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Assessing the Level of Bicycle Planning in Local Planning Efforts: A Case Study

Christopher Michael Hussey
University of Nebraska-Lincoln, cm.hussey@yahoo.com

ASSESSING THE LEVEL OF BICYCLE PLANNING IN LOCAL PLANNING EFFORTS: A CASE STUDY

By

Christopher Michael Hussey

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Christopher Michael Hussey, M.C.R.P.

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Advisor: Yunwoo Nam

The transportation system in the United States has long been dominated by motor vehicles. The US Department of Transportation has encouraged cities to increase bicycle transportation as a means to improve health and activity, reduce fuel consumption and greenhouse gas emissions, reduce congestion, improve air quality, and reduce vehicle miles traveled. Bicycle transportation is improved in a city when thorough planning documents have been created to help guide and improve bicycling facilities

This research creates a framework to evaluate a city's planning documents for the purpose of bicycle planning. The framework is derived from a thorough literature review and from sample plans from five cities. The cities used to help inform the framework are Davis, California; Seattle, Washington; Portland, Oregon, Austin, Texas; and Boulder, California. These cities were chosen based on their high rates of cycling and on their recognition by the US Department of Transportation as examples of cities that have complete and thorough planning documents.

The framework created from this research consists of indicators organized into the following categories: Knowledge and Recognition; Goals and Objectives;

Planning, Policy and Programs; Implementation and Funding; and Maintenance and Monitoring.

The framework is then applied to the city of Lincoln, Nebraska's long-range transportation plan as a way to illustrate how the framework can be applied to evaluate a city's planning efforts regarding bicycle transportation.

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Chapter 1 Introduction

Cities in the United States today are trying to diversify their transportation modal split. Cities have begun to recognize that the transportation policies and plans that have predominately focused on automobile transportation for the last 65 years, while initially extremely convenient to the user, have had unintended costs. Automobile transportation has also proven to be a very expensive solution to the task of moving citizens from point to point within the city.

The problems of relying on automobiles for transportation continue to build upon themselves. Congestion on roads leads to demand for increased road capacity. Increased road capacity provides for more drivers to reach areas farther from the city center. This ability to reach great distances in a relatively short amount of time combined with low-density development leads to urban sprawl. As a city sprawls, the only way to reach destinations is by automobile, increasing the amount of cars on the roads again increasing congestion. The cycle then continues on.

The consequences to being caught in this cycle are many. People don't walk or ride bicycles to reach destinations and are less active in their day-to-day lives, leading to health problems and obesity. Drivers are reliant on their cars and therefore reliant on a diminishing supply of fossil fuel, which with constant and growing demand is steadily increasing in price. The increasing cost of transportation strains budgets at the household level and at the municipal level, as well as negatively impacting the local and national economy. The burning of fossil fuels has a negative impact on air quality both locally in the form of smog, and globally in the form of climate change.

There exists as well an equity issue in regard to access to transportation. In a built environment designed with a focus on automobile travel, those without access to an automobile for reasons such as economic hardship, disability, legal issues, or advanced age are at best inconvenienced, and at worst effectively excluded from full participation in the economy and in society. While it has been shown that low-income households still utilize a private automobile for the vast majority of their transportation (Pucher and Renne, 2003) such households spend a larger proportion of their income on transportation.

Cities are spending more and more money to provide road infrastructure to far flung and relatively sparsely populated suburban areas while infrastructure needs in the central city go unmet. This is clearly an undesirable cycle most US cities find themselves in. Many municipal policies are now calling for diversifying the modal transportation split to increase forms of transportation other than the automobile such as public transit, walking, and bicycling.

Policies are being put into place to increase the population densities of cities to alleviate the strain each person places on a fragile transportation network, as well as to allow for the densities in the built environment required to make other forms of transportation feasible both physically, in the mode of walking and bicycling, and economically, in the mode of public transit.

While these other forms of transportation are underused in most US cities, one form in particular could easily be increased without requiring changes to the urban form of US cities. That form of transportation is the bicycle. Bicycling is a mode of transportation that provides a much greater range at a higher rate of speed

than walking, though it has a smaller range and at lower speeds than an automobile (although, at peak traffic times, this may not be the case). This spot in the transportation mode profile makes bicycling an attractive alternative to automobiles for certain trips for the average citizen where excessive distance isn't prohibitive.

The efficiency of the bicycle as a mode of transportation can be illustrated by the following quote: "Man on a bicycle can go three or four times faster than the pedestrian, but uses five times less energy in the process. He carries one gram of his weight over a kilometer of flat road at an expense of only 0.15 calories. The bicycle is the perfect transducer to match man's metabolic energy to the impedance of locomotion. Equipped with this tool, man outstrips the efficiency of not only all machines, but all other animals as well" (Illich, 1978, 135).

Bicycle transportation and transportation infrastructure can be retrofitted into existing transportation corridors, designed into new road projects, as well the creation of new designated facilities such as end of trip facilities and shared use paths. As a non-motorized form of transportation, benefits to a city can be realized in the areas of increased physical activity and public health, reduced fuel consumption, reduced emissions of greenhouse gasses (GHG), reduced congestion at peak travel times which lessens or delays the need for expensive expansions to the roadway network, reduced vehicle miles traveled and increased air quality. (United States Department of Transportation b., n.d.)

The precedent for expanded bicycle transportation can be seen in examples in both Europe and Canada. While rates of cycling in some European nations are

much higher than both the US and Canada, their experience may not be directly comparable to the US and Canadian cases due to a variety of differences in both the built environment, long-standing trends in the transportation modal split, and differing attitudes. The Canadian experience, however, is comparable to the US due to many similarities in these areas.

It is clear that the US transportation system could benefit greatly from diversification of the modes of transportation. An increase in the non-motorized modes of transportation is the most desirable mode from many aspects, and one that is most financially attainable.

Chapter 2 Purpose of Study and Research Methods

2.1 Purpose of Study

Bicycle transportation is a non-motorized form of transportation that accumulates many benefits to the individual, the city, the nation, and the world. The individual benefits from increased bicycle transportation in the form of health benefits and reduced fuel costs. The city benefits from increased bicycle transportation in the form of decreased peak traffic congestion resulting in reduced need for auto infrastructure and reduced pollutants such as smog improving air quality. The nation benefits from decreased fossil fuel use. Globally, fewer vehicle miles travelled reduce the release of greenhouse gasses and reduce the effects of global climate change. The US Federal Government recognizes these benefits and has been advocating cities to increase bicycle transportation for many years. (United States Department of Transportation, 2004)

It is a stated goal of the US Federal Hwy Administration to increase the bicycle modal share for transportation in the US. "Section 217 of Title 23 of the U.S. Code calls for the integration of bicycling and walking into the transportation mainstream. More importantly, it enhances the ability of communities to invest in projects that can improve the safety and practicality of bicycling and walking for everyday travel." (USDOTa, n.d.) Further, the United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations states, "Every transportation agency, including DOT, has the responsibility to improve conditions and opportunities for walking and

bicycling and to integrate walking and bicycling into their transportation systems." (USDOT, 2010)

The National Bicycling and Walking Study Ten Year Status Report established the goal of doubling the percentage of trips made by non-motorized forms of transportation from 7.9% (in 1990) of all trips to 15.8%. However by 2001, eleven years after the report only 9.5% of all trips were made by non-motorized forms of transportation. (USDOT, 2004)

US cities have clearly not achieved the goals set by the US Department of Transportation in achieving increases in the modal share towards more non-motorized forms.

Pucher and Buehler (2006) in their comparative analysis of bicycling trends and policies in the US and Canada note that Canadians use bicycles for trips to work at a rate 3 times higher than Americans, 1.2% compared to 0.4%. More recent studies have shown the US rate increased from 0.4% in 2006 to 0.5% in 2009 (Pucher and Buehler, 2011). Though this may seem like an insignificant increase, assuming 100 million people in the US workforce, or roughly 1/3 of the population, this amounts to 100,000 more people commuting to work by bicycle nationwide.

The authors note the higher rates of cycling in Canada are attributed to many factors including: denser, mixed-used development resulting in shorter trip distances; higher cost of car ownership; greater bicycle planning and infrastructure; and safer cycling. The authors note however that even Canadian rates lag far behind European rates and much more can be done to increase bicycling modal share. (Pucher and Buehler, 2006)

While there are many reasons why the US has lagged in this transition such as attitudes toward cycling, perceived difficulty or danger, social stigma, etc. The provision or lack of provision and planning for bicycle related infrastructure such as bike lanes, bike paths, and bike parking facilities has also played a role. The purpose of this study is to create a framework to analyze comprehensive plans' capacity to thoroughly plan for bicycle transportation. Once the framework for analysis is completed it may be used in two different manners. First is to provide the basis for a study in which different cities' comprehensive plans are analyzed. Second is to provide a framework for cities to evaluate their own planning efforts as they create or improve their bicycle transportation plans. The goal of this research is the creation of the framework for analysis. In addition, a case study for the city of Lincoln, Nebraska will be completed to illustrate how this framework may be used to evaluate a city's bicycle planning efforts.

2.2 Definition of Terms

It is important to define the terms that will be used throughout this paper. Descriptions of bicycle facilities and the words used to define them have sometimes subtle but very important differences:

Bicycle facility: A bicycle facility is a broad term to describe any improvement or installation that benefits or improves bicycle transportation for bicycle riders. The Transportation Equity Act for the 21st Century (TEA-21) defines bicycle facilities as, "a new or improved lane, path, or shoulder for use by bicyclists and a traffic control device, shelter, or parking facility for bicycles." (USDOT, 1998, 2)

Bicycle Lane or Bike Lane: Bike lanes are facilities located in the roadway separating bicycle and automobile traffic by a painted line. (USDOT, 2006)

Bicycle Parking: Bicycle parking refers to facilities located at destinations where bicyclists can park and lock their bicycles. These can range from bike racks, covered facilities, and limited-access facilities. (USDOT, 2006)

Bicycle Route or Bike Route: Bike routes are facilities located on roadways but bicycle traffic and automobile traffic are not separated by painted lines, as with bicycle lanes. These routes are usually marked by signs and are located on low-volume roads. Also called signed shared roadways. (USDOT, 2006)

Bikeway: Bikeway is a term used to describe any infrastructure used as a means of travel by a bicyclist. Bikeways are categorized in the literature as follows: Class I facilities are referred to as bike paths, shared paths, bike trails, etc. Class II facilities are bicycle lanes. Class III facilities are bicycle routes. (Litman, et. al., 2006)

Shared Path: Shared paths are facilities that are physically separated from roadways and are utilized by a variety of different users such as bicyclists, walkers, runners, skaters, etc. They are also referred to as bike paths, bike trails, multi-use trails, shared-use paths, etc. (USDOT, 2006)(AASHTO, 1999)

Bicycle Boulevard: Similar to shared roadways, bicycle boulevards discourage through motor vehicle traffic while allowing through traffic for bicycles. Local motor vehicle traffic is still allowed. Bicycle boulevards often employ traffic calming devices to achieve the goal of increased safety and attractiveness to bicyclists. (USDOT, 2006)

Complete Streets: Streets designed to be safe, convenient, efficient and accessible for all users including motorists, transit riders, bicyclists and pedestrians (USDOT, 2006).

2.3 Research Methodology

This study will provide the framework for analyzing bicycle transportation plans that can be used to provide a baseline of current plans, compare plans against peers, as well as to compare plans over time to note their improvement. This will presumably result in improved implementation and ultimately result in a higher modal share of bicycle transportation in US cities as plans improve over time.

2.3.1 Importance of Plan Quality and Evaluation

Why should planners be concerned with the strength of their bicycle plans? Do bicycle plans that have greater depth and breadth of coverage result in better plan implementation and higher rates of bicycle transportation?

Comprehensive plans are documents that are typically updated on a regular basis, to better address the needs of the city. Comprehensive plans are composed of different sections that address different areas of planning for cities. One component of comprehensive plans is transportation planning. Transportation planning is sometimes covered exclusively in a section of the comprehensive plan. Increasingly, transportation planning is given its own document to more deeply study and identify trends and issues in the transportation system and to provide more

coverage of topics regarding transportation planning. These transportation plans are stand-alone documents that complement the comprehensive plans. Bicycle planning issues are often times covered in transportation plans. Recently, some cities have begun to give bicycle planning more depth and breadth of coverage by creating stand-alone bicycle transportation plans to complement their transportation plans. While still a part of the comprehensive planning process, these stand-alone documents allow cities to provide more information about bicycle transportation and solutions to associated issues than was provided while bicycle transportation was addressed as a part of the comprehensive plan or the transportation plan.

New problems arise and new solutions come to the forefront. In this way comprehensive plans, transportation plans, and bicycle plans are adaptable guides that cities, both private sector and public sector interests, use to grow, adapt, and rebuild in a way that is to the benefit of the city. S.R. Brody (2003), in his research on whether plans improve over time, sites previous research (Talen, 1996; Hoch, 1998) that finds the quality of a comprehensive plan is correlated to the strength of its implementation. Brody's research finds that through updates plans do improve over time. These results show that it is important to create quality comprehensive plans and to improve and update to achieve improved implementation over time.

As indicated in the research above, higher quality plans providing greater depth and breadth of coverage do increase the strength and quality of implementation. In this way, it can be surmised that stand-alone plans that provide the greatest coverage of information related to bicycle planning are in fact higher

quality plans, and will result in stronger implementation compared to bicycle transportation planning being addressed as a part of a comprehensive plan or a transportation plan.

The method of creating a framework to analyze plan quality has been used previously in the field of environmental planning (Brody and Highfield, 2005; Tang, Bright, and Brody, 2009; Tang, Hussey and Wei, 2009) and sustainability (Berke and Conroy, 2000) to evaluate comprehensive plan capacity. This technique has been used to allow for comprehensive plan components to be given a numerical score that can then be statistically measured and compared across multiple cities (Berke and Conroy, 2000; Tang, et. al, 2009a). However for the purpose of this study, the framework will be created as an analytical tool to ensure proper coverage of topics in bicycle plans and numerical scoring will not be created nor tested.

2.3.2 Research Scope

This research seeks to create a framework for evaluating bicycling related planning efforts in the comprehensive planning process. First, this research will derive a set of indicators from a combination of sources to determine what elements, topics, and subject areas should be contained within comprehensive planning efforts to ensure proper planning guidelines for bicycle transportation. The indicators in the framework will be informed by the relevant literature, recommendations and best practices from the US Department of Transportation, and sample plans chosen due to the quality of their plans as noted by the US Department of Transportation. These indicators will be used to create a framework

for analyzing the quality of bicycle planning in cities' comprehensive planning efforts.

The sources used to develop indicators related to bicycle planning are from the three major source areas as follows: a literature review of previous studies, best practices from the federal government, and selected cities' bicycle plans.

The literature review component will research the following topics:

1. To establish a link between the provision of bicycle facilities and the increased modal share of bicycling in cities
2. To establish a link between coverage of bicycle planning and policies in comprehensive planning efforts and increased provision of bicycle facilities

The cities plan's selected to inform the research will be those cities that have high rates of bicycling and who are commonly known to be cities that have planned well for bicycle transportation, as well as being noted by the USDOT for having exemplary bicycle transportation plans.

The second portion of this research is to apply the analytical framework to a case study city. The case study city will be Lincoln, Nebraska. The city of Lincoln's Long Range Transportation Plan (LRTP) is the document that covers bicycle transportation planning for the city. The analysis to be performed will determine to what extent the Lincoln LRTP provides for bicycle planning according to their coverage of the indicators in the framework created in this research.

Chapter 3: Literature Review

Many studies have been conducted on the topic of bicycle transportation. Much of the literature has tried to determine bicycling behavior as way to understand and to increase the modal share of bicycle transportation. The literature and research written to study this problem has taken many different forms. Many studies focus on one or more aspects or factors that may determine rates of bicycling in communities. These factors include the provision of bicycle facilities, urban form and infrastructure, municipal policies, and bicycling programs. Still other research has utilized case studies to examine bicycle use. While some studies focused on planning and municipal policies, no studies have sought to analyze the comprehensive planning process as a way to improve bicycle transportation planning as proposed in this study. Finally, program theory evaluation has been developed as a means to determine how a program will work to achieve its objectives.

The availability, proximity and provision of bicycle facilities such as bicycle lanes, bicycle trails, and bicycle paths do have an effect on the transportation modal share of bicycling. The amount of bicycle facilities available does correlate to higher rates of bicycling (Dill and Carr, 2003). Proximity to bicycling facilities makes a difference as well (Krizek, et. al., 2009), although bicycle riders are willing to go out of their way to access certain types of bicycling facilities especially bike lanes (Tilahun, et. al., 2007; Dill, 2009). While proximity to bicycle lanes does influence the frequency to bicycle, some research shows that proximity to shared path facilities is not correlated with increased bicycle usage (Krizek and Johnson, 2006).

As important as the existence of proper facilities, so to is the urban form of built environments important. Proximity to retail, specifically small distances to retail, positively influence the rates of bicycle usage in urban areas (Krizek and Johnson, 2006). Cervero and Duncan (2003) in their study of the San Francisco Bay area found that diverse land use and bike-friendly urban design resulted in more people choosing to ride bicycles. The design of the street system and interconnectedness of paths, lanes, and routes plays a role as well. The older areas of many cities typically have a street system based on grids, which allows cyclists to plan a route that avoids streets with heavy automobile traffic while also having an urban built environment capable of providing a mix of uses that have been shown to increase bicycle use (Dill, 2009).

The level of urban density can affect the amount of bicycle transportation in a city or an area of a city. Higher densities are generally associated with increased bicycle usage. The reasons for this are multiple. Heinen, van Wei and Maat in their overview of multiple studies (2010) that investigated this topic found that "factors contributing to shorter travel distances, such as having a denser network layout, higher density and mixed land-use, affect cycling positively." (Heinen, et. al., 2010, 62) However, a study of the bicycling rates in the Netherlands finds that bicycle use does not continue to rise as density rises. "The use of the bicycle is low in low-density areas, as in such areas there might be fewer opportunities to make short trips. Then it reaches a maximum in medium density areas, and falls again, as might be expected, in high-density areas, where public transport is well provided so that it is a competitor to the bicycle." (Rietveld and Daniel, 2004, 536)

A primary concern for many people cycling is the issue of safety. The perception of safety is widely regarded as a reason some bicyclists don't ride to a particular location, and why people who don't ride a bicycle don't start riding. 13% percent of people who recently rode a bicycle reported feeling threatened at least once while riding in responding to a survey from the Bureau of Transportation Statistics. Broken down, 17% percent felt threatened when neither a bike lane nor path was present while only ten percent felt threatened when both a bike lane and a bike path were present. The existence of bicycle facilities increases the perception of safety and will help to get more people onto bicycles. However only 26.3% of the population has access to both bike paths and bike lanes while 43% have access to neither a bike lane nor a bike path. This data suggests the need for more bicycling facilities to simply enable people to be encouraged to begin using a bicycle for transportation (Bureau of Transportation Statistics, 2004). Figure 3.1 below shows the attitudes of both infrequent and frequent bicyclists towards the increased provision of bicycle facilities. People's perception of safety and the apparent demand for greater bicycling infrastructure shows that in the US there is an undersupply of facilities that, if adequately provided, would increase the modal share of bicycling.

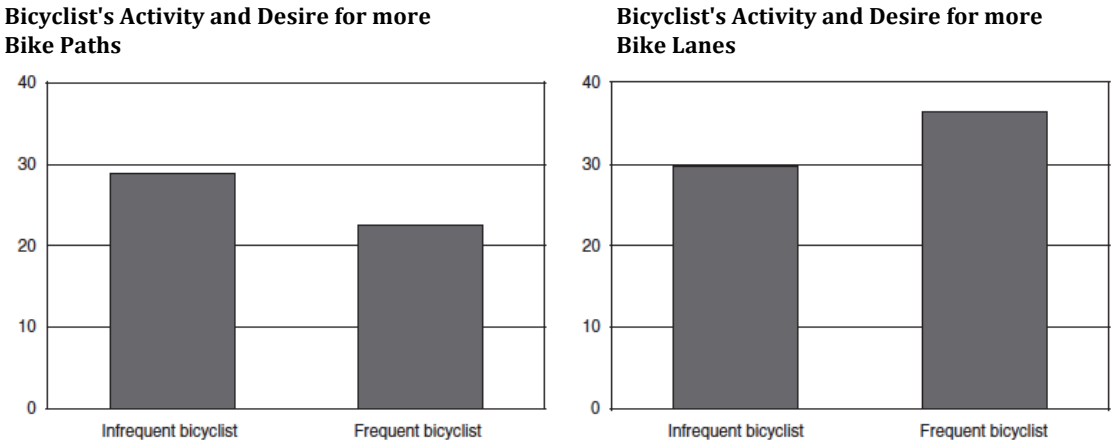

Figure 3.1 Demand for Increased Bicycle Facilities
Source: Bureau of Transportation Statistics, 2004, 4

A study of the Portland, OR region found among other things that riding a bicycle is contagious. Participants reported that living with, working with or even simply seeing other people riding a bicycle were more likely to ride a bicycle themselves (Dill and Voros, 2007). This finding indicates that efforts to get people to use a bicycle for transportation is indeed worth the effort, and the benefits will continue to build upon themselves.

To take this logic a step further, increasing the provision of bicycle facilities in a city will attract people to that city who place a high value on bicycling transportation and facilities. This alone will increase the modal share of bicycle transportation. (Xing, Handy, Buehler, 2008) However when combined with the previous study's findings, attracting more citizens who already ride a bicycle will then in turn help current citizen to consider bicycling themselves.

Bicycle programs are methods used to increase bicycle usage. These include media campaigns, promotion, and education. Examples include bike to work days, bike to school programs, and events that close streets to automobile traffic on specific days to encourage non-motorized mobility. These events have been shown to increase bicycle usage beyond the limited days of the events (Pucher, Dill and Handy, 2010).

Creating a culture of bicycling is an important component of changing the modal share of bicycling in cities. As mentioned earlier simply seeing another person riding a bicycle will increase the likelihood that someone will travel by bicycle (Dill and Voros, 2007). Agreeing with the statement, "I like riding a bike" is the single largest determinant of owning and riding a bicycle, while the built environment such as bicycle infrastructure were not found to be a statistically significant determinant (Xing, et. al., 2008).

While all of these studies mentioned previously attempt to determine correlations to bicycle usage by looking at various factors, none look at the comprehensive planning process' role in increasing the mode share of bicycling. Relatively few studies look at the role of municipal policy. There are more examples of case studies of individual cities comprehensive approach to bicycle planning.

One study examining the role of policy in encouraging more bicycle use was conducted in the Netherlands. The authors found that policies do have an effect on the transportation modal split. Their findings indicate there are two ways to change behavior, both relating to economics. One is to decrease the cost of the desired mode and the other is to increase the cost of the undesired mode (Rietveld and

Daniel, 2004). In the case of the US the focus of late has been to increase the rate of bicycle usage and to decrease the number of the automobile trips generated. Using the logic of the authors the correct course of action would be to decrease the cost of bicycling and increase the cost of automobile trips.

This presents two problems. First, riding a bicycle, once the up front costs are covered, is relatively free. Second, any attempts to increase the cost of automobile usage will surely be met with public backlash. There are however solutions to these problems.

First we will address the issue of automobile usage. There surely would be public outcry to any attempt to increase the cost of driving by way of policy. The right to drive, and to drive cheaply, is deeply ingrained in many Americans. If the stated policy was to be implemented in order to reduce the amount of automobile travel and to increase the use of bicycles there could conceivably be backlash towards current bicyclists (those that ride bicycles frequently in the US could attest to this). However, there are other economic forces at work that might drive up the cost of driving. First and foremost is the cost of gasoline. Without a readily available substitute to the internal combustion engine at the moment, increasing gas costs will push up the cost of driving. Second, the high gas costs will indirectly increase the price of land in city center, making parking more expensive. In the densest areas of our large urban areas, the cost of parking is already prohibitive to some would-be motorists.

Secondly, we must consider that costs associated with riding a bicycle may exist if we include non-monetary costs. This could include the added time of cycling

and the physical input required to propel a bicycle. We can institute policies that can reduce these costs by providing direct and graded routes to destinations allowing bicyclists to reach their destination more quickly while exerting less energy.

In an attempt to better judge the impact of improvements to the bicycle system, many case studies of entire cities have been undertaken to gauge the effectiveness of changes to infrastructure and facilities, programs, and policies.

Pucher, et. al. (2010) reviewed many of these case studies and found that cities worldwide were able to dramatically increase the mode share of bicycling by instituting cumulative, citywide programs aimed at increasing bicycle usage. Of note to this study are the gains achieved by cities in the US. Portland, OR and Boulder, CO experienced dramatic increases in their rates of bicycling. Davis, CA saw a drop in bicycling rates, however their rate of bicycling was dramatically higher than the national average, and despite the drop remains the top city for bicycle mode share in the US.

Program theory evaluation (PTE) is a field of study developed to help determine why a specific program is successful or unsuccessful. Program theory evaluation is also sometimes used to determine what causal relationships exist that relates the program to its successful outcomes. Determining this information can help to improve current and future programs. (Rogers, et. al., 2000)

One method of program theory evaluation uses causal models to explain cause-and-effect relationships. Often times these models involve diagrams linking problems, solutions, and outcomes (Rogers, 2000). In the field of bicycle

transportation planning, the goal is to increase the use of bicycles for utilitarian purposes. Increased use is the desired outcome. The problem initially is a lack of people using bicycles for transportation. The solution for bicycle planners then is what this paper aims to provide, which is the provision of proper and adequate infrastructure, programs, and policy to increase utilitarian use of bicycles.

Rogers (2000) work also describes virtuous and vicious circles. These terms describe an occurrence in which an initial effect leads to reinforcement and magnification. A virtuous circle refers to positive after-effects, and a vicious circle refers to negative after-effects. This can be seen in the example of car-based travel detailed in the introduction. Designing cities for motor vehicle use requires the use of an automobile at the expense of other modes of transportation. This leads to congestion, which in turn leads to urban sprawl, which makes it more difficult to utilize other modes of transportation. Conversely, as mentioned previously in this literature review, simply seeing someone riding a bicycle can lead to someone being more likely to cycle herself. In this way, increasing the use of bicycles can create a virtuous circle.

Another aspect of program theory evaluation is the use of matrices to monitor program performance, or program logic matrix. This method utilizes seven essential features that make up the matrix for evaluation and monitoring the performance of programs. These seven features are listed as follows: intended outcome; success criteria; program factors affecting success; non-program factors affecting success; activities and resources of program; performance information;

and sources of data (Funnell, 2000). This method has been used to assist the creation of the framework in this study.

Chapter 4 - Indicator Framework

The purpose of this study is to create a framework for analyzing comprehensive plans relative to their capacity to plan for bicycle transportation. This section will create a set of indicators or points that should be included to ensure quality bicycle transportation planning. These indicators will be derived from the existing literature, recommendations and best practices from the federal government, and the bicycle planning documents from selected cities. The selected cities will be those that have high rates of bicycle modal share as well as reputations as cities conducive to bicycle transportation (USDOT c. n.d.). The list of indicators is will comprise the framework for analyzing comprehensive plans.

4.1 Determining Indicators

The indicators will be chosen based on available literature research and by case study cities. The indicators will be broken into five sections. Each of these sections represents a subject area or dimension in which planners and policy makers must be informed and must plan for action in order to properly create planning documents and policy related to bicycle planning. The sections are:

(1) Knowledge and Recognition

(2) Goals and Objectives

(3) Planning, Policy and Programs

(4) Implementation and Funding

(5) Maintenance and Monitoring

The following discussion will provide justification for the selection of dimensions and why they provide the relevant framework for analyzing the quality of bicycle transportation plans

These sections or dimension were determined by using comparable research in the field of environmental planning, plan evaluation theory, and by investigating the bicycle plans of five cities as a way to integrate the research into the field of bicycle planning. The research and bicycle plans are detailed below.

This method of analyzing comprehensive plans for plan quality has been used previously in the field of environmental planning. The sections mentioned here have been modified from studies focusing on analyzing plans in relation to climate change. The first study sought to gauge plan performance relative to awareness, analysis and action (Tang, et. al., 2009a). Environmental impact reports evaluate plan quality by assessing plans by five categories: factual basis; goals and objectives; tools, approaches, and methodologies; coordination and communication; and implementation, monitoring, mitigation, and alternatives. (Tang, et. al., 2009b)

There has been researched published related to plan evaluation theory to establish what elements a quality plan should contain. William C. Baer (1997) in his article, "General Plan Evaluation Criteria" lists eight steps in completing a quality plan. They are the following: Adequacy of Context (knowledge and recognition), Rational Model Considerations (including goals and objectives), Procedural Validity (planning policy and programs), Adequacy of Scope, Guidance for Implementation (implementation and funding), Approach Data and Methodology (monitoring), Quality of Communication, and Plan Format.

In order to help inform this research technique to the field of bicycle planning, five model plans were used to help establish the indicator framework. The plans used are from the cities of Portland, Oregon; Davis, California; Seattle, Washington; Austin, Texas; and Boulder, Colorado. All of these cities are well regarded for both their high rates of cycling and the quality of the bicycle transportation plans they have created as a part of their comprehensive planning process. (USDOT c., n.d.)

The Portland, Oregon bicycle plan has five main sections. The first section is called, "A World-Class Bicycling City". This section makes the case for investing in bicycling, details the procedure for updating their plan, and discusses the nature of bicycling. The second section is a framework for bicycle transportation policy. This section sets a policy context, makes policy recommendations, and classifies the street system for bicycle transportation. The third section describes the bicycle transportation system. This section discusses expanding the bicycle network, bicycle facility design, bicycle parking, integration with other modes of transportation, trail networks, maintenance, and bikeways. The fourth section details programs to support bicycle transportation including programs to encourage bicycling, safety and education, and wayfinding. The final section is the implementation plan. (City of Portland, 2010)

The City of Davis, California bicycle plan has two main parts and three appendices. The first section explains the background and current condition of bicycle transportation in Davis, CA. The second section is a policy section with 6 major parts dealing with education, encouragement, enforcement, engineering,

equity, and evaluation. The first appendix details the implementation plan including a project list and financial analysis. The second appendix has maps of the bicycle transportation system. The third appendix details bicycle facility design standards. (City of Davis, 2009)

The City of Seattle, Washington set an ambitious goal in 2007 to triple the amount of bicycling in ten years, or by 2017. The city has used their bicycle master plan as the framework for achieving this goal. The Seattle plan first discusses plan background and updates before introducing the goals and objectives. Sections three and four discuss bicycling facilities and support facilities. Section five is dedicated to education and programs. The plan is finished with sections on implementation strategies and performance measures. (City of Seattle, 2007)

The USDOT notes the Austin, Texas Bicycle Plan as a good example of an action plan. (USDOT c., n.d.) The city's bicycle plan is structured similarly to the other plans previously mentioned. The first section is introductory, speaking to the benefits of increased bicycle transportation. The second section describes current conditions in Austin. The third section discusses education and promotional programs. The fourth section is dedicated to safety, and the final sections discuss implementation and funding. (City of Austin, 2009)

The final city's plan that will be used to instruct the framework is the city of Boulder, Colorado. The city of Boulder's plan is unlike the other plans described here in that the bicycle plan is integrated into the city's transportation plan. This plan is noted for the ways it is integrated (USDOT c., n.d.). The city's plan has a distinctively different format from the other plans utilized in this study, however

many of the same topics are discussed albeit in less detail. Similar topics include introducing the current state of the transportation system, determining funding and implementation, and performance monitoring. There are also unique sections that focus on individual forms of transportation including bicycling. There is also a focus on the concept of complete streets, making streets accessible and accommodating to all transportation mode users. (City of Boulder, 2008)

The common framework for these plans closely resembles the methods used to analyze environmental impact reports. There is a factual section, which in this research is referred to as **Knowledge and Recognition**, included in the introduction or elsewhere early in the plan. A **Goals and Objectives** section generally follows. Once the groundwork for the plan has been laid, the plans generally move on towards planning aspects. For the purpose of this research, those sections will be referred to as **Planning, Policy, and Programs**. This section includes descriptions of bicycle facilities, policy recommendations, and programs dealing with education, safety, and encouragement. The next main topic area deals with **Implementation and Funding** strategies. The final section deals with **Maintenance and Monitoring**.

4.2 Knowledge and Recognition Indicators

The indicators in this section will measure planners' level of understanding on the issues associated with bicycle planning. In order to take seriously the need to adequately plan for bicycle transportation planners must first be aware of the many benefits of increasing bicycle transportation modal share. Planning documents such

as comprehensive plans and transportation plans are a source of information and education for the citizens of the community as well. Clearly laying out the reasons for increasing the mode share of bicycle transportation not only illustrates the planners' knowledge but also informs citizens.

Indicator 1 - Recognize the importance and need for dedicated bicycle facilities.

The amount of bicycle facilities (Dill and Carr, 2003) and the proximity to bicycle facilities (Krizek, et. al. 2009) have been shown to increase the amount of bicycle transportation. If a city is to increase the mode share of bicycle transportation it is important for the planners and policy makers to understand the importance of providing adequate bicycle facilities.

The Portland, Oregon bicycle plan provides an entire section with a detailed description of the various types of bicycling facilities and their importance to bicyclists (City of Portland, 2010). The Seattle, Washington bicycle plan provides a definition section for the various types of facilities and their importance (City of Seattle, 2007). Davis, California notes that the provision of facilities has been of great importance in reaching their high level of bicycle transportation (City of Davis, 2009). Austin, Texas lists the various bicycling facilities, notes their importance to cyclists, and ties objectives to each facility for increasing bicycle transportation (City of Austin, 2009). Boulder, Colorado recognizes the role bicycling facilities play in ensuring a safe and efficient bicycle system (City of Boulder, 2008).

Indicator 2 – Recognize bicycle transportation's ability to limit use of fossil fuels

The USDOT has stated one of the reasons it has been advocating for increased bicycle transportation is because it limits fossil fuel use (USDOT b., n.d.). The US uses roughly ¼ of the oil consumed globally, and there are concerns about the supply of fossil fuels going towards the future. Further, global oil demand will likely continue to increase with the continued industrialization of highly populous countries (Stott, 2006). Increased bicycle transportation, a non-motorized form of transportation, can assist towards reducing the demand for fossil fuels.

The Austin, Texas bicycle plan notes the reduction of fossil fuel use with an increase in bicycle transportation (City of Austin, 2009). The Portland, Oregon bicycle plan recognizes that the increase in fuel costs will result in more people choosing to use a bicycle as a means of transportation (City of Portland, 2010).

Indicator 3 – Recognize bicycle transportation's ability to reduce greenhouse gas emissions.

The US Department of Transportation recognizes the need to reduce greenhouse gasses, and recognizes the need to incorporate more non-motorized transportation into our transportation modal split (USDOT b., n.d.). Carbon dioxide, a greenhouse gas emitted from burning fossil fuels used in transportation, accounts for 70% of greenhouse gasses (Stott, 2006). Until newer technologies arrive that can economically supplant the internal combustion engine (Haines, et. al., 2000), the

increased use of bicycle transportation can help to mitigate the release of greenhouse gasses.

Four of the plans used to inform this study recognize the ability of bicycle transportation to reduce the release of greenhouse gasses (City of Austin, 2009; City of Davis, 2009; City of Portland, 2010; City of Seattle, 2007). The Boulder, Colorado transportation plan recognizes the need to reduce greenhouse gasses, but does not associated this with the ability of increasing bicycling as a means to accomplish this goal (City of Boulder, 2008).

Indicator 4 – Recognize the health benefits of bicycling

The USDOT has stated the health benefits of riding a bicycle is one of the reasons they are pressing for more bicycle transportation, citing bicycle transportation's ability to lower an individual's body mass index (BMI) and to increase physical activity (USDOT b., n.d.). Increasing the modal share of bicycling, not only provides health benefits to the individual riding, but to the community as a whole through decreasing greenhouse gasses, which have a negative effect on health (Stott, 2006), and smog forming gasses. Bicycling for transportation can help individuals to get their recommended amount of exercise (Dill, 2009). Further, without the provision of sufficient bicycle facilities, this health benefit accrues more to men than women. Men are more likely to cycle than women, in part because men are less likely to be concerned with the safety aspects of cycling even when adequate facilities are not provided for (Dill, 2009) (BTS, 2002).

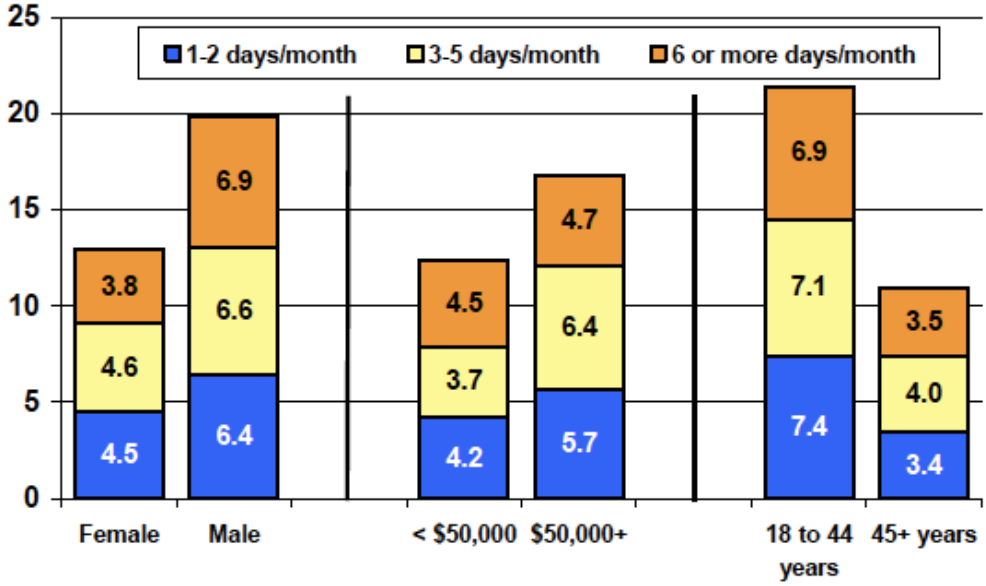

Figure 4.1 Frequency of Bicycle Use by Gender, Income, and Age (in millions)
Source: Bureau of Transportation Statistics, 2002, 2

All of the plans from the cities chosen to inform this study recognize the health benefits of increased bicycle transportation (City of Austin, 2009; City of Boulder, 2008; City of Davis, 2009; City of Portland, 2010; City of Seattle, 2007).

Indicator 5 – Recognize bicycle transportation's ability to reduce automobile congestion

The US Department of Transportation has cited increasing bicycle transportation as a way to decrease automobile congestion (USDOT b., n.d.) Increasing the mode share of bicycle transportation is seen as a method to reduce automobile commuting (Noland and Kunreuther, 1995). Bicycles take up considerably less room on the road than do automobiles, so a decreasing share of automobile travel frees up roadway capacity, especially at peak travel times.

The Austin, Texas bicycle plan (2009), the Davis, California bicycle plan (2008), and the Portland, Oregon bicycle plan (2010) all recognize the ability of bicycle transportation to reduce traffic congestion.

4.3 Goals and Objectives Indicators

The indicators in this section will determine if the planners in a city have set forth goals and objectives they hope to achieve with their bicycle plan. There is little academic research on the role goals and objectives play in increasing the modal share of bicycle transportation. However defining goals and objectives to be achieved by the plan is regarded as an important part of bicycle plan (Litman, et. al., 2006). A goals and objectives section is a common thread amongst the plans chosen to inform this study. The following is a brief overview of the goals and objectives in each of the plans. From this research indicators will be chosen for the framework for this study.

Indicator 6 – Expressed goal to increase the level of bicycle transportation

Indicator 7 – Expressed goal to increase the level of safety for bicycle transportation

The goals identified were presented together because the discussion and justification for these goals were often presented in the same section of the bicycle plans chosen to inform this study. The grouping will help to eliminate the duplicity of discussion. Further, some of the discussion of the Objectives indicator is also present in this section for the same reason.

The Portland, Oregon bicycle plan does not have a specific section for goals and objectives. However the goals are included in introductory sections and objectives are detailed in an appendix. There is an over-arching goal in the Portland plan to make Portland a world-class bicycling city. The Portland plan sets the following goals: to expand the network of bikeways, to create safe and inviting bikeways using the best-known design standards, to create a dense network of bikeways, and to create a cohesive network that provides direct routes (City of Portland, 2010).

The Portland plan includes the plan objectives in a detailed appendix section. The objectives listed cover the complete range of topics including safety, education, encouragement, bicycle facilities, urban bicycling districts, parking, end-of-trip facilities and others. (City of Portland, 2010)

The City of Davis, California also details its goals and objectives in its bicycle plan. The Davis plan sets the specific primary goal of achieving 25% of all trips in the city made by bicycle, which is the same percentage the city reached in 1990. The plan also lists goals and objectives covering topics that the plan refers to as the six "E's": Equity, Education, Encouragement, Engineering, Enforcement and Evaluation. There are then objectives to be reached to accomplish each of these goals. (City of Davis, 2009)

The Seattle, Oregon plan has two primary goals, to triple the amount of bicycle trips in the city from 2007 and 2017, and to reduce the rate of bicycle accidents by 1/3 over the same ten year time period. The plan lists four objectives to help to achieve these goals. The objectives cover such topics as the development

and maintenance of a safe, connected and attractive bicycle network, provision of support facilities, identifying partners to help administer bicycle programs, and to secure funding to implement improvements. (City of Seattle, 2007)

The Austin, Texas plan identifies two primary goals and four secondary goals. The primary goals are to increase bicycle use and to increase bicycle safety. The complementary goals are as follows: to provide and maintain a comprehensive bicycle system, to improve education and promotion, to reduce bicycle related crashes, and to strengthen implementation through funding. The Austin plan sets out specific objectives to accomplish these goals, and lists benchmarks to indicate when the goals have been met. (City of Austin, 2009)

The Boulder, Colorado plan is different from the other plans used as resources in this study in that it is not a stand-alone bicycle plan but rather a transportation plan with the bicycle elements integrated throughout. The goals and objectives section of the plan does not mention bicycle transportation specifically, but does focus on topics that include bicycle transportation, and conditions that can be improved by increased bicycle transportation. The goals include emphasis on multi-modal transportation and a transportation system supportive of urban design goals. Objectives include policies to reduce the dominance of single-occupant vehicle travel and reduced air pollution and emissions. (City of Boulder, 2008)

Indicator 8 – Objectives stated to help accomplish goals.

The examples point to a wide variety of objectives used to accomplish the goals of the plan. Some of the selected plans use indicators tied to each section of

the plan (City of Austin, 2009). Other plans have multiple objectives intended to accomplish each specific goal (City of Davis, 2009). The overarching theme from these plans is the importance of objectives to help accomplish the goals set out in the plan. Therefore the indicator derived from this section is simply to note the existence of objectives to help accomplish the goals set out in the plan.

4.4 Planning, Policy and Program Indicators

This section will introduce the indicators chosen to determine if planners are adequately providing relevant policies, tools, strategies and infrastructure as evidenced by their bicycle transportation planning documents.

4.4.1 Planning Indicators

Bicycle Facilities and Infrastructure

The first section of indicators will deal with infrastructure related to bicycle transportation. Providing proper infrastructure is a key component of encouraging people to bicycle for utilitarian purposes. There are five categories of bicycle facilities noted in the literature. Class I facilities are bike paths and trails; facilities that have separate rights of way than automobile traffic and are often shared-use paths. Class II facilities are bike lanes, on-street facilities separated by motor vehicle traffic by painted lines. Class III facilities are bike routes, on-street facilities that are not separated from motor vehicle traffic by painted lines. The next category is other infrastructure improvements to benefit bicycle transportation and the final category is bicycle parking and destination facilities (Litman, et. al. 2006)

Indicator 9 – Provision of bicycle lanes, bicycle trails, and bicycle routes.

Research studies by a wide variety of authors have come to the conclusion that providing infrastructure for a network of bikeways, including bike lanes, trails and routes, is vital to increasing the rate of bicycle transportation in a city. The amount of bicycle facilities (Dill and Carr, 2003; Pucher, et. al., 2010) as well as the proximity to bicycling facilities (Krizek, et. al., 2009; Tilahun, et. al., 2007; Dill, 2009) helps to increase the rates of bicycle transportation in a city. Bicycle lanes are an important feature to the bicycle network because they serve bicyclists of every experience level (USDOT, 2006). Additionally, all of the sample plans speak extensively to the provision of bikeway infrastructure (City of Portland, 2010; City of Austin, 2009; City of Boulder, 2008; City of Seattle, 2007; City of Davis, 2009)

Indicator 10 – Provision of destination bicycle facilities

End of trip bicycle facilities include bike parking as well as lockers and showers for those who commute to work by bicycle. Bike parking facilities can include bicycle racks, bicycle lockers, and bicycle lock-ups. Bicycle racks are open-air devices, to which bicycles can be locked, usually for short-term parking. Bicycle lockers are enclosed lockers for long-term bicycle parking. Bicycle lock-ups are secured, limited access areas for long-term parking. Providing bicycle parking is an important step in encouraging people to ride bicycles for commuting and other utilitarian trips (USDOT, 2006; Litman, et. al., 2006; Pucher, et. al., 2010).

End of trip facilities also include showers and lockers for people who commute to work by bicycle. The City of Seattle requires new office development and redevelopment projects to include showers and lockers (City of Seattle, 2007), while other cities encourage them (City of Portland, 2010; City of Austin, 2009, City of Davis, 2009).

Indicator 11 – Inclusion of public input and participation in the planning process

Including public participation is vital to any planning project (Burby, 2003), but especially so in the field of bicycle planning. Those public participants in bicycle planning projects are typically people who are already riding bicycles or are those that are likely to utilize bicycle transportation in the future. It is important to establish opportunities for public input and participation in the bicycle planning process (Litman, et. al., 2006; Pucher and Buehler, 2008). Some research focuses extensively on the role public participation plays in determining plan quality (Tang, et. al., 2009). The USDOT considers public participation to be vital to bicycle planning (USDOT, 2006).

All of the plans chosen to help inform this study advocate the addition of public participation and public input throughout the planning process (City of Austin, 2009; City of Boulder, 2008; City of Davis, 2009; City of Portland, 2010; City of Seattle, 2007).

4.4.2 Policy Indicators

This section will propose indicators that evaluate policies within bicycle plans that aid and encourage the use of bicycle facilities and help to increase rates of bicycle transportation. The USDOT (2006) recommends the inclusion of policy statements wherever possible when creating a bicycle transportation plan. The USDOT goes further by stating that not only should transportation policies be examined, but also land-use policies, to identify existing policy that may be hindering bicycle transportation (USDOT, 2006).

Indicator 12 – Policies to create connectivity in the bicycle network

This indicator recognizes the need for connected and continuous paths to make all areas of the city accessible by bicycle, and to minimize distance for cyclists. Areas can be connected with any of the bicycle facilities classes mentioned at the beginning of this section. For instance a bike lane or a bike route on a low traffic street, class II and class III facilities respectively, may be used to connect two bike paths or shared paths, a class I facility. It is sometimes prohibitive to connect class I facilities and use of other facility classes is ample to complete the bicycle network (City of Seattle, 2007). The bicycle network should be accessible, direct, and continuous (USDOT, 2006).

It is important to also note that cycling is more prevalent in older neighborhoods, which were traditionally built on grid street systems. This style of street system provides cyclists the opportunity to choose their own route while avoiding heavy automobile traffic (Dill, 2009). This should inform planners of the

need for a connected and accessible bicycle network. This also brings up an interesting point about older neighborhoods that will help to establish the next indicator.

Older neighborhoods, as mentioned earlier, generally have higher rates of cycling than newer neighborhoods. There are many reasons for this. First is the grid of streets mentioned above, that allow cyclists to create their own routes while avoiding heavy vehicular traffic. Newer neighborhoods are decidedly not built on a grid pattern, although some neighborhood urban designers such as Andres Duany are making a push for a neo-traditional or New Urbanism design. Newer neighborhoods are built with meandering roads and collector streets designed to reduce through traffic to maintain the appearance of a quiet and serene neighborhood, at the expense of the traffic infrastructure of the city. Bicyclists especially suffer, as these areas force cyclists to either take a circuitous route or to ride in potentially unsafe, high automobile traffic situations. The design of new neighborhoods presents a challenge to planners to design a bicycle network that can be accessible, direct, and continuous (USDOT, 2006). However there are other forces at work in more traditional neighborhoods. These neighborhoods were built before the use of the automobile was so predominant, and so can inform us as to how to build our neighborhoods now that we have reached a stage where we are trying to de-emphasize motorized transportation and to reintroduce public transit and non-motorized forms of transportation. These traditional neighborhoods were built at a higher density, often with more than one story development in commercial areas, and also contained a mix of uses.

All of the cities in this study advocate a complete bicycle network that ensures connectivity and access to all parts of the city (City of Austin, 2009; City of Boulder, 2008; City of Davis, 2009; City of Portland, 2010; City of Seattle, 2007).

Indicator 13 – Policies to increase mixed-use and compact development

This policy encourages higher density development. Higher density has been shown in the literature to increase rates of bicycle transportation (Heinen, et. al., 2010). These policies all result in shorter distances, which have been shown to increase bicycle transportation (Heinen, et. al., 2010; Krizek and Johnson, 2006). These urban design policies also stimulate a denser mix of uses, which alone results in higher bicycling rates (Cervero and Duncan, 2003; Heinen, et. al., 2010), but also reduces distances traveled to reach such destinations as work, schools, shopping, and other uses, increasing bicycle use (Dill, 2009; Rietveld and Daniel, 2004). Policies that encourage mixed-uses is recommended to create a more suitable environment for non-motorized transportation (Litman, et. al., 2006)

The bicycling plans of the selected cities also recognize the need for policies that encourage, anti-sprawl, dense, and mixed-use development. The City of Boulder, Colorado transportation plan (2008) states that mixed-use developments and areas with the highest use should have access to bicycle transportation, as well as other non-motorized forms and transit. The Portland, Oregon bicycle plan (2010) recommends that future development should take the form of dense, mixed-use development so that future residents are able to complete most of their daily routines within distances easily accessible by bicycle and recommends providing

opportunities for high-density mixed use developments along bicycle corridors. The Portland plan even goes so far as to recommend the creation of bicycle districts in high-density mixed-use areas. The Austin, Texas bicycle plan (2009) recommends the creation of mixed-use transportation oriented development as a way to increase bicycle use.

Indicator 14 – Integration of bicycle transportation with public transit

Better integration of bicycle transportation and public transit results in more people riding bicycles (Pucher, et. al., 2010), as well as more people riding transit (USDOT, 2006). Examples of transit integration include bike racks on buses, bike parking, lockers and showers at transit stations, as well as allowing riders to take bikes onto trains and light rail when not operating at peak time. In the US too much emphasis on motorist park-and-ride programs has resulted in the neglect of those who reach transit stops by non-motorized modes. Integrating bicycling and public transit makes very good sense. Bicycles are very useful for short to medium distance travel, where as public transit is a more feasible option for longer distances. The integration of bicycles to the transit network also increases the "catchment area" of a transit stop by expanding the area to include those that can reach the station by bicycle as opposed to by walking (USDOT, 2006). While the US has done a good job of providing bike racks on buses, they have been less effective at providing integration at rail transit stations (Pucher and Buehler, 2008).

The Portland, Oregon bicycle plan (2010) recognizes the efficiency of combining bicycle transportation with public transit and the need for policies that

enable combining these modes of transportation. The plan calls for bicycle racks and lockers at all new transit stations. In addition, the city has simplified the process for taking bicycles onto public transit by removing time-of-day restrictions and eliminating the need for a special permit. All buses in the Portland system are equipped with front bike racks, and 80% of light rail vehicles are equipped with bike hooks. These policies have increased the number of people taking bicycles onto public transit that there are now congestion issues at peak travel times resulting in strategies that increase the amount of long-term secure bicycle parking facilities referred to as bike-and-ride. Access to transit stations by bikeways is also mentioned as a priority in the plan.

Seattle, Washington advocates policies that integrate bicycling with transit in their bicycle master plan (2007). These policies include increased bicycle storage at transit facilities, multimodal hubs, and bus stops. Additionally, there are also policy recommendations for improved access to transit stops and facilities to take bicycles onto transit vehicles.

The Davis, California bicycle plan (2009) lists among its objectives an effort to ensure bicycle transportation is integrated into the local and regional transit network. In an effort to improve access from the city to the UC Davis campus, a large employer and destination for bicyclists, the city also recommends coordination between the city plans and the UC Davis Bikeway and Transit Network Study.

The Austin, Texas bicycle plan (2009) sets explicit benchmarks to reach to integrate bicycle transportation and transit modes. This plan sets the benchmarks

of 100% of buses and transit vehicles having the facilities to accommodate three bicycles by 2020. Also by 2020, the plan aims to have bicycle parking at 100% of all transit stops.

Indicator 15 – Inclusion of bicycle facilities in new streets and street renovations

There are in place Federal requirements that call for the inclusion of bicycle and pedestrian infrastructure in new roads projects as a means to increase non-motorized transportation. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the subsequent Transportation Equity Act for the 21st Century (TEA-21) of 1998 required state and metropolitan planning organizations (MPOs) to address bicycle and pedestrian needs (USDOT, 2006).

Incorporation of bicycle facilities into roads projects can result in a reduction of costs compared to retrofitting facilities after roads projects have been completed. Further, incorporating bicycling facilities into roads projects can save money over the life of the road by encouraging and enabling commuters to use non-motorized forms of transportation (Litman, et. al., 2006).

The Austin, Texas bicycle plan (2009) recommends amending the land development code and subdivision regulations to include more detailed criteria for providing bicycling facilities on new roads, as well as providing incentives for the inclusion of bicycling facilities.

The Davis, California bicycle plan (2009) advocates treating bicycle facilities with equal importance in the planning, engineering, and funding of new roadways.

The plan also calls for taking advantage of routine maintenance of roadways as opportunities to improve the bicycle transportation network.

The Portland, Oregon bicycle plan (2010) mentions an Oregon state requirement that bikeways be a part of all roads projects in recommending that the city update its new street design guidelines to incorporate bicycle facilities.

The Seattle, Washington bicycle plan (2007) has an appendix dedicated to design guidelines for retrofitting Seattle streets with bicycle facility improvements.

4.4.3 Program Indicators

This section will discuss and put forth indicators to access the programs created to encourage bicycle use in a community. The sample transportation plans used in this study note a variety of programs to be instituted in their communities related to bicycle transportation. The Portland, Oregon plan (2010) has programs that encourage bicycling; programs for safety, education, and enforcement; and programs for wayfinding. The Seattle, Washington plan (2007) has programs on the topics of education, encouragement, and enforcement. The Austin, Texas plan (2009) lists programs for education, promotion, safety and enforcement. The indicators in this section were derived from the common programs from these sample plans.

Indicator 16 – Programs for bicycle education and safety

Education is of paramount importance for the safety of non-motorized transportation users, and educating both motorists and bicyclists can drastically

reduce accident rates. Education can take the form of school programs, adult classes, and public awareness campaigns (Litman, et. al. 2006). It is important to teach safety awareness and techniques to children, adults, and motorists (USDOT, 2006).

The Seattle, Washington bicycle master plan (2007) notes the existence of educational programs for many years and the continuation of these programs is consistent with the goals of the master plan to increase bicycling safety. Not only does the city offer programs to educate children and adults about safe riding practices, but also educates drivers on safe practices while driving near bicycling facilities. They also provide a list of the key components of a bicycle safety education program in an appendix.

The Portland, Oregon bicycle plan (2010) divides its safety education programs into three parts: general driver education, driver education specific to interaction with bicyclists, and education specific to bicyclists. Austin, Texas (2009) makes clear the point that just because someone knows how to ride a bicycle doesn't mean they know how to safely ride a bicycle in traffic. The city of Davis, California (2009) encourages a program to give away free bicycle lights for safe night bicycling to people who complete an education course.

Indicator 17 – Programs for bicycle promotion.

Encouragement and promotional programs include parks and recreation programs, special events and activities, and promotional materials. Economic incentives can be given by public and private employers such as parking cash out,

which is the cash equivalent of parking subsidies given to people who do not drive. (Litman, et. al., 2006)

Programs such as Bike-To-Work Week have been shown in studies to have a lasting effect, increasing the number of people who commute by bicycle weeks or even months after such programmatic events (Pucher, et. al., 2010).

The USDOT recommends requiring companies to make their workforce commute mode share more balanced by removing incentives to drive by removing disincentives to use non-motorized transportation (USDOT, 2006).

The City of Seattle, Washington lists the following programmatic techniques to advocate and promote bicycle transportation: an online map of bicycle network to assist in wayfinding, and displaying bicycle network maps around the city. The city also vows to work with employers to reduce the number and length of drive-alone work related commute trips as required by the Washington State Commute Trip Reduction (CTR) Law. These measures include providing bike parking facilities, maps and promotional materials, contests for riding the most days to work, and agreements with shops to provide discount incentives to employees of companies participating. (City of Seattle, 2007)

In addition to providing promotional brochures, the city of Portland has a wide variety of promotional programs they refer to as the SmartTrips programs. These programs advocate bicycling to a variety of destinations and areas including residential programs, trips to school, business programs and programs for new residents. The city also recommends providing personalized training and outreach events. (City of Portland, 2010)

The Austin, Texas bicycle plan (2009), and the Davis, California bicycle plan (2009) also have programs designed to encourage bicycle transportation.

Indicator 18 – Programs for bicycle transportation safety enforcement

The USDOT recommends enforcement programs that enforce traffic rules on motorists, as well as bicyclists and pedestrians. In addition, they recommend programs that deal specifically with bicycle theft and the harassment of bicyclists (USDOT, 2006). Litman, et. al. (2006) recommend enforcement programs aimed at stopping traffic violations, but also at cyclists who ride into oncoming traffic and who ride at night without proper lights. The purpose of this enforcement is to ensure the safety and well being of bicyclists and pedestrians. A sense of safer travel will encourage more people to take to the streets and trails on their bicycles.

The Austin, Texas bicycle plan (2009) makes note of the fact that for purposes of law bicycles are vehicles in the State of Texas and are subject to the same rules and regulations as automobiles with minor exceptions. The city of Austin recommends increasing the number of citations and warnings issued, especially in high-collision areas. In addition, the plan calls for enforcement of rules violations for both drivers and for bicyclists. Davis, California notes that the reason for an increased focus on enforcement is ultimately to ensure the safety of bicyclists (City of Davis, 2009). While also citing increased safety, Portland, Oregon states that increased enforcement is a vital component to becoming a world-class bicycling city (City of Portland, 2010). The city of Seattle, Washington stresses the importance of obtaining funding for enforcement and encouragement programs (City of Seattle,

2007). Boulder, Colorado (2008) also recommends combining education and enforcement programs aimed specifically at students.

4.5 Implementation and Funding

The implementation section of bicycle plans guides programs, policies, and actions to implement the bicycle plan (City of Davis, 2009). Topics generally include implementation strategies, cost estimates, implementation schedule and phasing (City of Seattle, 2007), challenges and recommendations (City of Portland, 2010), and cooperation with other agencies and departments (City of Austin, 2009).

Indicator 19 – Design guidelines

Design guidelines for bicycle facilities ensure best practices are used to create safe, attractive, and quality facilities. Design guidelines include minimum widths for a variety of road conditions including striping, parking, road width, etc., as well as obstacles that should be avoided such as storm drain grates (USDOT, 2006; AASHTO, 1999). Design guidelines are important to increasing bicycle transportation and to reduce accidents (Pucher, et. al., 2010).

The Portland, Oregon bicycle plan (2010) recommends updating street design guidelines to reflect the complete streets concept of providing safety and access for all users. This includes creating design guidelines for streets, bicycle lanes, bicycle boulevards, and shared paths. The plan states that new design guidelines should address the following principals: safety, comfort, attractiveness, direct routes and a cohesive system.

The Seattle, Oregon bicycle plan (2007) requires street designers and engineers to consult with a list of best practice publications as well as to comply with national, state, and local design standards. The plan's appendix has an expansive section dealing with design guidelines on a wide variety of scenarios encompassing topics such as bicycle facilities, intersection treatment, motor vehicle parking requirements, traffic levels, and many more. Illustrated representations of a variety of roadway types are included, for example cross-sections of one-way streets and two-way streets with multiple lane examples.

The Austin, Texas bicycle plan (2009) includes design standards as an appendix to their bicycle plan. While considerably less extensive a section compared to the Seattle bicycle plan, the Austin plan also recommends using local, state, and national standards when constructing streets that contain bicycle facilities and when constructing multi-use trails.

Davis, California (2009) recognizes that different groups of cyclists, such as experienced riders versus school-aged children or beginning cyclists, have different attitudes and abilities and the design of the bicycle network should recognize these differences. The Davis plan also makes note of planning and designing bicycle facilities for the expected speed of cyclists in particular areas. For example most bicycle facilities are designed for speeds of up to 20 miles per hour, except on grades greater than 4 percent, which are designed for speeds of 30 miles per hour. The Davis plan provides design guidelines for bicycle facilities including all types of bikeways, bicycle parking, intersections, roundabouts, and grade separation at intersections.

Indicator 20 – Financial estimates and funding sources

The Davis, California bicycle plan lists the potential source of funds as follows, "the General Fund, Construction Tax, development impact fees, redevelopment monies, Mello-Roos Bonds, and cost participation by other entities" (City of Davis, 2009, Appendix I, iii). The plan also notes the availability of state and federal funding options. Austin, Texas (2009) recognizes the importance of funding the items included in the bicycle plan as critical to ensure the increased use of the bicycle network and to ensure a safe and complete network. Portland, Oregon (2010) shows what the city will be able to achieve in providing bicycle facilities depending on the level of financial commitment from the city. This is a great informational tool for the citizens of Portland to have an idea of what they would be getting by pledging their tax dollars to funding bicycle facilities. At a minimum, the implementation section of the bicycle plan should identify financial resources necessary for implementation (USDOT, 2006).

The Seattle, Washington bicycle plan contains a section for cost estimates in the appendix. There is information on funding that was earmarked by the passage of the "Bridging the Gap" funding initiative passed by voters in 2006 (City of Seattle, 2007).

Indicator 21 – Capital improvement plan

A capital improvement plan should include a list of projects, a timeline for implementation or implementation schedule, and funding sources. The Seattle, Washington bicycle plan (2007) also includes cost estimates, and a section on

phasing. Having a plan for the capital improvements ensures a project is committed to completion, as well as having a funding source directly tied to a specific project. The Davis, California bicycle plan (2009) states that bikeway projects are funding from a variety of sources, and that separate bikeway projects are not competing for funds with each other. The Austin, Texas bicycle plan (2009) recommends an annual update to its project list. The Portland, Oregon plan (2010) has an appendix with a complete list of project information.

4.6 Maintenance and Evaluation

The final section of plan quality indicators deals with maintenance and evaluation.

Indicator 22 – Provision of maintenance

Maintaining bicycle facilities is a key component to the task of increasing bicycle transportation. Best practices in planning for bicycle transportation recommends detailing maintenance policy and procedures, including priorities, standards, and delegation of tasks to specific departments or agencies (Litman, et. al., 2006). Bicyclists tend to stay away from facilities that have maintenance problems as what would seem to be small problems, such as potholes, can cause serious damage to bicycles (City of Austin, 2009; USDOT, 2006). As a result bicyclists may not use poorly maintained facilities, and may stay off their bicycles altogether. This clearly opposes the goal of increasing bicycle ridership.

Austin, Texas recognizes the need for bicycle facility maintenance in their bicycle plan (2009). The plan recommends policy action that includes bicycle facility maintenance within the budget of the Division of Public Works. The plan also calls for establishing guidelines for maintenance of bicycle paths, and to add bicycle lane sweeping as a separate part of the cities regular street sweeping schedule. Finally the plan calls for routine maintenance for all bike facilities, maintaining and routinely updating markings and signage, and training workers in the city call centers to deal with bicycle facility related concerns.

The Portland, Oregon bicycle plan (2010) address the issue of maintenance by recommending regular maintenance of the bicycling facilities and focusing on removing any debris in the bicycle path or lane as it presents a hazard to bicyclists. The plan also makes note of best practices to employ when a construction project displaces bicycle facilities and when a street is undergoing maintenance or resurfacing. The recommendation is to provide an alternate route and adequate signage.

Seattle, Washington (2007) covers the topic of maintenance as well in their bicycle plan. The Seattle plan disclosed an estimate for maintenance costs in their funding forecast for the ten-year implementation of their bicycle plan. Their action plan had tasks to improve the quality and quantity of bike facility maintenance, to fix spot maintenance problems on streets and paths, and to prioritize bicycle facility maintenance to protect the investment made by the community.

Davis, California (2009) has an annual program for repair and maintenance.

Indicator 23 – Monitoring and evaluation

Monitoring and evaluation of bicycle programs and bicycle facilities helps to insure the facilities are being used, and if they are not helps to identify condition and maintenance problems that may be preventing the facility from being used to its fullest capacity (Litman, et. al., 2006). Monitoring and evaluation provides usable statistics on bicycle facilities to judge success and failure and to inform future bicycle facility projects, and is an essential piece of the implementation strategy (USDOT, 2006).

The City of Seattle, Washington (2007) monitors performance measures to gauge the success of programs and policies aimed at increasing bicycle transportation. The city takes a base-line measure of goals and objectives and compares it to their target on a bi-annual basis. In the plan the city has designated specific entities responsible for collecting data information on each specific measurement. The goals include tripling the number of cyclists in a ten-year period, reducing the number of accidents by 1/3 in a ten-year period, and increasing the provision of bicycle infrastructure.

The Davis, California bicycle plan (2009) sets the goal of providing continuous improvement through monitoring and evaluating bicycle programs and projects. The city then uses the monitoring and evaluation findings to allocate funds for projects.

Austin, Texas (2009) plan calls for regular monitoring of implementation progress and to update the bicycle plan on a regular basis. Similarly to Seattle, the Austin plan recommends setting baseline numbers and monitoring progress

towards predetermined benchmarks. The monitoring section also recommends evaluating the benchmarks on an annual basis. The Austin plan calls for an extensive monitoring program that monitors objectives covering topics such as the bikeway system, education and promotion, safety and enforcement, and implementation and funding.

The Portland, Oregon bicycle plan (2010) has a section devoted to measuring the performance of the bikeway system. The plan calls for monitoring a wide range of topics dealing with the bicycle transportation system. The topics in the Portland plan are bicycle mode share, the bikeway network, children bicycling, bicycle safety, economic vitality, healthy and livable city, and the environment,

4.7 Plan Evaluation Framework

This table shows the complete framework listing all of the sections and indicators.

Indicator Framework	
Knowledge and Recognition	
Indicator 1	Recognize the importance and need for bicycle facilities
Indicator 2	Recognize bicycle transportation's ability to limit use of fossil fuels
Indicator 3	Recognize bicycle transportation's ability to reduce greenhouse gas emissions
Indicator 4	Recognize the health benefits of bicycling
Indicator 5	Recognize bicycle transportation's ability to reduce automobile congestion
Goals and Objectives	
Indicator 6	Expressed goal to increase the level of bicycle

	transportation
Indicator 7	Expressed goal to increase the level of safety for bicycle transportation
Indicator 8	Objectives stated to help achieve goals
Planning, Policy and Programs	
Planning Indicators	
Indicator 9	Provision of bicycle lanes, bicycle trails, and bicycle routes
Indicator 10	Provision of destination bicycle facilities
Indicator 11	Inclusion of public input and participation in planning process
Policy Indicators	
Indicator 12	Policies to create connectivity in the bicycle network
Indicator 13	Policies to increase mixed-use and compact development
Indicator 14	Integration of bicycle transportation with public transit
Indicator 15	Inclusion of bicycle facilities in new streets and street renovations
cont. **Program Indicators**	
Indicator 16	Programs for bicycle education and safety
Indicator 17	Programs for bicycle promotion
Indicator 18	Programs for bicycle transportation safety enforcement
Implementation and Funding	
Indicator 19	Design guidelines
Indicator 20	Financial estimates and funding sources
Indicator 21	Capital improvement plan
Maintenance and Monitoring	
Indicator 22	Provision of maintenance
Indicator 23	Monitoring and evaluation

Figure 4.2 Indicator Framework

The following table, figure 4.3, shows a list of the indicators and the cities' plans that were used to inform this study. A mark was made under the cities whose relevant planning document provided coverage of the topic associated with the indicator. This table brings an important fact to light. The plan that exhibited coverage of the least amount of indicators is also the only plan that is not a stand-alone bicycle plan. This research shows that a stand-alone bicycle plan provides coverage of more indicators in this study than bicycle planning documented in an integrated transportation plan. The commitment to create a stand-alone bicycle plan shows the city is committed to increasing their modal share of bicycle transportation, and is willing to invest resources in determining how to make that possible through the planning process.

The indicators derived in this research are not an all-encompassing list of everything that was contained in each bicycle transportation plan. Rather, the indicators presented here are selected because of their prevalence in the selected plans, and supported by research in the literature and recommended as best practices by the USDOT. This list of indicators details the important components, as derived by the research, necessary for complete coverage of bicycle transportation issues in a city's planning document.

Performance of Selected Plans					
Indicator	**Austin, Texas**	**Boulder, Colorado**	**Davis, California**	**Portland, Oregon**	**Seattle, Washington**
Knowledge and Recognition					
Indicator 1	x	x	x	x	x
Indicator 2	x			x	
Indicator 3	x		x	x	x
Indicator4	x	x	x	x	x

Indicator 5	x		x	x	
Goals and Objectives					
Indicator 6	x		x	x	x
Indicator 7	x		x	x	x
Indicator 8	x		x	x	x
Planning Policy and Programs					
Planning					
Indicator 9	x	x	x	x	x
Indicator 10	x		x	x	x
Indicator 11	x	x	x	x	x
Policy					
Indicator 12	x	x	x	x	x
Indicator 13	x	x		x	
Indicator 14	x		x	x	x
Indicator 15	x		x	x	x
Programs					
Indicator 16	x	x	x	x	x
Indicator 17	x		x	x	x
Indicator 18	x	x	x	x	x
Implementation and funding					
Indicator 19	x		x	x	x
Indicator 20	x		x	x	x
Indicator 21	x		x	x	x
Maintenance and Evaluation					
Indicator 22	x		x	x	x
Indicator 23	x		x	x	x

Figure 4.3 Performance of Selected Plans

Chapter 5 Case Study of Lincoln, Nebraska

5.1 Case Study Introduction

As a means to illustrate the use of this framework to evaluate bicycle plans, the framework will be applied to the transportation plan of Lincoln, Nebraska. Lincoln updated their long-range transportation plan (LRTP) on December 1, 2011. The plan is titled Lincoln Metropolitan Planning Organization 2040 Long Range Transportation Plan. The plan was developed as an integrated part of the Lincoln-Lancaster County Comprehensive Plan to meet all Federal requirements, and to guide transportation planning in the Lincoln Metropolitan area for the next 30 years. (City of Lincoln, 2011)

Unlike four of the five plans used to inform the creation of the framework for analysis for this study, the City of Lincoln does not have a stand-alone bicycle plan. Instead, bicycle planning in the City of Lincoln is therefore similar to the fifth city's planning efforts used in this study, Boulder, Colorado. This document represents the bicycle planning efforts of the City of Lincoln and will be used for the purpose of evaluation.

For this section, each indicator will be presented followed by a brief discussion about how the Lincoln, Nebraska LRTP addresses the content of the indicator. Following the analysis a discussion of the results of the analysis of the Lincoln, Nebraska plan, areas where bicycle transportation concerns are well planned for, and areas where the plan could be improved. Based on this discussion, a list of recommendations will be given to detail what the city could improve upon to ensure adequate planning for bicycle transportation.

5.2 Evaluation of the Lincoln, Nebraska Long-Range Transportation Plan

Knowledge and Recognition Indicators

Indicator 1 - Recognize the importance and need for dedicated bicycle facilities.

The LRTP does recognize the need for the provision of bicycle facilities as a major part of the bicycle plan. However the plan only gives brief topical mention to the need for bicycle facilities. There is no mention of the importance of bicycle facilities as an important part of the city's transportation infrastructure as a means to get more people to use a bicycle for transportation. The plan does also recognize that most streets are bicycle facilities and that bicyclists should be considered "design users", meaning the needs of bicyclists should be incorporated into the design of most streets.

Indicator 2 – Recognize Bicycle Transportation's ability to limit use of fossil fuels

The Lincoln LRTP does not recognize the ability of bicycle transportation to limit the use of fossil fuels. This is an important omission as the use of the bicycle could be used by citizens to save money on their transportation budgets as fuel prices continue to rise.

Indicator 3 – Bicycle Transportation's ability to reduce greenhouse gas emissions

The plan does identify that increased bicycle transportation can help to improve air quality. This subject is not explored fully, and is only mentioned briefly. The plan does not mention greenhouse gases specifically, only mentions improved air quality as a benefit. To further express this point, the plan could have identified the consequences of air pollution and explained how increased bicycle transportation could mitigate this problem.

Indicator 4 – Recognize the health benefits of bicycling

The plan does identify that bicycle transportation is a healthy alternative to the automobile. However this topic is also mentioned only briefly without any discussion or facts relating to why automobile dependence leads to sedentary lifestyles, and how an individual can get their daily exercise needs while using a bicycle for transportation purposes.

Indicator 5 – Reduce automobile congestion

The Lincoln plan does make brief mention of the ability of bicycle transportation to reduce automobile congestion. However, there is no discussion on this subject relating to the savings that would be spent for added vehicle capacity, time saved by motorists, or the space saving aspects of a bicycle versus an automobile.

Goals and Objectives

Indicator 6 – Expressed goal to increase the level of bicycle transportation

The Lincoln LRTP does not include the goal of increased levels of bicycle transportation. The plan does mention one goal that the transportation system should be balanced. However there is no mention of any specific goals such as benchmarks to reach in terms of the percentage of work trips or total trips made by bicycle. Without specific goals to increase bicycle trips, and without benchmarks set to know when those goals have been reached, bicycle planning for an increased modal share will receive the focus it needs.

Indicator 7 – Expressed goal to increase the level of safety for bicycle transportation

There is no mention of a goal to increase the level of safety for bicyclists in the Lincoln plan. There is mention of increasing the safety of transportation users, but again there are no statistics on the current number of bicycle accidents and no set benchmarks to achieve.

Indicator 8 – Objectives stated to help accomplish goals.

Since the plan did not lay out any specific goals related to bicycle transportation planning, no objectives to reach those goals were laid out. The plan does have a goals and objectives section, and there are objectives tied to each of the goals in the plan. A few of the goals mentioned included a wide variety of subjects that included bicycle transportation. The goal of improving the efficiency,

performance and connectivity of a balanced transportation system does include the bicycle transportation mode. The objective to achieve this goal tied somewhat to bicycle transportation was that users should be able to choose multiple modes of transportation and to move between these modes safely and efficiently.

Planning, Policy and Programs

Planning Bicycle Facilities and Infrastructure

Indicator 9 – Provision of bicycle lanes, bicycle trails, and bicycle routes.

The Lincoln plan does advocate for the provision of increased signed bicycle routes and sharrows, which are shared roadways marked by a chevron and an image of a bicyclist. These are the least costly of bicycle facilities. The plan does not call for an increase in the amount of bicycle lanes citing a lack of designated funding for pioneering new bicycle lanes.

Indicator 10 – Provision of destination bicycle facilities

The Lincoln plan does recommend an increased provision of parking facilities at multi-use areas and on both public areas and in private developments. While there is mention of other cities and mixed-use areas providing lockers, long-term storage, and showers for bicycle commuters, there are no plans in the Lincoln plan to provide, or to require the provision of these facilities.

Indicator 11 – Inclusion of public input and participation

The Lincoln Plan, in accordance with the Lincoln Metropolitan Planning Organization's Public Participation Plan had many public meetings in which citizens were encouraged to assist in formulating the goals and objectives of the LRTP. These meetings covered the whole transportation system for the metropolitan area, and no meetings or public involvement were specifically related to bicycle transportation, facilities, or planning.

Policy Indicators

Indicator 12 – Policies to create connectivity in the bicycle network

While the goals section of the plan mentioned the importance of creating a connected transportation system, there are no specific planning policies to create connectivity in the bicycle network. The plan goes so far as to state that due to a lack of funding, major gaps in the sidewalks and pedestrian network will not be closed.

Indicator 13 – Policies to increase mixed-use and compact development

The Lincoln LRTP does mention policies to increase mixed-use development and in-fill development as a way to increase density in the city. The city seeks to locate this increased dense development along transportation corridors so that residents can choose from an array of transportation modes. While this segment does not speak to the importance of increased density and a mix of uses for bicycle

transportation specifically, it does relate the importance of this style of development towards creating a more diverse transportation modal share.

Indicator 14 – Integration of bicycle transportation with public transit

Public transportation in Lincoln is served solely by the StarTran bus service. The Lincoln plan does mention that public transportation should be integrated with all other modes of transportation. However, this topic is mentioned only briefly and it does not indicate how this integration should take place. There is no mention of bikeway connections to transit stops, bicycle parking and storage facilities at transit stops.

Indicator 15 – Inclusion of bicycle facilities in new streets and street renovations

The plan cites the US legislation SAFETEA-LU as it discusses the inclusion of bicycle transportation facilities in every transportation project. In addition the plan notes that bicyclists should be considered in the design of streets. However, there is no concrete planning requirements that this should occur. There is no dedication of funds to include bicycle facilities in new street projects or street renovation projects. There are no recommendations to change the current policies regarding street construction, just a mention that bicycle facilities needs should be considered.

Program Indicators

Indicator 16 – Programs on bicycle education and safety

The Lincoln plan makes note of the importance of having education programs to insure facilities are used, and used correctly. The plan also notes the importance of safety, and how it relates to getting people to use bicycling facilities more frequently. However, the plan does not detail specifics of how to provide safety and education programs, funding for providing programs, content of programs, or who will administer the programs.

Indicator 17 – Programs on bicycle promotion.

The plan does note the need for programs to promote full and safe use of facilities. Again the coverage of this topic merely mentions that programs should be provided without any information about funding, administration, or content

Indicator 18 – Programs on bicycle transportation safety enforcement

The plan mentions the importance of enforcement in providing for safety in using bicycling facilities, including the importance of knowing the rules of the road. There is no mention, however, of any providing any programs by law enforcement to enforce the laws for bicyclists or for motorists. There is no mention in the plan of increasing the issuance of tickets or warnings for infractions by bicyclists or motorists that infringe on the safety of bicycle transportation.

Implementation and Funding

Indicator 19 – Design guidelines

The Lincoln LRTP recommends the creation of design standards for shared paths and for on and off street bikeways appropriate for differing levels of automobile traffic. The plan does not provide any standards or guidelines, merely mentions that they should be created. There are no illustrations or recommendations for standards for different road traffic situations, no standards for different bicycle facilities, intersection treatment, or for end-of-trip facilities.

Indicator 20 – Financial estimates and funding sources

The Lincoln plan does make financial estimates based on the amount of funding that will be available. Estimates are made on the amount of money spent on capital projects and on the amount spent on the rehabilitation of existing facilities. Funding sources are provided by the budget for roadways for on-street bicycle facilities, and by the parks budget for off-street shared trails. The plan notes that funding is limited, and that the number of projects able to be undertaken is constricted as a result. The plan recommends a designated funding source for bicycle and pedestrian facility projects be created, but no specifics are given as to the source of these funds.

Indicator 21 – Capital improvement plan

There is no capital improvement plan or list of projects in the Lincoln LRTP. It is noted in the plan that projects will be undertaken on an ad-hoc, as needed basis as opportunities arise. The plan estimates that 46 miles of shared use trails could be provided for in the 30 years of the plan under current financial projections. There is no estimate for the amount of bike routes and sharrows that could be provided. The plan states no new bike lines will be pioneered in the coming years given the current financial outlook.

Maintenance and Monitoring

Indicator 22 – Provision of maintenance programs

The Lincoln plan recommends adequate maintenance of bicycle facilities, and includes funding for the rehabilitation of current facilities. However no mention of routine maintenance is made. It is assumed that the Parks department provides the maintenance of shared use trails such as snow removal, since that is the source of their funding. As well, it is assumed that the on-street bicycle facilities are maintained by public works, along with the rest of the road system. The provision of routine maintenance for on-street bicycle facilities is not separated from routine street maintenance.

Indicator 23 – Monitoring and evaluation programs

There is no mention of programs in the Lincoln LRTP for evaluating the use of the bikeway system, safety and educational programs, network connectivity, or

enforcement. No specific goals or benchmarks relating to the amount of bicycle transportation or safety were set, and no monitoring programs were mentioned to measure to performance of the bikeway system.

5.3 Discussion and Recommendation

The Lincoln Metropolitan Planning Organization 2040 Long Range Transportation Plan does an adequate job of exhibiting knowledge related to many factors of bicycle planning. Most of the indicators in the framework were addressed in the LRTP, showing a good breadth of topic discussion relating to bicycle planning. However, while the breadth of coverage was adequate, the depth of discussion into each of the indicators was inadequate. The plan did not go into great depth discussing any of the indicators, perhaps due to the fact that this is not a stand-alone bicycle plan. While a stand-alone plan may have provided more in-depth analysis and recommendations, more could have also been explored under the currently used format.

In the following sections, recommendations for improving the plan will be given on each of the main subject groupings.

Knowledge and Recognition

Four of the five indicators in this section were identified by the LRTP. The indicator that was not identified was that increasing bicycle transportation reduces the use of fossil fuels. This is an important indicator given the current cost and demand for fossil fuels. Further, while the other indicators were mentioned, they were mentioned very briefly. More information should be provided on these

subjects. The LRTP, as part of the comprehensive planning process, is the document that guides a city's future development. Both citizens and developers look to this document for an explanation of present and future conditions in their city. The plan should provide background information to explain the cities impetus for expanding bicycle transportation.

Goals and Objectives

This section of the framework was not well covered by the LRTP. It is important to set goals in the plan so that there is a focus on where the city wants to be in the future in terms of bicycle transportation, and to follow up with objectives to achieve those goals. Without tangible goals such as specific benchmarks for bicycle transportation rates or safety numbers, it doesn't appear that increasing bicycle transportation is a true priority.

Planning, Policy and Programs

This is another section of indicators of which the LRTP provided good breadth of coverage, but lacked depth. Many of the policy and program indicators were covered, but merely by saying that they should be created. The Lincoln LRTP could be improved by listing a specific set of parameters for those programs and policies to be created, identifying responsibilities, partners, funding sources, etc. for the provision of these programs. Without any sort of action plan, the policy and program recommendations seem like goals that are a good idea, but nothing the city is actually committed to accomplishing.

Implementation and Funding

In this section, the planners were very pragmatic about the future of bicycle transportation in Lincoln. They made it very clear under the current funding forecasts that the city would not be able to afford to provide new bicycle facilities. As a result, no design guidelines were created for the construction of new facilities. However, there is a bit of a "chicken and egg" argument. Which should come first, funding for the facilities or a plan in place for implementing facilities. Perhaps with better information, education, and knowledge of the benefits to the city of increased bicycle transportation, policy makers and decision makers may be more apt to provide funding. A solid bicycle plan can help to make that argument for increased funding.

Maintenance and Monitoring

While the plan does mention funding sources for the rehabilitation of aging bicycle facilities, no mention is made of routine maintenance. Maintenance is an important component to a successful bicycle network due to the fragile nature of bicycles and the vulnerability of bicyclists. Monitoring and evaluation of the bicycle network is not mentioned at all. Perhaps that is due to the fact that no goals or benchmarks were set out in the plan, making evaluation seem unimportant. Both goals and evaluation and monitoring are important parts of a quality bicycle plan.

5.4 Conclusion

The Lincoln plan is a good starting point based on the breadth of knowledge it exhibits relating to bicycle transportation. However, the plan could be improved in a way that will help the city achieve the goal of more people making more utility related bicycle trips. The plan could increase the depth of coverage of the indicators presented in this framework. Specific goals and objectives, and clear proposals for programs and policy changes to help accomplish those goals will help to create a complete, cohesive and connected system of bicycle facilities that will allow bicyclists to reach destinations safely and efficiently.

There are benefits, and an argument to be made for a stand-alone plan. For many years other modes of transportation have taken a back seat to automobile transportation. While a stand-alone transportation plan does allow for more consideration for bicycle transportation than what is provided in a comprehensive plan, a stand-alone bicycle plan would remove bicycle transportation from the influence of automobile transportation. A stand-alone bicycle plan will give the topic enough coverage to properly provide adequate planning to ensure an increase in bicycle transportation in the city.

Chapter 6 Discussion and Conclusion

6.1 Discussion of Findings

The research performed in this study sought to find the conditions or factors necessary to prepare a bicycle plan that would provide adequate planning resources to ensure a bicycle network that would result in increased transportation by bicycle. Using a variety of sources including the available literature, recommendations from the Federal Government, and sample bicycle plans from cities considered to be on the forefront in the US on planning for bicycle transportation. From these sources a list of twenty-three indicators was created to act as a framework for analyzing bicycle transportation plans.

While not an all-encompassing list of indicators, the list of indicators chosen for inclusion in the framework created in this study represent planning topics that are common across multiple well-regarded bicycle transportation plans, backed up by available literature, and recommended by the US Department of Transportation. While a community can certainly investigate topics not covered by this framework in their bicycle transportation plans, the indicators in this framework represent those topics that are deemed necessary for the creation of a complete and functional bicycle transportation plan.

The research found that the only integrated plan used to inform the study addressed fewer indicators when applied to the indicator framework. This suggests that a stand-alone bicycle transportation plan contains more complete coverage of bicycle planning. The willingness of a city to invest the resources necessary to

create a stand-alone bicycle plan shows the city is committed to increasing bicycle transportation, and is willing to provide an adequate plan to ensure that it happens.

In the case study segment of this research, it was found that the Lincoln, Nebraska Long Range Transportation Plan, which includes the information from the city on planning for bicycle transportation, while providing good breadth of coverage to the indicators, could improve the depth of coverage of the indicators. The result is a plan that identifies important concepts related to bicycle planning, but does not fully investigate those topics and provide policy and programmatic recommendations that could positively affect the rate of bicycle transportation in the city.

6.2 Research Limitations

There are certain limitations that must be noted in regard to this research. First, these indicators were developed and informed by the selected bicycle plans. The performance of the sample plans when measured against the indicator framework in figure 4.3 is for illustrative purposes only. The results have not been analyzed statistically and the results are not statistically significant.

Second, future research may need to take into account the issue of providing weights to the indicators. The indicators are not all equal. That is, not all indicators are equally important to the creation of a complete bicycle transportation plan. If future research seeks to provide numerical scoring to rank or compare bicycle transportation plans, indicators could be given a weight depending on their importance to the strength of the planning document.

Next, it is important to note that a thorough bicycle-planning document is not the sole predictor of rates of bicycling. As an example, in this study the Boulder, Colorado transportation plan did not address many of the indicators in the framework created in this study. Despite this lack of coverage in their planning documents Boulder, Colorado has a rate of bicycle use well higher than the national average, and is a community known for being bicycle friendly. However, if a city has as a goal an increase in the utilitarian use of bicycles, the transportation-planning document for the community is the ideal place to put forth the new ideas that will guide the city towards the achievement of this goal.

Finally, it is possible that some of the indicators in this framework may not appear in some planning documents due to the fact that as a city more adequately plans for bicycle transportation, it may not have the need to address each indicator as the potential issue may have already been adequately provided for and therefore does not need to be addressed in future planning documents. This could be particularly true for indicators in the Knowledge and Recognition section. It would be less likely in the Planning, Policy, and Programs section, as these issues will likely need ongoing adjustments to reflect changes in the needs of the community.

6.3 Future Research Possibilities

This research could be expanded and used in two different ways. First, a city-planning agency could use this framework as a guide to evaluate their practices related to bicycle planning, much in the way that was done in the case study segment of this research. Second, this framework could be applied across multiple

cities and compared. This framework could serve as a basis for scoring plans and determining which indicators across multiple cities performed the best, and which performed the worst as a means to discover prevailing trends in planning for bicycle transportation.

As mentioned in the research limitations above, some issues will need to be resolved before the indicator framework can be used in this way. First, there will need to be an investigation into proper weighting for each indicator. Second, a decision will need to be made to determine a measurement system for scoring the indicators. Previous research in the field of environmental and sustainability planning has used a scoring system of 0, 1, or 2 (Berke and Conroy, 2000; Tang, et. al., 2009a). A score of 0 indicated no mention of the indicator, a score of 1 indicated the indicator being mentioned but the topic not fully developed, and a score of 2 indicated the indicator had been fully discussed and researched. To utilize this method it must be determined parameters that constitute differentiation in the scoring method.

To assist future research, a table with keywords to help identify discussion of each indicator is a provided in Appendix A.

References

American Association of State Highway and Transportation Officials (AASHTO). (1999). *Guide for the Development of Bicycle Facilities*, Washington, D.C.

Baer, W.C. (1997). General plan evaluation criteria: an approach to making better plans. *Journal of the American Planning Association,* 63(3), 329-344

Berke, P.R., Conroy, M.M. (2000). Are we planning for sustainable development? *Journal of the American Planning Association*, 66(1), 21-33

Brody, S.D. (2003). Are we learning to make better plans? A longitudinal analysis of plan quality associated with natural hazards. *Journal of Planning Education and Research*, 23, 191-201

Brody, S.D., Highfield, W.E. (2005). Does planning work? Testing the implementation of local environmental planning in Florida. *Journal of the American Planning Association*, 71, 159-175

Burby, R.J. (2003). Making plans that matter. *Journal of the American Planning Association,* 69(1), 33-49

Bureau of Transportation Statistics. (2004). *How bike paths and lanes make a difference*. BTS Issue Brief. Washington, DC: Bureau of Transportation Statistics.

Bureau of Transportation Statistics. (2002). *Bicycle use among adult US residents.* Omnistats. 2,6

Cervero, R., Duncan, M. (2003). Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay Area. *American Journal of Public Health, 93*(9), 1478-1483

City of Austin Public Works Department. (2009). *Austin 2009 Bicycle Plan Update* http://www.austintexas.gov/sites/default/files/files/Public_Works/2009_bicyclemasterplan.pdf

City of Boulder Public Works Administration. (2008). *City of Boulder Transportation Master Plan* http://www.bouldercolorado.gov/files/Transportation_Master_Plan/2008_BoulderTMP.pdf

City of Davis Public Works Department. (2009). *City of Davis Bicycle Plan,* http://cityofdavis.org/bicycles/pdfs/Bike-Plan-2009.pdf

City of Lincoln, Lincoln Metropolitan Planning Organization. (2011). *Lincoln Metropolitan Planning Organization 2040 Long Range Transportation Plan,* http://lincoln.ne.gov/city/plan/lplan2040/plan/document/lrtp/final/lrtp.pdf

City of Portland Bureau of Transportation. (2010). *Portland Bicycle Plan for 2030,* http://www.portlandonline.com/transportation/index.cfm?c=44597

City of Seattle Department of Transportation. (2007). *Seattle Bicycle Master Plan* http://www.seattle.gov/transportation/docs/bmp/final/BikeMasterPlanCOMPLETE.pdf

Dill, J., Carr, T. (2003). Bicycle commuting and facilities in major U.S. cities: if you build them, commuters will use them – another look, Paper presented at the Transportation Research Board 2003 Annual Meeting

Dill, J. (2009). Bicycling for transportation and health: the role of infrastructure. *Journal of Public Health Policy,* 30, S95-S110

Dill, J., Voros, K. (2007). Factors affecting bicycling demand: Initial survey findings from the Portland, Oregon Region. *Transportation Research Record*. 2031, 9–17

Funnell, S.C. (2000). Developing and using a program theory matrix for program evaluation and performance monitoring. In P. J. Rogers, T. A. Hacsi, A. Petrosino, & T. A. Huebner (Eds.), *Program theory in evaluation: Challenges and opportunities. New directions in evaluation* (Vol. 87, pp. 17–27). San Francisco, CA: Jossey-Bass.

Haines, A., McMichael, T., Anderson, R., Houghton, J. (2000). **F**ossil fuels, transport, and public health: Policy goals for physical activity and emission controls point the same way. *British Medical Journal.* 321(7270), 1168-1169.

Heinen, E., van Wee, B., Maat, K. (2010). Commuting by bicycle: an overview of the literature. *Transport Reviews*, 30(1), 59-96

Hoch, C. (1998). Evaluating plan pragmatically. Paper presented at the 40th Annual Conference, Association of Collegiate Schools of Planning, Pasadena, CA, November 5.

Illich, I. (1978). *Toward a History of Needs,* Pantheon Books, New York, NY.

Krizek, K. J., Barnes, G., Thompson, K. (2009). Analyzing the effect of bicycle facilities on commute mode share over time. *Journal of Urban Planning & Development,* 35*(*2), 66-73

Krizek, K.J., Johnson, P.J. (2006). Proximity to trails and retail: effects on urban cycling and walking. *Journal of the American Planning Association,* 72(1), 33-42

Litman, T., Blair, R., Demopoulos, W., Eddy, N., Fritzel, A. Laidlaw, D. Maddox, H. (2006). Pedestrian and bicycle planning: a guide to best practices. *Victoria Transport Policy Institute,* Victoria, BC, Canada

Noland, R.B., Kunreuther, H. (1995). Short-run and long-run policies for increasing bicycle transportation for daily commuter trips. *Transport Policy*, 1(3), 67-79

Pucher, J., Buehler, R. (2011). Analysis of bicycling trends and policies in large North American cities: lessons for New York. *University Transportation Research Paper,* Final Report

Pucher, J., Buehler, R. (2008). Making cycling irresistible: lessons from the Netherlands, Denmark, and Germany. *Transport Reviews,* 28(4), 495-528

Pucher, J., Buehler, R. (2006). Why Canadians cycle more than Americans: a comparative analysis of bicycling trends and policies. *Transport Policy,* 13*,* 265–279

Pucher, J., Dill, J., Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: An international review. *Preventative Medicine,* 50, S106-S125

Pucher, J., Renne, J.L. (2003). Socioeconomics of urban travel: evidence from the 2001 NHTS. *Transportation Quarterly*, 57(3), 49-77.

Rietveld, P., Daniel, V. (2004). Determinants of bicycle use: do municipal policies matter? *Transportation Research Part A,* 38, 531-550

Rogers, P.J. (2000). Causal Models in Program Theory Evaluation. In P. J. Rogers, T. A. Hacsi, A. Petrosino, & T. A. Huebner (Eds.), *Program theory in evaluation: Challenges and opportunities. New directions in evaluation* (Vol. 87, pp. 17–27). San Francisco, CA: Jossey-Bass.

Rogers, P.J.; Petrosino, A.; Huebner, T.A.; Hacsi, T.A. (2000). Program theory evaluation: practice, promise, and problems. In P. J. Rogers, T. A. Hacsi, A. Petrosino, & T. A. Huebner (Eds.), *Program theory in evaluation: Challenges and opportunities. New directions in evaluation* (Vol. 87, pp. 17–27). San Francisco, CA: Jossey-Bass.

Stott, R. (2006). Healthy response to climate change. *British Medical Journal,* 332(7554), 1385–1387

Talen, E. (1996). Do plans get implemented? A review of evaluation in planning. *Journal of Planning Literature,* 10 (3), 248-59.

Tang, Z., Hussey, C.M., Wei, T. a. (2009). Assessing local land use planning's awareness, analysis, and actions for climate change. *International Journal of Climate Change Strategies and Management,* 1(4), 368-81

Tang, Z., Bright, E., Brody, S. b.(2009). Evaluating California local land use plan's environmental impact reports. *Environmental Impact Assessment Review* 29, 96–106

Tilahun, N.Y., Levinson, D.M., Krizek, K.J. (2007). Trails, lanes, or traffic: valuing bicycle facilities with an adaptive stated preference survey. *Transportation Research Part A.* 41, 287-301

U.S. Department of Transportation, Federal Highway Administration. (2004). *National bicycling and walking study ten year status report*. Washington, DC. http://www.fhwa.dot.gov/environment/bikeped/study/

U.S. Department of Transportation, Federal Highway Administration. (2006). *Federal Highway Administration University Course on Bicycle and Pedestrian Transportation,* Washington, DC. http://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/pdf/lesson19lo.pdf

U.S. Department of Transportation, Federal Highway Administration. (2010.) *United States Department of Transportation policy statement on bicycle and pedestrian accommodation regulations and recommendations*. http://www.fhwa.dot.gov/environment/bikeped/policy_accom.htm

U.S. Department of Transportation, Federal Highway Administration a. (n.d.) *Bicycle and pedestrian provisions of the Federal aid program.* http://www.fhwa.dot.gov/environment/bikeped/bp-broch.htm

U.S. Department of Transportation, Federal Highway Administration b. (n.d.) *Health and environmental benefits of walking and bicycling*. http://www.fhwa.dot.gov/environment/bikeped/benefits_research.htm

U.S. Department of Transportation, Federal Highway Administration c. (n.d.) *Pedestrian and bicycle information center: sample plans.* http://www.bicyclinginfo.org/develop/sample-plans.cfm

Xing, Y., Handy, S. L. and Buehler, T. J. (2008) *Factors Associated with Bicycle Ownership and Use: A Study of 6 Small U.S. Cities* (Washington, DC: Transportation Research Board).

Appendix A

This appendix will contain a table that shows keywords that can be utilized to help future researchers apply this framework to bicycle transportation plans. This list of keywords is important because universal nomenclature is not used when discussing planning issues related to bicycle transportation. Increasingly, planning documents are made available on city websites in .pdf format. .pdf format allows the document to be scanned for keywords, highlighting each time in the document the keyword is used. By using a keyword search of planning documents, a researcher may more readily scan documents. However, it is important to use a variety of keywords for each topic to ensure each planning document is adequately searched. This section, while not exhaustive, will provide much of the verbiage used to describe each indicator. When searching a .pdf, if either word in a search is present, the program will flag the term. This feature helps to ensure complete scanning of documents.

Scanning the document alone will not be sufficient to account for indicators. The researcher will have to read the text that was flagged by the keyword to ensure the context of the use of keywords. The use of keywords should also be used in conjunction with the table of context to determine if and where in the document planners discuss each of the indicator, and that full section should be examined to determine if an indicator has been addressed, and to what extent.

Indicator Keywords	
Indicator	**Keywords**
Indicator 1	bicycle facility, bicycle lane, bicycle path, bicycle route, bike facility, bike lane, bike path, bike route, mixed-use trail, shared path, shared trail,
Indicator 2	fossil fuel, fuel, gas, gasoline, oil, petroleum
Indicator 3	air quality, CO2, carbon dioxide, climate change, emission, global warming, greenhouse gas, pollution
Indicator 4	air quality, asthma, body mass index, BMI, exercise, health, obesity, physical activity, pollution
Indicator 5	congestion, peak travel times, roadway capacity, traffic
Indicator 6	bicycle use, bicycling, bicyclists, goal, increase
Indicator 7	bicycle safety, safety, safety levels
Indicator 8	objectives
Indicator 9	bicycle facility, bicycle lane, bicycle path, bicycle route, bike facility, bike lane, bike path, bike route, infrastructure, mixed-use trail, shared path, shared trail,
Indicator 10	bicycle facilities, bike facilities, end of trip facilities, lockers, lock-ups, parking, racks, showers
Indicator 11	public input, public participation
Indicator 12	accessible, accessibility, bicycle network, connected, connectivity, continuous, direct, direct route, network
Indicator 13	compact, dense, denser, density, development, mixed-use, short distance, shorter distance, transit-oriented development, TOD,
Indicator 14	bike racks, bus, buses, bus system, integrate, integration, light rail, light rail station, public transit, rail station, transit, transit station, transit stop, trolley
Indicator 15	design, design guideline, infrastructure, new road, redevelopment, road, road design, road engineering, road work, street, street design, street engineering, street project, streetscape, street work
Indicator 16	bicycle education, bicycle safety, driver education, educate, education, interaction, program, programmatic, safety,
Indicator 17	bike to school, bike to work, bicycle to school, bicycle to work, encouragement, encouragement program, program, programmatic, promotion, promotional, promotional program
Indicator 18	bicycle laws, bicycle enforcement, bike laws, bike enforcement, enforcement, enforcement program, law, program, safety, safety enforcement, safety program
Indicator 19	complete streets, design, design guidelines, design standards, facility design, guidelines, standards, road design, street design
Indicator 20	bonds, financial estimates, fund, funding, funds, funding

	sources, grants, sources
Indicator 21	capital improvement plan, project, project list
Indicator 22	best practices, maintain, maintenance, potholes, snow removal, sweep, trash removal
Indicator 23	capacity, evaluate, evaluation, goals, monitor, monitoring, objectives, performance measures, program evaluation, program, program performance, progress

Figure A.1 Indicator Keywords