safety is a primary

concern, and larger populations lead to decreased safety, and therefore decreased comfort. The results are shown in Figure D.2.

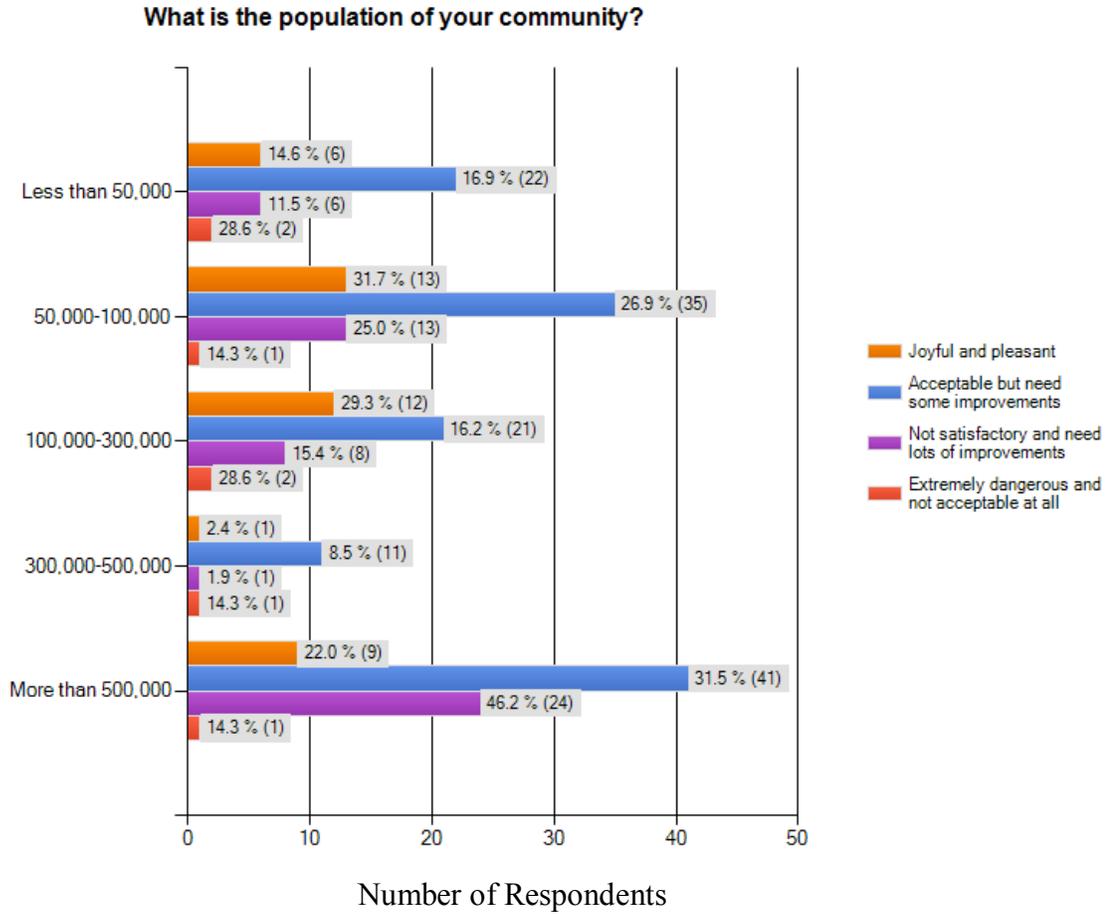


Figure D. 2: Population Size and Communities of Different Comfort Levels

3. Overall, Bicycling in your community is?

This is the question in which all questions in this section are cross-referenced. The majority of respondents (56.7%) indicate that bicycling in their community is acceptable but needs some improvement. This could indicate that bicycling is progressing as a successful and accepted means of transportation in many areas, but further improvements to the system still need to be made. The results of this question are shown in Figure D.3.

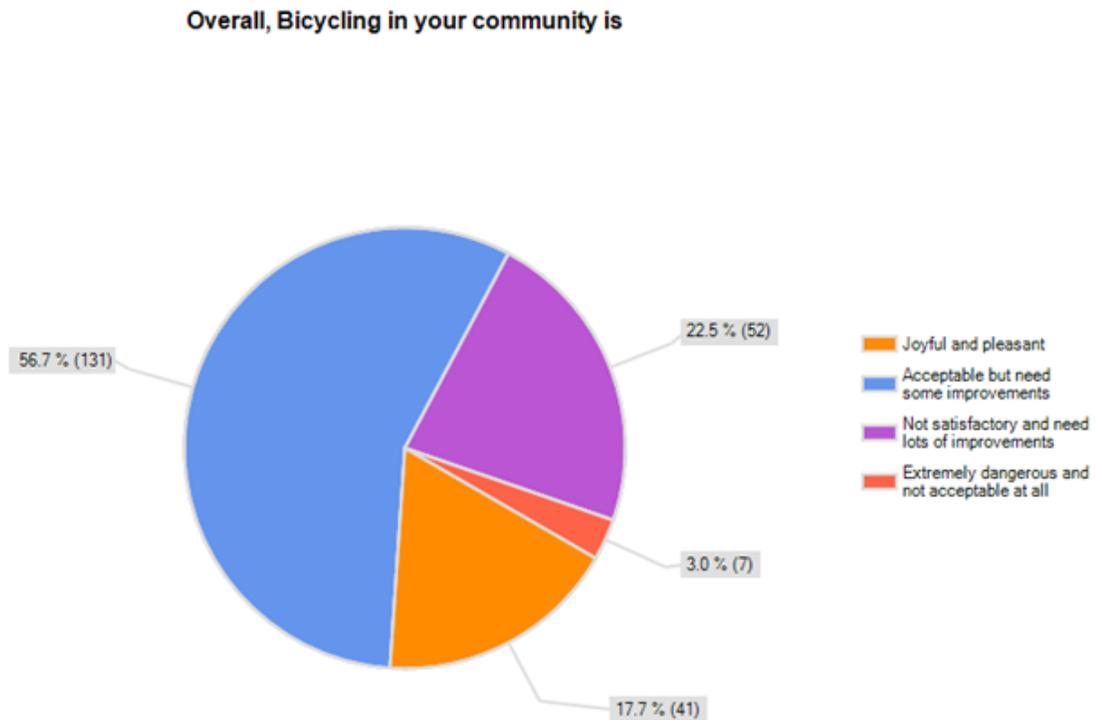


Figure D. 3: Perceived Comfort Level of Bicycling in a Community

4. On a scale from 0 to 10 (with 10 being the best), how would you rate your community's efforts to promote bicycling?

This question allowed respondents to indicate the efficacy of bicycle promotion in their community. Respondents in communities claiming that bicycling is joyful and pleasant gave their community an average rating of 7.80. Respondents in communities claiming that bicycling is acceptable but needs some improvement gave their community an average rating of 6.42. Respondents in communities claiming that bicycling is not satisfactory and needs lots of improvements gave their community an average rating of 3.58. Lastly, respondents in communities claiming that bicycling is extremely dangerous and not acceptable at all gave their community an average rating of 4.5. These responses seem to indicate that more successful communities promote bicycling far better than other communities. Therefore, bicycle promotion plays an important role in creating a successful bicycling community.

5. In your opinion, what is the most important factor for creating a bicycle friendly community?

The majority of respondents from each community of different bicycling comfort levels indicated that political support, funding, culture, a strong advocacy group, and education are all equally important to creating a bicycle friendly community. Therefore, no community should ignore any of these factors when implementing a bicycle plan. The results of this question are shown in Figure D.4.

In your opinion, what is the most important factor for creating a bicycle friendly community?

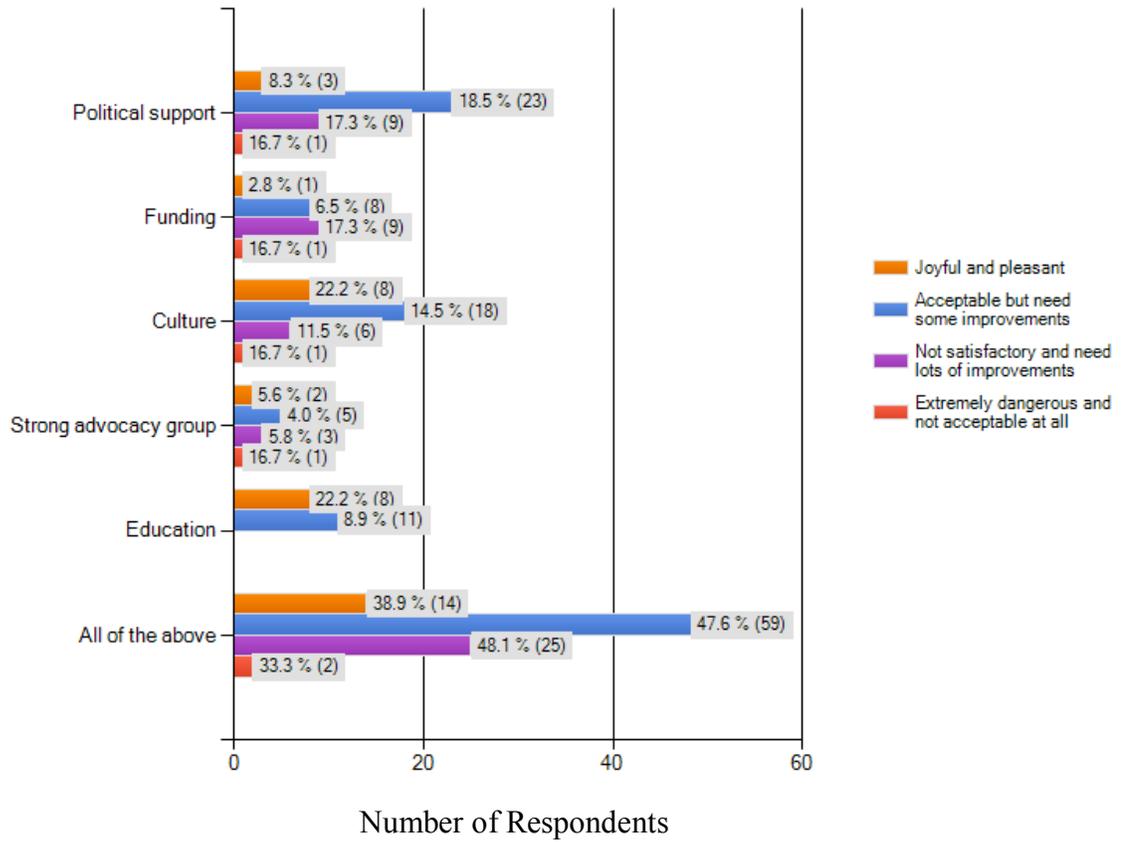


Figure D. 4: Important Factors for Bicycling in Communities of Different Comfort Levels

6. What is the most common reason for you to make a trip by bicycle? (check all that apply)

The majority of respondents who claim bicycling in their community is joyful and pleasant (70.7%) or acceptable but needs some improvement (63.6%) indicated that their primary reason for bicycling is commuting to and from work. This could indicate that these communities have better developed bicycling systems that are more accommodating to practical reasons for bicycling. The majority of respondents from other communities use bicycling primarily for recreation. This could indicate a lack of safety and useful bicycle structures in these communities when compared to more successful communities, causing bicyclists to be less comfortable riding their bicycles in urban areas. These results are shown in Figure D.5.

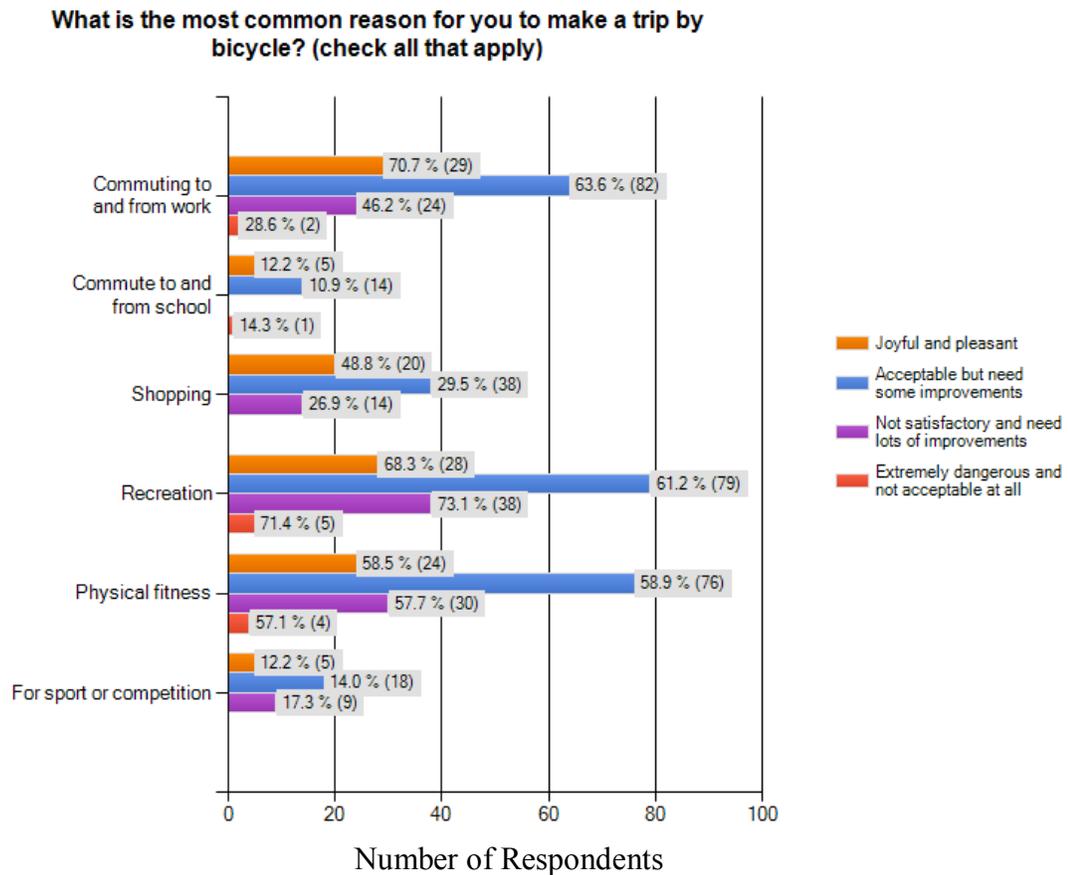


Figure D. 5: Primary Reasons for Bicycling and Community Comfort Level

7. Which of the following problems associated with bicycling have you observed in your community? (check all that apply)

The majority of respondents from all community sizes indicated that the primary problem associated with bicycling in their communities is roadway design features unfriendly to bicyclists. This likely indicates the lack of planning when most communities were developed before bicycling gained popularity. Future developments should be planned to make roadways safer for and more accommodating to bicyclists. The results are shown in Figure D.6.

Which of the following problems associated with bicycling have you observed in your community? (check all that apply)

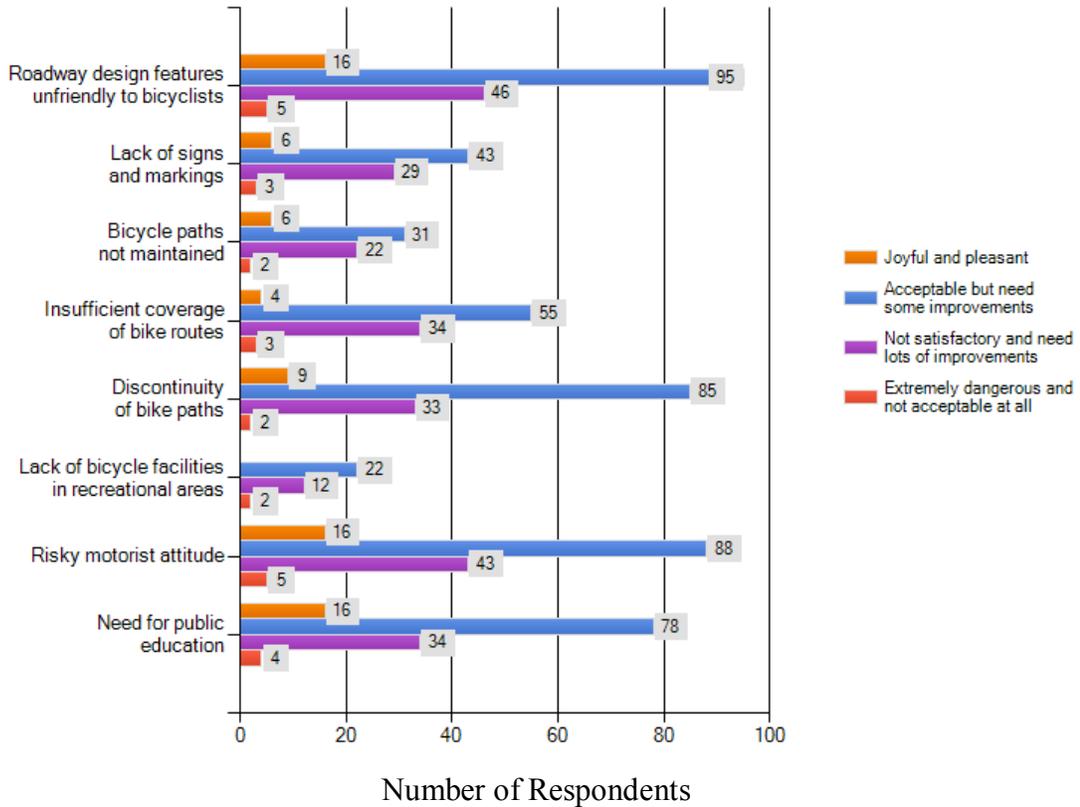


Figure D. 6: Common Problems Associated with Bicycling in Communities of Different Comfort Levels

8. Rank the factors that may encourage you to use a bicycle more often (with 1 being most important and 8 being least important)

The majority of respondents from all communities except extremely dangerous communities indicated that safer road conditions would be the primary factor that encouraged them to bicycle more often. This clearly indicates the universal concern for safety that bicyclists feel, and supports many of the previous assumptions about safety being a primary concern and motivation. The respondents in extremely dangerous communities ranked safer road conditions as extremely important, but they chose improved continuity and accessibility of bicycle network as the most important factor. This could be due to the simple lack of supporting bicycle infrastructure in those communities. Figure D.7 shows the results of this question.

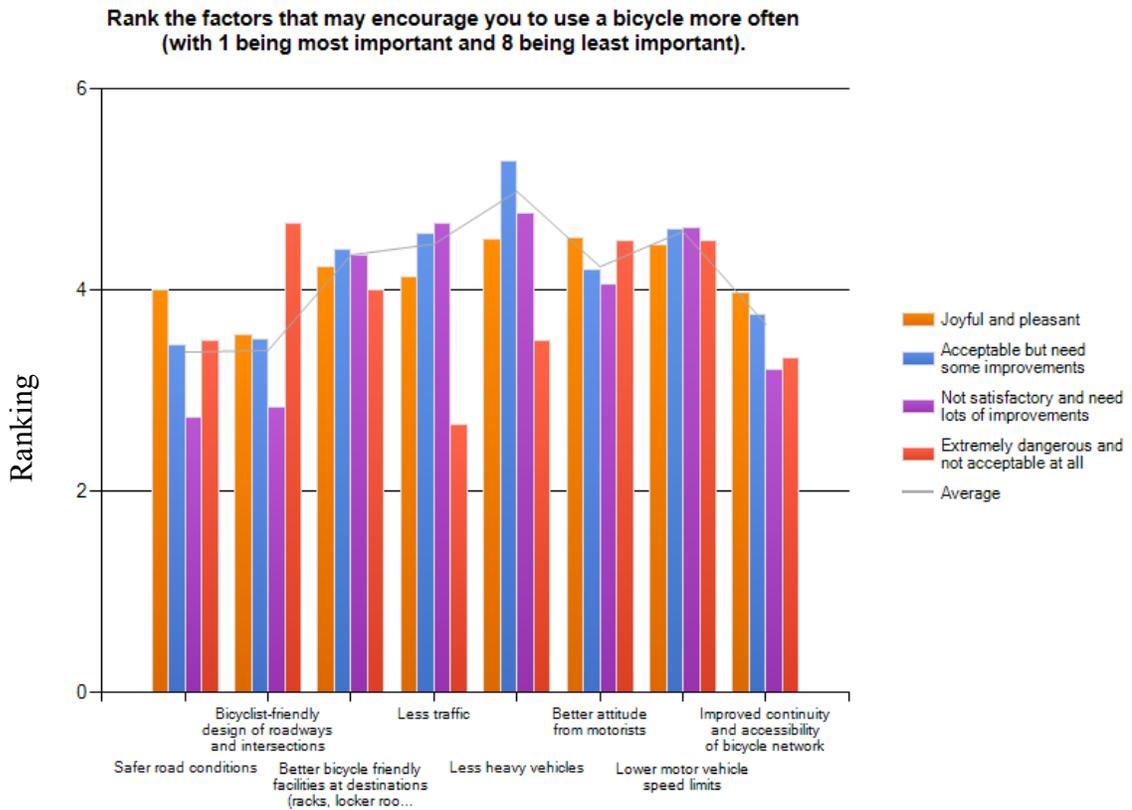


Figure D. 7: Factors That Encourage Bicycling in Communities of Different Comfort Levels

9. Rank the following factors that discourage you from cycling more often in your community (with 1 being most important and 7 being least important)

In all communities except joyful and pleasant ones, the majority of respondents indicated that road safety is the primary discouraging factor for bicycling. This again illustrates the universal concern for safety and demonstrates that safer conditions lead to more comfortable and successful bicycling communities. The majority of respondents in communities in which bicycling is joyful and pleasant indicated that their primary concern is distance to destinations. This could indicate a need for better bicycle facility planning so that bicycle commuters can reach destinations more directly and more quickly. The results of this question are shown in Figure D.8.

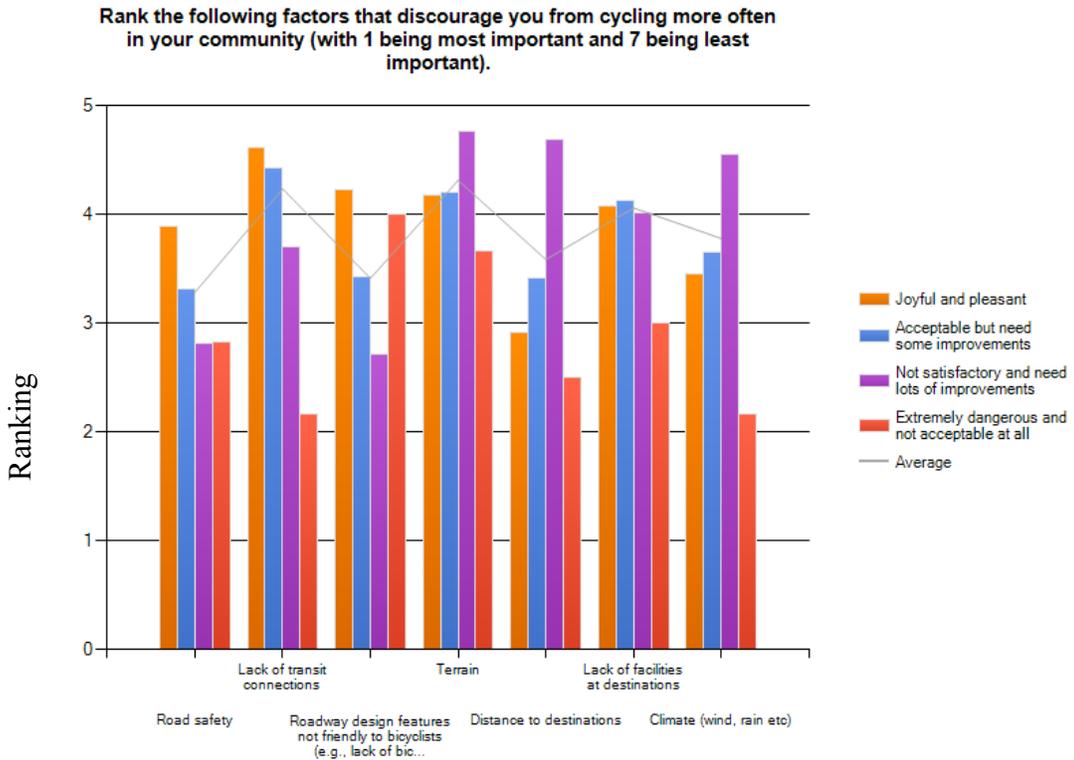


Figure D. 8: Factors That Discourage Bicycling in Communities of Different Comfort Levels

10. What is a comfortable distance for you to commute by bicycle under current roadway condition and availability of bicycle facilities in your city?

The majority of respondents in all communities except the most dangerous ones indicated that they are comfortable commuting up to five miles by bicycle. This indicates that more successful communities are generally safer. The results of this question are shown in Figure D.9.

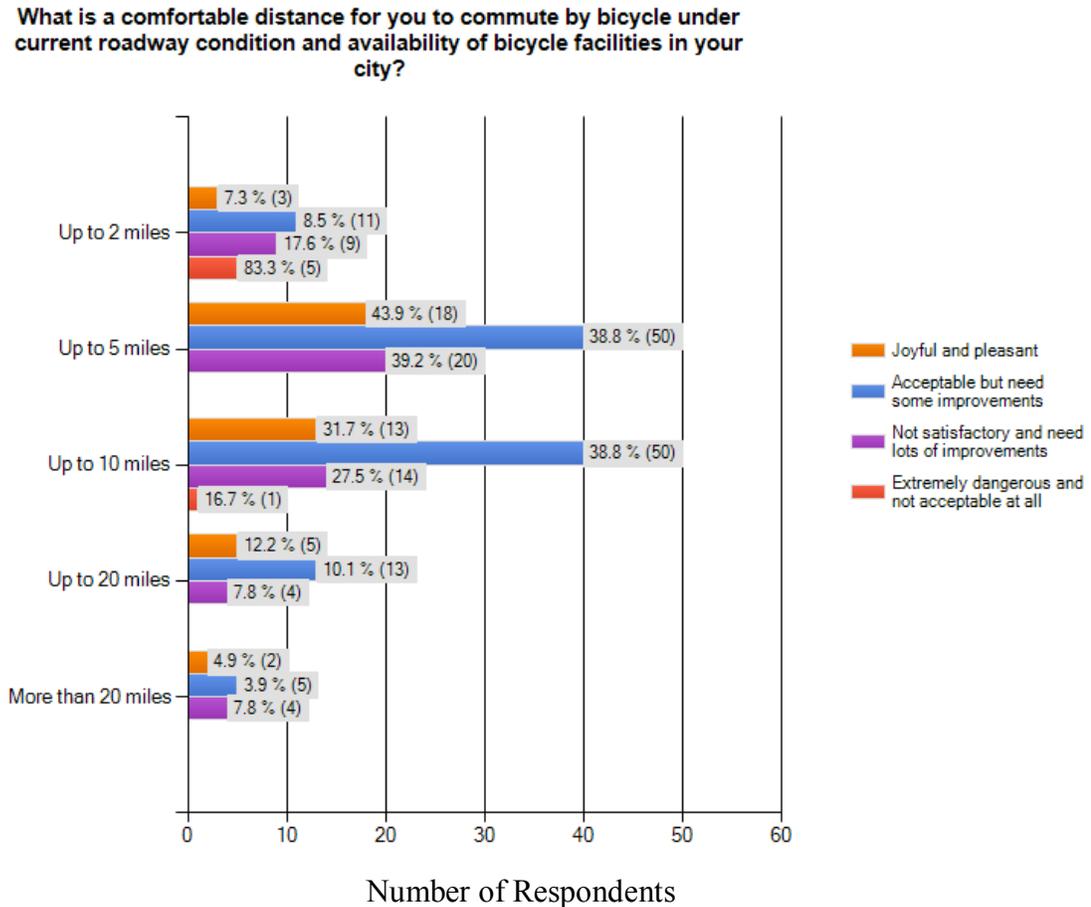


Figure D. 9: Comfortable Bicycle Commuting Distance in Communities of Different Comfort Levels

11. What is a comfortable distance for you to commute by bicycle if your city's infrastructure and overall environment is more bicycle friendly?

The majority of respondents from the three most successful bicycling communities indicated that they would be comfortable commuting up to 10 miles if their city's infrastructure and environment was more bicycle friendly. This shows that even successful communities can still be improved in terms of bicycling. The results are shown in Figure D.10.

What is a comfortable distance for you to commute by bicycle if your city's infrastructure and overall environment is more bicycle friendly?

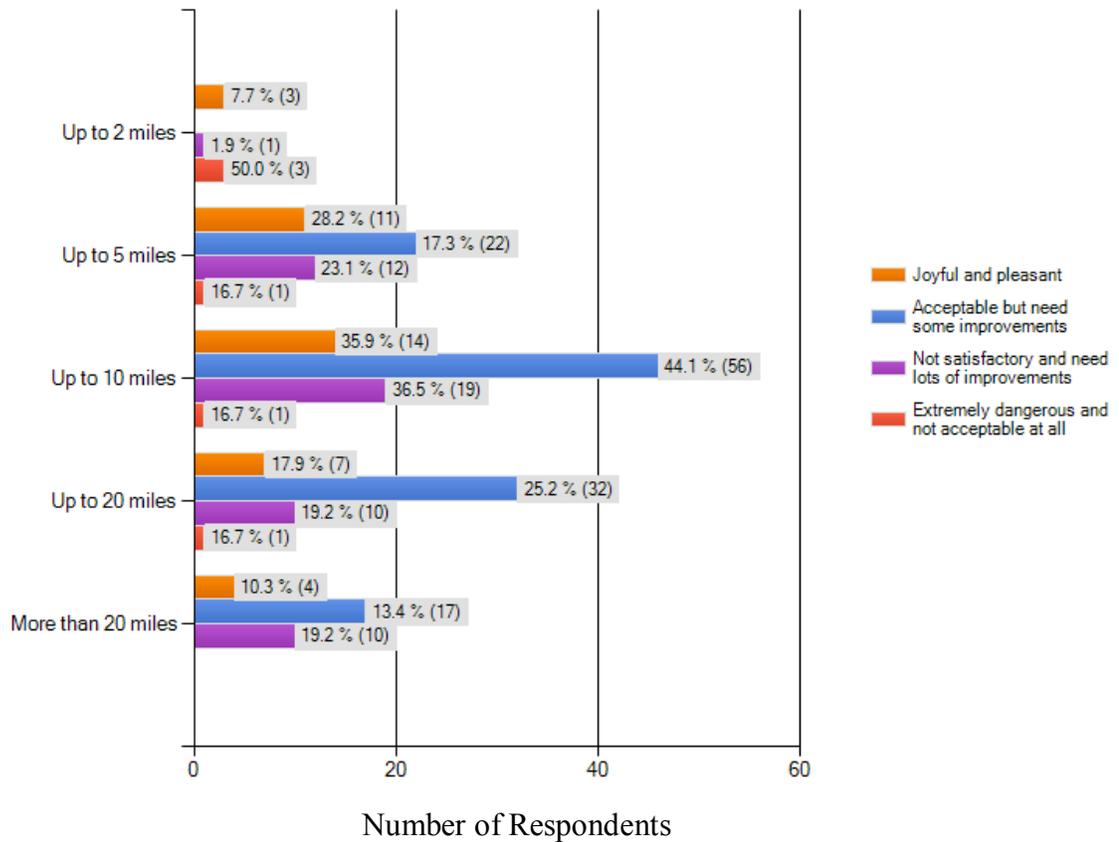


Figure D. 10: Comfortable Bicycle Commuting Distance with Improved Conditions in Communities of Different Comfort Levels

12. *If designated/signed bike routes are available, you would consider bicycling on the streets and highways with a posted speed limit of?*

The majority of respondents in the three most successful community types are comfortable bicycling on streets and highways with designated bike routes at a posted speed limit of 35 miles per hour (mph) (joyful and pleasant communities) or 40 mph (acceptable and not satisfactory communities.) The majority of respondents from extremely dangerous communities (83.3%) only feel safe bicycling at posted speed limits of 30 mph and lower. This again illustrates that safety is a primary concern; even when designated bike routes are available, bicyclists in unsafe communities do not feel safe bicycling on roadways with higher speed limits. Figure D.11 shows the results of this question.

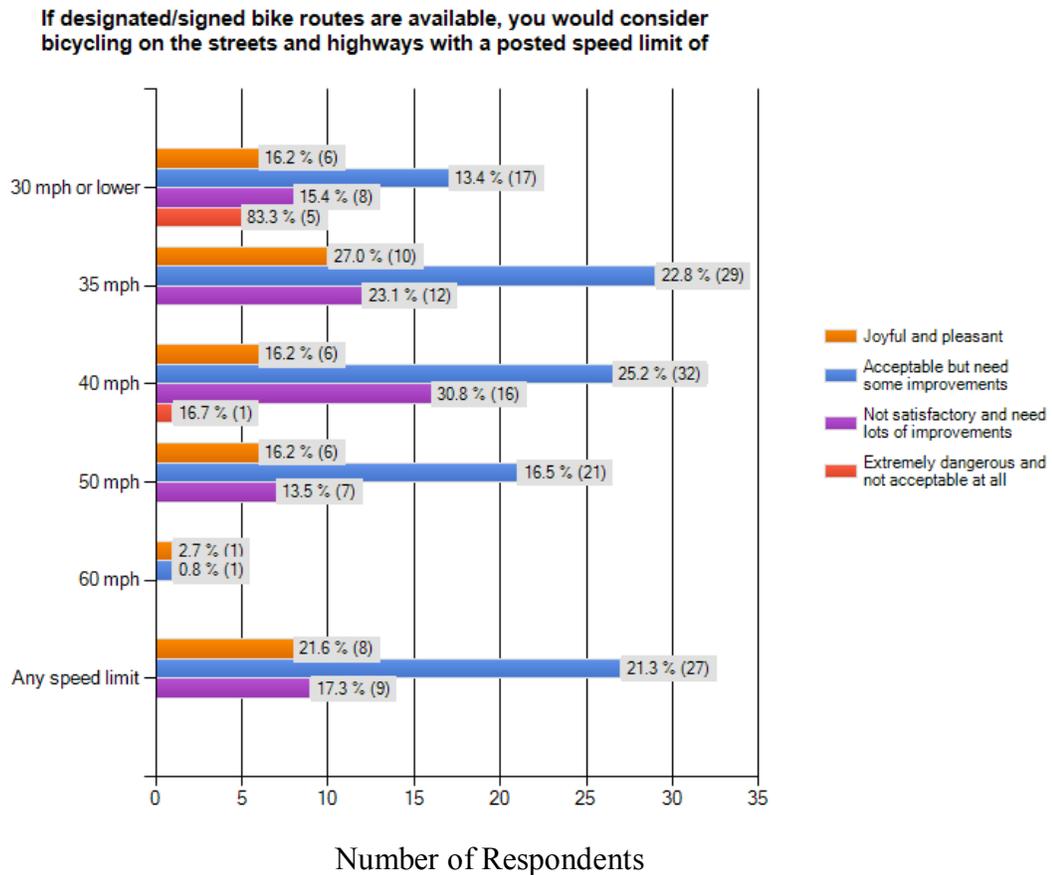


Figure D. 11: Comfortable Bicycle Commuting Speed Limits in Designated Bike Routes in Communities of Different Comfort Levels

13. If shared lanes (wide lanes shared by autos and bicycles) without signs are available, you would consider bicycling on the streets and highways with a posted speed limit of?

The majority of respondents from all communities indicated that they do not feel safe bicycling in a shared lane with a posted speed limit greater than 30 mph. This indicates that bicyclists perceive shared lanes to be less safe than other bicycle facilities and reinforces the importance of safety. The results of this question are shown in Figure D.12.

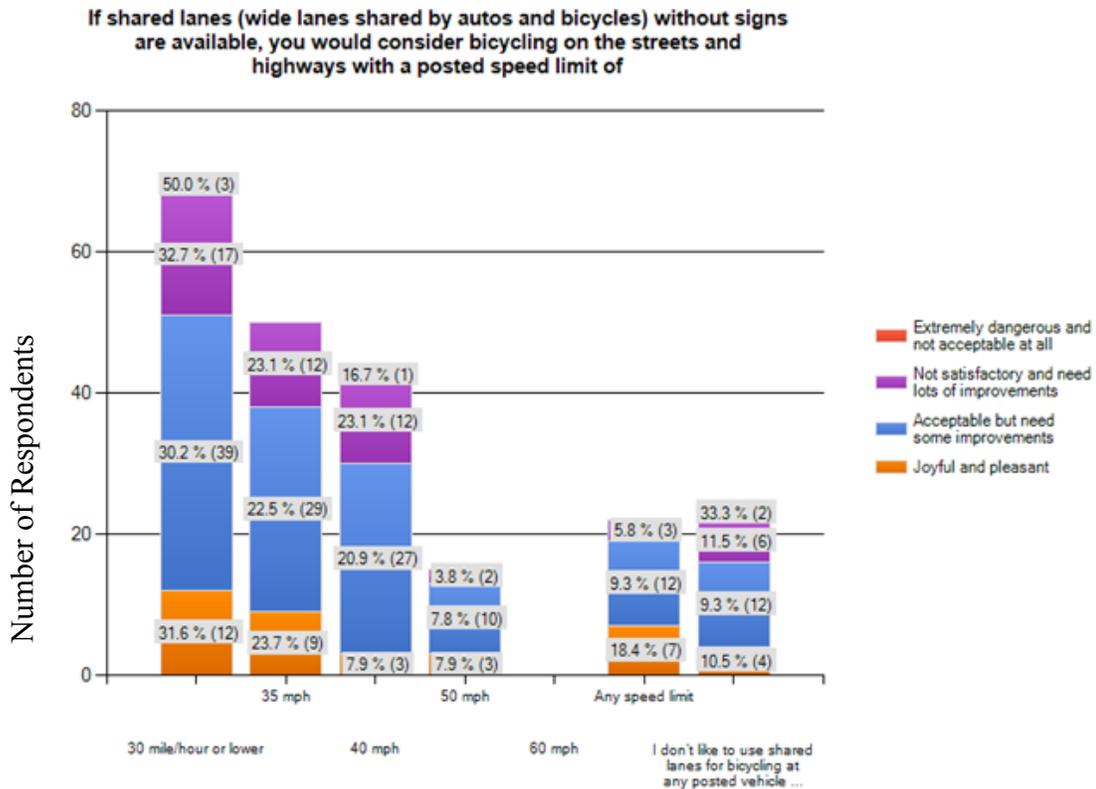


Figure D. 12: Comfortable Bicycle Commuting Speed Limits in Shared Lanes in Communities of Different Comfort Levels

14. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of safety?

Unsurprisingly, communities with a higher comfort level also seem to be safer for bicyclists. The majority of respondents from joyful and pleasant communities (47.5%) indicated that their community is good in terms of safety. In communities that are acceptable but need some improvement, the majority of respondents (51.2%) indicated that their communities are acceptable in terms of safety. The majority of respondents from communities that are either not satisfactory (83.7%) or extremely dangerous (100%) indicated that the safety levels in their communities are poor. The results of this question validate the assumption that safety is the primary concern for bicyclists and determines how successful and comfortable bicycling is in their community. The results of this question are shown in Figure D.13.

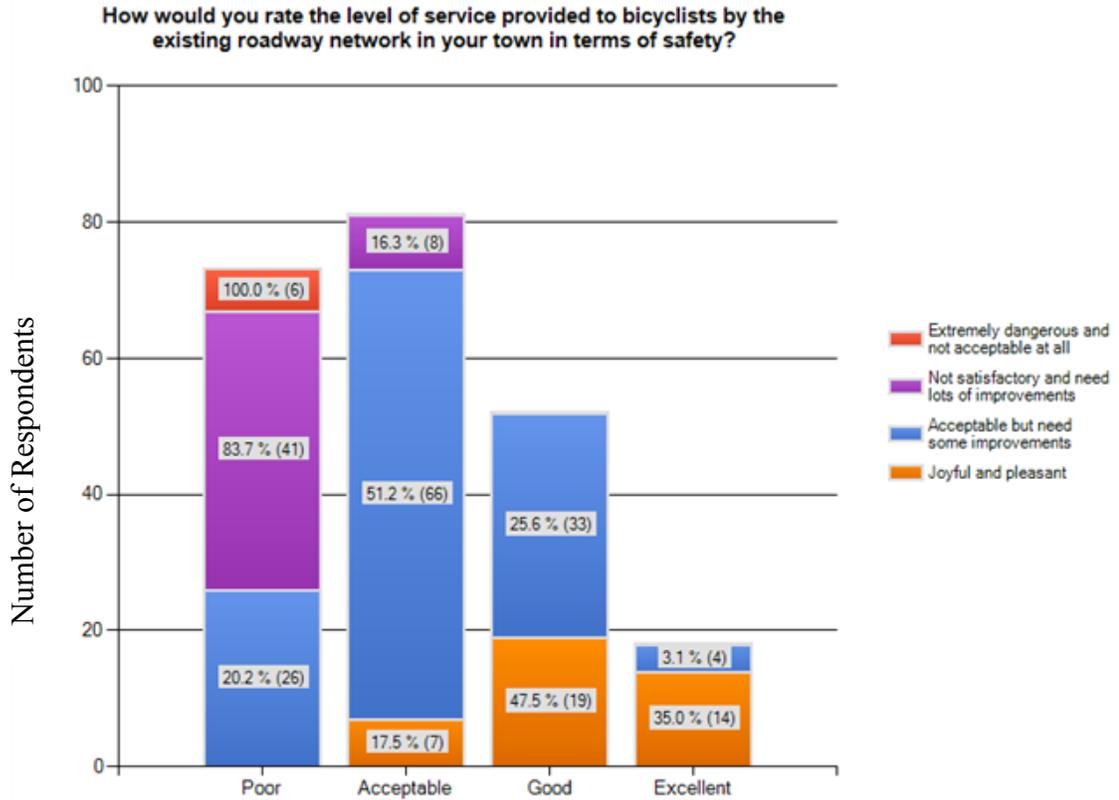


Figure D. 13: Perceived Safety Level of Existing Roadways in Communities of Different Comfort Levels

15. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of connectivity?

The majority of respondents from communities claiming that bicycling in their community is joyful and pleasant (43.9%) rated their communities good in terms of connectivity. The majority of respondents from communities claiming that bicycling is acceptable also listed connectivity in their towns as acceptable (51.9%). The other communities rated connectivity in their towns as poor. These results indicate that good connectivity leads to a comfortable bicycling climate. The results from this question are shown in Figure D.14.

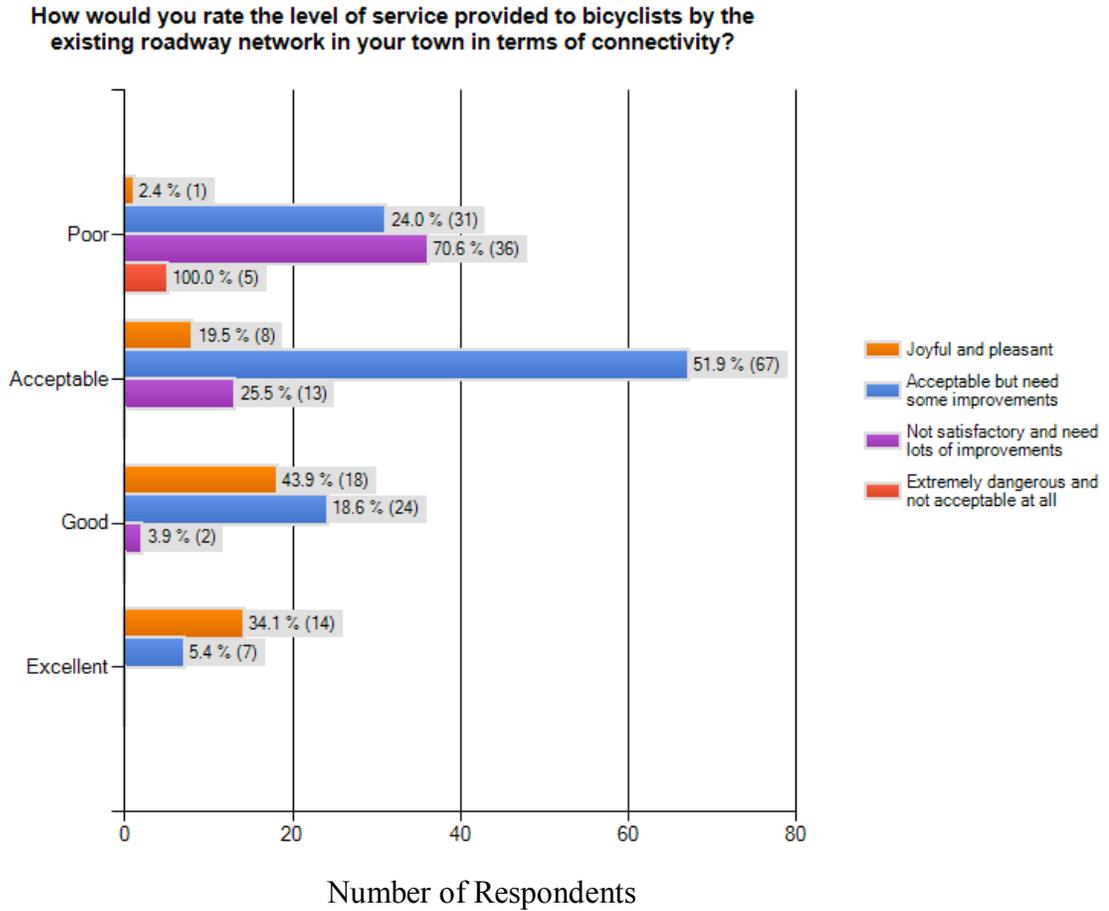


Figure D. 14: Connectivity Level of Existing Roadways in Communities of Different Comfort Levels

16. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of efficiency?

The results of this question are very similar to those of the previous question. The majority of respondents from joyful and pleasant communities (60.0%) rated their towns' efficiency levels as good. The majority of respondents from acceptable bicycling communities (56.3%) rated roadway efficiency in their towns as acceptable. The majority of respondents from other communities rated their towns as poor in terms of efficiency. Similarly to safety and connectivity, communities with a more efficient roadway system for bicyclists are typically viewed as more comfortable for bicyclists. The results of this question are shown in Figure D.15.

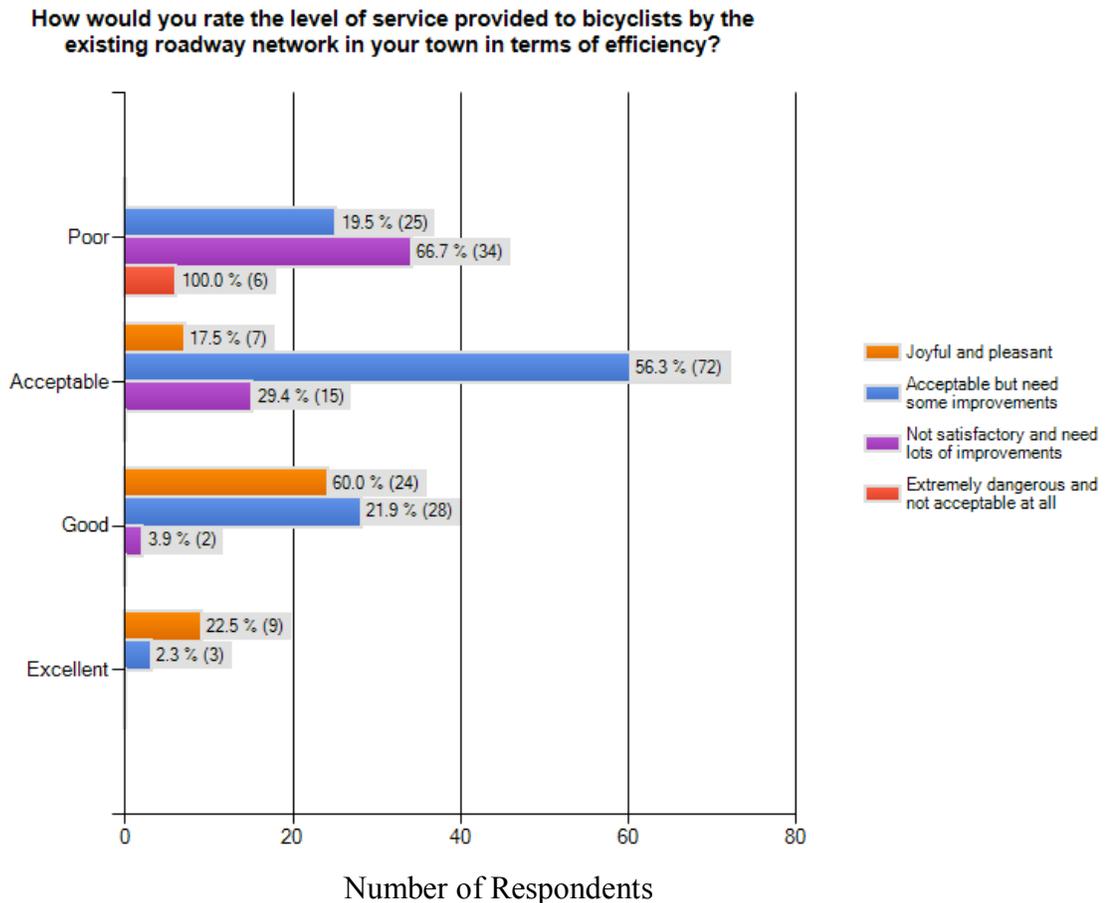


Figure D. 15: Efficiency Level of Existing Roadways in Communities of Different Comfort Levels

17. *Is media effectively used in your community in promoting safe bicycling?*

The results of this question are unsurprising. The majority of respondents from joyful and pleasant communities (42.5%) claimed that media is used effectively, while the majority of respondents from acceptable communities claimed that media is used somewhat effectively (48.4%). The majority of respondents from the less-successful community types claimed that media is not used effectively in their communities. These results indicate that media can be used as an effective tool to promote bicycling and improve the comfort level and success of bicycling in a community. The results of this question are shown in Figure D.16.

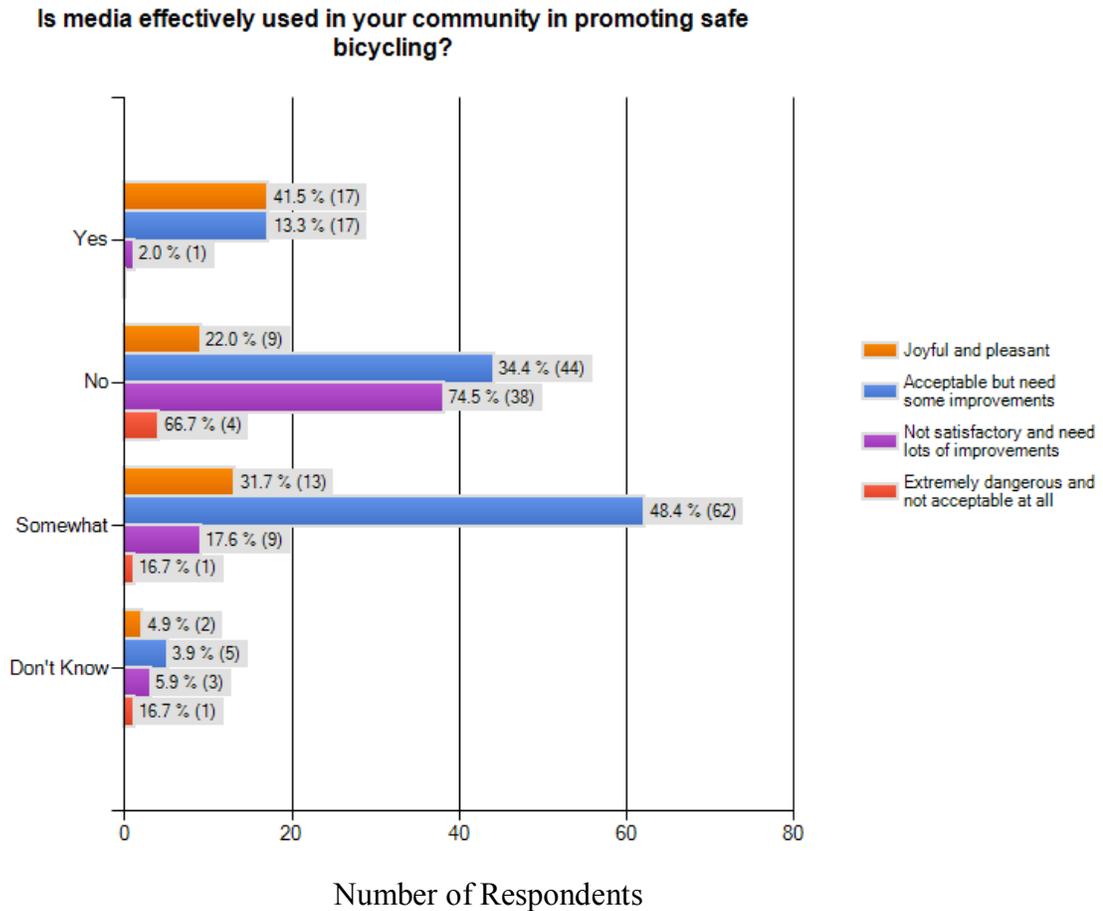


Figure D. 16: Effective Media Use in Communities of Different Comfort Levels

18. Does your community have any of the following activities? (check all that apply)

This question asked respondents to indicate all of the bicycling activities held in their communities. While respondents from every community type indicated that their community types have all or most of these activities, it seems that not every activity is held as abundantly in every community. Respondents from joyful and pleasant communities indicated a higher percentage of Bike Month/Bike Week, Bike to Work, and Bike to School activities than any other community type. Therefore, it seems that a higher number of bicycling activities held in a community improves its overall comfort and success rating. The results of this question are shown in Figure D.17.

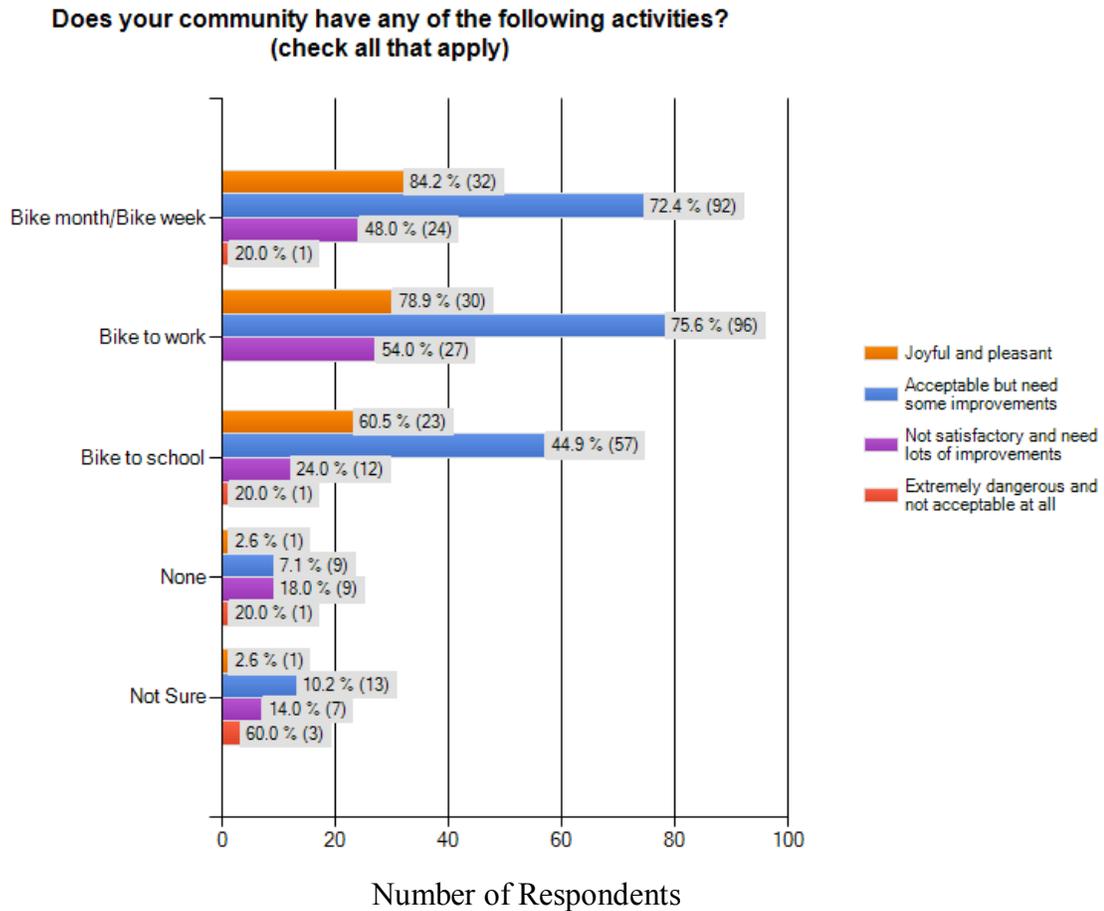


Figure D. 17: Different Bicycling Activities in Communities of Different Comfort Levels

19. How would you rate the motorists' attitude towards bicyclists in your town?

The majority of respondents from joyful and pleasant communities (47.5%) indicated that motorists' attitudes in their communities are acceptable. The majority of respondents from acceptable communities (45.0%) rated their motorists' attitudes as neutral. The majority of respondents from unsatisfactory communities claimed that motorists' attitudes are negative. Interestingly, the results from extremely dangerous communities show that motorists' attitudes are either acceptable or negative, so it should be assumed that overall the attitudes are not as good as they could be. These results could indicate that increased education and promotion helps improve motorists' attitudes, which in turn improves the comfort level of bicycling in a community. However, this question indicates that all communities could improve from better motorist attitudes. The results of this question are shown in Figure D.18.

How would you rate the motorists' attitude towards bicyclists in your town?

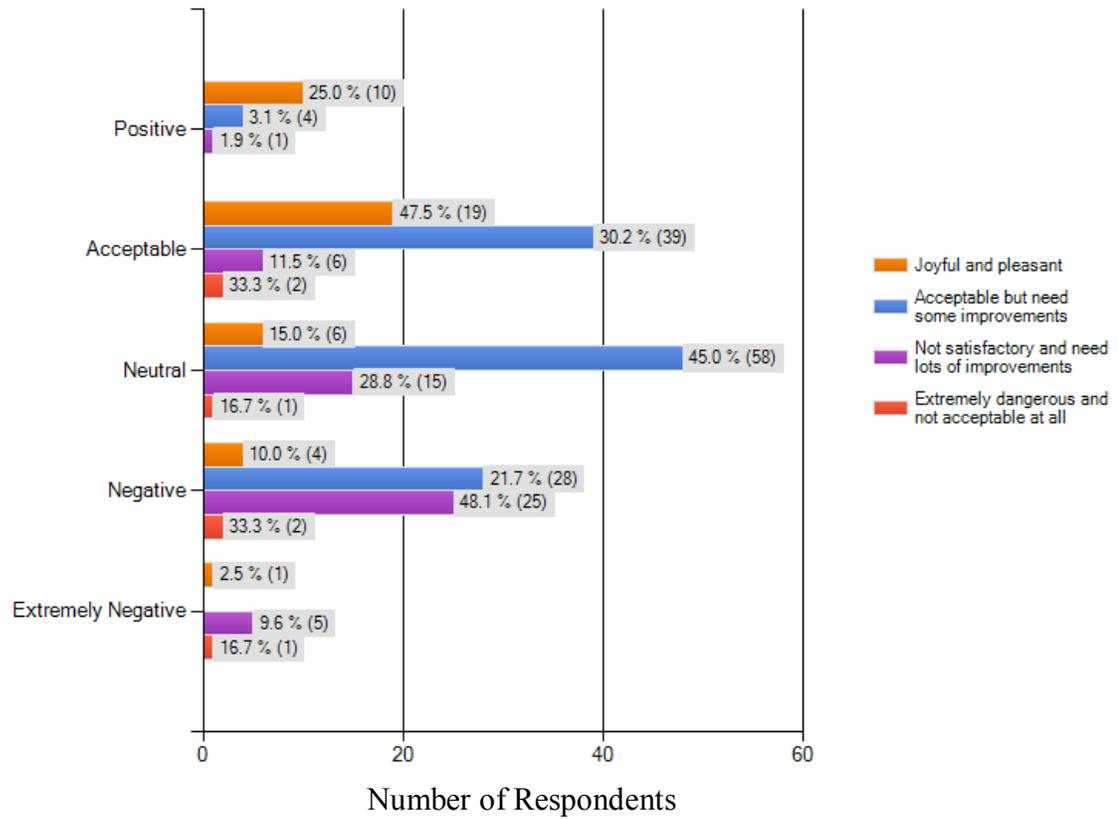


Figure D. 18: Motorists' Attitudes toward Bicyclists in Communities of Different Comfort Levels

20. As a bicyclist, do you think that you are given the same rights and responsibilities as a motor vehicle operator in your community?

The majority of respondents from joyful and pleasant communities (68.3%) claimed that they are given the same rights and responsibilities as motor vehicle operators. The majority of respondents from all other communities indicated that they are not given the same rights and responsibilities as motor vehicle operators. These results seem to indicate another crucial difference between successful and unsuccessful bicycling communities. It seems that bicyclists who are given greater rights and responsibilities are more comfortable, leading to a higher success rate. These increased rights could come from increased education and media usage, although it is difficult to tell. However, securing these rights does seem like an important factor in creating a successful bicycling community. The results of this question are shown in Figure D.19.

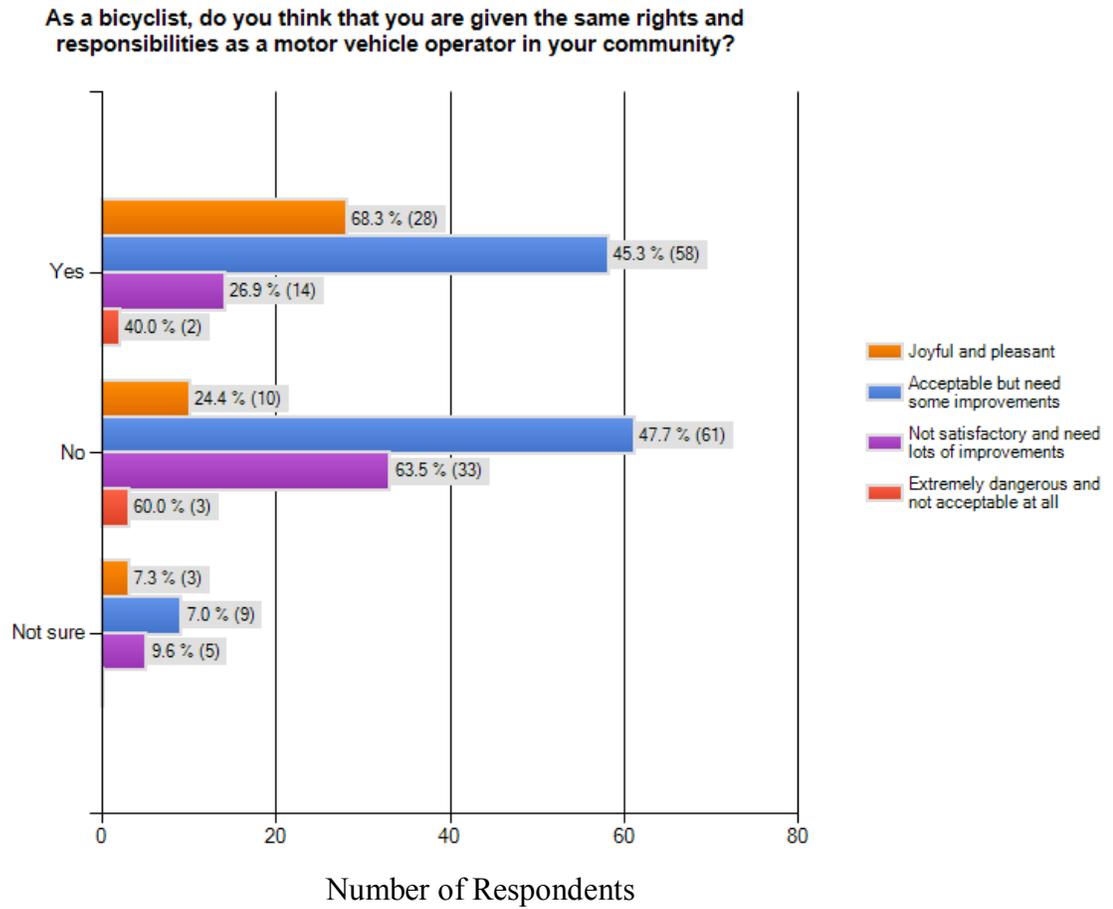


Figure D. 19: Bicyclist Rights and Responsibilities in Communities of Different Comfort Levels

21. What are your concerns with respect to safety when cycling? (Check all that apply)

Respondents from all community types indicated that all of the concerns indicated in Figure D.20 are concerns for them when cycling. In successful communities, the majority of respondents (68.8%) indicated that riding at intersection areas is a major concern, while respondents from all other community types indicated that the speed of surrounding traffic and the volume of surrounding traffic are their primary concerns. The difference between the concerns of successful communities and unsuccessful communities could be a result of more efficient and safer roadway conditions, leaving intersections as the only major concern.

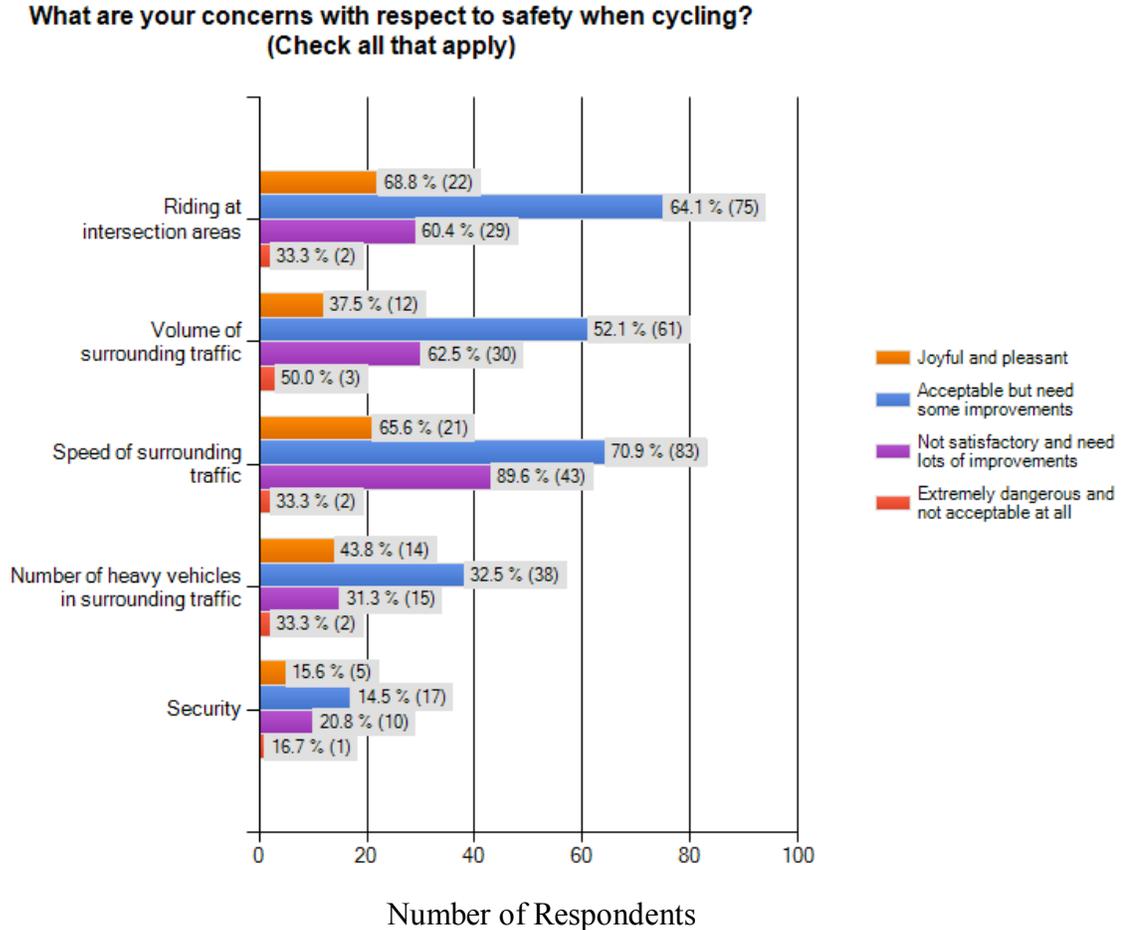


Figure D. 20: Safety Concerns for Bicyclists in Communities of Different Comfort Levels

22. Do you encounter any of the following problems with motorists while riding your bicycle? (check all that apply)

Respondents from all communities experienced each of the problems shown in Figure D.21, but the majority of respondents from joyful and pleasant communities, not satisfactory communities, and extremely dangerous communities indicated that they experience motorists not seeing a bicyclist on his bike most frequently. The majority of respondents from acceptable communities indicated that a motorist making a turn in front of a bicyclist and cutting him off was the most frequently observed problem. This shows that no matter how successful, all communities could benefit from improved motorist education.

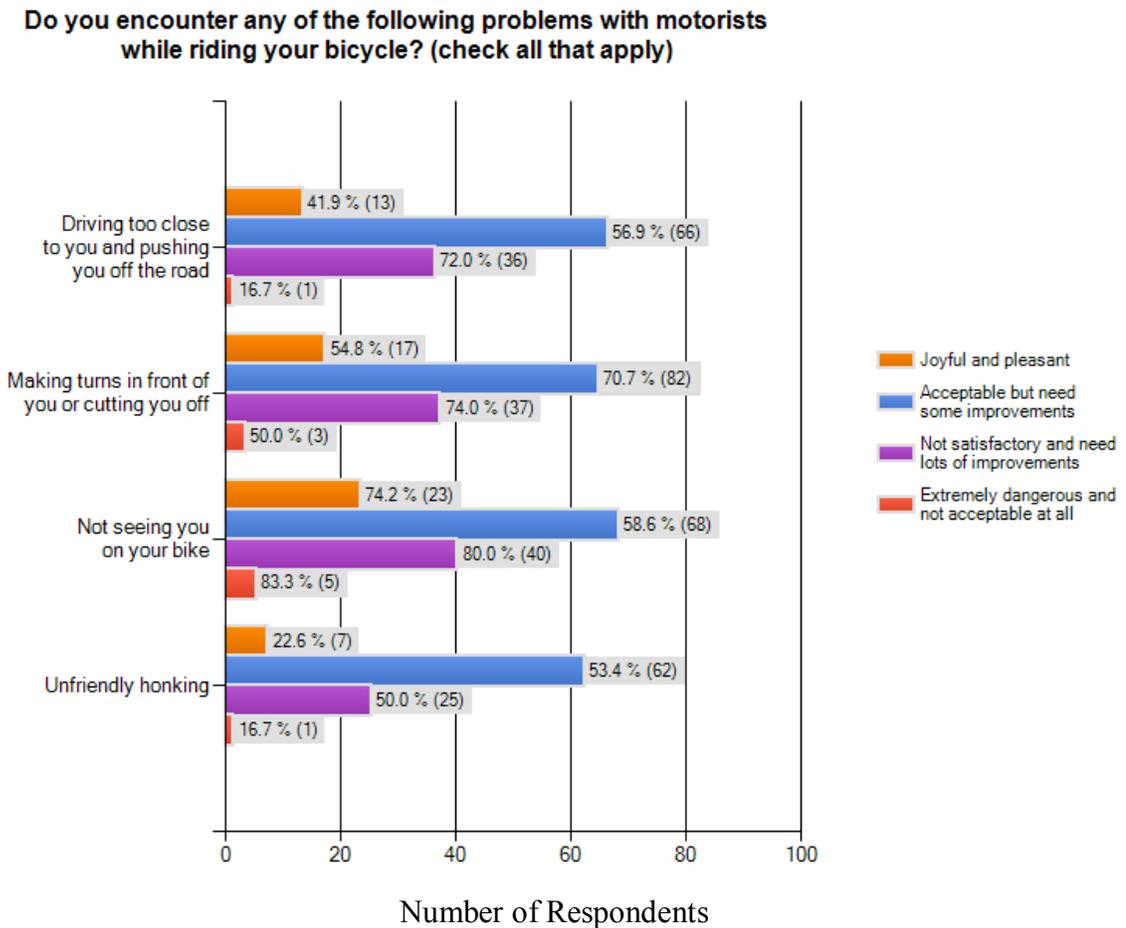


Figure D. 21: Problems with Motorists in Communities of Different Comfort Levels

23. Is there high incidence of bicycle-related accidents in your city?

The majority of respondents from joyful (61.0%) and acceptable communities (42.6%) indicated that there is not a high incidence of bicycle related accidents in their cities. The majority of respondents from the other community types indicated that they are unsure if there is a high incidence of bicycle related accidents in their cities. This difference could be a result of increased education of bicyclists and better media support in more successful communities. In the two lesser successful community types, a higher percentage of respondents indicated that there is a high incidence of bicycle accidents. The results indicate that there is a higher degree of safety in more successful bicycling communities, again demonstrating the correlation between safety and comfort/success. The results of this question are shown in Figure D.22.

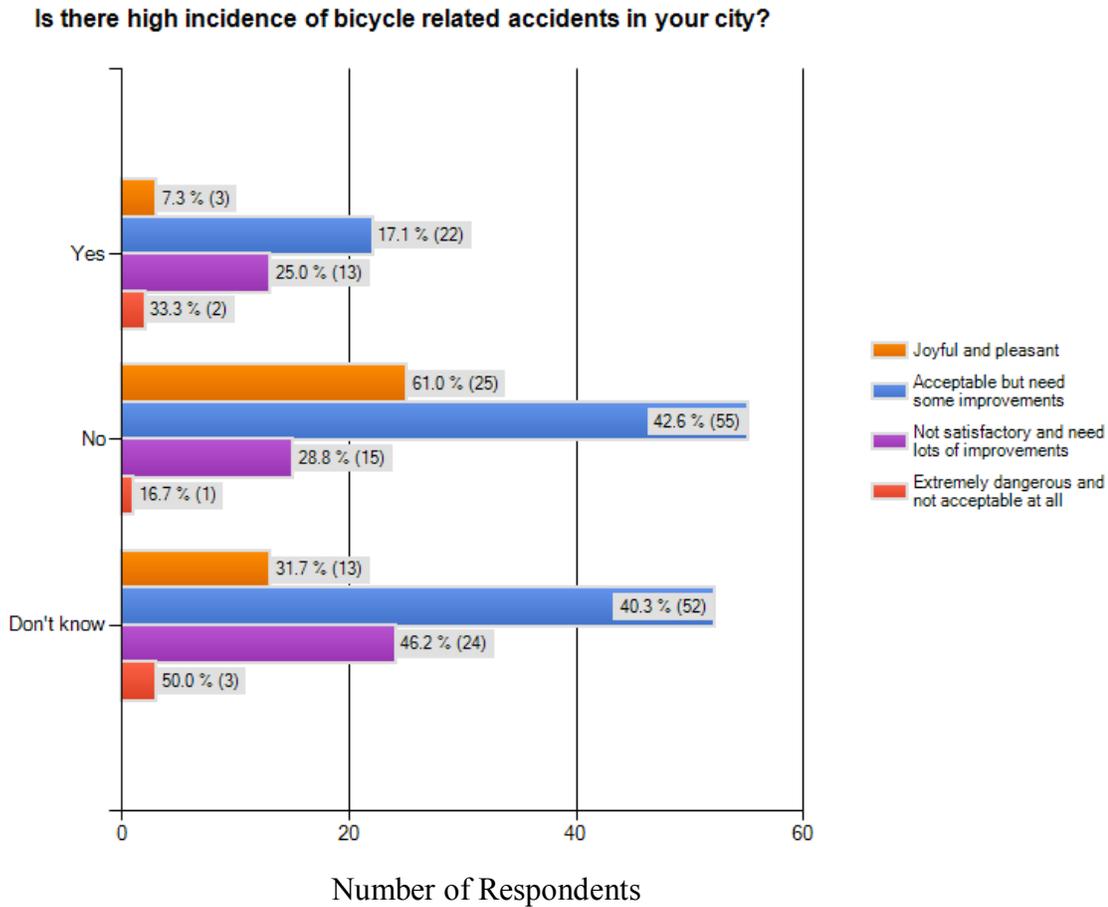


Figure D. 22: Incidence of Bicycle Related Accidents in Communities of Different Comfort Levels

24. What are the most frequently observed types of bicycle crashes in your city/region?

The majority of respondents from all community types indicated that the most common type of bicycle crash in their communities involves bicyclists and motorists. This shows that in all community types, there is need for greater education of motorists and demonstrates the importance of improving safety conditions. The results of this question are shown in Figure D.23.

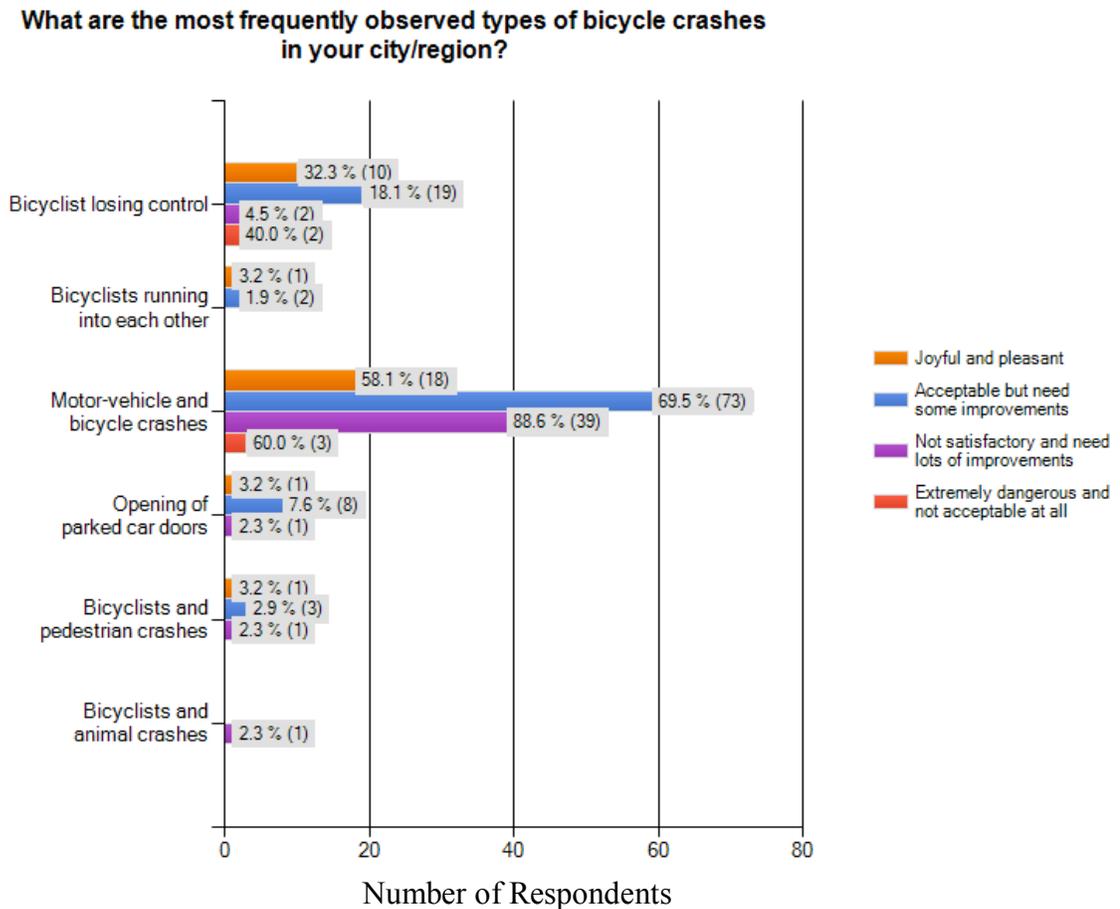


Figure D. 23: Most Observed Bicycle Related Accidents in Communities of Different Comfort Levels

25. *How would you rate your city's effort in terms of examining and learning from bicycle related crashes and injuries?*

The majority of respondents from joyful and pleasant communities (34.2%) claim that their city's effort in terms of examining and learning from bicycle related crashes and injuries is good. The majority of respondents from acceptable communities (45.5%) rated their city as average. The majority of respondents from the other community types indicated that their cities are poor in this regard. These results demonstrate another factor that makes certain communities more successful and comfortable than others. This improved effort could also explain some of the differences in safety level that lead to improved community success. The results of this question are shown in Figure D.24.

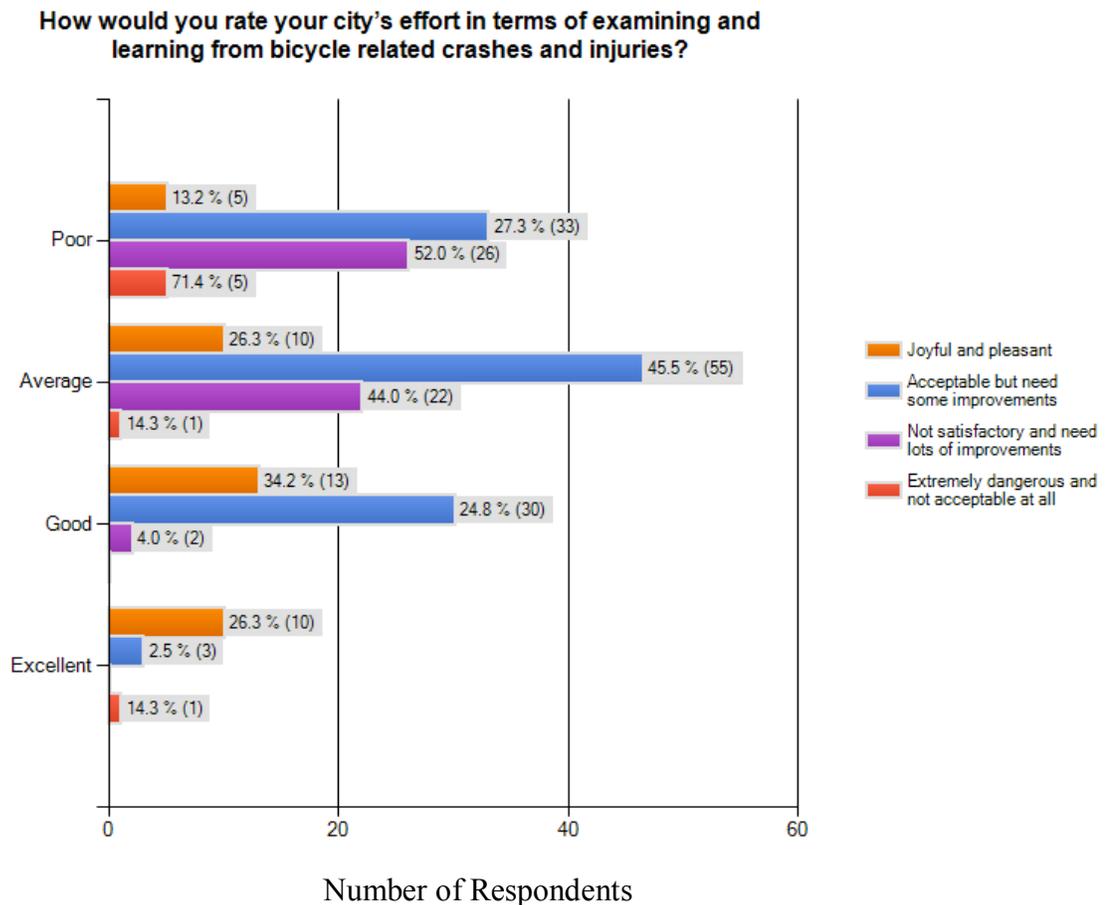


Figure D. 24: City's Effort in Terms of Examining Bicycle Related Accidents in Communities of Different Comfort Levels

26. *Within the intersection area, rank the most risky/dangerous maneuver for bicyclists (with 1 being most dangerous and 4 being least dangerous)?*

The majority of respondents from joyful, acceptable, and not satisfactory communities indicated that the most dangerous maneuver in an intersection area is turning left. Traditionally, left turns are considered extremely dangerous for bicyclists due to poor intersection design. These results reinforce this finding. The majority of respondents from extremely dangerous communities indicated that right turns are the most dangerous. This difference could be due to less bicycle friendly roadway designs that include single lane roads. The results of this question show that turn lanes are still a primary concern with intersections, and unique solutions should be developed for future bicycling communities. The results of this question are shown in Figure D.25.

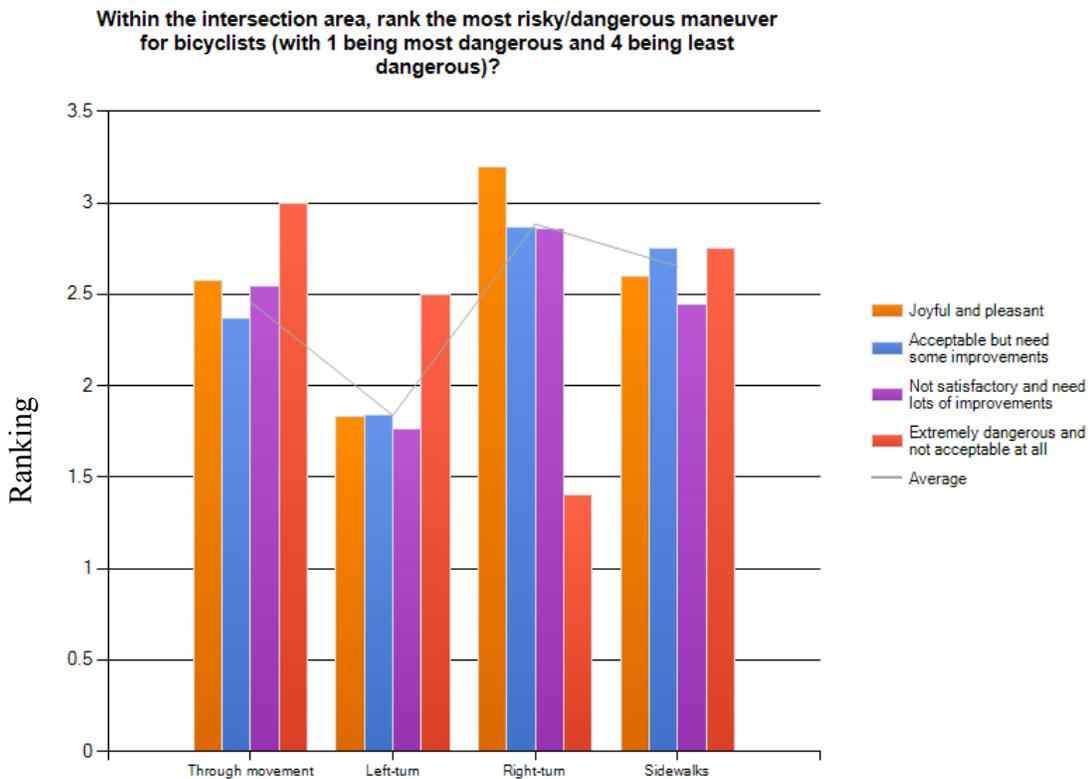


Figure D. 25: Most Dangerous Intersection Maneuvers in Communities of Different Comfort Levels

27. Based on your experience, rank the most risky/dangerous places for bicyclists (with 1 being most dangerous and 7 being least dangerous)?

The majority of respondents from all communities indicated that ramp terminals are the most dangerous place for bicyclists. Ramp terminals are traditionally very dangerous for bicyclists because of a lack of supporting bicycle facilities and the high speed of incoming and merging traffic. These results show that unique solutions should be developed in future bicycling communities to improve ramp terminals and overall roadway safety. The results of this question are shown in Figure D.26.

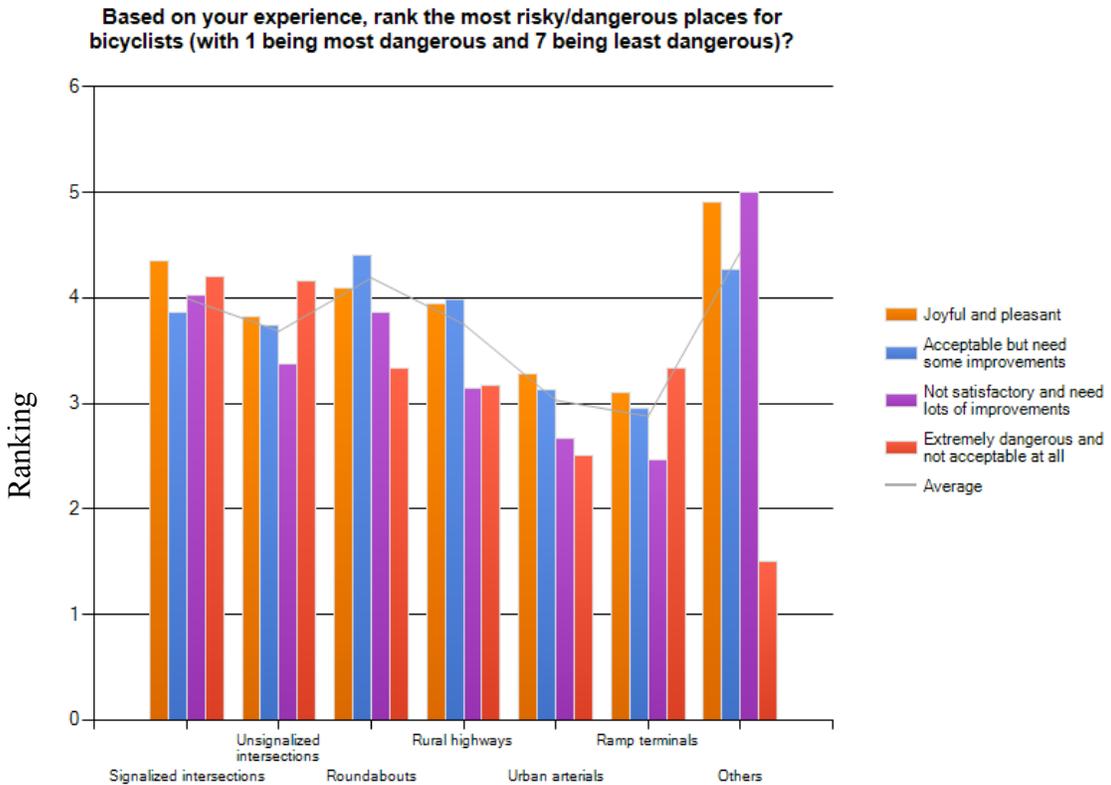


Figure D. 26: Most Dangerous Locations for Bicyclists in Communities of Different Comfort Levels

3.1.2: Questions for Government Officials

The following questions are directed at government officials, including MPO officials, city planners, planning committee members, and TxDOT employees. The section will list each question with an accompanying analysis and a chart that shows the responses.

1. Are you employed with?

When cross-referenced with the rating of comfort levels in a community, this question produced interesting results that allowed a comparison of different communities and government agencies to be performed. The majority of respondents claiming that bicycling in their community is joyful and pleasant (80%) or acceptable but needs some improvement (61.5%) are employed with a local government agency. The majority results for not satisfactory and needs lots of improvement communities are evenly distributed between state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and local government agencies (28.6%). All of respondents claiming that bicycling in their community is extremely dangerous and not acceptable at all are employed with state DOTs. These results seem to indicate that local governments may be the most effective at implementing bicycling and ensuring success. The results of this question are shown in Figure D.27.

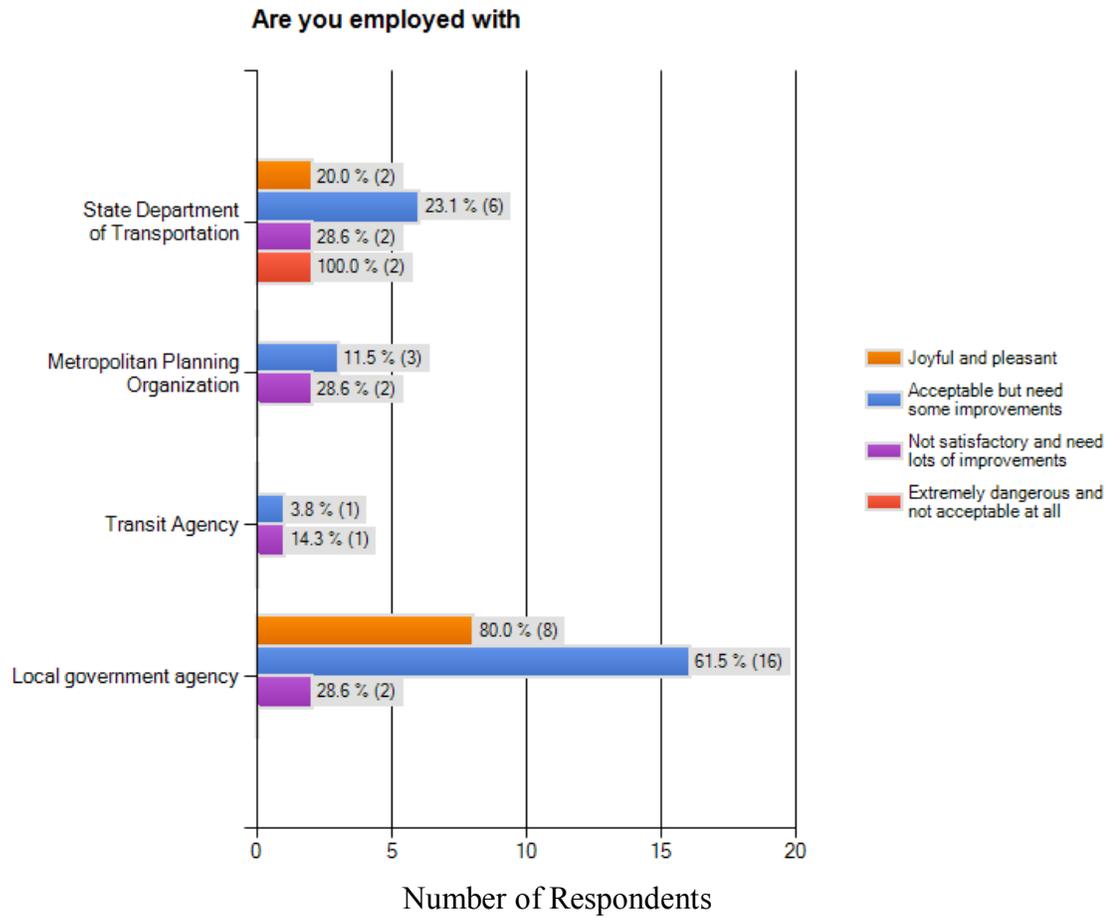


Figure D. 27: Different Government Agencies and Communities of Different Comfort Levels

2. In your opinion, what is the most important factor for creating a bicycle friendly community?

For this question, the majority of respondents from joyful and pleasant communities were split between political support (33.3%) and all of the above (political support, funding, culture, strong advocacy group, and education) (33.3%) as the most important factor for creating a bicycle friendly community. The majority of respondents from acceptable communities (54.8%) and not satisfactory communities (61.5%) indicated that all of the choices shared equal importance. The majority of respondents from extremely dangerous communities were split between funding (50%) and all of the above (50%). These results show that all factors are important for creating a more successful bicycling community. However, political support may cause communities to become more comfortable and successful, while less funding may result in communities becoming more dangerous. The results of this question are shown in Figure D.28.

In your opinion, what is the most important factor for creating a bicycle friendly community?

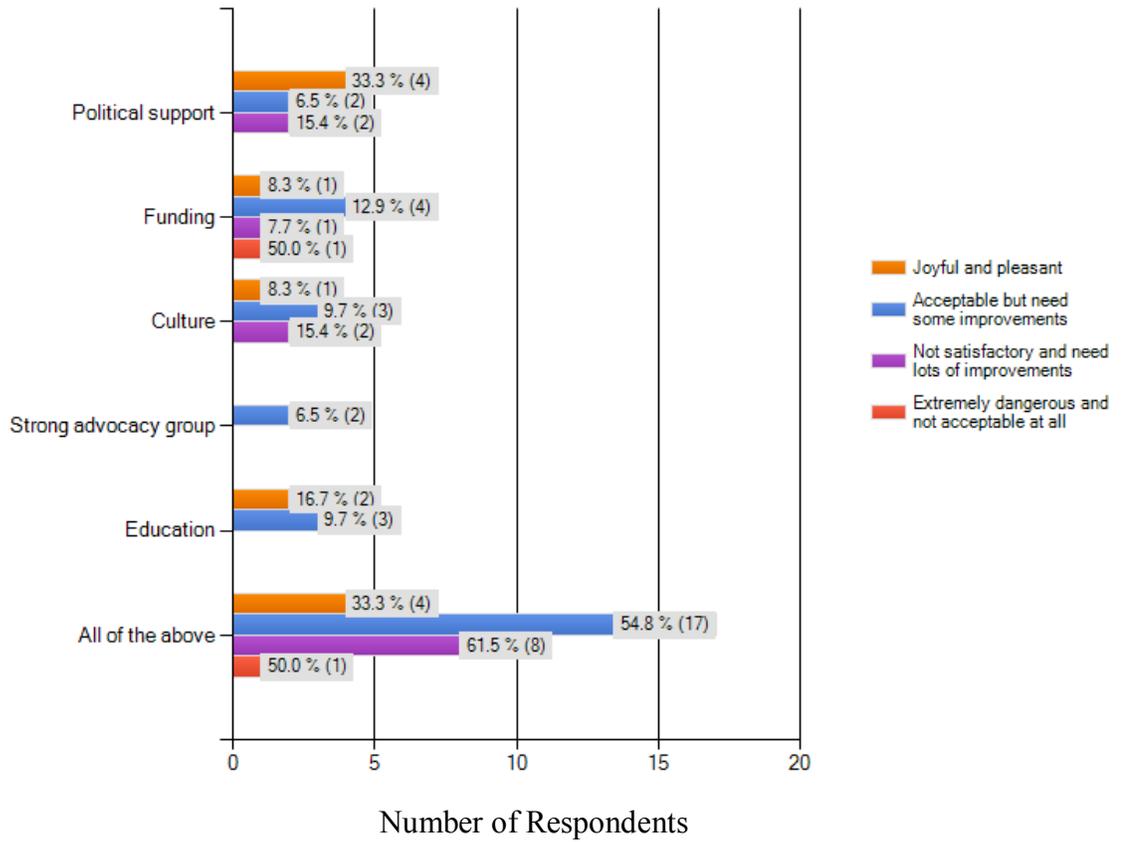


Figure D. 28: Importance Factors for Communities of Different Comfort Levels

3. In your state, who plays a major role in decision-making as to how federal funds are spent at the regional and local level?

The majority of respondents from joyful and pleasant communities (58.3%) and from acceptable communities (46.4%) indicated that the local MPO is the primary decision maker for how federal funds are spent. The majority of respondents from not satisfactory communities (54.5%) indicated that the state DOT is the primary decision maker in this regard. Respondents from extremely dangerous communities were split between the local MPO (50%) and the state DOT (50%). These results indicate that MPOs are likely better at making decisions for how federal funds can be used to support bicycling than state DOTs are. The results are shown in Figure D.29.

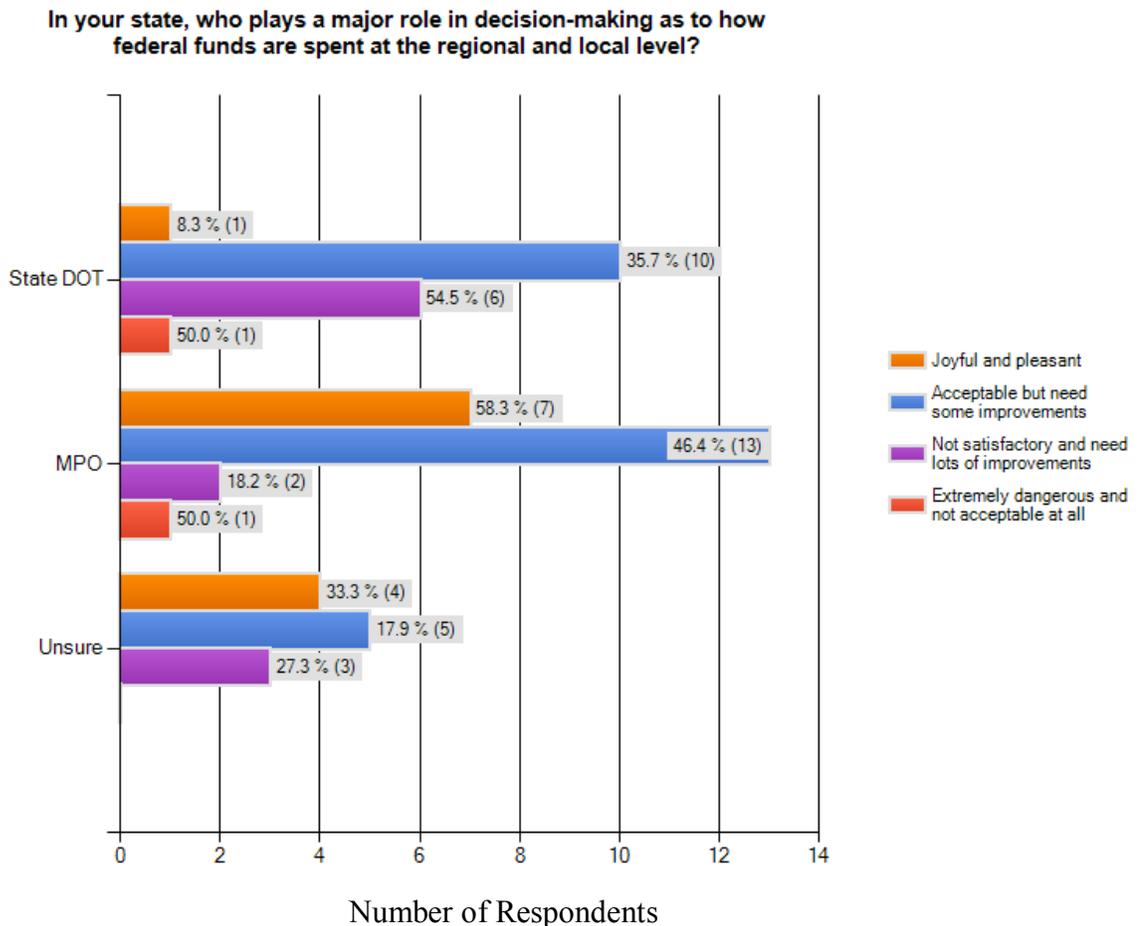


Figure D. 29: Primary Funding Decisions Makers for Communities of Different Comfort Levels

4. Does your state have a sub-allocation scheme that gives flexibility to MPOs to control some of the federal transportation funds to address their needs?

The majority of respondents from joyful communities (50%) and from acceptable communities (48.4%) claimed that their state does have a sub-allocation scheme that gives flexibility to MPOs to control some of the federal transportation funds to address their needs. The majority of respondents from not satisfactory communities (54.5%) claimed that they are unsure if such a sub-allocation scheme exists. The respondents from extremely dangerous communities were split between yes (50%) and unsure (50%). These results could indicate that more successful bicycling communities have sub-allocation schemes in place that provide their MPOs with flexibility, as opposed to less successful communities not having such a plan. These results reinforce the results of the last question that indicate that MPOs are more successful as primary funding decision makers. The results of this question are shown in Figure D.30.

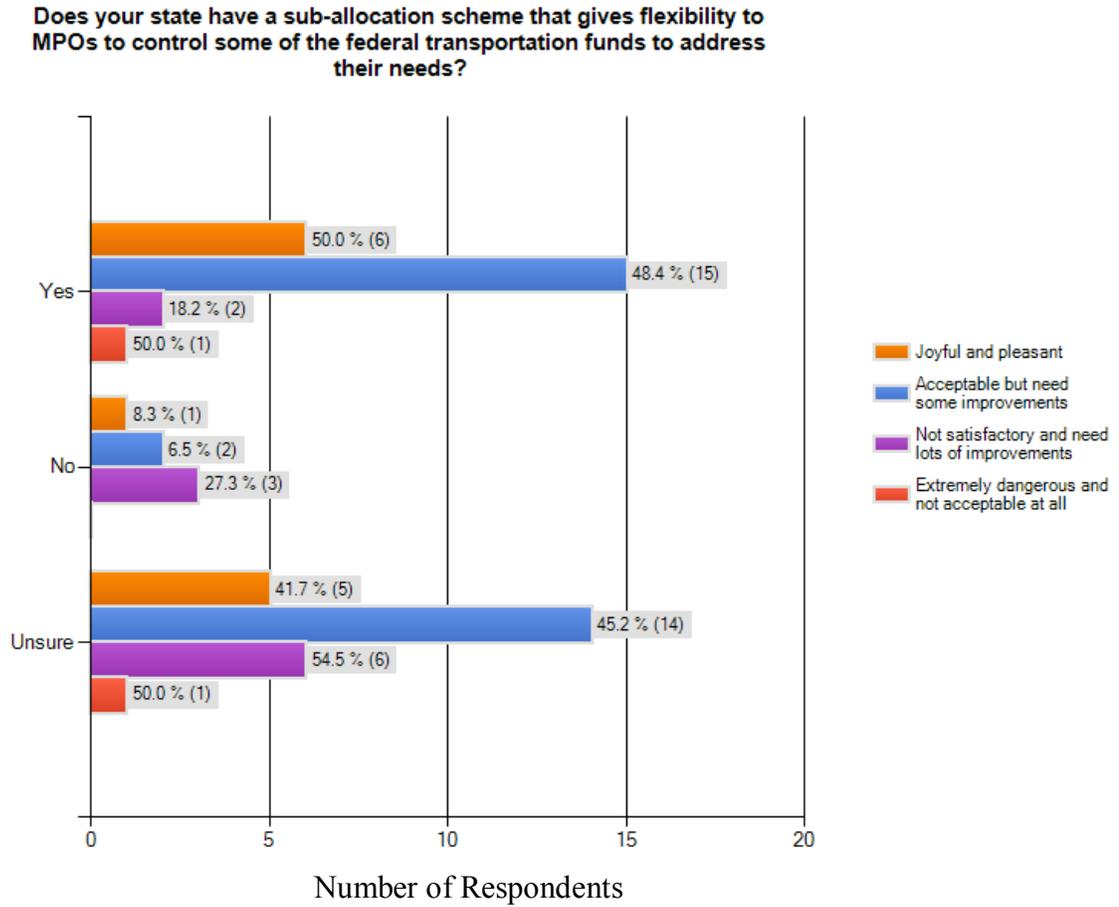


Figure D. 30: Sub-Allocation Scheme for MPO for Communities of Different Comfort Levels

5. Under the existing scheme for allocation of federal transportation funds, is the MPO in your region able to reflect community intent in its approach to bicycle and pedestrian projects?

The majority of respondents from joyful and pleasant communities (58.3%) and acceptable communities (69%) indicate that the MPO in their region is able to reflect community intent in its approach to bicycle and pedestrian projects. The majority of respondents from not satisfactory communities (50%) indicated that they are unsure if their MPO is able to do this. The one respondent from an extremely dangerous community indicated that the MPO in his or her region is able to do this. These results could indicate that with more funds allocated to MPOs, an MPO is better able to address community intent when implementing bicycle and pedestrian projects. However, the fact that even the extremely dangerous community respondent claimed yes could indicate that this ability to reflect community intent is not highly important. The results of this question are shown in Figure D.31.

Under the existing scheme for allocation of federal transportation funds, is the MPO in your region able to reflect community intent in its approach to bicycle and pedestrian projects?

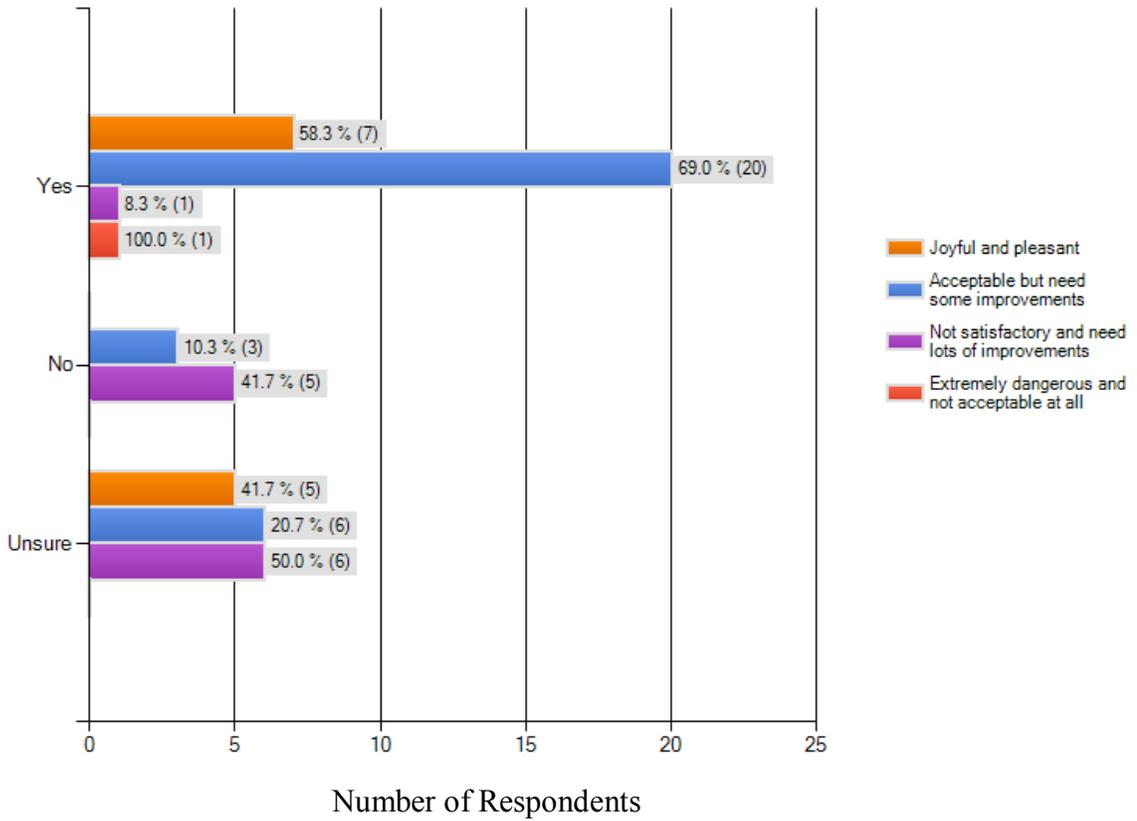


Figure D. 31: Ability of MPO to Reflect Community Intent for Communities of Different Comfort Levels

6. In your region, financial support for bicycle projects is achieved through?

The majority of respondents from joyful and pleasant communities (75%), acceptable communities (65.2%), and extremely dangerous communities (100%) indicated that funding for bicycle projects is achieved through regional transportation planning. The majority of respondents from not satisfactory communities (75%) claimed that financial support is achieved through individual project applications to the state administered transportation program. These results could indicate that funding for bicycle projects is more successful when it comes from regional transportation planning rather than through a state administered transportation program. This could also indicate that local and regional governments are more successful at providing funding for bicycle projects than state government agencies. These results are shown in Figure D.32.

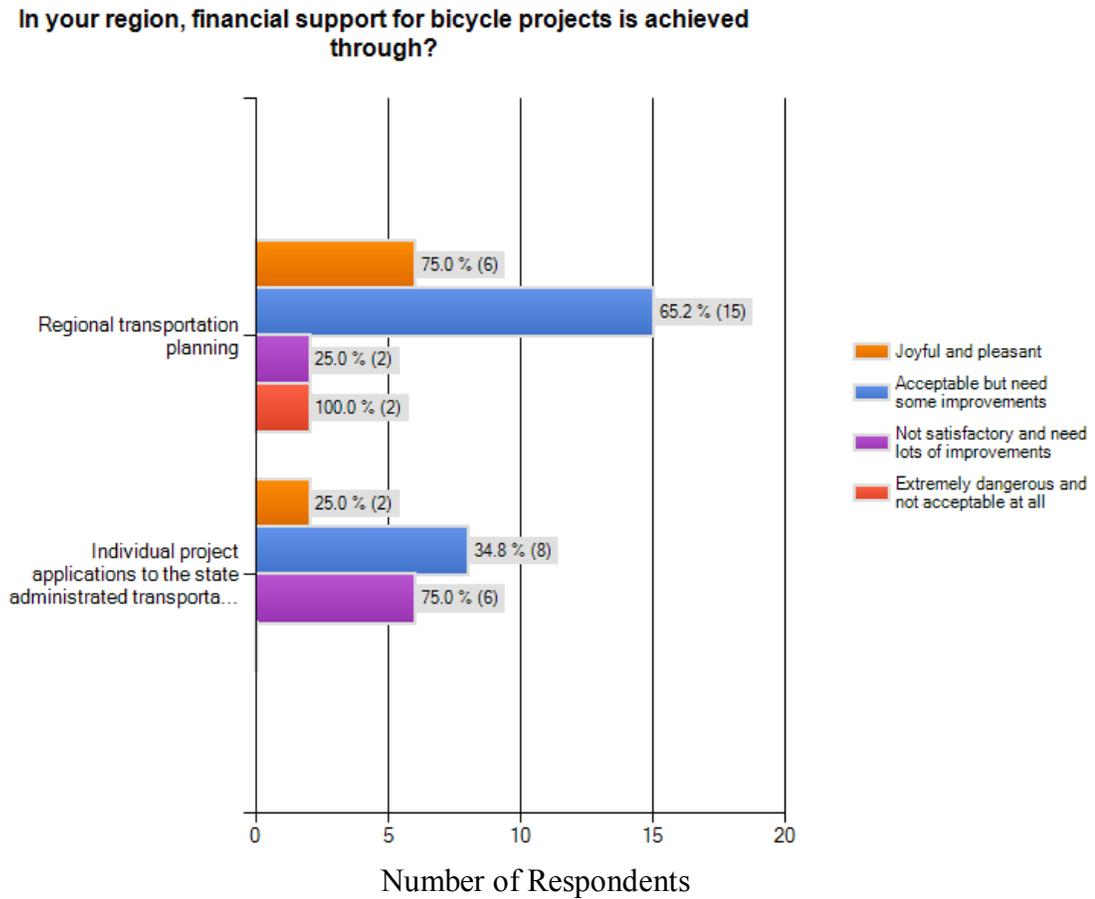


Figure D. 32: Financial Support for Communities of Different Comfort Levels

7. Which of the following programs are most often used for funding bicycle projects?

The majority of respondents from all community types (66.7% for joyful and pleasant, 57.7% for acceptable, 60% for not satisfactory, and 50% for extremely dangerous) indicated that Transportation Enhancement (TE) programs are primarily used for funding bicycle projects in their communities. Although the most successful communities primarily use TE programs for funding, it is difficult to list this as the most successful source because the other community types primarily use TE funds as well. Perhaps communities should use the other sources such as Congestion and Mitigation Air Quality programs, Safe Route to School programs, and other various programs in order to increase their efficacy and success. The results of this question are shown in Figure D.33.

Which of the following programs are most often used for funding bicycle projects?

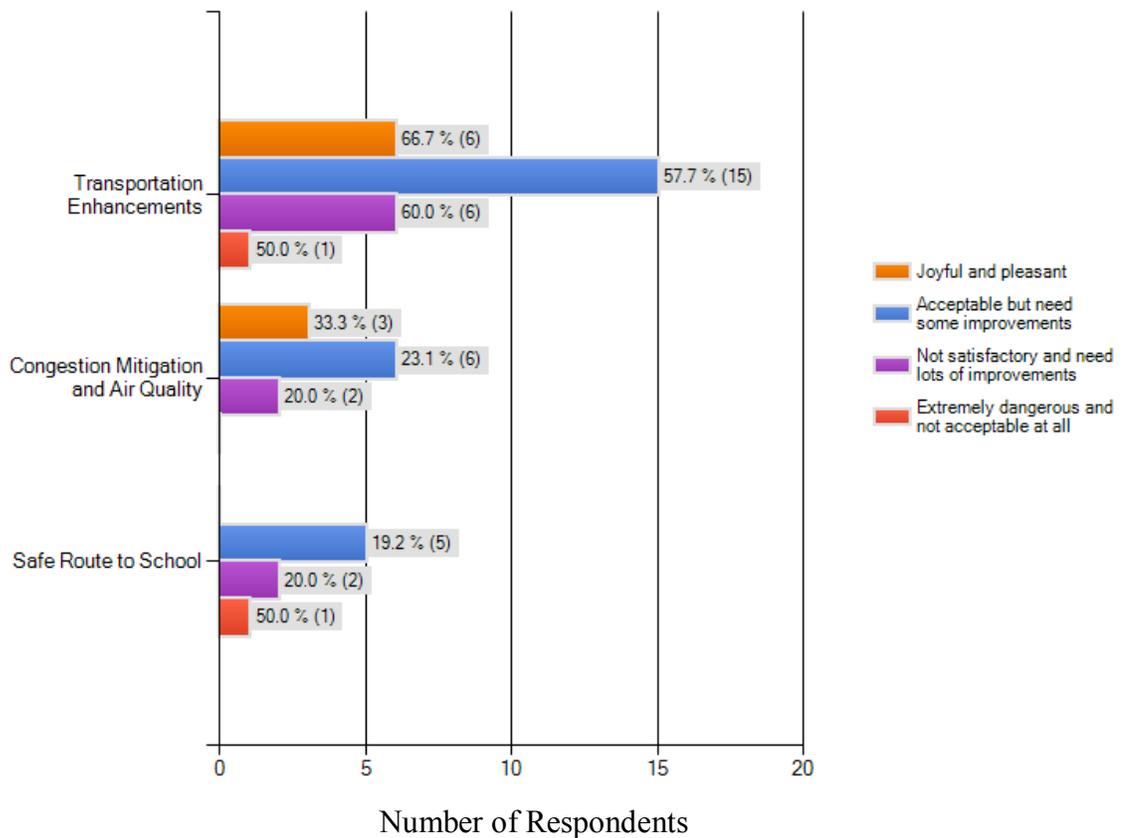


Figure D. 33: Primary Funding Sources for Communities of Different Comfort Levels

8. Which of the following are provided in your region/city? (check all that apply)

Although all of the community types indicate that they use most, if not all, of the listed bicycle structures, the most frequently used structure in joyful and pleasant communities (90.9%) and acceptable communities (96.8%) is a bike lane. In not satisfactory communities, the two most often used bicycle structures are bike lanes (63.6%) and signed shared roadway (63.6%). The most frequently used structure listed by extremely dangerous community respondents are paved shoulders (100%). These results seem to indicate that bicyclists feel most comfortable in bike lanes, so communities with a higher percentage of bike lanes seem to be more successful. These results are shown in Figure D.34.

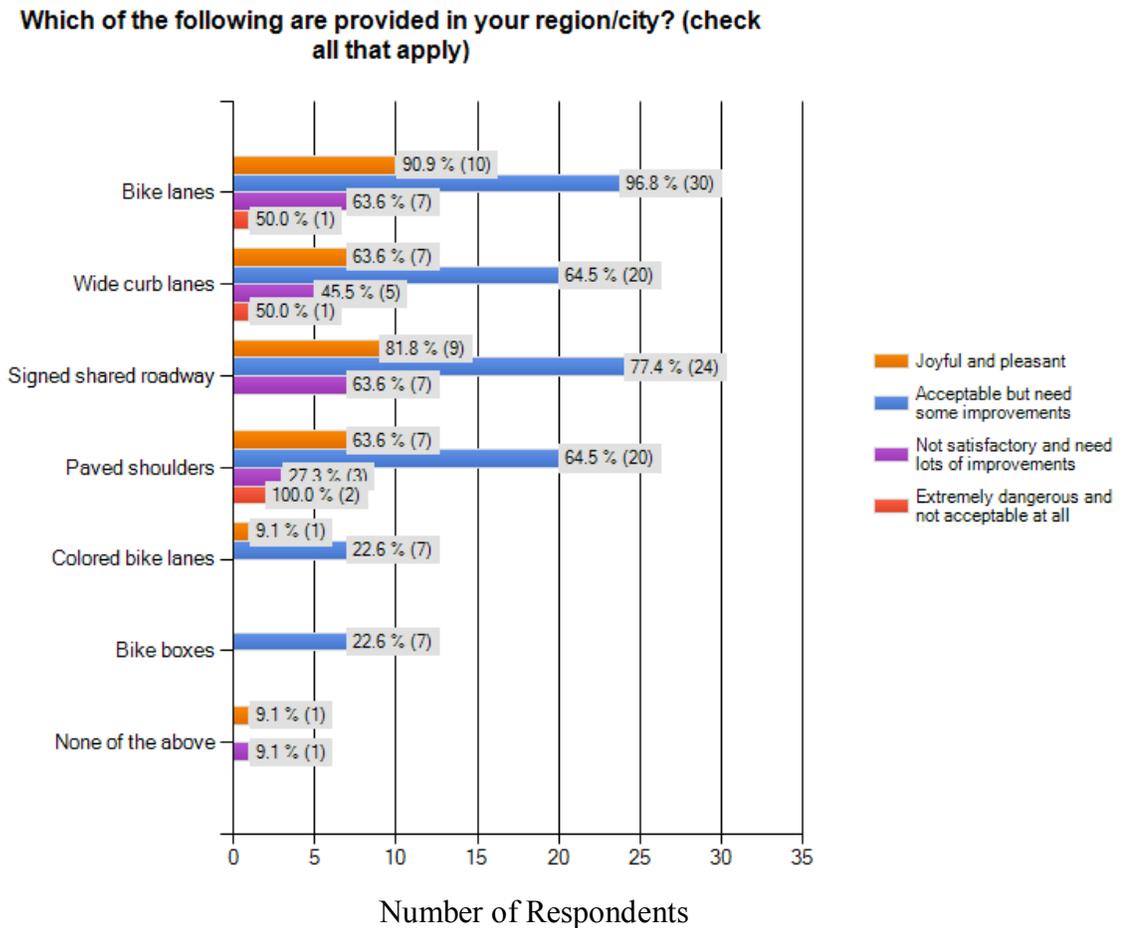


Figure D. 34: Bicycle Structures in Communities of Different Comfort Levels

9. Does your city use a bicycle Level of Service to assess the performance of bicycle facilities?

The majority of respondents from all community types (45.5% for joyful and pleasant, 58.1% for acceptable, 72.7% for not satisfactory, and 50% for extremely dangerous) indicated that their city does not use a bicycle Level of Service (LOS) to assess the performance of bicycle facilities. These results seem to indicate that a bicycle LOS either has little impact on the comfort and success level of a community or is not properly used to improve the comfort level of bicyclists in most communities. The results of this question are shown in Figure D.35.

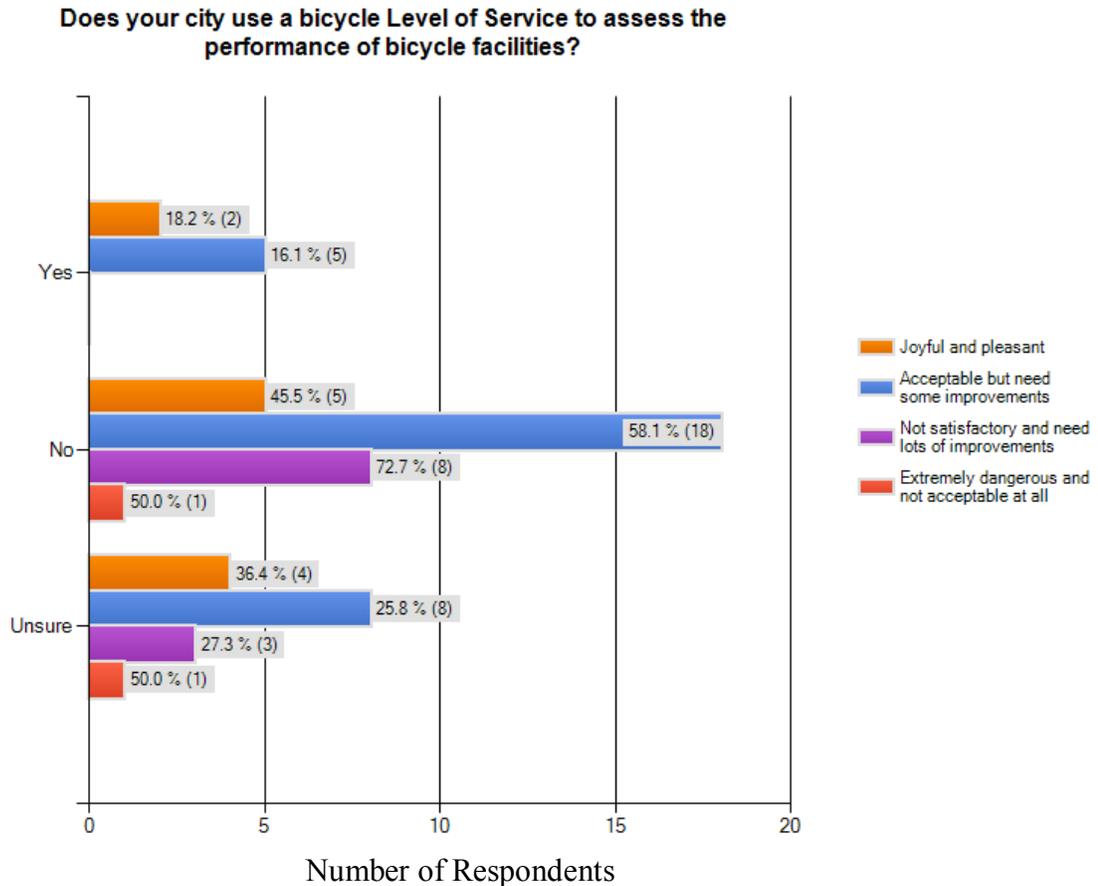


Figure D. 35: Bicycle Level of Service in Communities of Different Comfort Levels

10. Is there a program in your region/city to actively manage and maintain bike routes?

The majority of respondents from joyful and pleasant communities (72.7%) and acceptable communities (61.3%) indicated that their cities have programs to actively manage and maintain bicycle routes. The majority of respondents from not satisfactory (54.5%) communities and extremely dangerous (50%) communities indicated that their cities do not have a program to actively manage and maintain bicycle routes. These results indicate that when bicycle routes are actively managed and maintained, rider comfort increases, so the bicycling communities can be considered more successful. The results of this question are shown in Figure D.36.

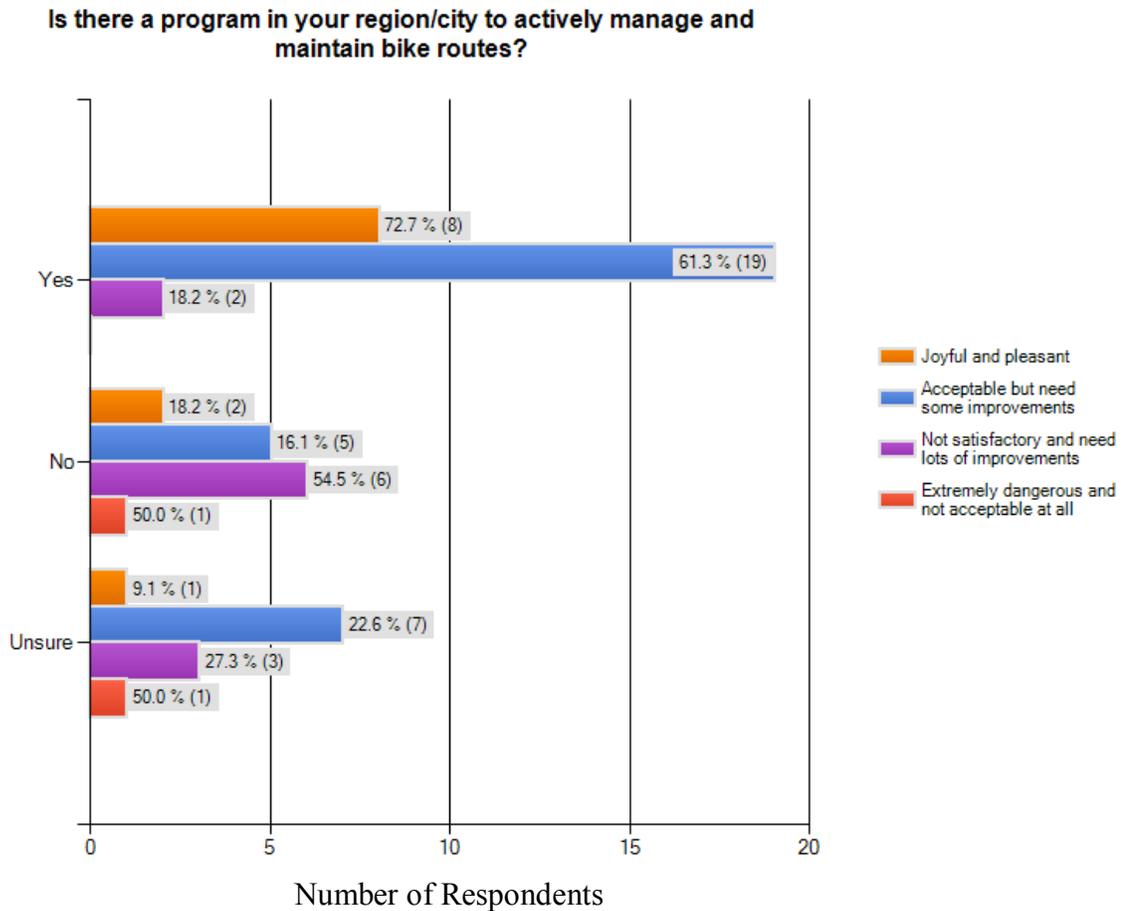


Figure D. 36: Program to Actively Manage and Maintain Bike Routes in Communities of Different Comfort Levels

11. Does your community have an official bicycle and pedestrian committee that gets involved in enhancement, provision and use of bicycle facilities?

The majority of respondents from joyful and pleasant communities (72.7%) and acceptable communities (71.0%) indicated that their community does have an official bicycle and pedestrian committee that supports bicycling. The majority of respondents from not satisfactory communities were split between having (45.5%) and not having (45.5%) such a committee in their community. The majority of respondents from extremely dangerous communities either did not have such a committee in their community (50%) or were unsure if such a community existed (50%). These results seem to indicate that more successful communities are supported by an official bicycle and pedestrian committee that gets involved in enhancement, provision, and use of bicycle facilities. These results are shown in Figure D.37.

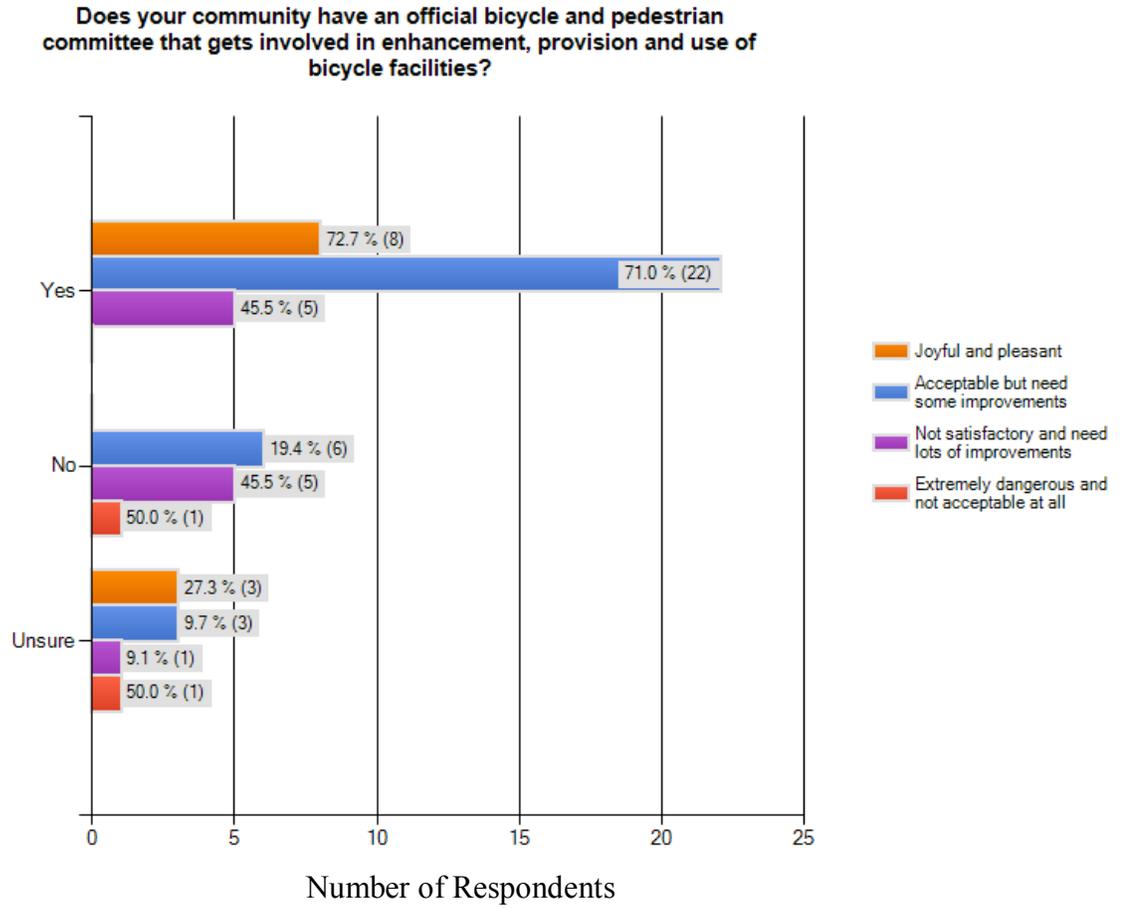


Figure D. 37: Official Bicycle and Pedestrian Committee in Communities of Different Comfort Levels

12. Does your state/city have specific law enforcements to protect bicyclists?

The majority of respondents from joyful and pleasant communities (63.6%) indicated that their community does have specific law enforcement to protect bicyclists. However, the majority of respondents from all other community types (41.9% for acceptable, 63.6% for not satisfactory, and 100% for extremely dangerous) answered that their city or state does not have specific law enforcement to protect bicyclists. This question clearly indicates a factor that the most successful communities possess that other communities do not, and that leads to more comfortable and successful bicycling. Other communities should consider implementing specific law enforcements for bicyclists to improve bicycling in their communities. The results of this question are shown in Figure D.38.

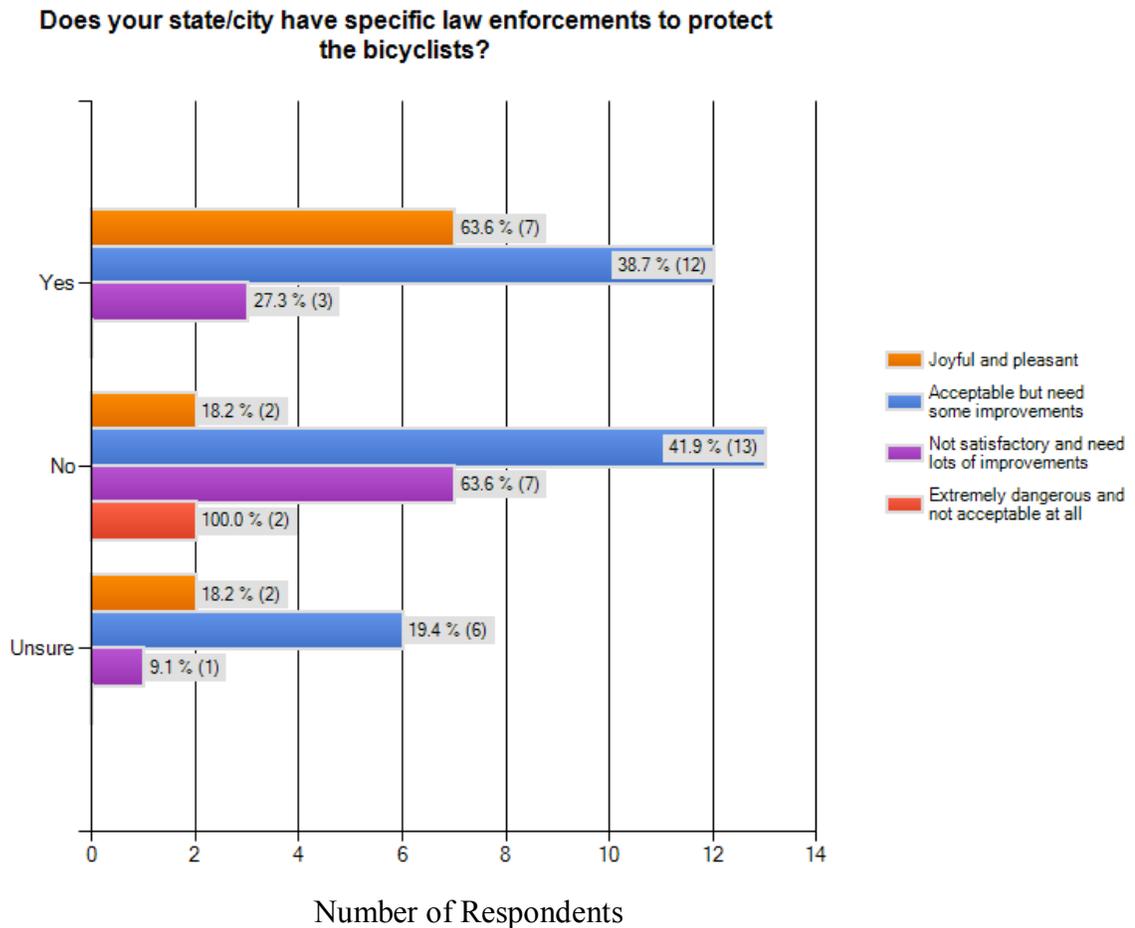


Figure D. 38: Specific Law Enforcements for Bicyclists in Communities of Different Comfort Levels

13. Does the MPO in your region have a written bicycle plan?

The majority of respondents from joyful and pleasant communities (54.5%) indicated that they are unsure if their MPO has a written bicycle plan. The majority of respondents from acceptable communities (63.3%) and not satisfactory communities (54.5%) claimed that their MPO does have a written bicycle plan. All of respondents from extremely dangerous communities claimed that they are unsure if their MPO has a written bicycle plan. These results indicate that a written bike plan is less important to successful bicycle communities than other factors. The results of this question are shown in Figure D.39.

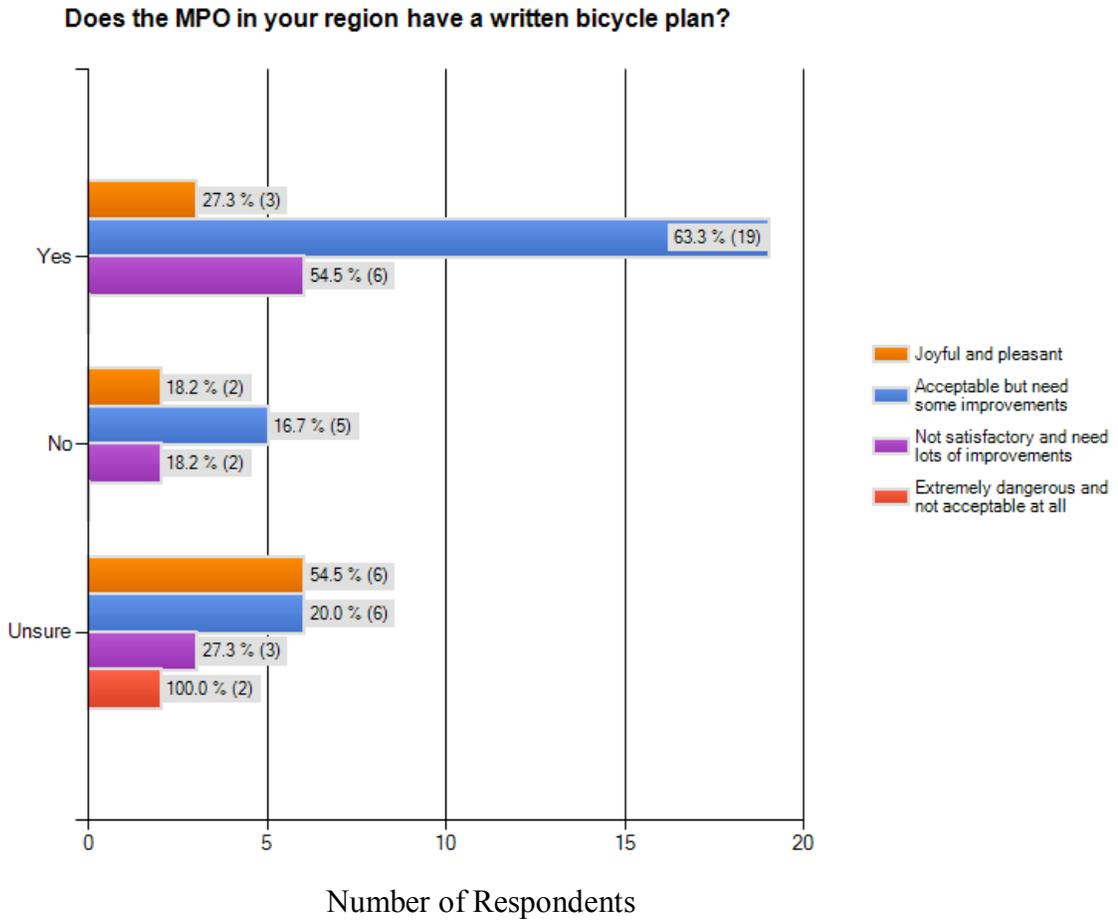


Figure D. 39: Written Bike Plans in Communities of Different Comfort Levels

14. *If there is a written bicycle plan, how often is the bicycle plan updated?*

The majority of respondents from joyful and pleasant communities (66.7%), not satisfactory communities (50%) and extremely dangerous communities (100%) indicated that they are unsure how often the MPO in their region updates a written bicycle plan. The majority of respondents from acceptable communities (37%) indicated that the written bicycle plan is only updated every five to ten years. These results seem to indicate the findings from the previous question that either written bicycle plans have little impact on the comfort level of bicyclists or are not used properly to improve and support bicycling in a community. These results are shown in Figure D.40.

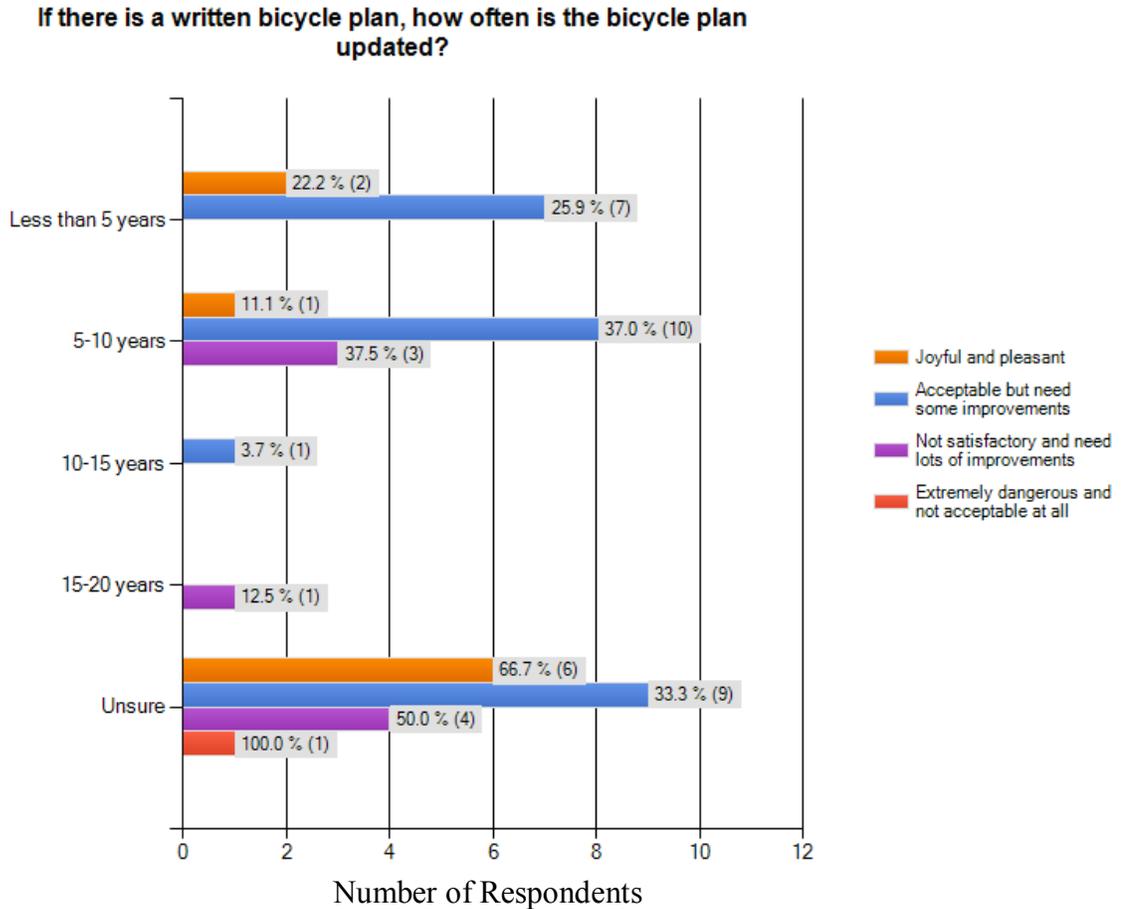


Figure D. 40: Updating Written Bike Plans in Communities of Different Comfort Levels

15. Does the bicycle plan include any measures to evaluate the progress of plan implementation?

The majority of respondents from all community types (88.9% for joyful and pleasant communities, 50.0% for acceptable communities, 62.5% for not satisfactory communities, and 100% from extremely dangerous communities) were unsure if their community’s bicycle plan includes any measures to evaluate the progress of plan implementation. Again, these results seem to indicate that written bicycle plans are either unimportant to successful bicycle implementation or are not utilized properly to improve and support bicycling. These results are shown in Figure D.41.

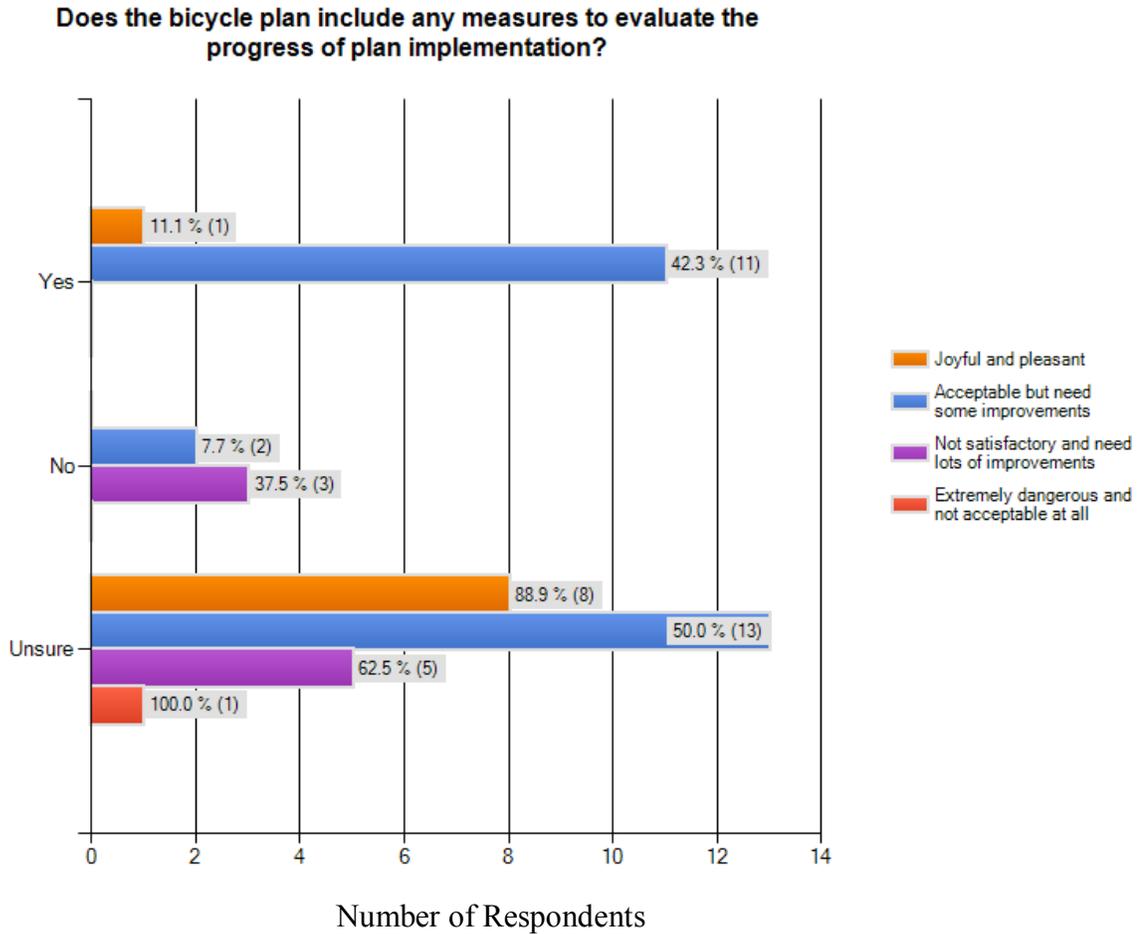


Figure D. 41: Written Bike Plans with Measures to Evaluate Implementation Progress in Communities of Different Comfort Levels

16. Is there anyone who is an active advocate of bicycle/pedestrian programs in the MPO's (local government) policy-making body?

The majority of respondents from joyful and pleasant communities (45.5%) and not satisfactory communities (36.4%) were split between being certain that their community does have an active bicycle advocate and being uncertain. The majority of respondents from acceptable communities (69.0%) indicated that their communities do have an active bicycle advocate. All of respondents from extremely dangerous communities were uncertain if their communities have an active bicycle advocate. These results could indicate that communities with active bicycle advocates are generally more successful, although even in successful communities, the bicycle advocate can have little impact. Bicycle advocates should always try to be active in order to improve bicycling in their communities. These results are shown in Figure D.42.

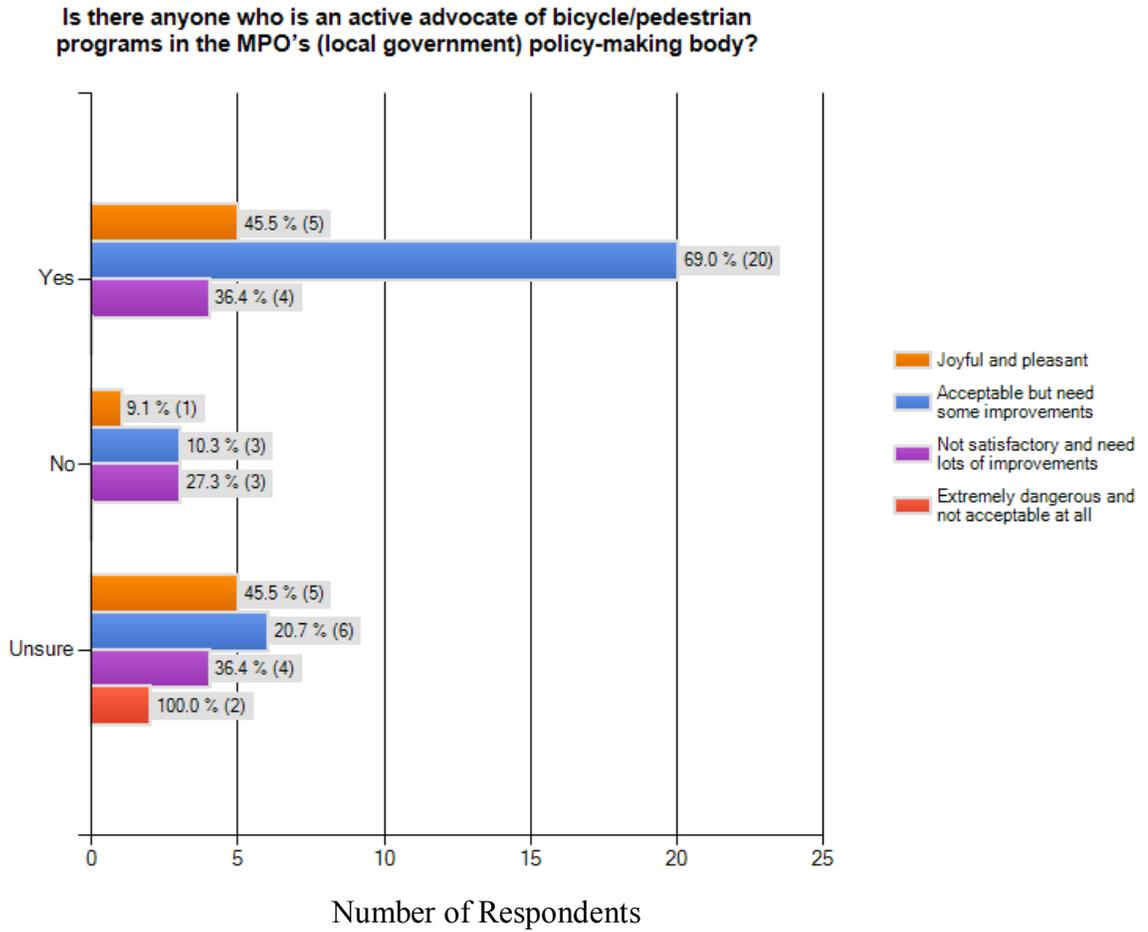


Figure D. 42: Active Bicycle Advocates in Communities of Different Comfort Levels

17. Does the Transportation Authority in your region employ a dedicated employee in charge of bicycle/pedestrian issues?

The majority of respondents from joyful and pleasant communities (54.5%) and extremely dangerous communities (100%) were uncertain if the Transportation Authority in their region employs a dedicated employee in charge of bicycle/pedestrian issues. The majority of respondents from acceptable communities (51.6%) indicated that their Transportation Authority does indeed employ such a dedicated employee. The majority of respondents from not satisfactory communities were split between their Transportation Authority having a dedicated employee for bicycle issues (36.4%) and being uncertain if the Transportation Authority employs such a person (36.4%). These results seem to indicate that a dedicated Transportation Authority employee who advocates for bicycle and pedestrian issues has little importance on the comfort level and success rate of bicycling in a community. Perhaps most communities do have such an advocate, but the advocate is not active enough to have a large impact on bicycling in that community. The results of this question are shown in Figure D.43.

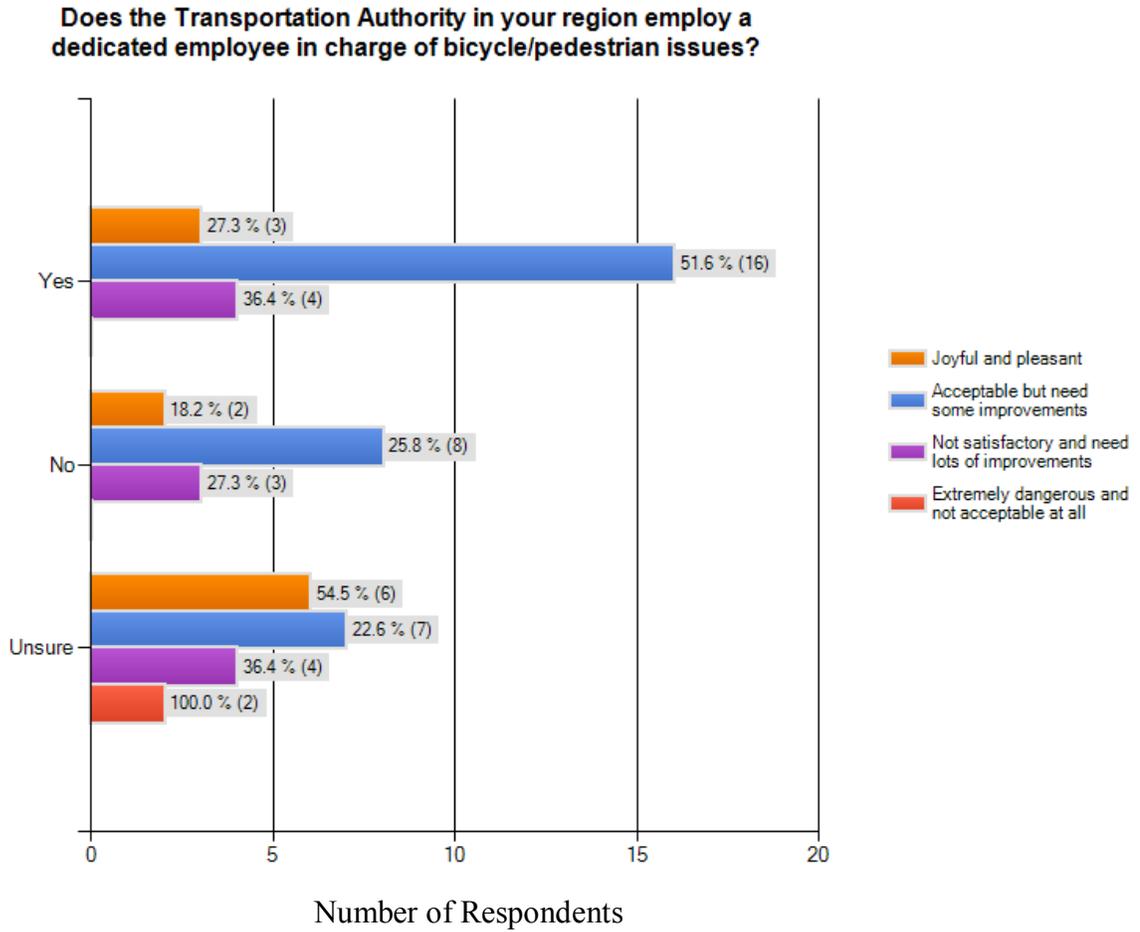


Figure D. 43: Dedicated Transportation Authority Employees in Communities of Different Comfort Levels

18. In your opinion, is bicycling given dual consideration in the state or region's long-range transportation plans?

The majority of respondents from joyful and pleasant communities (45.5%), acceptable communities (43.3%), and not satisfactory communities (54.5%) indicated that bicycling is not given dual consideration in their state or region's long-range transportation plans. All of respondents from extremely dangerous communities indicated that they are unsure if bicycling is given dual consideration. This question reinforces the findings that state governments are likely less successful at implementing bicycling and do little to improve bicycling in communities. State and regional governments could likely improve bicycling conditions if they did give dual consideration to bicycling. The results from this question are shown in Figure D.44.

In your opinion, is bicycling given dual consideration in the state or region's long-range transportation plans?

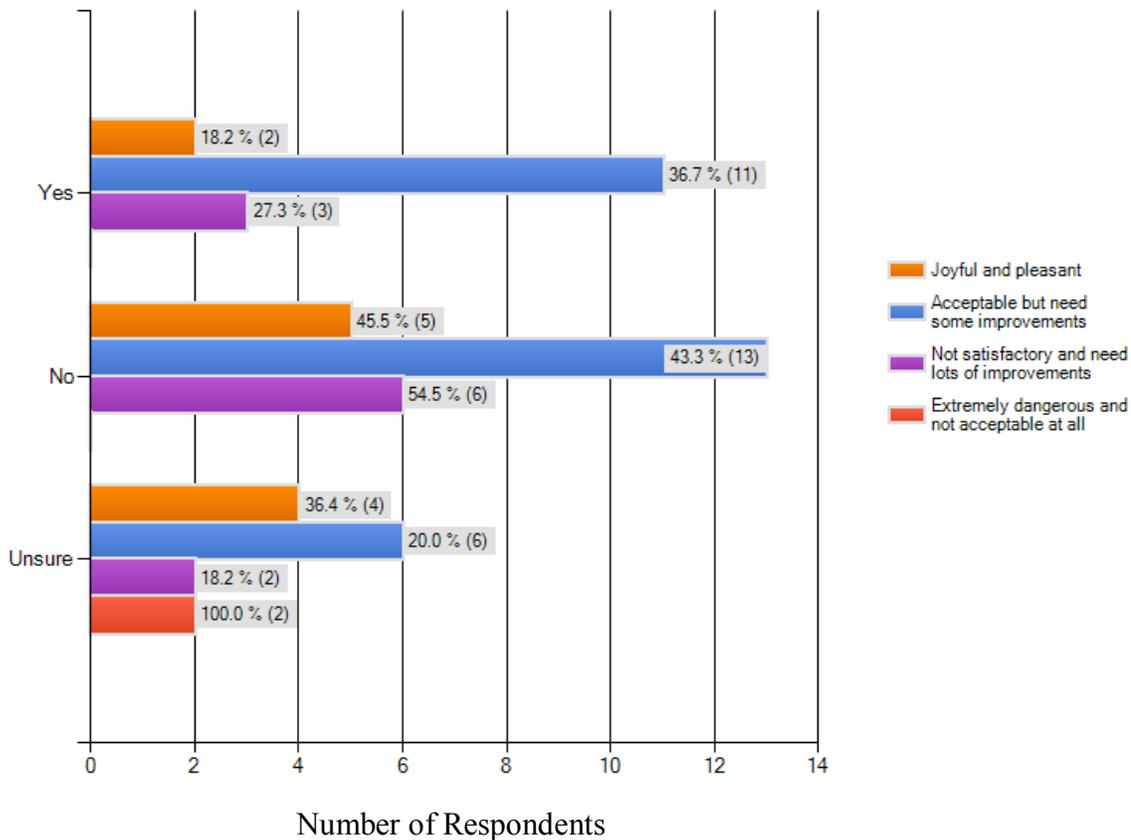


Figure D. 44: Dual Consideration of Bicycling in Communities of Different Comfort Levels

19. Does your city/region have any plans to enhance bicycle facilities in the near future?

The majority of respondents from joyful and pleasant communities (45.5%), acceptable communities (80.6%), and not satisfactory communities (54.5%) indicated that their cities do have plans to enhance bicycle facilities in the near future. The majority of respondents from extremely dangerous communities were split between not having such plans (50.0%) or being uncertain if such plans exist (50.0%). These results seem to indicate that local government agencies are working to improve bicycling and are effective at providing more comfortable and successful bicycling than are larger government agencies. These results also show that many communities are actively working to improve bicycling, which demonstrates that bicycling is gaining importance and credibility as an alternative means of transportation in cities across the country. The results of this question are shown in Figure D.45.

Does your city/region have any plans to enhance bicycle facilities in the near future?

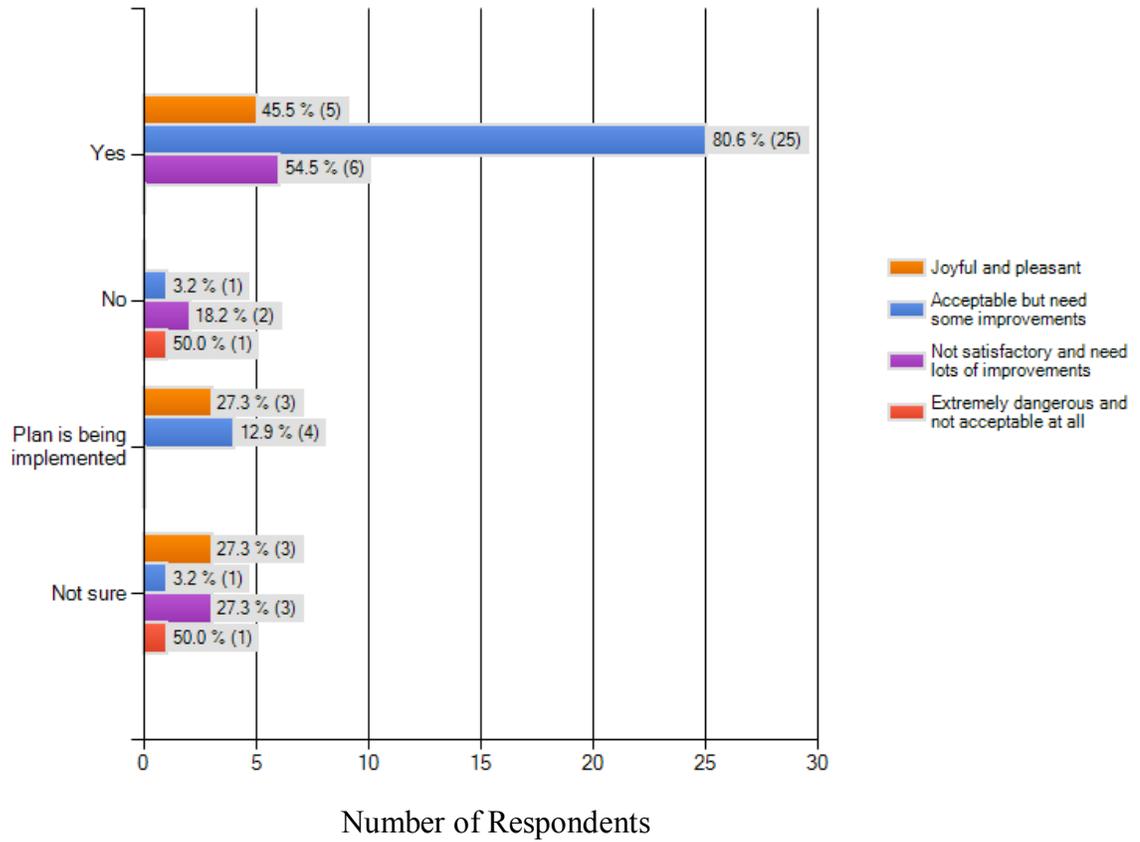


Figure D. 45: Active Plans to Enhance Bicycle Facilities in Communities of Different Comfort Levels

20. Does the MPO in your region account for bicycling in its travel demand forecasting model?

The majority of respondents from all community types (63.6% for joyful and pleasant communities, 41.4% for acceptable communities, 40.0% for not satisfactory communities, and 100% for extremely dangerous communities) were unsure if their MPO accounts for bicycling in its travel demand forecasting model. The results for not satisfactory communities were split between being unsure and not knowing if their MPO accounts for bicycling in its travel demand forecasting model. These results seem to again indicate that MPOs are currently ineffective at improving bicycling, and should take a more active role in including bicycling into its policies and forecast models. The results of this question are shown in Figure D.46.

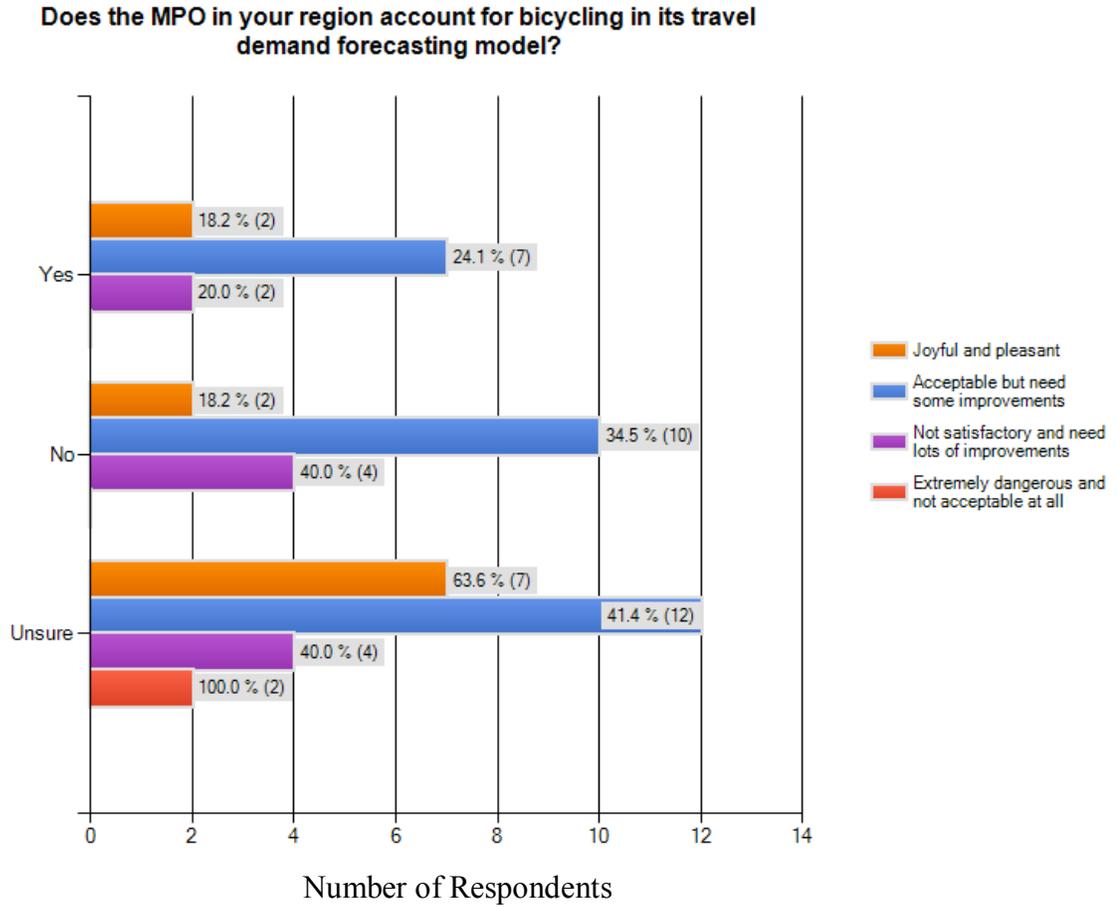


Figure D. 46: MPOs Accounting for Bicycling in Demand Forecasting Models in Communities of Different Comfort Levels

21. Does your city/region have any of the following resources to promote education of bicyclists?

Most of the community types use most if not all of the indicated resources to promote education of bicyclists (bicycle driver's manual, bicycling-specific website, media involvement, workshops/courses, interactive bicycle maps, and social networking communities). However, the majority of respondents from joyful and pleasant communities indicated that the most frequently used resources were media involvement (28.6%) and workshops/courses (28.6%). The majority of respondents from both acceptable communities (36.0%) and not satisfactory communities (50.0%) indicated that a bicycling-specific website is the most frequent resource used to promote education of bicyclists in their communities. No responses were gathered from extremely dangerous communities for this question. These results seem to indicate that the most effective modes of bicycling education are media involvement and workshops/courses, because these are the resources are most often used by the most successful communities. It seems that more communities should attempt to improve their use of these resources. The results of this question are shown in Figure D.47.

Does your city/region have any of the following resources to promote education of bicyclists?

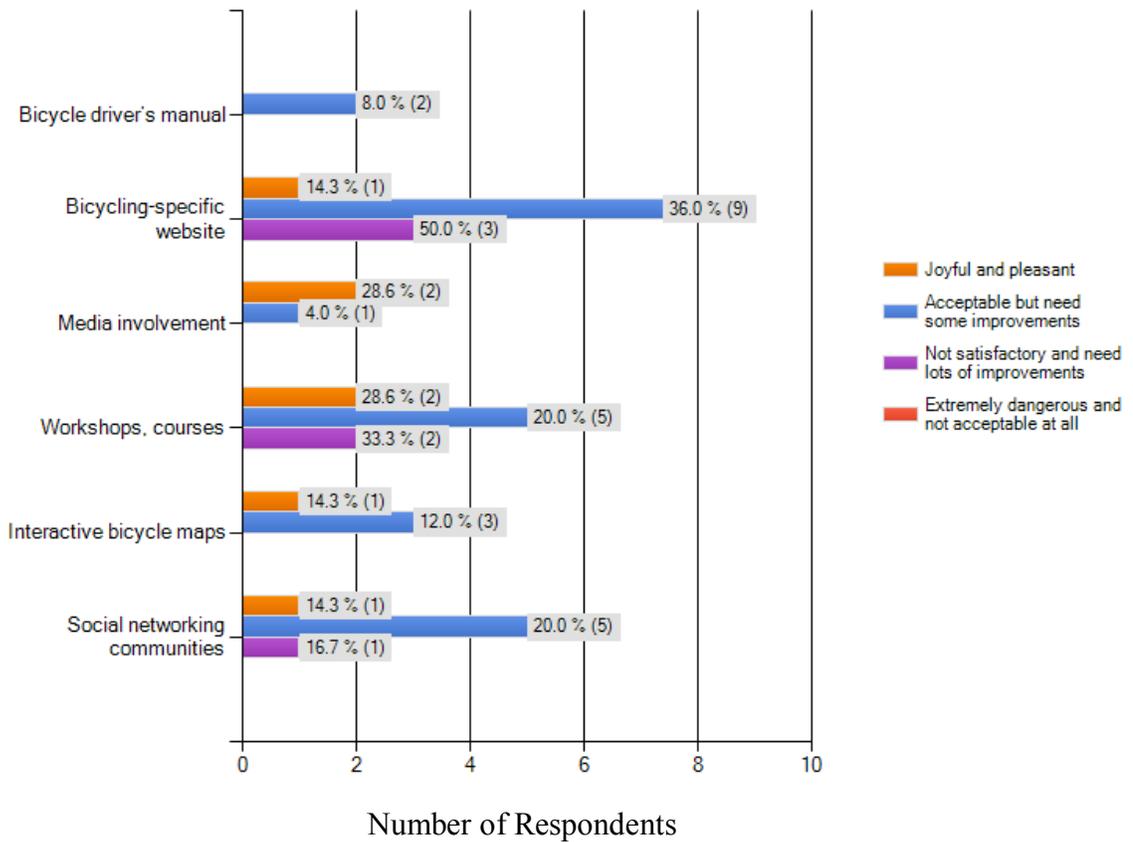


Figure D. 47: Primary Bicycle Education Resources in Communities of Different Comfort Levels

22. In the past five years, how many projects have been conducted towards better accommodation of bicycling in your community?

The majority of respondents from joyful and pleasant communities (36.4%) and from acceptable communities (48.4%) indicated that their communities have conducted many projects towards better accommodation of bicycling. The majority of respondents from not satisfactory communities (54.5%) indicated that few projects of this type have been conducted. Respondents from extremely dangerous communities were split between no projects (50.0%) and being unsure how many projects were conducted (50.0%). The results of this question are unsurprising. It seems clear that communities that undertake a larger number of bicycle projects than other communities would enjoy a higher bicycling comfort level. More communities should conduct more projects to better accommodate bicycling in order to improve bicycling in their communities. The results of this question are shown in Figure D.48.

In the past five years, how many projects have been conducted towards better accommodation of bicycling in your community?

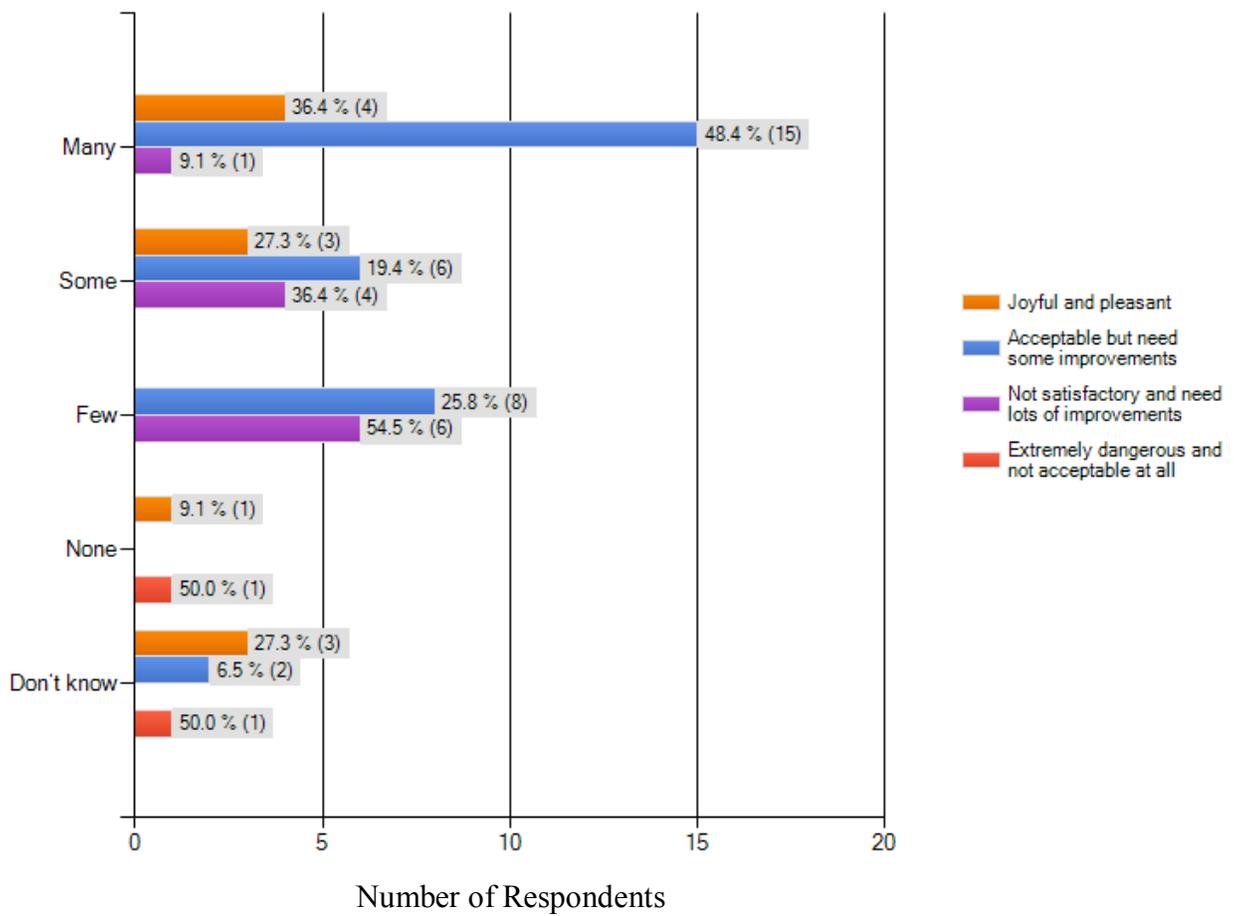


Figure D. 48: Number of Projects Conducted to Improve Bicycling in Communities of Different Comfort Levels

23. What is your opinion with respect to bicycle planning, implementation, and maintenance in your community?

The results of this question were unsurprising and reinforce the assumption made that comfort level can be equated to success of bicycle implementation. All of respondents from joyful and pleasant communities rated that their community is successful in terms of planning, implementation and maintenance. The majority of respondents from acceptable communities (62.1%) also rated their communities as successful. The majority of respondents from not satisfactory communities (50.0%) and extremely dangerous communities (100%) rated their communities as unsuccessful. These results are important because they validate the previous assumptions of this report and show that there is a direct correlation between success and comfort. These results are shown in Figure D.49.

What is your opinion with respect to bicycle planning, implementation, and maintenance in your community?

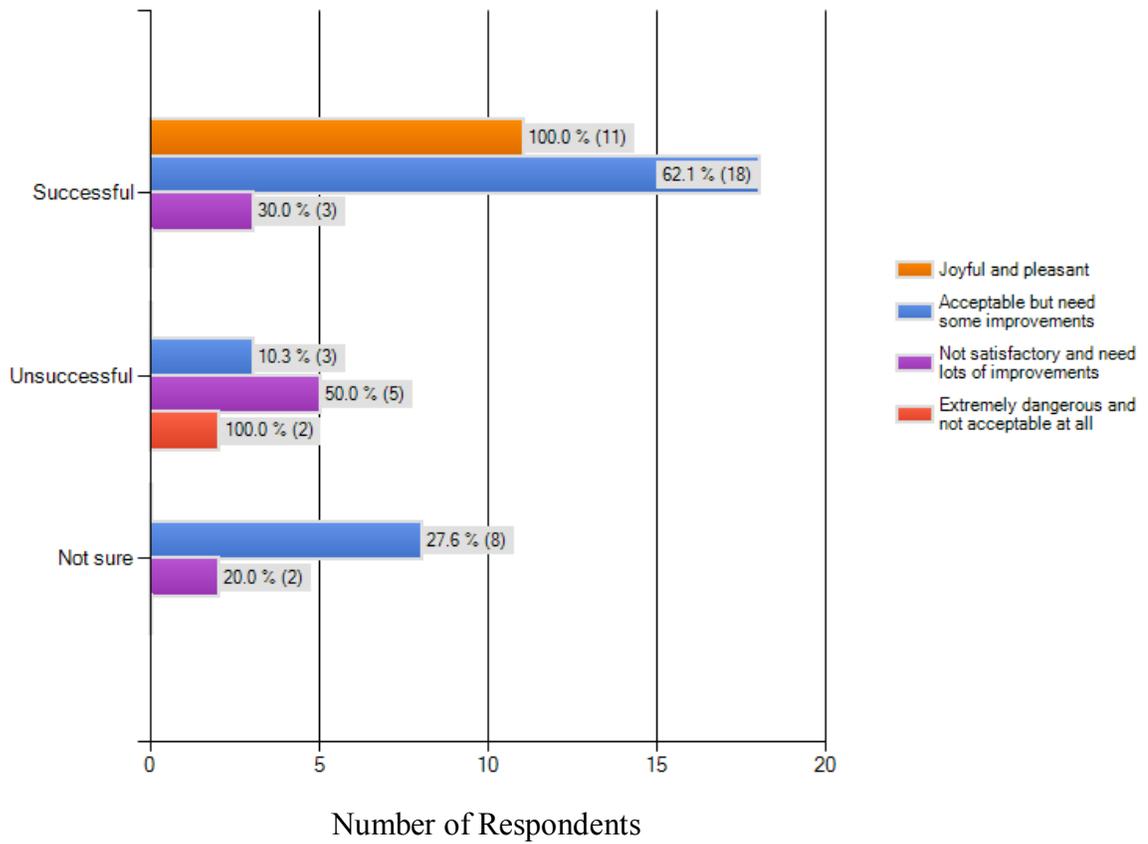


Figure D. 49: Success of Bicycle Planning, Implementation, and Maintenance in Communities of Different Comfort Levels

24. *Would you attribute your city's success in bicycle planning to (check all that apply)*

The majority of respondents from joyful and pleasant communities (90.0%) and from acceptable communities (48.3%) attribute their communities' success in bicycle planning to a strong commitment to bicycling by the local government. The majority of respondents from not satisfactory communities (54.5%) indicated that the greatest source of success comes from active outside advocates. The respondents from extremely dangerous communities were split between not considering that bicycling is a success in their community (50.0%) and not having a bicycle plan (50.0%). These results support the previous conclusions that strong advocacy from a local government agency leads to more comfort and success for bicycling in a community. The results of this question are shown in Figure D.50.

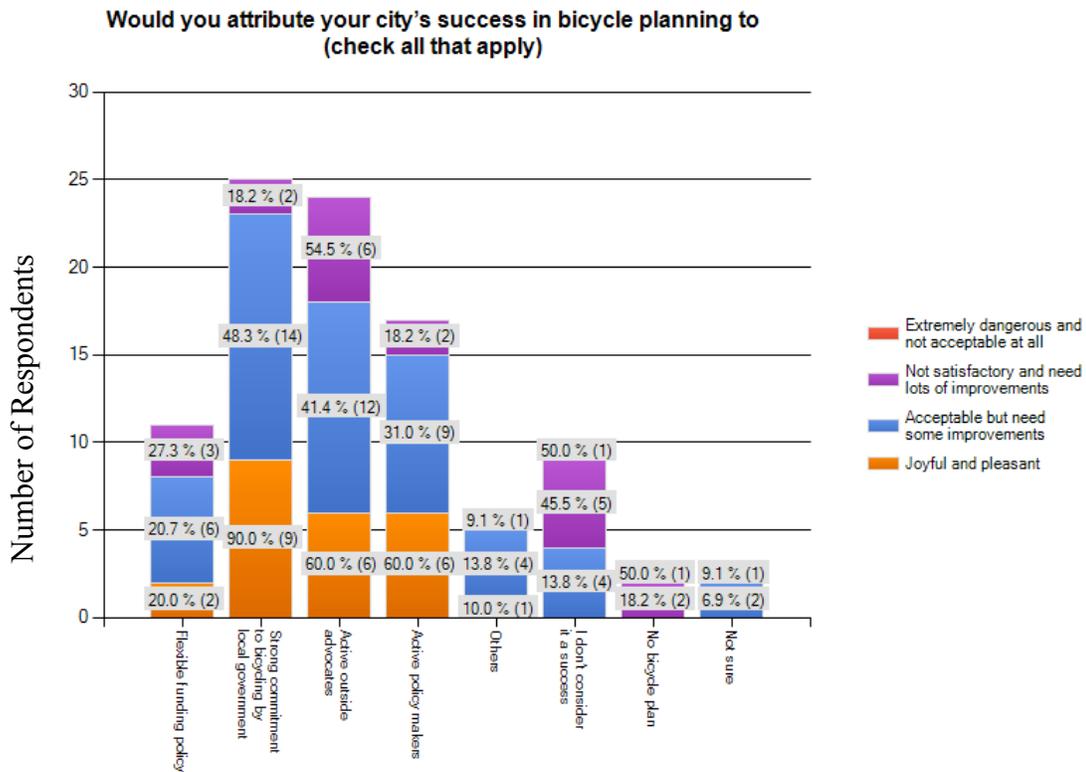


Figure D. 50: Sources of Successful Bicycle Planning in Communities of Different Comfort Levels

25. In your opinion, what are the major barriers for planning and implementation of bicycle projects in your community? (check all that apply)

The majority of respondents from all community types (100% for joyful and pleasant communities, 82.1% for acceptable communities and 81.8% for not satisfactory communities) indicated that the primary barrier to successful bicycle planning and implementation is a lack of funding. The results were also split for extremely dangerous communities between lack of funding (33.3%), lack of government support (33.3%), and insufficient bicycle demand (33.3%). These results clearly show that insufficient funding is a major problem for bicycle implementation, even in successful communities. A possible solution to this problem could be greater financial support from state and federal institutions for local governments to improve bicycling. However, it is unclear how local governments could secure such funds. The results of this question are shown in Figure D.51.

In your opinion, what are the major barriers for planning and implementation of bicycle projects in your community? (check all that apply)

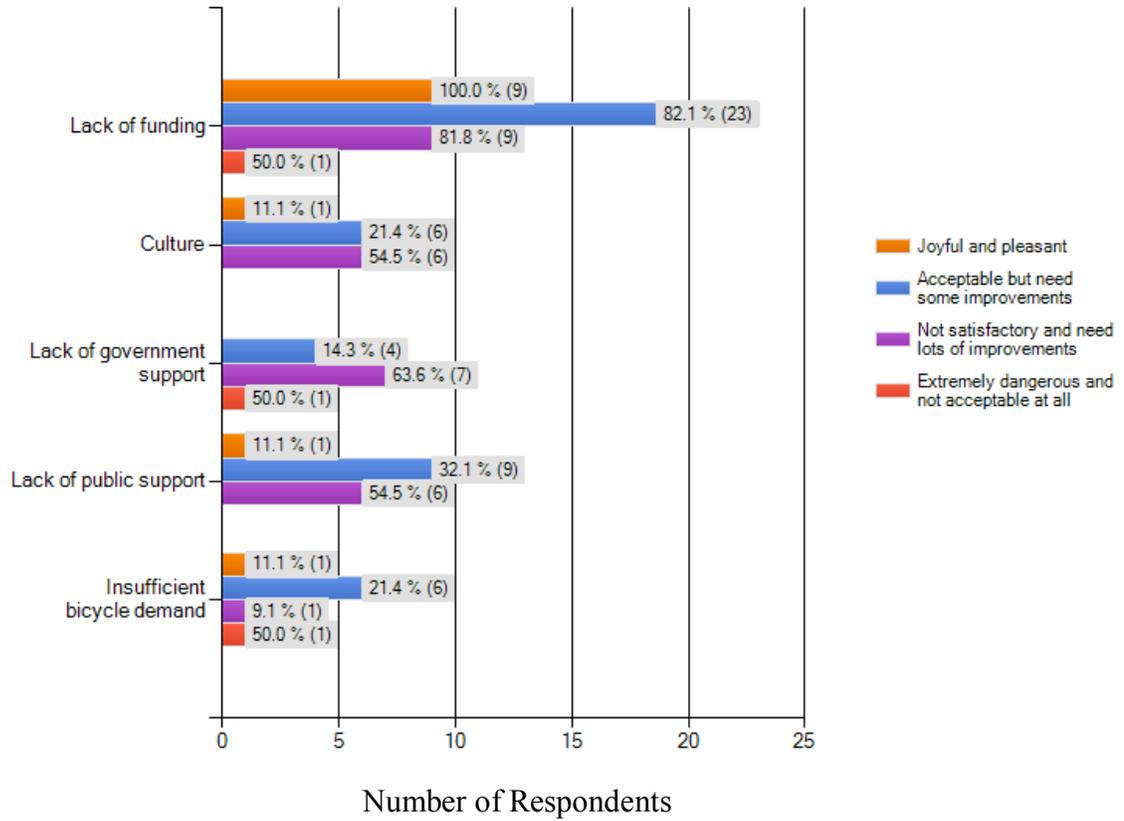


Figure D. 51: Major Barriers Successful Bicycle Planning in Communities of Different Comfort Levels

26. In your opinion, the efforts of your local authority (City/MPO/State) towards promoting bicycling in your community is?

The majority of respondents from joyful and pleasant communities (63.6%) indicated that the efforts of their local authority toward promoting bicycling is sufficient. However, the majority of respondents from all other community types (50.0% for acceptable communities, 90.9% for not satisfactory communities, and 50.0% for extremely dangerous communities) indicated that the efforts of their local authority are insufficient. These results reinforce the earlier conclusions that strong support from a local agency leads to more successful bicycling. These results are shown in Figure D.52.

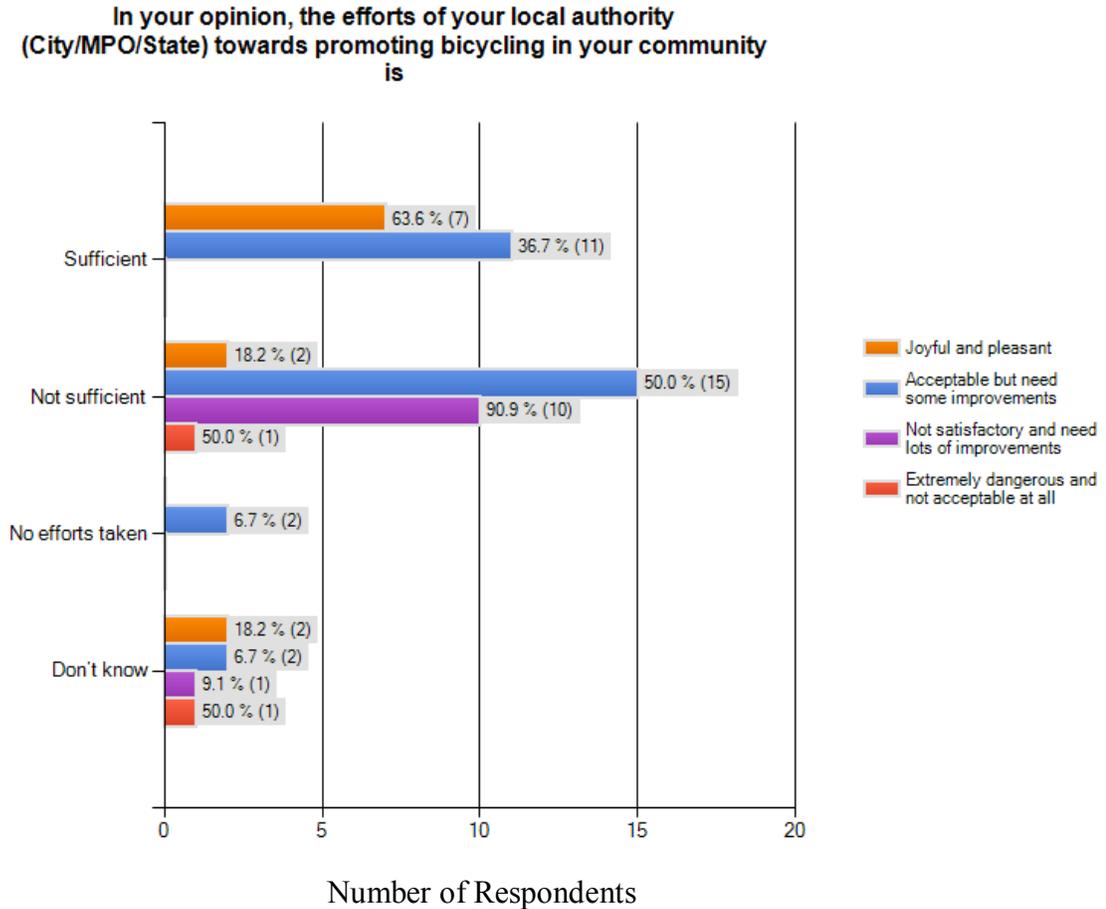


Figure D. 52: Efforts of Local Authority toward Promoting Bicycling in Communities of Different Comfort Levels

3.2: Analysis of Different Community Sizes

This section analyzes the results of the survey to compare and contrast factors that differ between different bicycling communities. This is accomplished by cross-referencing questions with the main question: "What is the population of your community?" The responses to each question are cross-referenced with five possible responses to the main question: less than 50,000, 50,000-100,000, 100,000-300,000, 300,000-500,000, and more than 500,000. This section includes two sub-sections for bicycle users and government officials. Charts are presented for each question to show the full response statistics.

3.2.1: Questions for Bicycle Users

The following questions are directed at bicycle users and bicycle advocacy groups. This section will list each question with an accompanying analysis and a chart that shows the responses.

3. Overall, bicycling in your community is?

The majority of respondents from all community sizes indicated that bicycling in their communities is acceptable but needs some improvement. This shows that generally speaking, bicycling has progressed to an acceptable level in the United States, but further advancement is desired. This question also likely indicates that bicyclists in all community sizes face similar concerns and challenges. Therefore, the solutions used to solve problems in very large or very small cities may be used to solve problems in mid-size cities. The results of this question are shown in Figure D.53.

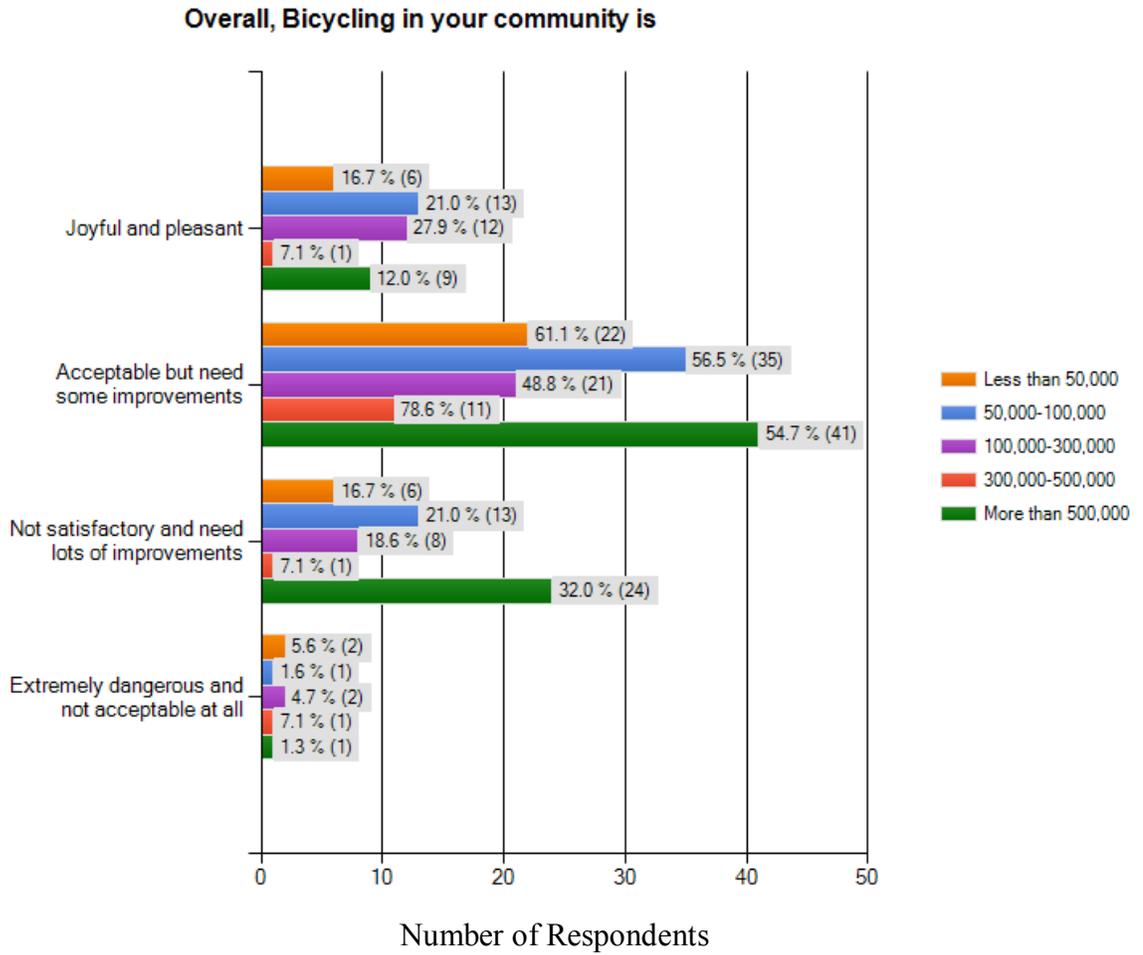


Figure D. 53: Bicycle Comfort Level in Communities of Different Sizes

5. In your opinion, what is the most important factor for creating a bicycle friendly community?

A majority of respondents from every community size indicated that all of the listed factors (political support, funding, culture, strong advocacy group, and education) are equally important for creating a bicycle friendly community. Again, the results of this problem suggest that numerous factors affect bicycling, and that the challenges faced in any community, regardless of size, are similar. The results of this question are shown in Figure D.54.

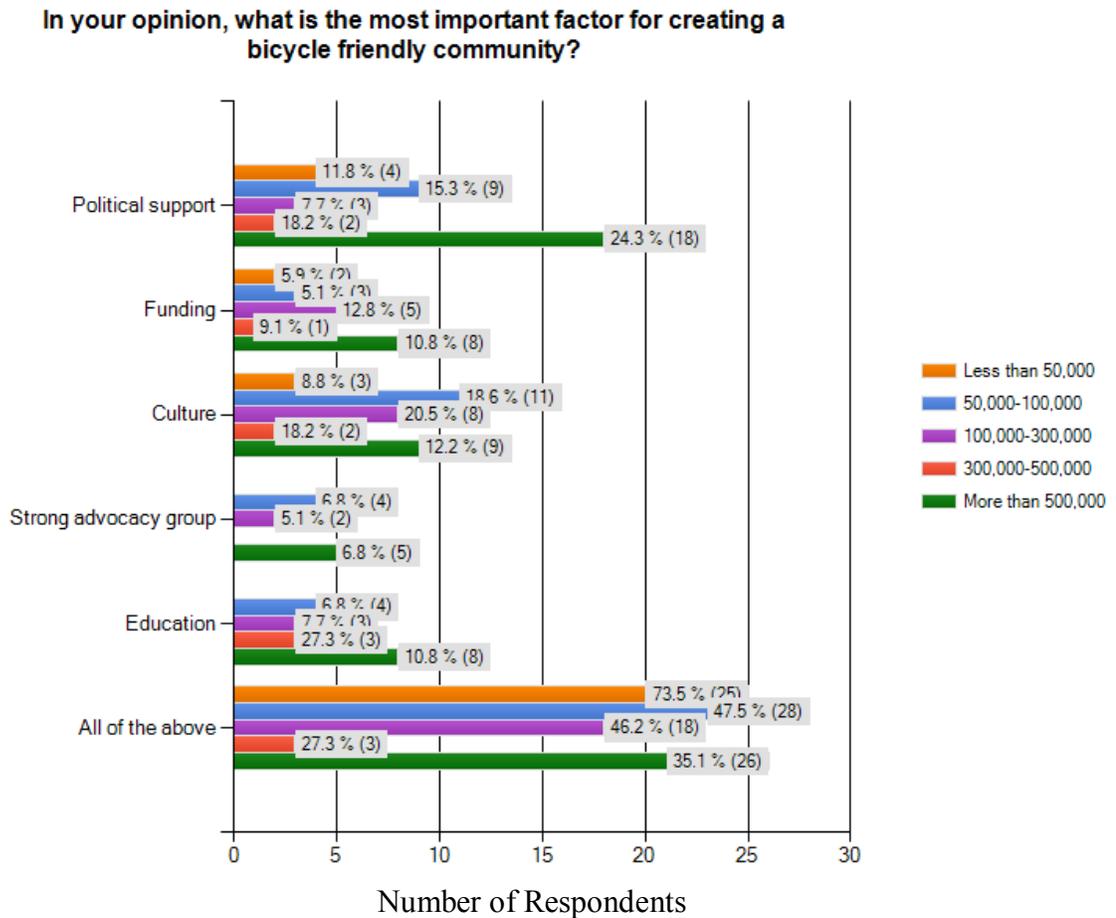


Figure D. 54: Factors Affecting Bicycling in Communities of Different Sizes

10. What is a comfortable distance for you to commute by bicycle under current roadway conditions and availability of bicycle facilities in your city?

The majority of respondents in the three smallest city sizes indicated that they are only comfortable bicycling up to five miles under current roadway conditions. Conversely, the majority of bicyclists in the two largest city types indicated that they are comfortable bicycling up to a distance of 10 miles. The difference between these distances could indicate that better facilities exist in larger cities or that the existing roadway conditions are better for bicyclists, allowing them to travel greater distances. This could be a result of increased funding in larger cities. The results of this question are shown in Figure D.55.

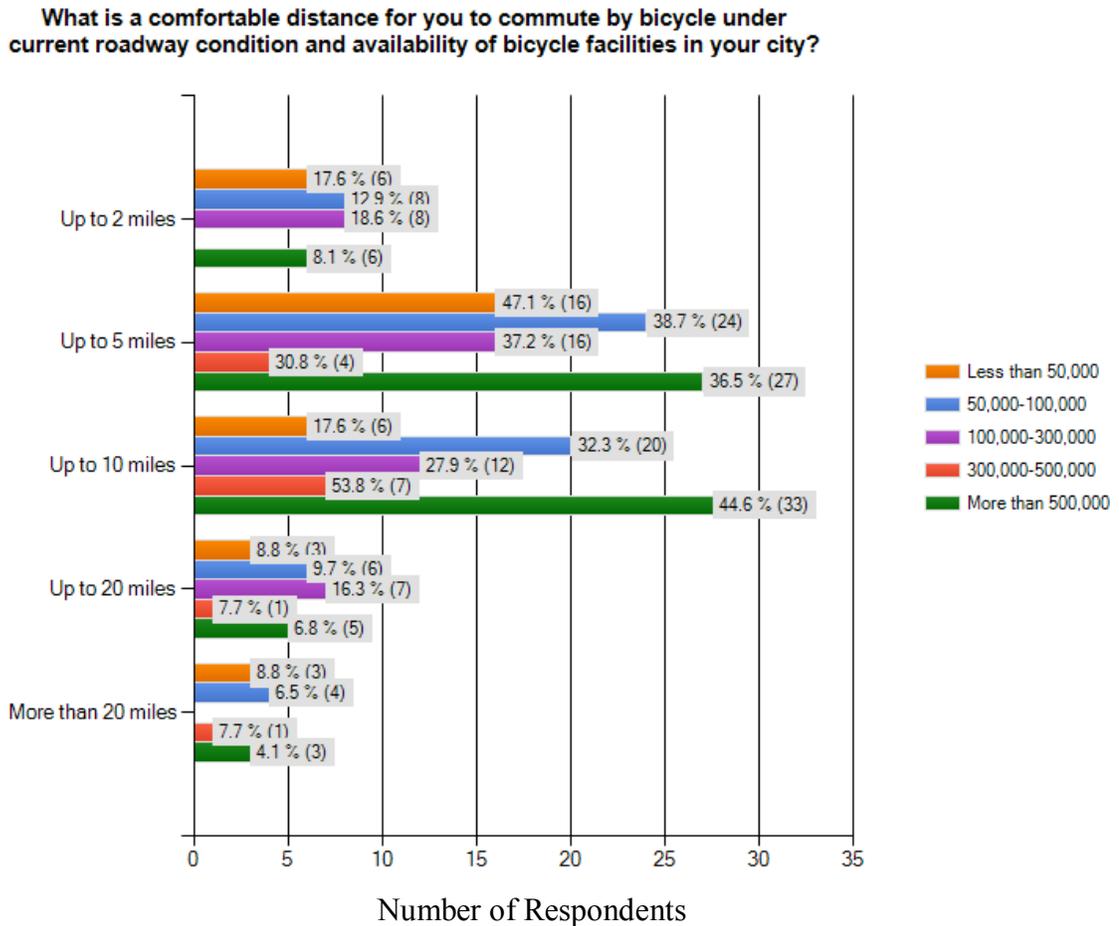


Figure D. 55: Comfortable Bicycling Distances under Current Roadway Conditions in Communities of Different Sizes

14. How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of safety?

The majority of respondents in mid-sized (35.7%) and suburban (37.7%) communities indicated that their community is acceptable in terms of safety. The majority of respondents from urban areas (46.2%) rated their communities as good in terms of safety. These results seem to indicate that many different community sizes are very similar in terms of roadway network level of service. The split for metropolitan and rural communities may be due to overly congested roadways for metropolitan communities and very few roadways for rural communities. From these results, it seems that safety may be less a product of population but more of an issue relating to other factors. The results of this question are shown in Figure D.56. Similar results to this question were shown for Questions 15 and 16, indicating that there is virtually no difference between city sizes for level of service in terms of connectivity and efficiency. These questions simply reinforce the findings of Question 14, so the results are not presented.

How would you rate the level of service provided to bicyclists by the existing roadway network in your town in terms of safety?

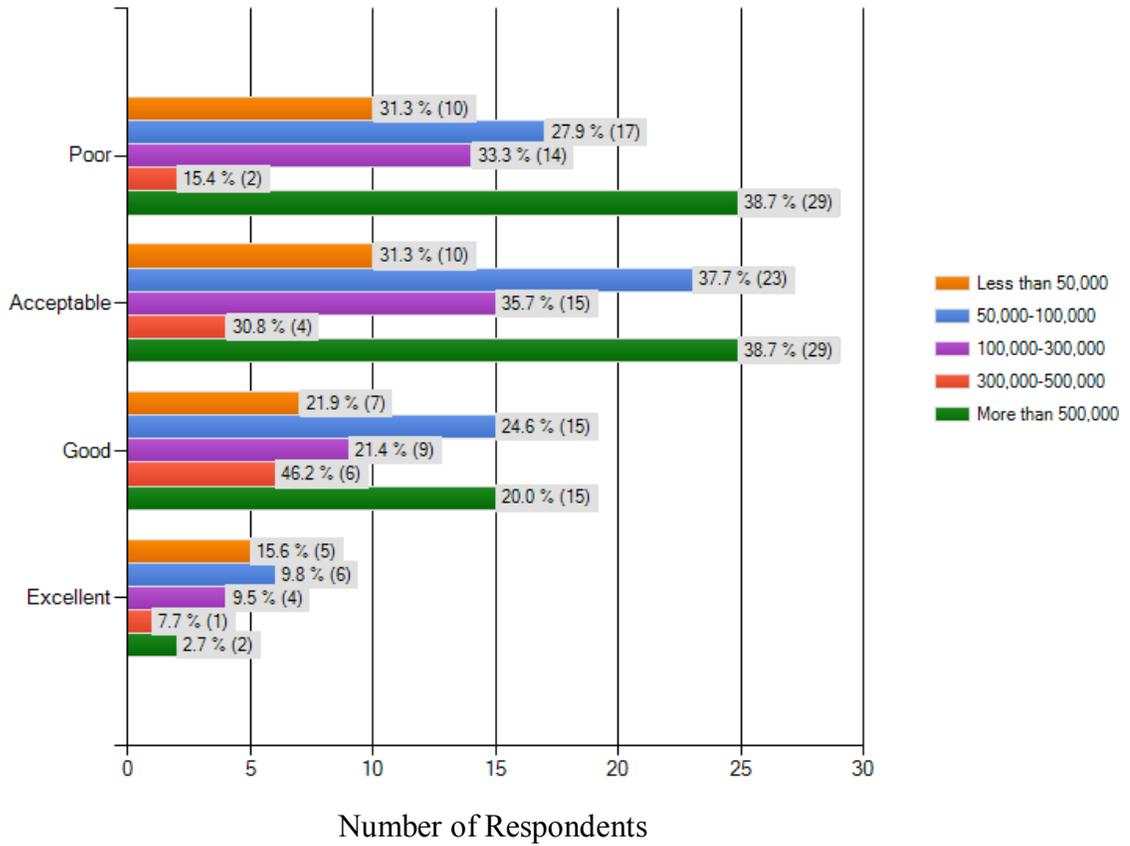


Figure D. 56: Level of Service Ratings in Terms of Safety in Communities of Different Sizes

19. How would you rate the motorists' attitude towards bicyclists in your town?

The results of this question indicate that as population increases, motorist attitudes (and likely education level) becomes more negative to bicyclists. A majority of respondents in rural areas (45.7%) indicated that motorist attitudes are acceptable. The majority of respondents from suburban (37.7%), mid-size (37.2%), and urban (53.8%) cities indicated that motorist attitudes are neutral. The majority of respondents from metropolitan areas (37.8%) indicated that motorist attitudes are negative towards bicyclists. This could likely be due to an increase in the number of drivers in larger cities. However, the results of this question show that motorist attitudes in all regions could be improved. The results of this question are shown in Figure D.57.

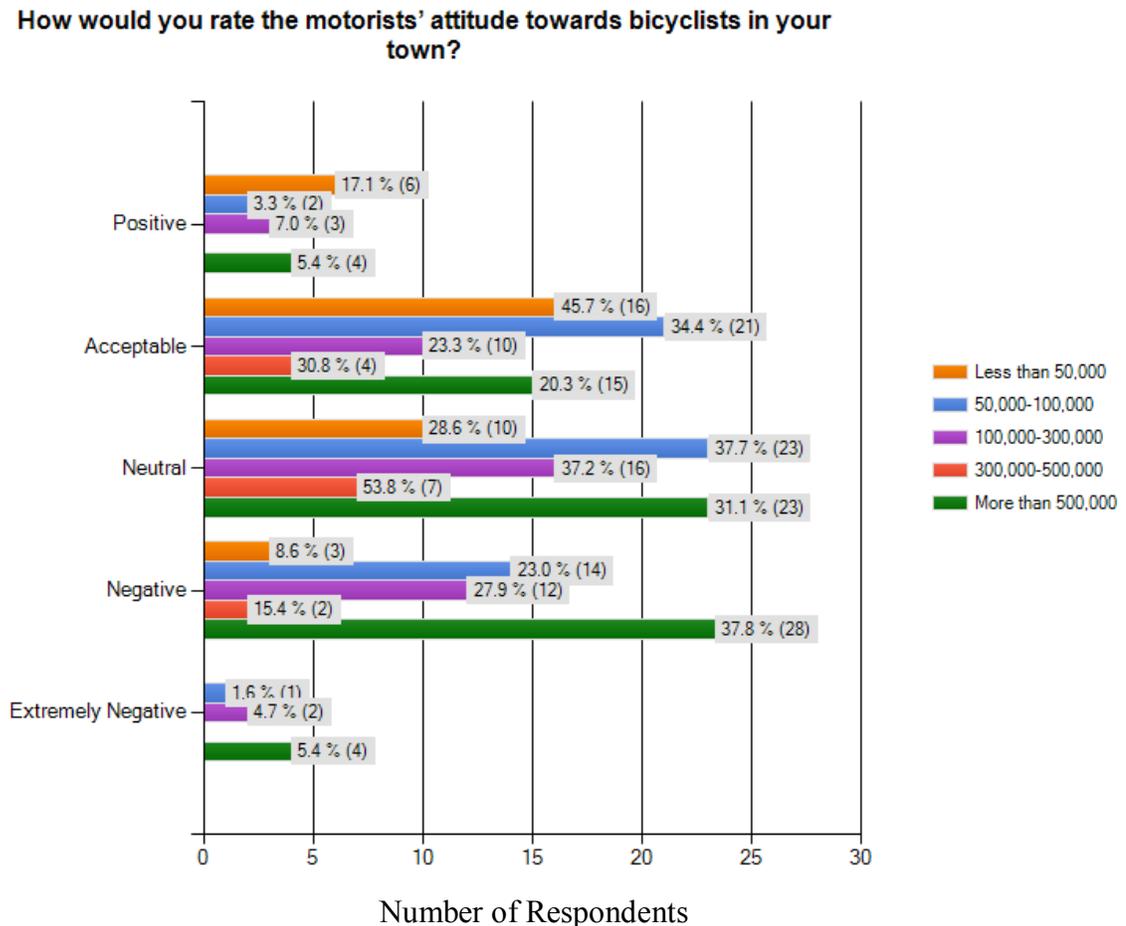


Figure D. 57: Motorist Attitudes toward Bicyclists in Communities of Different Sizes

24. *What are the most frequently observed types of bicycle crashes in your city/region?*

The majority of respondents in all communities indicated that the most common types of accidents occur between motor-vehicles and bicycles. This reinforces the assumption that motorist attitudes and education should be improved for all regions. The results of this question are shown in Figure D.58.

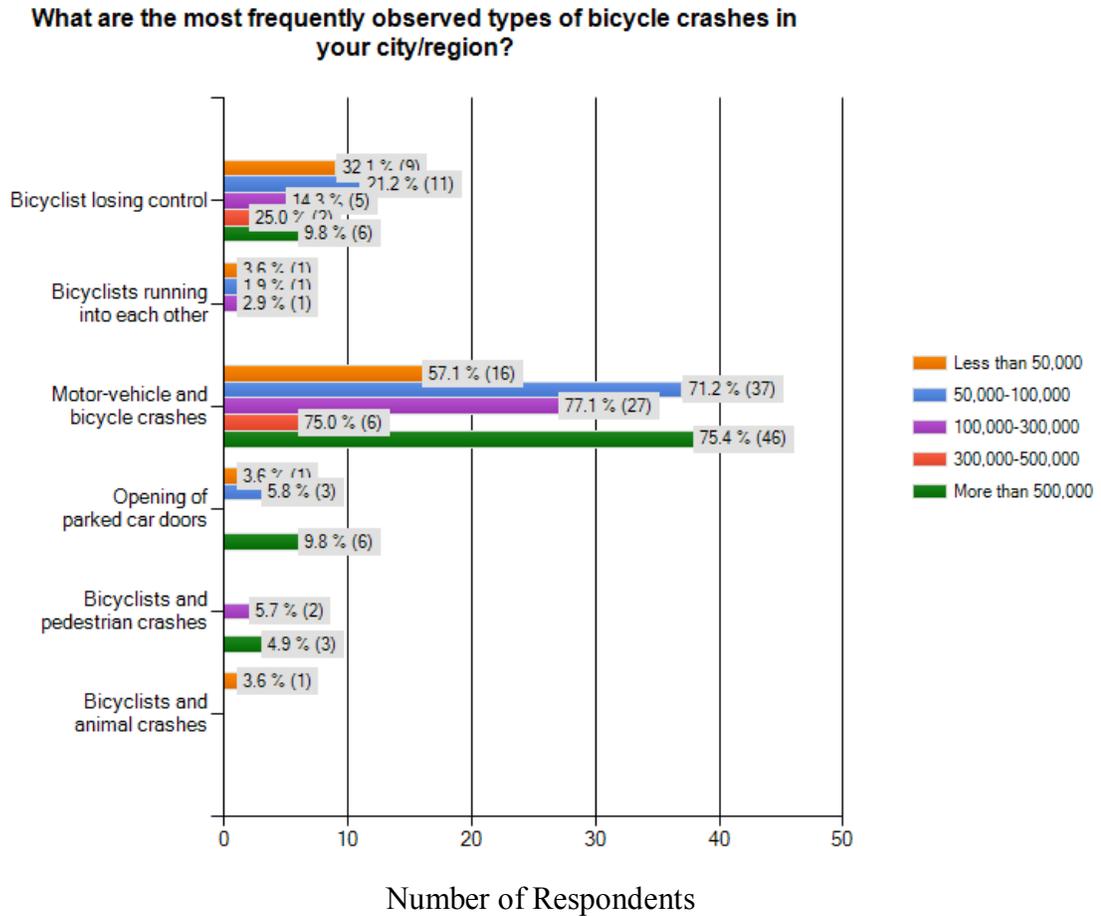


Figure D. 58: Most Common Types of Accidents in Communities of Different Sizes

3.2.2: Questions for Government Officials

The following questions are directed at government officials, including MPO officials, city planners, planning committee members, and TxDOT employees. This section lists each question with an accompanying analysis and a chart that shows the responses.

2. In your opinion, what is the most important factor for creating a bicycle friendly community?

Similarly to respondents in the bicycle users section, the majority of respondents from all community sizes indicated that all of the given choices (political support, funding, culture, strong advocacy group, and education) are important for creating a bicycle friendly community. The results from this question reinforce the previous conclusions that there is little difference in terms of bicycling between communities of different sizes. The results from this question are shown in Figure D.59.

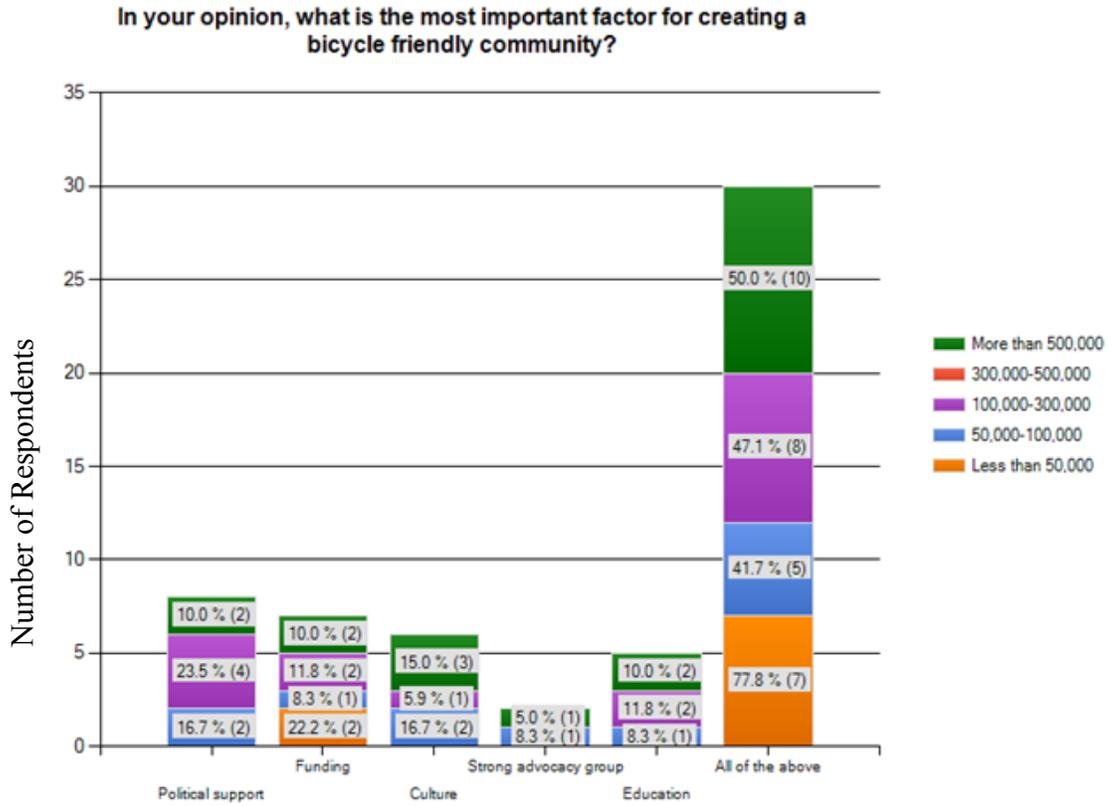


Figure D. 59: Important Factors for a Bicycle Friendly Community in Communities of Different Sizes

3. In your state, who plays a major role in decision-making as to how federal funds are spent at the regional and local level?

Unsurprisingly, the majority of respondents from all community sizes except rural areas indicated that the MPO plays a major role in decision-making for federal funds. The majority of respondents (77.8%) from rural areas indicated that the state DOT makes those spending decisions for them. This is likely due to a lack of MPOs in smaller areas. These results seem to indicate that perhaps the MPO is the most effective funding decision-maker for any population, regardless of size. These results are shown in Figure D.60.

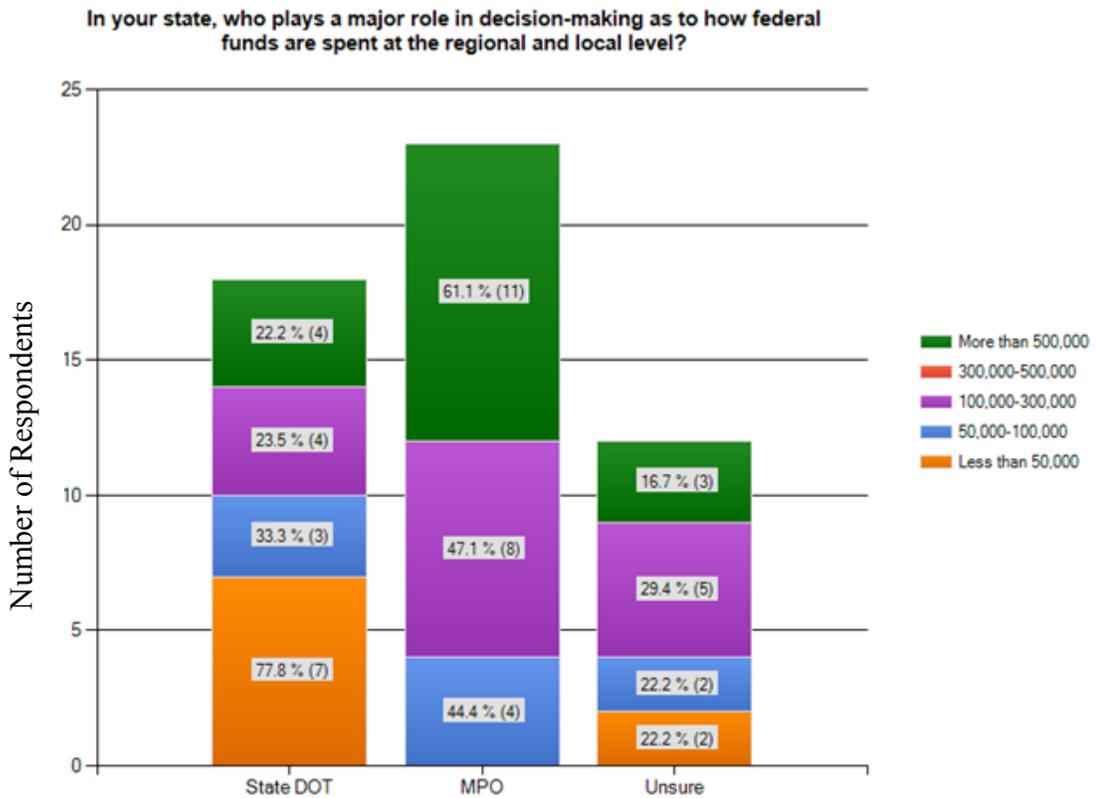


Figure D. 60: Major Decision-Makers for Spending Federal Funding in Communities of Different Sizes

9. Does your city use a bicycle Level of Service to assess the performance of bicycle facilities?

The majority of respondents from mid-size cities (35.3%) indicated two responses: that their city does use a bicycle Level of Service to assess the performance of bicycle facilities, or they were unsure if their city did. Conversely, the majority of respondents from rural, suburban, and metropolitan areas indicated that their city does not use a bicycle Level of Service. No responses were gathered from urban cities. Because few of the responses have been different thus far between different community sizes, it is likely that a bicycle Level of Service, whether existent or not, has little effect on the success of bicycling in a given city. These results are shown in Figure D.61.

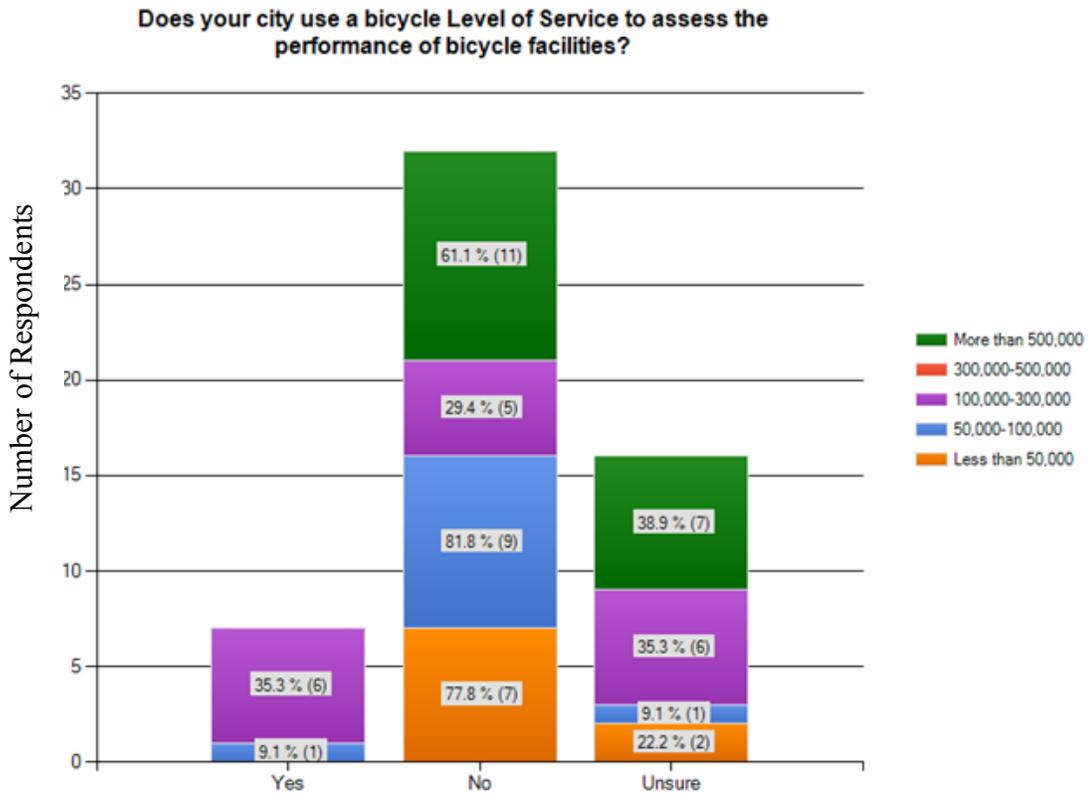


Figure D. 61: Bicycle Level of Service in Communities of Different Sizes

14. *If there is a written bicycle plan, how often is the bicycle plan updated?*

The majority of respondents from rural areas (50.0%) and mid-size cities (50.0%) indicated that they were unsure how often the bicycle plan for their city is updated. The majority of respondents from suburban areas (50.0%) indicated that the plan is updated less frequently than every five years, and the majority of respondents from metropolitan cities (46.7%) indicated that the bicycle plan is updated every five to 10 years. These responses likely indicate that a bicycle plan is relatively unimportant or underutilized in improving bicycling conditions in mid-size cities. This is because most respondents were unsure how often the plan is updated. Perhaps bicycle plans could be better used and more frequently updated to improve bicycling in mid-size cities. These results are shown in Figure D.62.

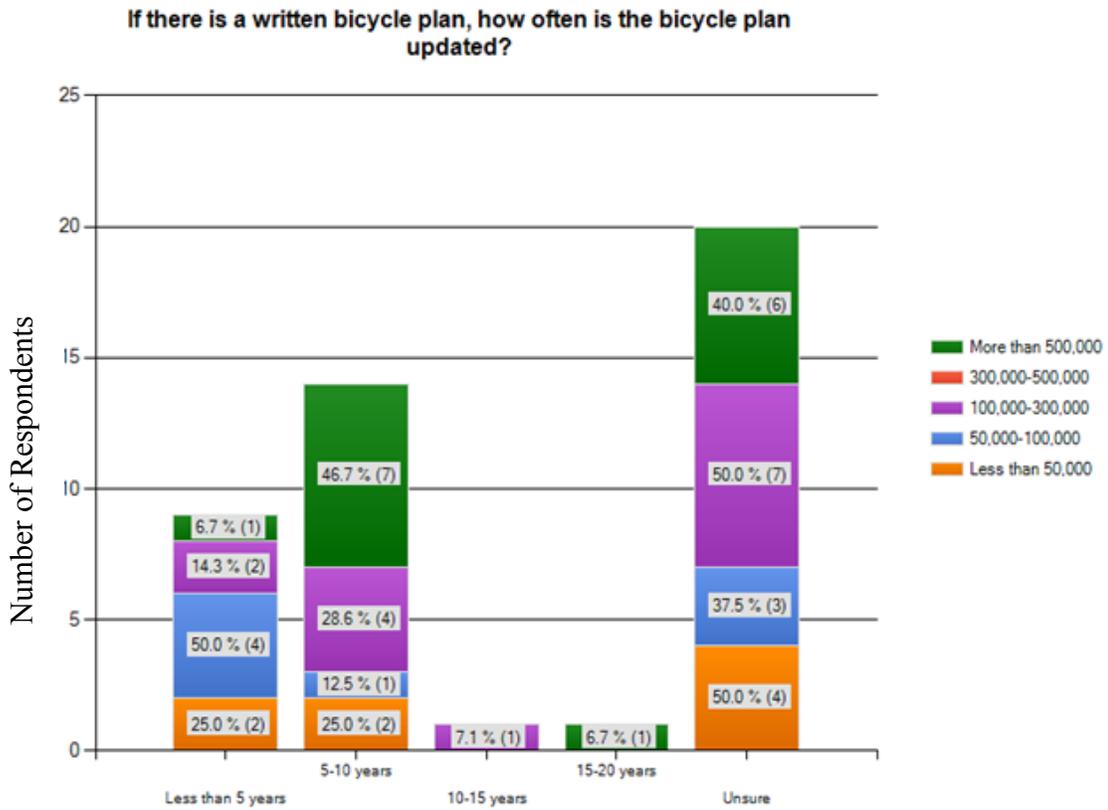


Figure D. 62: Frequency of Updates to a Bicycle Plan in Communities of Different Sizes

17. Does the Transportation Authority in your region employ a dedicated employee in charge of bicycle/pedestrian issues?

The majority of respondents from rural areas (44.4%) and mid-size cities (41.2%) indicated that they are unsure if the Transportation Authority in their region employs a dedicated employee in charge of bicycle and pedestrian issues. Conversely, the majority of respondents from metropolitan cities (61.1%) indicated that the Transportation Authority does in fact employ such an individual. These results may indicate an advantage that larger cities have over smaller cities. Perhaps the greater population allows the Transportation Authority to employ a dedicated bicycle advocate. This may show that bicycling in mid-size cities could benefit from such an individual with the local Transportation Authority. These results are shown in Figure D.63.

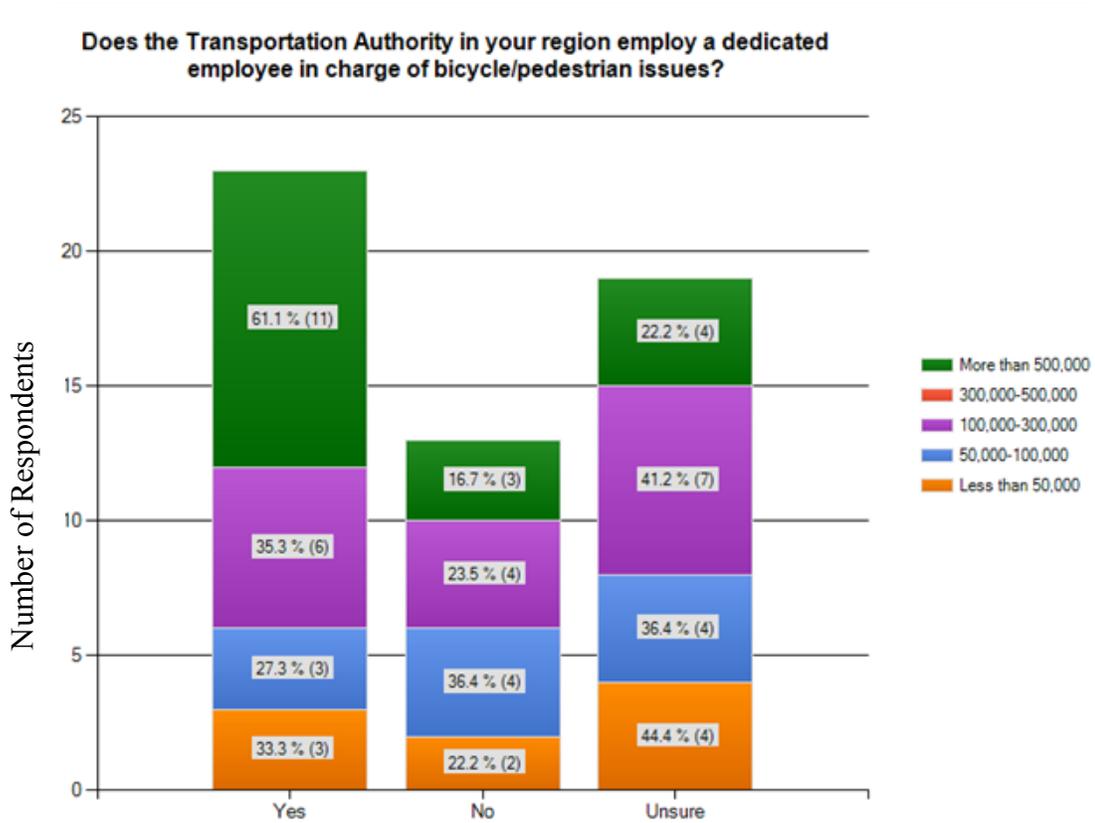


Figure D. 63: Employment by Local Transportation Authority of a Dedicated Bicycle Employee in Communities of Different Sizes

24. *Would you attribute your city's success in bicycle planning to? (check all that apply)*

The majority of respondents for all city sizes indicated that the two biggest factors for a city's success in bicycle planning are a strong commitment to bicycling by the local government and active outside advocates. Because these two choices are common to the majority of respondents from all community sizes, it can be assumed that these two forms of support should always be sought when planning for bicycling in a region. The results of this question reinforce the earlier findings from the first analysis section. These results are shown in Figure D.64.

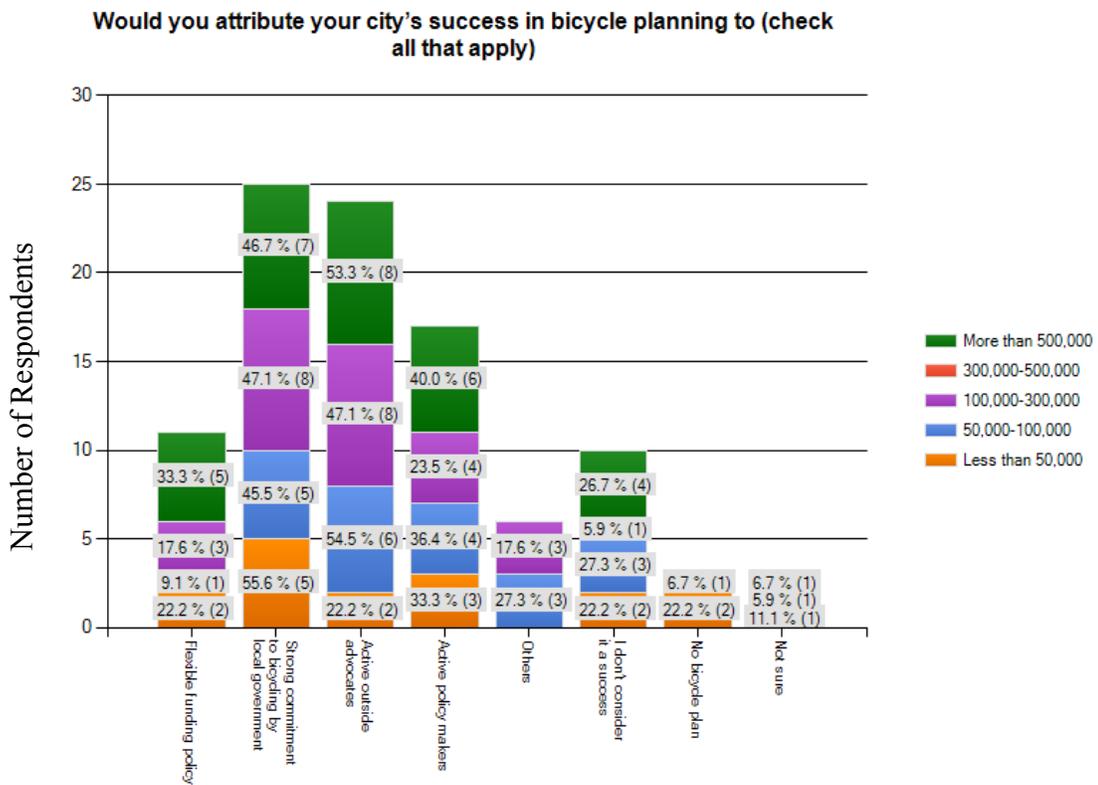


Figure D. 64: Factors That Contribute to Successful Bicycle Planning in Communities of Different Sizes

Chapter 4: Results

This section discusses many of the findings of the analysis of this survey. These discussions are split between the two analyses performed and between the sections for bicycle users and government officials. The constraints and limitations of these findings will be also discussed.

4.1: Analysis of Success Results

This section discusses key findings from the analysis of success rates. The results are split into a section of questions for bicycle users and a section of questions for government officials.

4.1.1: Findings from Questions for Bicycle Users

This section discusses the major findings from the questions for bicycle users. It also lists the corresponding survey questions from which these conclusions were drawn.

4.1.1.1: Safety is the Primary Concern for Bicyclists

Numerous questions in this section deal directly with safety or other factors with implications on safety. It became apparent during the analysis that safety is the primary concern for bicyclists. The results indicate that safety is a good measure of bicyclist comfort, which in turn indicates the success rate of a community in terms of bicycling. The questions that most directly relate to these conclusions are 6, 7, 8, 9, 10, 11, 12, 13, 14, 19, 21, 22, 23, 24, 25, 26, and 27. The major issues related to safety are:

- Communities with safer bicycling conditions are considered more comfortable, and therefore more successful.
- Unsafe roadway conditions is the primary discouraging factors for most bicyclists. When bicycling conditions become safer, bicyclists are more comfortable traveling greater distances and at higher speeds. Bicyclists who are more comfortable are also more likely to use a bicycle for commuting rather than just recreation.

- Bicycle lanes and designated bicycle paths are typically considered safer than shared use paths, and lead to greater bicyclist comfort.
- Better education of motorists and greater promotion of bicycling can result in safer conditions for bicyclists, increasing their comfort level. The majority of bicycle-related accidents involve collisions with motorists, so cities that perform better at studying and learning from bicycle accidents help create safer conditions and raise the overall comfort level.

4.1.1.2: Community Size

The size of the community has some effect on the overall comfort level of bicyclists. The questions that most directly relate to these conclusions are 1 and 2. Respondents in mid-size cities and urban areas typically rate their communities as more comfortable. This could be due to a better mix of funding and population size. Metropolitan areas are typically seen as less comfortable because of their large size.

4.1.1.3: Other Factors That Lead to Increased Success Rates

The following factors also impact the success level of bicycling in a community. The questions that most directly relate to these conclusions are 4, 5, 15, 16, 17, 18, and 20.

- Communities with a higher comfort level rate their communities higher in promoting bicycling.
- Better connectivity leads to higher success and comfort levels.
- More efficient roadway designs lead to higher success and comfort levels.
- Better media use leads to higher success and comfort levels.
- Bicyclists being given more rights and responsibilities correlates to a higher success rate.
- Political support, funding, culture, strong advocacy group, and education are all very important in creating a bicycle friendly community.

4.1.2: Findings from Questions for Government Officials

This section discusses the major findings from the questions for government officials. It also lists the corresponding survey questions from which these conclusions were drawn.

4.1.2.1: Local Government Agencies Are More Effective at Promoting Bicycling

The results of numerous questions indicate that local government agencies are more effective at supporting bicycling and providing a comfortable and successful environment than are larger or outside government agencies. The questions that most directly relate to these conclusions are 1, 6, 18, 24, and 26. The major issues relating to local agencies are listed below:

- The most successful bicycling communities attribute success to local government support and active promotion of bicycling.
- Regional transportation planning seems to be the most effective source of funding for bicycle projects.
- Bicycling is not usually given dual support in a state's long-term transportation plans, so local government agencies have to provide the necessary support for bicycling.

4.1.2.2: MPOs Are Most Effective When Making Funding Decisions but Often Ineffective Otherwise

Numerous questions showed that successful communities often rely on MPOs to make critical funding decisions and demonstrate flexibility in spending, but they can count on their MPOs for little else. This could be an indication that MPOs are capable of being effective at supporting bicycling but currently lack the necessary focus or ability to provide direct support. The questions that most directly relate to these conclusions are 3, 4, 5, 13, 14, 15, 16, and 20. The major issues relating to MPOs are listed below:

- MPOs are effective at making funding decisions.
- MPOs either do not have written bicycle plans or do not use them effectively.

- A bicycle advocate in an MPO could lead to success in communities but may not be very effective in current uses.
- MPOs often do not account for bicycling in their travel demand forecasting models.

4.1.2.3: More Successful Communities Are Active in Improving Bicycle Conditions

Success in bicycling communities often accompanies active maintenance and support in a city. The questions that most directly relate to these conclusions are 10, 19, and 22. The major issues relating to active maintenance include:

- The most successful communities actively maintain and manage their bicycle structures.
- The most successful communities have numerous bicycle projects planned for the future.

4.1.2.4: Other Key Findings

The following list of findings are important, but cannot be grouped together under one category. The questions that most directly relate to these conclusions are 2, 7, 8, 9, 11, 12, 17, 21, 23, and 25. These miscellaneous findings are listed below:

- Political support, funding, culture, strong advocacy groups, and education are all important for creating a bicycle friendly community.
- Funds from Transportation Enhancements seem to be used most often by the most successful communities.
- Bike lanes are the most frequently used structures in successful communities because of their higher perceived safety.
- A Level of Service for evaluating bicycling is not used very frequently in successful communities, so it may not have much impact on the success of bicycling in a community.
- Successful cities typically have an active bicycle committee.
- Specific law enforcements to protect bicyclists can result in higher success rates.

- Local Transportation Authorities may or may not have dedicated bicycle employees. Therefore, these employees may be largely ineffective at improving bicycle success.
- The most successful communities use media involvement and workshops/courses as the primary means to promote education of bicyclists.
- Funding is the major barrier to successful bicycle implementation.
- There is a direct correlation between perceived comfort level and success rate. This validates the assumption upon which this analysis was performed.

4.2: Analysis of Community Sizes

This section discusses key findings from the analysis of success rates. The results are split into a section for questions for bicycle users and a section of questions for government officials. Many of the findings from this analysis reflected earlier findings from the first analysis, so this section focuses on the key findings from this section.

4.2.1: Findings from Questions for Bicycle Users

This section discusses the major findings from the questions for bicycle user. It also lists the corresponding survey questions from which these conclusions were drawn.

4.2.1.1: There Are Few Differences between City Sizes for Bicycle Users

The results of this analysis indicate that there is virtually no difference for bicyclists in terms of city size. Most of the issues and solutions pertinent to one city size are still relevant to most of the others. Therefore, it is likely that planners in mid-size cities can apply lessons from other cities, regardless of size, to improve bicycling conditions in mid-size cities. The questions related to this finding are 3, 5, 14, 19, and 24.

4.2.1.2: There is a Difference in Comfortable Bicycling Distance

The results seem to indicate that bicyclists in larger cities are more comfortable bicycling greater distances. Although this could be for a variety of reasons, it is likely that this is due to either better connectivity or availability of bicycle facilities, or due to different

reasons for bicycling, such as commuting. Whatever the cause, it is likely that bicyclists in mid-size cities would be more comfortable bicycling longer distances if conditions improved for them. The question related to this finding is 10.

4.2.1.3: Motorist Attitudes are Generally Negative and Seemingly Worsen with Population Increase

Except in very small cities, the majority of all bicyclists, regardless of city size, indicated that motorist attitudes towards bicyclists are either neutral or negative. The attitudes also seem to worsen as population increases. This is likely due to a lack of education for motorists in larger cities because of the sheer number of drivers. Therefore, mid-size cities should work harder to improve motorist education. The questions related to this finding are 19 and 24.

4.2.2: Findings from Questions for Government Officials

This section discusses the major findings from the questions for government officials. It also lists the corresponding survey questions from which these conclusions were drawn.

4.2.2.1: There Are Few Differences between City Sizes for Government Officials

Similarly to the results of the analysis of the questions for bicycle users, the results of the questions for government officials showed that there are very few differences between cities of different sizes in terms of bicycling. As previously asserted, it is likely that planners in mid-size cities could adopt successful strategies from other cities, regardless of size, to improve bicycling conditions. The questions related to this finding are 2, 3, and 24.

4.2.2.2: Level of Service Likely Has Little Effect on Success in Mid-Size Cities

Although respondents in mid-size cities indicated that they often do use a bicycle Level of Service to measure success, it is likely that this actually has little impact on the success rate. This is because the majority of respondents from the other cities indicated that they do not use one, and yet all the city sizes indicated similar levels of success. Therefore, a

bicycle Level of Service should not be relied on to measure or improve success. The question related to this finding is 9.

4.2.2.3: It is Likely That a Bike Plan is Underutilized in Mid-Size Cities

There were discrepancies between the frequencies of how often a Bike Plan is updated, although it is possible that larger population centers tend to update their plan less often. However, this difference likely indicates that Bike Plans are often underutilized, especially in mid-size cities. Perhaps, if the Bike Plan was updated more often, it could be used more effectively to improve conditions in mid-size cities. The question that relates to this finding is 14.

4.2.2.4: A Dedicated TA Bicycle Advocate May Be An Advantage of A Larger Population

Although it is unclear whether or not a dedicated bicycle advocate employed by a Transportation Authority can improve bicycling conditions, it does seem that having such an employee is an advantage that larger population centers have over smaller ones. Such an employee could possibly aid the success rate of bicycling in a community, so it may be beneficial for planners in mid-size cities to ensure that they can have the support of such an individual. The question related to this finding is 17.

4.3: Constraints and Limitations

This section discusses the constraints on data and limitations of the findings for both analyses. The primary concern with the data is that not all respondents answered every question. Because the cross-referenced question, "Overall, bicycling in your community is?" originally appeared in the bicycle users section, only approximately 10% of the respondents in the government officials section answered this question. Therefore, the number of responses that could be cross-referenced in the government officials section was significantly lower than in the bicycle users section. This could have resulted in a decrease in reliability for the results of the government officials section when compared to the bicycle users section. Similarly, the cross-referenced question "What is the

population of your community?” originally appeared in the bicycle users section, so the government officials data had similar shortcomings. Additionally, no respondents to this cross-referenced question indicated that they were a government official from an urban city, so a good comparative analysis of urban areas could not be performed. However, some clear implications could probably still be drawn, so the data and above conclusions should not be ignored.

Chapter 5: Best Practices in Bicycle Planning

Although bicycle plans can be less important for developing successful bicycling in a community than other factors, they can still be used as effective tools for focusing on important topics and creating a cohesive picture of proposed improvements. This section summarizes known strategies and policies for bicycle planning as well as making recommendations for bicycle implementation in mid-size cities based on the gathered data. Much of this section is modeled on the 2009 City of Davis Bicycle Plan due to the success in bicycling that Davis has experienced. Aspects of Bike Plans, effective strategies for implementation, and recommendations for improvement are highlighted below.

5.1: Aspects of Bicycle Planning

There are numerous aspects that encompass an effective bicycle plan, and it is important to cover all necessary issues when writing such a plan. Bicycle plans should cover historical overviews of bicycling (especially in the region being addressed), policies to be implemented, projects to be conducted, financing, and engineering needs (City of Davis, 2009). These sections will create both an understanding of how bicycling has developed in a community and provide direction for how bicycling can be improved.

5.1.1: Historical Overview

This section is important for addressing the development of bicycling in a particular community. Relevant topics to be addressed in this section include:

- Basic overview of community, including population
- Relevant data of bicycle ridership and support
- Relevant progress made in bicycling
- Awards and recognitions

Providing these data should demonstrate how bicycling has become a pivotal aspect of transportation in a particular region and show the need for continued progress.

5.1.2: Policies to be Implemented

This section will demonstrate the need for continued improvement and highlight the policies and actions that will accomplish the desired level of improvement. It is critical to list tangible goals, such as increasing safety, and include related objectives that will allow the goals to be met. These goals and objectives should be relevant and achievable. An effective strategy used by the City of Davis in 2009 was to list the City's goals as a list of six "Es" that will improve bicycling; this was both an effective marketing tool and informative, demonstrating the City's desire to gain support from the public and focus on relevant issues. The six "Es" include (City of Davis, 2009):

- Equity
- Education
- Encouragement
- Engineering
- Enforcement
- Evaluation

These topics provide focus to Davis's bicycle plan and demonstrate the various factors of bicycling to be improved. They are an effective model for other bicycle plans.

5.1.3: Projects to be Conducted

This section will list relevant projects that the city is conducting or will conduct in order to improve the condition of bicycling. It is necessary to include these projects as concrete evidence of support for bicycling and to keep the plan focused to achieve the tangible goals previously established. Completion of these projects is an effective way to measure the success and efficacy of a bicycle plan.

5.1.4: Financing

As previously established in the Results section of this report, improvements in bicycling cannot be achieved without proper funding. It is important to list sources of funding to

ensure that resources are used to maximum efficiency. However, the sources of financing must be realistic in order to achieve the desired goals, and extra financing should continually be sought.

5.1.5: Engineering Needs

This section should include relevant maps, figures, and specifications. These details will help ensure that the plan is being implemented effectively and that required engineering needs are being met. Sound engineering should always be practiced.

5.2: Recommendations

This section highlights recommendations based on the results gathered from the survey analysis. These recommendations should be integrated implicitly or explicitly with the various sections of the bicycle plan and should help provide a clear direction to meet the needs of a community. These recommendations are targeted specifically at mid-size cities. Mid-size cities have numerous advantages, including effective sources of funding, a substantial but not excessive population, and local control. Mid-size cities should use these advantages to apply in the following recommendations.

5.2.1: Bicycle Plans Should Be Used More Effectively

The data suggest that mid-size cities underutilize bicycle plans. This could be a result of poorly structured or poorly focused plans. Mid-size cities should carefully develop bicycle plans to access the numerous advantages of their population sizes and focus improvements to bicycling. It is likely that bicycling could be significantly improved if bicycle plans were used more effectively.

5.2.2: Local Government Agencies Should be Responsible for Developing a Plan

The data suggest that local government agencies are the most effective entities for improving bicycling conditions and providing a comfortable bicycling environment in a city. Therefore, mid-size city governments should take advantage of their size and build a

focused plan that addresses the needs of bicycling in the community without yielding to external influences. This will provide a more focused and relevant bicycle plan and likely produce tangible results.

5.2.3: Local Government Agencies Should be Responsible for Financing

The data suggest that the most effective source of financing is regional transportation planning. Therefore, mid-size city governments should attempt to effectively use and secure this source of funding, rather than relying on external sources. This will ensure that improvements are relevant to the city's goals for bicycling. It may be beneficial to coordinate efforts with an MPO to make funding decisions. However, influence from the MPO should be limited in order to maintain the local focus on bicycling.

5.2.4: Mid-Size Cities Should Effectively Promote Bicycling

Mid-size cities are capable of effectively using various sources, including the media and workshops, to effectively promote bicycling. The city government should make every effort to promote bicycling, as this will likely increase education levels of both motorists and bicyclists, thereby increasing safety. Safety is the primary concern of bicyclists, so promotion should not be overlooked.

5.2.5: Mid-Size Cities Should Be Vigilant in Following the Plan

The data suggest that cities that actively seek to improve bicycling produce more successful bicycling communities. One way to stay active in implementing bicycling is to adhere to a well-developed bicycle plan. It is likely that as goals and objectives are met, the overall state of bicycling in a community will improve. This in turn will likely bolster efforts to continue improving. Therefore, mid-size city governments should follow well-developed plans and constantly seek to improve bicycling conditions.

Chapter 6: Conclusions

The purpose of this analysis was to synthesize success stories to create a clear picture of what makes certain bicycling communities successful. After analyzing the cross-referenced responses to the survey, the research team believes that it has found several key factors that relate to improved success rates for bicycling in various communities. This conclusion is supported by the fact that Question 23 of the government officials section validated the initial assumption that bicyclist's comfort directly correlates to community success rate. Although numerous factors take part in creating success, perhaps the two most important factors are safety and local government support. Without safe roadway design conducive to bicycling and support from a local government agency that promotes and supports bicycling, it is very likely that communities will not be able to establish successful bicycling environments. However, according to Question 3 of the bicycle users group section, approximately 56.7% of bicyclists rate their community as acceptable but needing some improvement. This shows that bicycling is progressing as a viable mode of transportation in this country, and that by paying attention to the key factors for increasing bicycle user comfort, more communities can become successful bicycling communities. Additionally, it was found that there is little difference in bicycling between different sizes of communities. Therefore, the same practices and principles used to improve bicycling in a rural community or a metropolitan center can be applied to a mid-size city.

Appendix E

Bicycle Implementation in Midsize Cities: Using Survey Results to Develop Successful Bicycle Policy Guidelines

This appendix is a copy of a paper submitted for publication to the Transportation Research Board (TRB) for publication. This paper summarizes the research of Phase 2. The paper was not accepted for publication.

Bicycle Implementation in Midsize Cities: Using Survey Results to Develop Successful Bicycle Policy Guidelines

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Total Words: 5330

Total Figures: 6

Total Tables: 1

Total Combined: 7080

Submitted for presentation and publication at the 91st Annual Meeting of the
Transportation Research Board.

August 1, 2011

Bicycle Implementation in Midsize Cities: Using Survey Results to Develop Successful Bicycle Policy Guidelines

ABSTRACT

Bicycling in the United States is a traditionally underutilized mode of transportation. Many communities were developed with little thought for bicycling as a viable means of transport. However, recent trends in economics and policy have allowed the bicycle to gain prominence as an alternative mode of transportation. In order to determine how bicycling can be effectively integrated into a multi-modal transportation system, the researchers at the Texas Tech Center for Multidisciplinary Research in Transportation (TechMRT) conducted a survey of bicycle users and government officials on behalf of the Texas Department of Transportation (TxDOT). This survey aimed to identify factors that lead to successful bicycling in various communities, particularly developing cities and midsize cities. This paper delves further into those findings and provides definitive guidelines that can be used to ensure successful bicycling in a community. The key focus is on promoting safe bicycling in a midsize city.

KEY WORDS: Bicycling, funding, engineering and design, education, safety, policy, implementation, correlation, midsize city

INTRODUCTION

Although it is gaining popularity as a means of transportation, bicycling has historically been underutilized in the United States. The federal transportation funding program in the United States has focused on highway construction and maintenance for automated travel. As a result, many U.S. cities were developed with very little thought for the use of bicycling as a means of transportation either for recreation or travel. Insufficient and badly designed bicycle facilities have caused many problems, including insufficient access, insufficient street markings, limited right-of-way (ROW), discontinuity, or heavily motorized vehicle traffic on bike paths. These challenges make it difficult for bicyclists to properly access and use the necessary facilities.

Over the past few decades, the views of bicycling and federal interest in promoting non-motorized vehicles have changed significantly in recognition of the abundant benefits of bicycling, including improved health and physical fitness, environmental benefits, and as an alternate mode of transportation (1). With the support of federal, state, and local transportation agencies, many U.S. communities have successfully implemented bicycle programs through planning, policymaking, and engineering activities.

The goal of this research project was to synthesize successful practices of bicycle planning in midsize cities. To accomplish this goal, the research team at the Texas Tech Center for Multidisciplinary Research in Transportation (TechMRT) conducted a survey targeting what was believed to be some of the key factors affecting bicycling in the United States. This survey was distributed to various bicycle users and government officials across the nation in order to gather crucial information regarding different factors affecting bicycling.

BACKGROUND AND LITERATURE REVIEW

Before developing the bicycle survey and analyzing the data, the research team at TechMRT performed a background and literature review to better understand the current condition of bicycling in the United States. The team reviewed known literature from a wide range of sources to develop a clear understanding of the various aspects of bicycling culture. This background and literature review presents the following topics:

1. Reasons for Bicycling
2. Bicycle Commuter Profiles
3. Factors Affecting Bicycling

Reasons for Bicycling

There are multiple reasons why Americans choose bicycling as an alternative, or in many cases, primary mode of transportation. According to Moritz (2), the primary reasons that survey respondents indicated they bicycle are:

- 95% for health and fitness
- 82% for the environment
- 52% to avoid congestion
- 46% to save money on gasoline
- 34% to avoid car-parking costs and availability

Bicycle Commuter Profiles

Although bicycling is not a new hobby, data on bicyclist demographics were relatively scarce until the late 1990's. In his national survey of bicyclists in 1997, Moritz sought to create a coherent picture of who bicycles in the United States (2). In this study, Moritz found that the average age of bicyclists was 39 years old. In a more recent study, it was found that Americans with higher incomes tend to have better access to bicycles (3). In the 2001 National Household Travel Survey, it was determined that there are .86 adult-size bicycles per household (4). This shows that many Americans are likely to have access to a bicycle for commuting. Males are more likely to be bicyclists than females (3). Lastly, white Americans are more likely to bicycle than other ethnicities (5).

Factors Affecting Bicycling

Although it has been shown that numerous Americans have access to bicycles, there are several factors that affect whether Americans will bicycle. These reasons include:

- Safety
- Community
- Facilities
- Funding

Safety

Safety is a major concern for many bicyclists. Approximately 13% of bicyclists felt unsafe on their most recent day of bicycling (3). Statistics like this are the reason the

research team chose to focus on safety as an important factor impacting bicycling. Royal and Miller-Steiger's study found that there are numerous factors that made bicyclists feel unsafe (3), including:

- Motorists
- Uneven walkways or surfaces
- Dogs or other animals
- Potential for crime
- Too much bicycle or pedestrian traffic

Community

Many bicyclists feel that community support is an important factor for bicycling. Bicyclists want to live in neighborhoods that support bicycling and provide appropriate facilities that make bicycling more accessible. One study showed that half of all bicyclists (48%) were satisfied with their communities' designs in terms of bicycle safety (3). Approximately 19% were very satisfied. These high percentages show that many modern communities are in fact embracing bicycling as a legitimate and functional mode of transportation. However, it is obvious that changes and improvements still need to be made. In that same study, almost half (47%) of all the urban respondents indicated they would like to see some improvements to current bicycling conditions. The top three desired improvements (3) were:

4. More bike lanes
5. More bike paths
6. More bike trails

Facilities

The presence of supporting bicycle facilities is a major influence on the frequency and likelihood of bicycling in a community. There are numerous kinds of bicycle facilities, with some more common than others. These include:

- Wide curb lanes (also known as wide outside lanes or shared roadways) (6)
- Signed shared roadways (7)
- Bike lanes (8)
- Paved Shoulders (9)

Funding

Federal legislation has dealt specifically with bicycling since the 1973 Federal-Aid Highway Act (10). Subsequent acts have updated the policies of that influential act, and the most recent transportation bill is the Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (SAFETEA-LU). This act provides great flexibility for states and Metropolitan Planning Organizations (MPOs) to fund bicycle and pedestrian projects from a wide variety of programs, such as providing paved shoulders, restriping roads to provide wider outside lanes, and modifying intersections to include bicycle paths. It further stipulates a number of provisions to improve conditions for bicycling and walking and increases the safety of these two modes. It requires that safe and convenient access to jobs, services, and recreational facilities be provided not only to motorized vehicles but also to bicycles. SAFETEA-LU requires that bicycle projects, except for the recreational trails program, be “principally for transportation rather than recreation” purposes (11).

Under current federal policies, state Departments of Transportation (DOTs) are responsible for allocating the funds in the Transportation Enhancements (TE) and the Congestion Mitigation and Air Quality (CMAQ) programs, the two major programs for bicycling projects. Apart from that, the federal government only distributes a portion of the funds in the Surface Transportation Program (STP) to allow regional MPOs with a population of 200,000 and over to decide how funding is spent. State DOTs have enormous influence on the selection and funding of bicycle projects (1).

At the state and regional level, the spending pattern or funding structure plays an essential role in determining how and to what degree the states and MPOs spend federal dollars on bicycle projects. Giving more flexibility and directing more funding to MPOs, rather than routing it from state DOTs, seems to be a successful experience in terms of

promoting bicycle and pedestrian projects (1). Studies have shown that spending on the state level does impact bicycle commuting directly. In 2009, Flusche showed that as federal funding for state bicycle and pedestrian programs increases, bicycle commuting increases (12). Because of its large impact on increasing ridership, careful administration of federal and state funds should be taken in order to improve bicycling on a state and regional level.

METHODOLOGY

TechMRT worked together with TxDOT to conduct a survey of successful bicycle policies and practices in the United States. The team developed and released an online survey targeted at various groups, including: MPOs, government officials, bicycle users, bicycle advocacy groups, TxDOT employees, and members of the Texas District of the Institute of Transportation Engineers (TexITE). The purpose of this survey was to rate various issues of funding, safety, and organization to create a clear picture of how successful bicycling would appear in Texas, particularly in mid-size cities. The team used the website www.surveymonkey.com. The link for the survey was <http://www.surveymonkey.com/s/5TB5FXN>. The survey was distributed to approximately 1300 respondents, many of whom disseminated it among other colleagues and posted the link on various websites. A total of 436 respondents took the survey, totaling about 34% of the initial survey population. The high level of responses both lends credibility to the study and indicates the importance and popularity of bicycling as a means of transportation.

The research team initially performed two analyses on the survey data. These analyses involved cross-referencing all of the responses with the responses from two particular questions. The first question was “Overall, bicycling in your community is?” Cross-referencing with this question allowed the team to compare factors leading to varying levels of success. The second question with which all responses were cross-referenced was “What is the population of your community?” Midsize cities have a population of 100,000 to 300,000, urban cities have a population of 300,000 to 500,000, metropolitan cities have a population greater than 500,000, suburban areas have a

population of 50,000 to 100,000, and rural areas have a population less than 50,000. This allowed a comparison of communities of different cities to be performed.

A correlation analysis was also performed to test the validity of some of the conclusions from the previous analysis. For this analysis method, all textual responses to every survey question were assigned numerical values in an Excel spreadsheet. For ease of data manipulation, responses to questions asking respondents to choose one answer were typically valued “1,2,3,4, etc.” For questions asking respondents to check all answers that apply, a binary value was assigned to each response, and an aggregate score for each respondent was calculated. For example, the first answer to such a question would be valued 1, and the second answer would be numbered 10. If a respondent chose both of these answers but no other answers, his score was 11. The numeric rankings for each answer on questions asking respondents to rank a series of selections were left as is.

Once all of the responses were collected in numeric format, the data for each question in each section was compared to the data set for one specific question in each section. All of the data in the Bicycle Users section was compared to the results of the question “Overall, bicycling in your community is?” All of the data in the Government Officials section was compared to the results of the question “What is your opinion with respect to bicycle planning, implementation, and maintenance in your community?” Correlations between the data were determined, and used to verify previous conclusions. A further correlation study was performed by cross-referencing all of the data in the Bicycle Users section with the question “What is the population of your community?” This was performed to determine if any correlations exist between the different community sizes and other factors affecting bicycling.

After performing these analyses, the research team reexamined the data, particularly the city size results, and developed guidelines for success from the data. Presented in this paper are the four key focus areas for bicycle policies, as well as accompanying data and figures. From these four focus areas, a comprehensive guide to planning and establishing a successful bicycle system is provided.

PREVIOUS FINDINGS

The previous study of the survey data produced numerous conclusions based off of basic statistical comparisons. These findings, although not definitive, provide initial observations and assumptions with which the data could be further tested. These findings include:

- Safety is the primary concern for bicyclists
- The size of the community has some effect on the overall comfort level of bicyclists
- Local government agencies are most effective at promoting bicycling
- MPOs are most effective when making funding decisions but often ineffective otherwise
- More successful communities are active in improving bicycle conditions
- There are few differences between city sizes for bicycle users
- There is a difference in comfortable bicycling distance
- Motorist attitudes are generally negative and seemingly worsen with population increase
- There are few differences between city sizes for government officials (with respect to bicycling)
- Level of service likely has little effect on success in midsize cities
- It is likely that a bike plan is underutilized in midsize cities
- A dedicated TA bicycle advocate may be an advantage of a larger population

The percentages of responses for each question were compared to develop the preceding conclusions. To test the validity of the initial assumptions about bicycling, this paper contains further analysis of the survey results using statistical analysis and data correlation. From these results, refined conclusions are drawn.

KEY FOCUS AREAS FOR BICYCLE POLICY

Using results from the earlier analysis, as well as more in-depth statistical analysis, four key focus areas for successful bicycling implementation in midsize cities were determined. These focus areas include:

- Funding
- Engineering and Design
- Education
- Safety

Although there is some overlap between the factors that impact each of these areas, there are several critical findings related to each focus group. This section addresses each of these four areas and attempts to ascertain the important factors that lead to successful implementation in each focus area in midsize cities. It also addresses other factors that can affect bicycling, including how they relate to these four key focus areas. The findings below are considered to be representative of midsize cities because the majority of respondents from midsize cities consider bicycling in their communities to be acceptable, although needing some improvement. The second highest percentage of respondents from midsize cities indicated that bicycling in their communities is joyful and pleasant. Because of these results, it is assumed that conclusions drawn from the survey results are accurate. Figure E.1 shows the results of cross-referencing two questions from the Bicycle Users section: “What is the population of your community?” and “Overall, bicycling in your community is?”

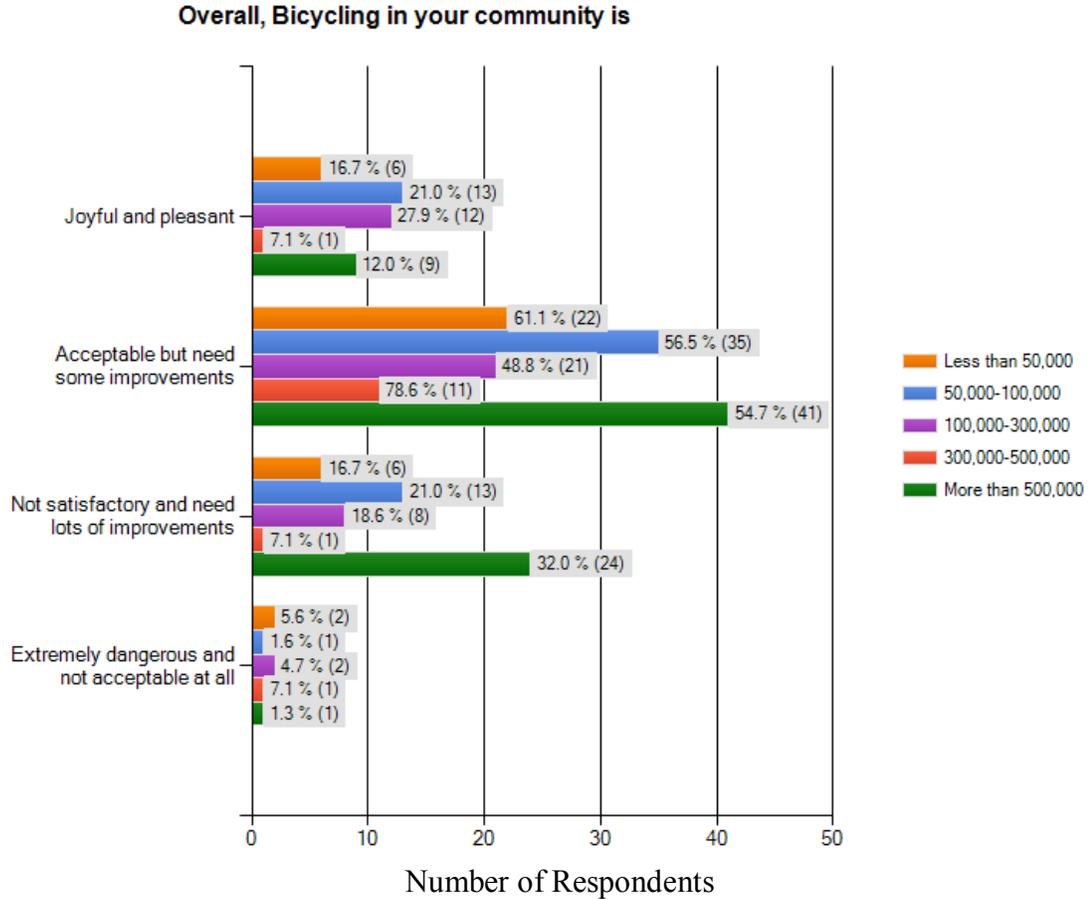


Figure E. 1: Success Rates in Communities of Different Population Values

Funding

Funding is one of the crucial factors impacting the successful implementation of bicycling in a midsize city. The results of the previous study showed that funding was a primary concern, so this section will explore the survey results further to show what funding sources are typically considered effective in midsize cities. Figure E.2 shows that a majority of respondents in midsize cities consider funding to be a major barrier to success in midsize cities.

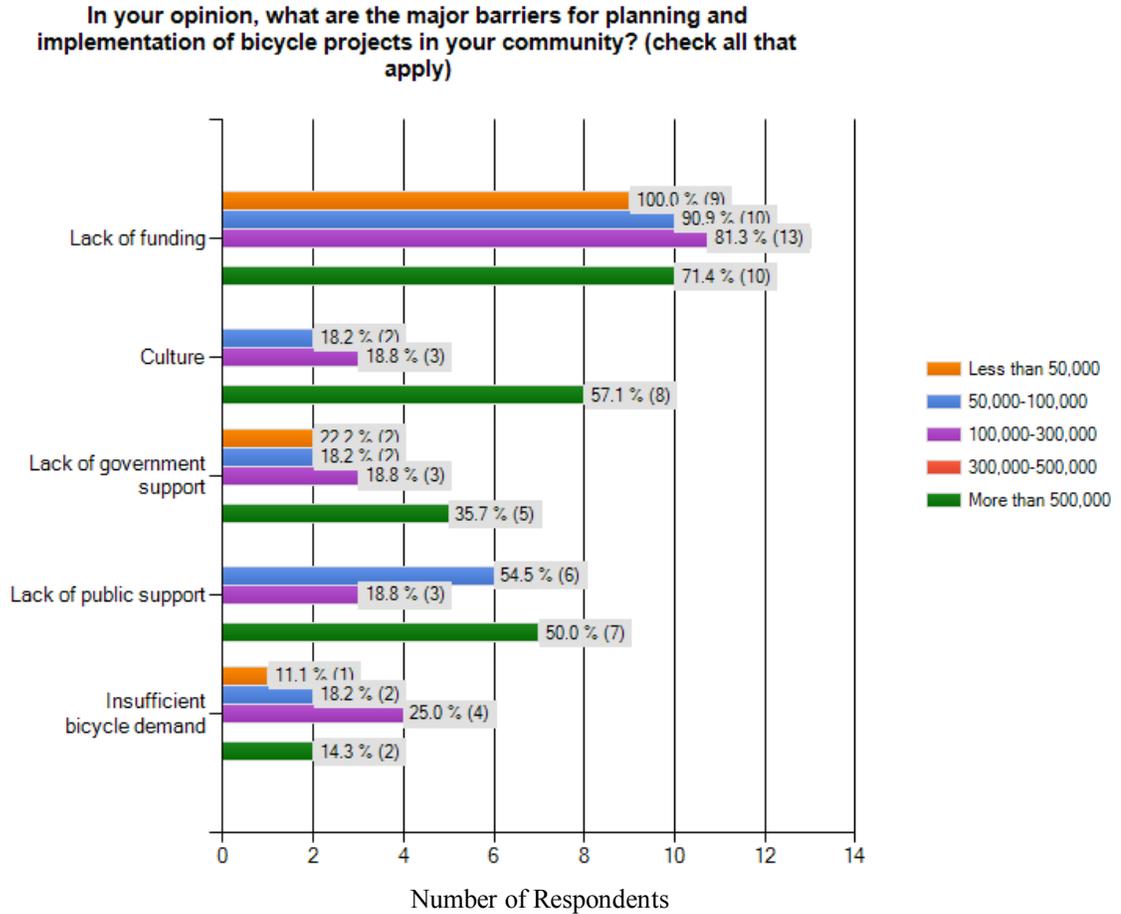


Figure E. 2: Major Barriers to Bicycling in Communities of Different Population Values

When planning bicycling, better results are typically associated with communities that achieve financial support through regional transportation planning as opposed to individual project applications to the state administered transportation program. The majority of respondents from midsize cities (53.8%) chose regional transportation planning as the means to achieve financial support. These results show that regional transportation planning should be the primary source of funding, although individual project applications should in fact still be used to gain funding. If both sources are used effectively, it is likely that communities could easily achieve a more successful level of funding.

The researchers next identified individual programs that can provide funding. Although TE, CMAQ, and Safe Route to School (SRS) programs are all effective sources

of funding, one respondent from a community in California listed several other funding sources that could likely be used by midsize cities. These funding sources include:

- State Transportation and Growth Management (TGM) programs
- City bonds
- Metropolitan Mobility Funds
- STP
- Local sources and supporters

Although TE and CMAQ programs account for the majority of funding for bicycle programs in midsize cities, other sources do exist. If transportation planners could supplement the regional planning sources with funding from local projects and other sources, it is likely that the funding barrier could be overcome. Therefore, the best practices for bicycle funding include applying early and often to Federal, regional, and local transportation programs.

Engineering and Design

Although the majority of bicyclists in midsize cities indicated that bicycling in their communities is acceptable, a major problem associated with bicycling in midsize cities is that roadway design features are unfriendly to bicyclists. Figure E.3 shows that this, along with risky motorist attitudes, is the primary problem associated with bicycling in midsize communities.

Which of the following problems associated with bicycling have you observed in your community? (check all that apply)

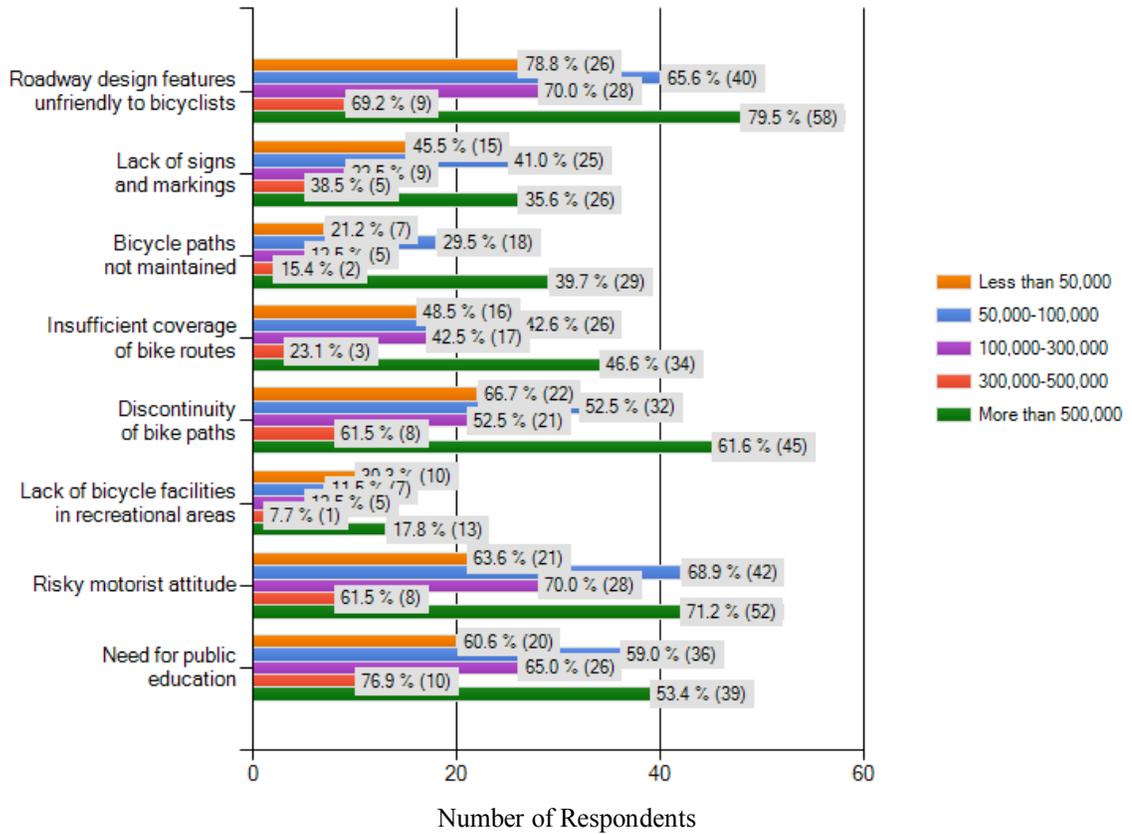


Figure E. 3: Problems Associated with Bicycling in Communities of Different Population Values

To address the issue of roadway design features being unfriendly to bicyclists, the team determined numerous improvements that engineers could make to roadway design in order to improve bicycling. Several questions were asked that provide before-and-after parameters for comfortable bicycling and could be used to show which improvements would have major impacts on bicycling comfort in midsize cities.

Bike lanes were indicated to be the most commonly appearing bicycle facility in midsize cities. Designated bike routes (bike lanes on roadways with specified signing and markings) are likely the most preferred form of facility. Bike lanes can be considered part of designated bike routes when signed and marked properly, and if these facilities comprise the majority of bicycle facilities on roadways in a community, it is likely that

bicyclists in midsize cities would feel comfortable bicycling on the roadways under any speed limit. In contrast to this, the majority of respondents (39.0%) in midsize cities only feel comfortable bicycling in shared lanes at speeds less than 30 miles per hour (mph) (48.28 kilometers per hour [km/h]) or lower. Therefore, it seems that designated bike lanes are the preferred facility, and engineers should design roadways with this facility in mind.

Similarly, bicyclists in midsize cities are also likely to bicycle further distances if roadway conditions are improved. A majority of respondents from midsize cities (37.2%) indicated that they are only comfortable bicycling up to 5 miles under current roadway conditions, but that same majority indicated that they would be comfortable bicycling up to 10 miles under improved roadway conditions. This shows the importance of improved engineering practices and planning in regards to implementing bicycling in a community.

Roadway features that prove to be very dangerous for bicyclists include intersections (particularly when a bicyclist is attempting to turn left) and ramp terminals. In particular, ramp terminals were considered to be the most dangerous area for the majority of bicyclists in midsize cities (32.4%). Therefore, special care should be taken when planning and designing roadways in a community. Bike routes should be designated that avoid ramp arterials and provide access to different areas of a city without forcing a bicyclist onto a ramp terminal. Additionally, careful signing and marking could be used to make bicycling at intersections safer. The survey results clearly show that roadways could be laid out with greater concern for bicyclists.

An interesting note to make is that in midsize cities, the majority of respondents indicated that recreation and physical fitness were the two primary reasons for bicycling. However, other communities indicated that commuting to and from work is the primary reason for bicycling. This disparity is likely due to poor roadway design in midsize cities. It seems likely that bicyclists would use roadways as a means of commuting more often, thereby increasing the modal share of bicyclists on the road, if better roadway designs were available.

Education

Education in midsize cities is a serious problem for bicycle implementation. Poor education often results in poor safety conditions and ineffective promotion of bicycling. These factors greatly affect bicycle ridership, so education should be used properly to promote bicycling and safe vehicle use in midsize cities.

One of the primary issues with education is bicyclist safety, particularly when dealing with motorists. Bicyclists often lack the education necessary to obey all traffic laws and feel uncomfortable bicycling on major roadways. Motorists typically harbor a neutral to negative attitude toward bicyclists without proper education on how to share roadways, as shown by Figure E.4.

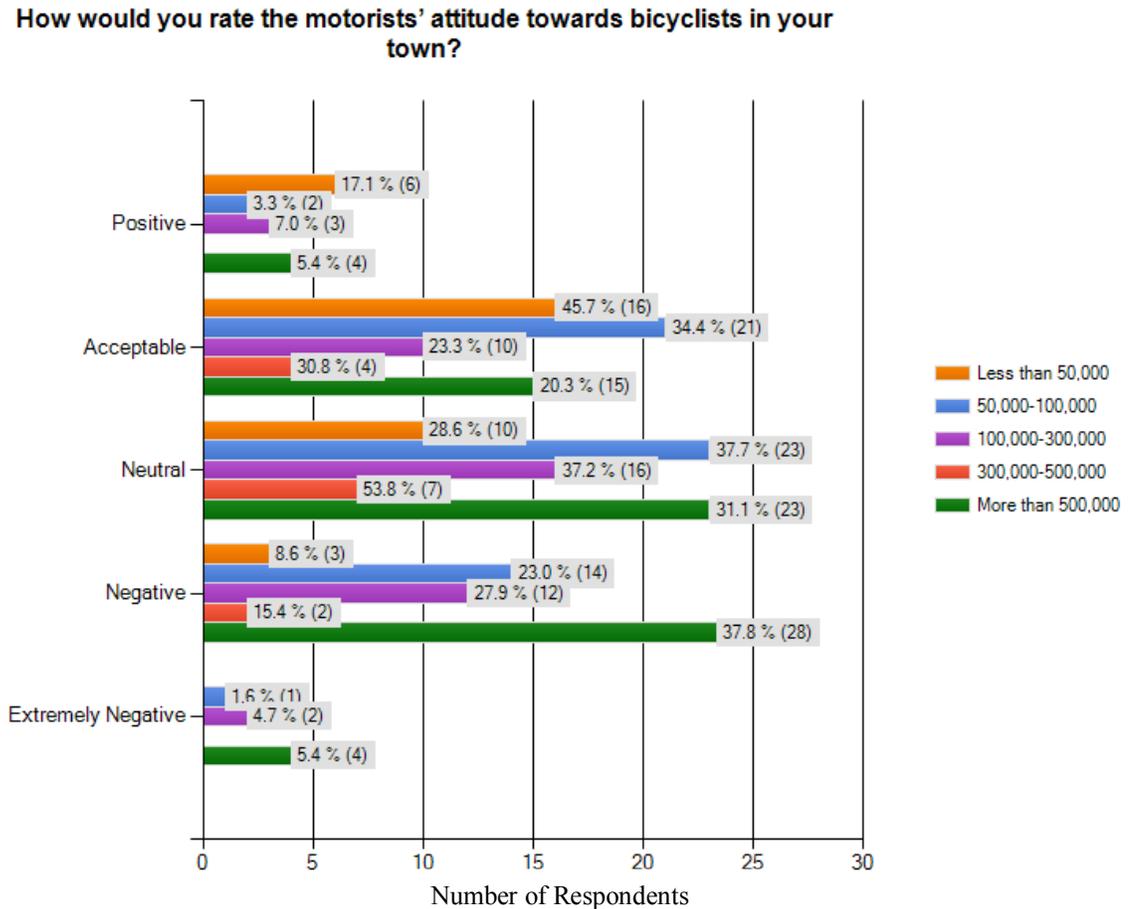


Figure E. 4: Motorists' Attitudes toward Bicyclists in Communities of Different Population Values

Numerous bicyclists in midsize cities indicated that they are not given the same rights as motorists on the roadways (53.7%) and that the most frequently observed accident involving a bicyclist is a motor vehicle/ bicycle crash (77.1%). These problems should be alleviated to produce safer, more successful bicycling in midsize cities.

To promote better bicycling conditions, several measures should be taken to improve education. These factors involve gaining the support of the local government and more effectively using media. Media usage is actually considered to not be used effectively to promote bicycling in midsize cities, according to a majority of respondents (40.5%). There are multiple forms of media that can be used to promote education of bicyclists. These media include:

- Bicycle driver's manual
- Bicycling-specific website
- Workshops/ courses
- Interactive bicycle maps
- Social networking communities

The promotional material indicated by bicyclists in midsize cities to be used most often (33.3%) is a bicycling-specific website. Many of the other promotional materials are used sparingly if at all. Better use of all available types of media would likely improve conditions for bicyclists by allowing motorists to be better educated on how to interact with bicyclists and allowing bicyclists to learn how to use roadways more effectively. This would likely lead to safer conditions.

Safety

The previous survey study indicated that safety is a top priority to bicyclists. All of the other key focus areas affect safety. Without safe bicycling conditions, people in midsize cities are unlikely to bicycle. Safer road conditions were indicated by the majority of bicyclists in midsize cities (38.5%) to be the factor that would encourage them to bicycle more often, as shown in Figure E.5. In this figure, the lowest rank indicates the most importance.

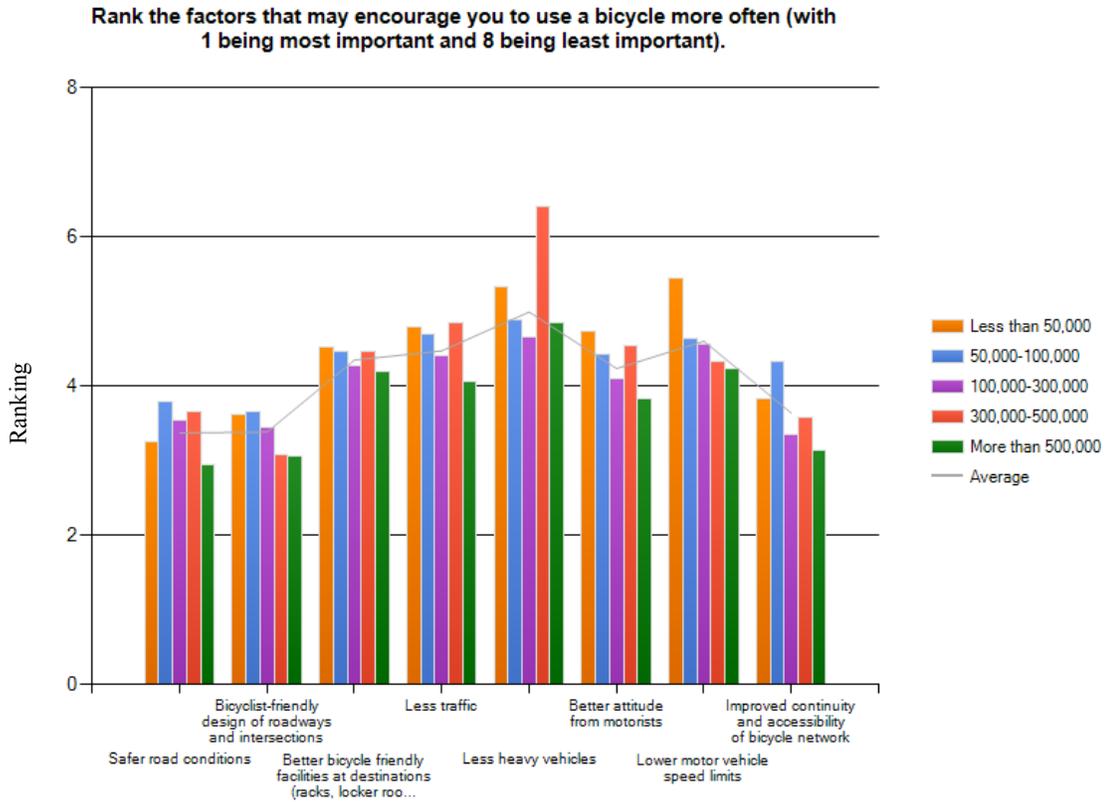


Figure E. 5: Factors that Encourage Bicycling in Communities of Different Population Values

As mentioned before, all of the other factors play a role in creating safe conditions for bicyclists. In the survey, bicyclists indicated that funding, engineering, and education can all lead to safer road conditions, and as Figure 5 demonstrates, safer road conditions encourage more people to bicycle. Therefore, safety can be considered the single most important factor for establishing a successful bicycling program in any community.

Other Important Factors

To test the results of the previous survey findings, several correlation studies were performed on the bicycle data. These correlation studies, although only indicative of the effects of certain factors on others, do show some interesting results that hint at the importance of numerous factors on bicycle policy. The results of each question were grouped into categories based on the strength of the correlation. Questions with a

correlation between -0.5 and 0.5 were considered to have a weak correlation. Questions with a correlation between 0.5 and 0.8 were considered to have a good correlation (13). Questions with a correlation equal to or greater than 0.8 were considered to have a very strong correlation.

Only two questions in the initial correlation analysis of the survey produced strong correlations, although only one of these correlations relates to the results of this paper. The strongest correlation found was produced by correlating the responses to the question, "How would you rate the motorists' attitude towards bicyclists in your town?" with the responses of the question "Overall, bicycling in your community is?" The r value for this correlation is $r=0.871477$. This is a much stronger correlation than most of the other responses produced, so it may indicate that there is a strong correlation between the comfort level of bicycling in a community and motorists' attitudes towards bicyclists in that community. This correlation, although not definitive by any means, could indicate the importance of proper education for both motorcyclists and bicyclists to improve relations on the road. This could in turn increase the success and comfort of bicycling in a community.

Numerous questions from each section produced good correlations when correlated with the indicated question for each section. In the bicycle users' section, the correlations range from $r=0.540568$ to $r=0.796392$, with an average correlation value of $r=0.683393$ and a standard deviation $s=0.090677$. The correlations could point to the importance of numerous factors for success, some of which were determined in the previous study, including:

- Population
- Proper facilities
- Education
- Safety
- Other factors

These numerous correlations seem to show that bicyclist comfort is a multi-faceted value affected by a multitude of variables, so very little should be disregarded

when planning transportation systems for bicyclists.

The last correlation study used to compare community sizes produced similar results. Although none of the data produced a strong correlation, numerous factors indicated a good correlation. The question numbers, correlation rankings, and r values are shown in Table E.1.

Table E. 1: Correlations to Population for Bicycle Users

| Correlations to Population for Bicycle Users | | |
|--|----------------------|---------|
| Question | Correlation Strength | r |
| 1 | Weak | 0.5030 |
| 3 | Good | 0.7549 |
| 4 | Weak | 0.0605 |
| 5 | Good | 0.5948 |
| 6 | Weak | 0.2622 |
| 7 | Weak | 0.3058 |
| 8 | Weak | -0.1002 |
| 9 | Weak | -0.1675 |
| 10 | Good | 0.7208 |
| 11 | Good | 0.7280 |
| 12 | Good | 0.5971 |
| 13 | Good | 0.5360 |
| 14 | Good | 0.6437 |
| 15 | Good | 0.6346 |
| 16 | Good | 0.6791 |
| 17 | Good | 0.7135 |
| 18 | Weak | 0.2123 |
| 19 | Good | 0.7876 |
| 20 | Good | 0.7023 |
| 21 | Weak | 0.3002 |
| 22 | Weak | 0.4916 |
| 23 | Good | 0.6841 |
| 24 | Good | 0.6286 |
| 25 | Good | 0.6728 |
| 26 | Weak | -0.0368 |
| 27 | Weak | -0.0624 |

Although there were no strong correlations for this section, there were three very good correlations. These correlations were for questions 3, 11, and 19, with the correlation values as indicated in Table 2. The topics of these questions include:

- Success level
- Comfortable distance to bicycle
- Motorists' attitudes

This correlation study serves to validate several of the previous assumptions presented in this paper. First, it shows that the assumption that the conclusions drawn by cross-referencing questions with population are acceptable because there is a good correlation between the success level of a community and its population. Additionally, these results show that two of the four key focus areas (engineering and education) directly impact bicyclists in different population sizes, showing that effectively using these tools can lead to successful bicycling in midsize cities. All of these correlations point to the validity of the previous survey findings and conclusions, although correlation does not necessarily mean causality.

GUIDELINES FOR ESTABLISHING SUCCESSFUL BICYCLE IMPLEMENTATION

Having addressed the key factors affecting bicycling implementation, the team developed guidelines to aid communities in developing a successful bicycle culture. The research team believes that the steps shown in Figure E.6 should essentially be followed in order, although several of the processes are continual and can be performed simultaneously. Following this flow chart is likely to produce successful bicycling conditions in a community.

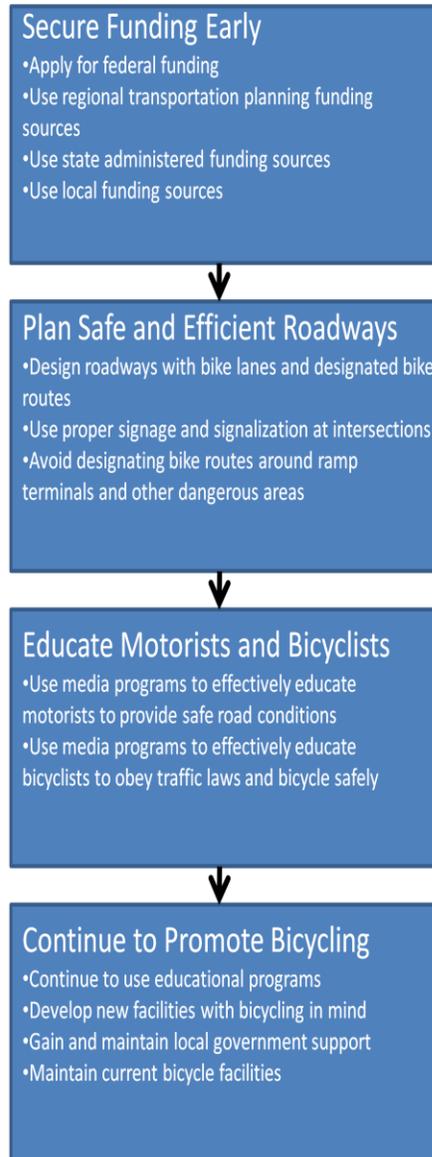


Figure E. 6: Flowchart for Successful Bicycling in Midsize Cities.

The final step in this guide may be the most important. Without proper maintenance and vigilance, a bicycling community will likely suffer. Therefore, transportation planners should be mindful to continually improve bicycling in their communities by acquiring funding, properly designing roadways, using education, and maintaining safe conditions. If these steps are followed, it is likely that bicycling in a community will be successful.

CONSTRAINTS AND LIMITATIONS

The primary concern with the data is that not all respondents answered every question. The cross-referenced question “What is the population of your community?” originally appeared in the bicycle users section, so not all of the respondents who answered this question responded to questions in the Government Officials section. It should also be noted that correlation does not mean causality, so although correlations may hint at possible causes, they do not prove that one set of data causes another set. However, some clear implications could probably still be drawn, so the data and above conclusions should not be ignored.

CONCLUSIONS

This study produced several useful results. Aside from listing several key topics that affect bicycling, it provided a deeper analysis of those key topics and identified several other factors that impact each focus area. From these conclusions, a policy for successful bicycling planning and implementation was devised. Guidelines were provided to take advantage of these successful policies. The research team believes that these guidelines provide useful insight to transportation planners when developing and implementing bicycling in midsize cities. Although this is not a definitive guide, the findings should be extremely helpful in establishing a successful bicycle community.

ACKNOWLEDGMENTS

This study used the data collected as part of TxDOT project 0-6582. The opinions expressed herein are solely those of the authors and do not represent TechMRT, Texas Tech University, or TxDOT. Special thanks to surveymonkey.com and TxDOT for aiding in the dispersion of the bicycle survey.

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