Disparities in Biking Infrastructure Development:

Analyzing Policy, Economic, and Social Factors in Colorado's Front Range Cities

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ABSTRACT

The context for this project is to understand whether and how Bicycle Master Plans (BMP) affect the implementation of bicycling infrastructure to support active lifestyles. Public health organizations view these plans as important for achieving health behavior change. The objective for this is to analyze the factors that influence the implementation of bicycle friendly places. The methods used varied in several ways. The spatial analysis results suggest that there are disparities in bicycle master plan connectivity in each city, as well as inequitable distribution of such infrastructure. The interviews also suggested additional factors for implementation that could not be drawn out or concluded from spatial analysis. The conclusion discusses the findings of the results as well as the recommendations for each respective city.

I. INTRODUCTION

Urban transportation networks play a crucial role in shaping the accessibility, sustainability, and equity of cities. In recent decades, cities across the United States have increasingly prioritized sustainable infrastructure to address challenges related to traffic congestion, air pollution, and public health. A critical component of sustainable transportation planning is the development of biking infrastructure, which provides an alternative to car dependency while contributing to broader environmental and public health goals. Biking infrastructure can provide cheaper and more sustainable forms of transportation to people of all ages and backgrounds, assisting people with day-to-day tasks ranging from recreational to utilitarian reasons. Despite the recognized benefits of biking, the extent and quality of biking infrastructure vary widely between cities. While some municipalities have embraced comprehensive bike networks with dedicated lanes, policy support, and multimodal integration, others lag due to economic constraints, political resistance, and urban design priorities.

This disparity is particularly evident in Colorado's Front Range Area, where cities exhibit significant variation in their approach to biking infrastructure. Despite statewide policies that encourage alternative transportation and sustainability, local implementation of biking infrastructure remains uneven. Some cities, such as Boulder and Fort Collins, have developed extensive and well-connected bike networks supported by comprehensive policy frameworks and financial investments. Others, such as Colorado Springs and Pueblo, have been slower to integrate biking infrastructure into their transportation planning, often treating cycling as a recreational activity rather than a viable mode of urban mobility. This variation raises important questions about the factors driving these discrepancies and their broader implications for transportation equity and sustainability in the region.

1.1. Research Gap

A key factor in successful biking infrastructure is the presence of a supportive policy framework that includes dedicated funding, urban design regulations, and multimodal transportation plans. In cities where such policies are lacking, biking infrastructure tends to be fragmented, less safe, a nd underutilized. Additionally, disparities in economic resources can further impact a city's ability to invest in biking networks, often reinforcing existing inequalities in transportation access.

Existing literature on biking infrastructure primarily focuses on cities that have successfully implemented comprehensive networks, often overlooking the challenges and barriers faced by municipalities with weaker biking policies. While studies highlight the benefits of biking for urban sustainability, public health, and economic development, less attention has been given to the underlying political, economic, and social dynamics that shape local investment in biking infrastructure. Moreover, research on biking infrastructure in mid-sized cities, particularly those with varying political and economic landscapes, remains limited.

Colorado's Front Range presents a unique case for examining these issues. As one of the fastest-growing urban corridors in the United States, the region faces increasing pressure to provide sustainable transportation options. However, cities within the Front Range differ in their prioritization of biking infrastructure, reflecting broader trends in urban governance, economic investment, and community engagement. Understanding these differences is crucial for developing more effective policies that promote equitable and sustainable urban mobility.

1.2. Research Question and Objectives

This study seeks to answer the following research question: Why do cities in Colorado's Front Range differ in their biking infrastructure development, and what factors contribute to the disparities in the implementation of bike master plans? To address this question, the research examines five cities: Boulder, Colorado Springs, Denver, Fort Collins, and Pueblo. These Front Range cities represent a range of population sizes, economic conditions, and policy approaches, providing a comparative framework for analyzing the determinants of biking infrastructure development.

1.3. Identifying Bicycle Infrastructure

For purposes of clear interpretation of the research, it is important to accurately identify what bicycle infrastructure means. Bicycle infrastructure in this research is defined as any means of network or system that supports bicycle transportation. These can range from on-street bike lanes, off-street bike paths, multi-use paths, or on-street protected bike lanes. For clarity, shared-lane infrastructure or signage is not included as bicycle infrastructure as it does not provide the same level of safety or prioritization that these other infrastructure types do. Figure 1.1. shows the different types of bicycle infrastructure used for this research. All examples are in the selected cities. The types of infrastructure are On-Street Unprotected Bike Lane, On-Street Protected Bike Lane, Off-Street Bike Path, and Multi-Use Path.

Figure 1.1: On-Street Protected Bike Lane (Denver, CO)
Source: Denver Streets Partnership

Figure 1.2: Multi Use Path (University of Colorado Boulder)
Source: City of Boulder

1.4. Significance of the Study

As urban areas seek to transition toward more sustainable transportation systems, understanding the barriers and facilitators of biking infrastructure development is essential for informing policy and planning decisions. The findings from this study will contribute to the broader discourse on urban mobility by identifying best practices and challenges in implementing effective biking networks. Moreover, this research provides insights into the intersection of policy, community involvement, and economic conditions in shaping transportation infrastructure, offering valuable lessons for cities beyond Colorado's Front Range.

By highlighting the structural and contextual factors that influence the development of biking infrastructure, this study aims to provide policymakers, urban planners, and transportation advocates with actionable recommendations for fostering more bike-friendly cities. Ultimately, integrating biking into urban transportation planning is not merely a matter of infrastructure but a broader issue of equity, sustainability, and urban livability.

Figure 1.3: On-Street Protected Bike Lane (Denver, CO)
Source: Denver Streets Partnership

Figure 1.4: Multi Use Path (University of Colorado Boulder)
Source: City of Boulder

II. Literature Review

In the past half-century, cities across the United States have embraced the concept of bikeability and started implementing bicycle master plans (BMPs). These long-term plans aim to expand and improve bicycle infrastructure within urban areas, creating opportunities for recreational and essential transportation beyond the use of cars. Such plans contribute to public health and sustainability efforts while simultaneously reducing carbon emissions (Oja, 2021). The presence of a well-developed bicycle master plan reflects public opinion on the value of cycling and supports bike-friendly city planning. While these plans have become more prominent, understanding their origins and evolution is essential to grasp their current implementation and limitations.

Bicycle master plans began to develop nationwide as urban planners recognized the benefits of integrating bicycle network systems into city designs. The Intermodal Surface Transportation Efficiency Act of 1991 marked a significant federal push, allocating funds to various forms of transportation infrastructure, including bicycle infrastructure. Interestingly, this federal law was inspired by earlier efforts in Colorado. The Colorado Bicycle Bill of 1977 required the Colorado Department of Transportation to include bicycle paths in its funding allocations. By 1981, Boulder had established its first bicycle master plan, with Colorado Springs following suit in 1983. These pioneering efforts in Colorado set a foundation for statewide and national advancements in bicycle infrastructure planning. While the development of bicycle mas ter plans represented a critical step toward integrating biking infrastructure into urban landscapes, their implementation has varied widely across different cities.

Political dynamics, economic constraints, public attitudes, and geographic conditions all influence how effectively these plans are executed. To comprehensively evaluate these factors, I studied theories of policy change, which help explain the conditions under which bicycle master plans are successfully implemented and the barriers they face. It is vital to delve into the academic discourse that informs our understanding of these efforts and their varied outcomes across different cities in Colorado's Front Range.

Existing literature on biking infrastructure primarily focuses on cities that have successfully implemented comprehensive networks, often overlooking the challenges and barriers faced by municipalities with weaker biking policies. While studies highlight the benefits of biking for urban sustainability, public health, and economic development, less attention has been given to the underlying political, economic, and social dynamics that shape local investment in biking infrastructure. Moreover, research on biking infrastructure in mid-sized cities, particularly those with varying political and economic landscapes, remains limited.

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2.1. Policy Change and Theoretical Frameworks

Theories of policy evolution offer insights into the factors driving changes in urban policies, particularly those related to sustainability and health.

Kingdon's Framework

One such approach is Kingdon's multiple streams framework, which explains how policy change occurs when three streams—problem recognition, policy proposals, and political circumstances—align to create windows of opportunity (Kingdon 1984). The problem stream involves identifying an issue that requires government intervention, the policy stream consists of potential solutions developed by experts and stakeholders, and the political stream reflects the broader political climate, including public opinion and government priorities.When applied to bike infrastructure policies, this model helps clarify why and how certain initiatives gain momentum.

If a city recognizes growing concerns about traffic congestion,
environmental impact, or public health (problem stream), and planners propose well-developed solutions such as a Bicycle Master Plan (policy stream), these efforts are more likely to advance when the political climate is supportive, such as through leadership backing or available funding (political stream). By analyzing these interactions, we can better understand the conditions that drive the adoption and implementation of bike infrastructure policies.

Within the policy stream, city governments propose solutions like dedicated bike lanes and master plans, drawing on design standards and funding strategies. However, the politics stream—encompassing leadership shifts, public opinion, and advocacy efforts—often determines whether these proposed solutions gain traction. When the three streams align, the policy window will open and the master plan will be implemented (Kingdon).

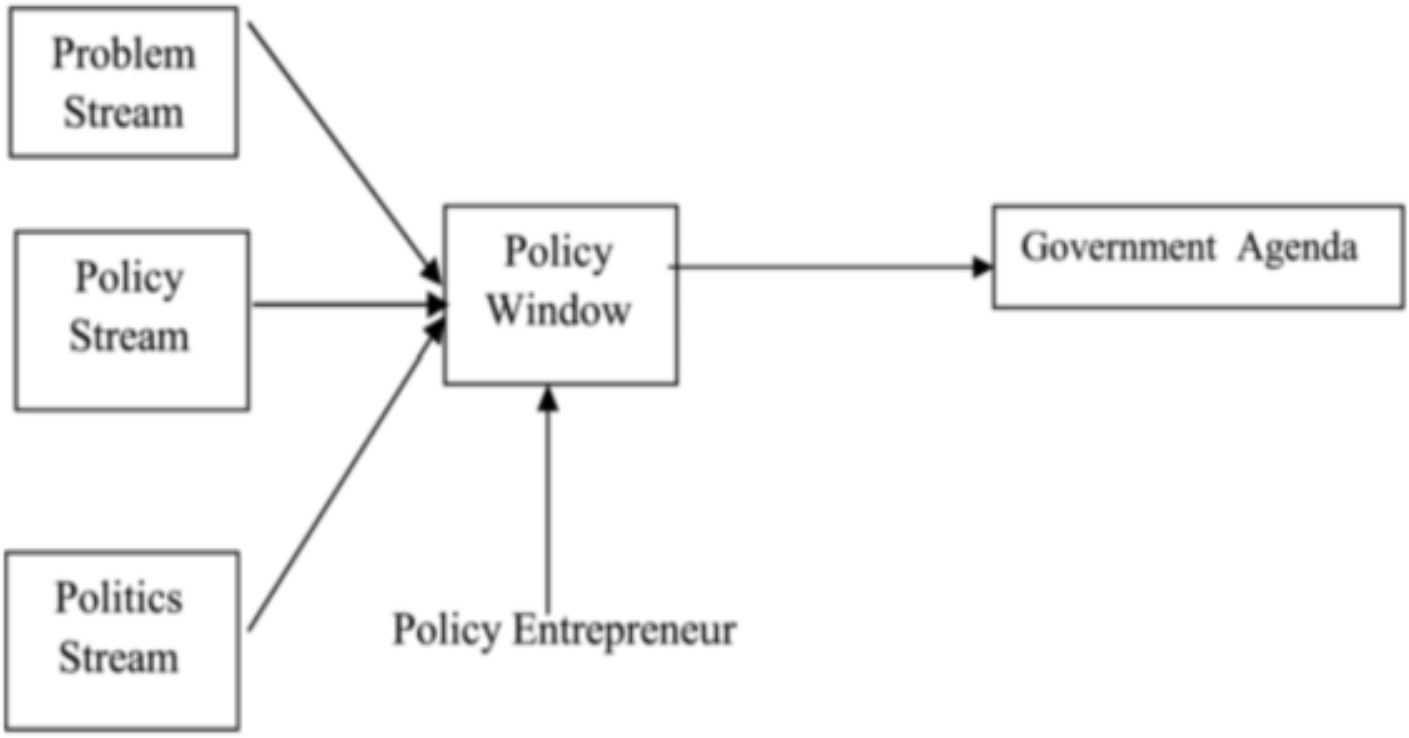

Figure 2.1: A schematic chart visualizing Kingdon's Framework

Ostrom Framework

Ostrom's Institutional Analysis and Development (IAD) Framework further enriches this analysis by emphasizing the role of formal and informal rules in policy design and implementation. This framework examines how institutions—understood as sets of rules, norms, and shared strategies—shape decision-making processes and policy outcomes. By analyzing the interactions between actors, governance structures, and external influences, the IAD framework helps explain why some policies, including those related to bike infrastructure, succeed while others face obstacles. Understanding these institutional dynamics provides a deeper perspective on the complexities of urban planning and policy execution.

In Colorado, shared resources like bike infrastructure involve diverse stakeholders, including city officials, advocacy groups, and residents. These stakeholders bring unique interests and resources to the table, influencing the success or failure of policy initiatives.

Ostrom's emphasis on collective resource management underscores the complexity of implementing bike infrastructure in a way that balances individual and community needs. These theoretical perspectives provided a structured approach to identifying, formalizing, and categorizing the factors influencing the implementation of Bicycle Master Plans. By applying Kingdon's multiple streams framework and Ostrom's Institutional Analysis and Development framework, problems were analyzed to explain how recognition, policy proposals, political `dynamics, and institutional structures interact to shape policy outcomes. This approach allowed for key barriers to be assessed such as financial constraints, varying levels of community support, and political shifts, all of which contribute to disparities in bike infrastructure investment. Understanding these factors is crucial for explaining the uneven implementati on of biking infrastructure and the broader challenges cities face in translating policy plans into tangible outcomes.

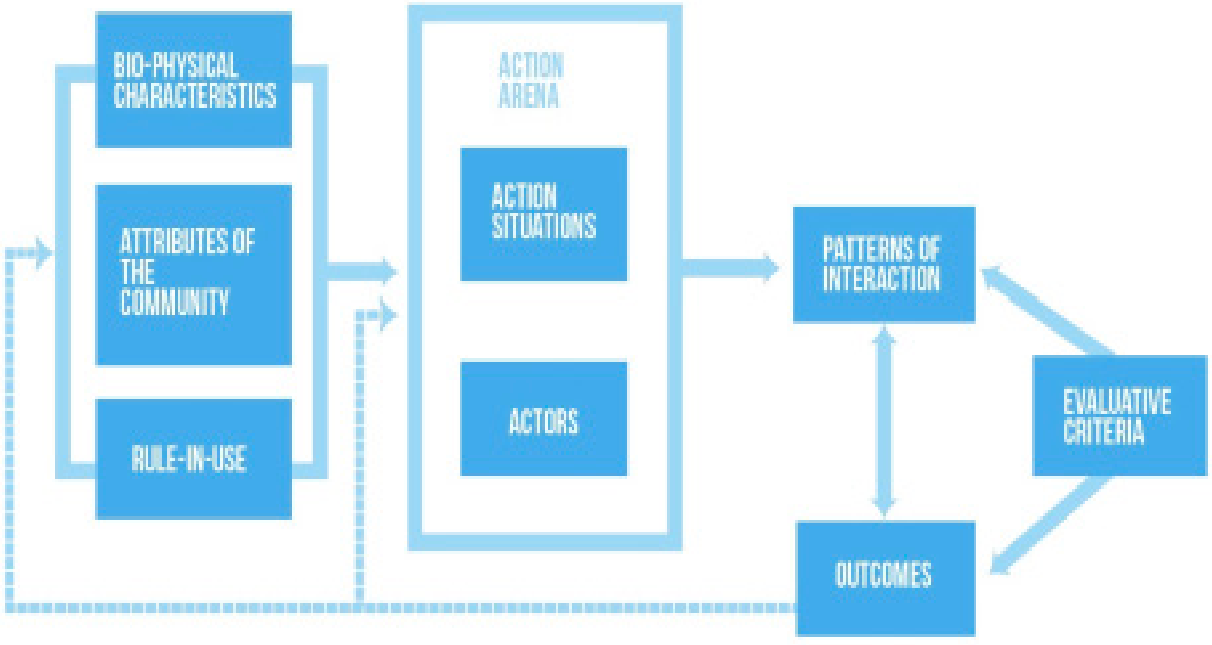

Figure 2.2: A schematic chart visualizing Ostrom's Framework

According to these two frameworks, factors that affect the implementation of bike master plans can be categorized into the broader categories of social and cultural attitudes, economic resources, political support and geography. The goal of this research is to understand how a combination of these factors affect the implementation of BMPs in the Colorado Front Range area. and to understand which factor has had a significant impact in this regard.

2.2. Factors in Infrastructure Implementation

In this section, we delve into specific factors—identified in the literature—that play a crucial role in shaping bike infrastructure development, particularly in the context of social, economic, and geographical considerations.

Social and cultural attitudes toward cycling significantly impact infrastructure implementation. In areas where car-centric lifestyles dominate, biking initiatives often face resistance due to perceptions of driving as more convenient or prestigious. For instance, Cimarron Hills in Colorado Springs exemplifies a community where car dependency overshadows cycling efforts (Aldred et al., 2016; Pucher & Buehler, 2008). Conversely, cities with strong environmental values and pro-cycling cultures, such as Boulder, demonstrate how public support can drive quicker and more extensive infrastructure development (Pucher et al., 2010). Denver's approach to urban mobility—creating multiple urban centers—has further integrated biking infrastructure into a broader vision of connectivity and circulation (Hersey, 2016).

Geographically, both natural and built environments present challenges and opportunities for bike network integration. The IAD framework accounts for how external conditions, such as landscape and urban form, influence institutional decision-making. Colorado's mountainous terrain has necessitated creative solutions to connect cities through bicycle infrastructure. Boulder's integration of bike paths with existing greenways illustrates how planners can work within geographical constraints to promote cycling. In contrast, Pueblo has faced greater challenges due to its sprawling urban layout and highway infrastructure, which have created physical barriers to bike-friendly development.

By structuring these factors through policy change frameworks, we can better understand the varied success of bike infrastructure implementation and the barriers that different communities face. Economic resources also play a pivotal role in shaping bicycle infrastructure. The IAD framework highlights how institutional arrangements, such as budget allocations and funding mechanisms, determine policy implementation success. Wealthier cities often have greater financial flexibilty to support biking initiatives, while lower-income areas may struggle to secure funding. This economic disparity contributes to uneven infrastructure development across Colorado's Front Range, with Piatkowski et al. (2014) noting how financial constraints limit access to biking facilities in less affluent communities.

III. Research Methods

This research employed a mixed method approach to investigate the factors influencing the implementation of bicycle infrastructure in Colorado's Front Range Area. Through archival review, GIS analysis, and interviews with key informants, these methods collectively informed the findings of this research.

The research began with selecting cities to be included in this study. It was essential for the selected cities to be of a substantial size and to have a preexisting commitment to support a bicycle infrastructure. Boulder, Colorado Springs, Denver, Fort Collins, and Pueblo in the Front Range area were selected for this study. These Five cities not only met the mentioned criteria but are also major economic hubs crucial to the state of Colorado. (see figure 3.1 for the location of these cities in the Front Range area)

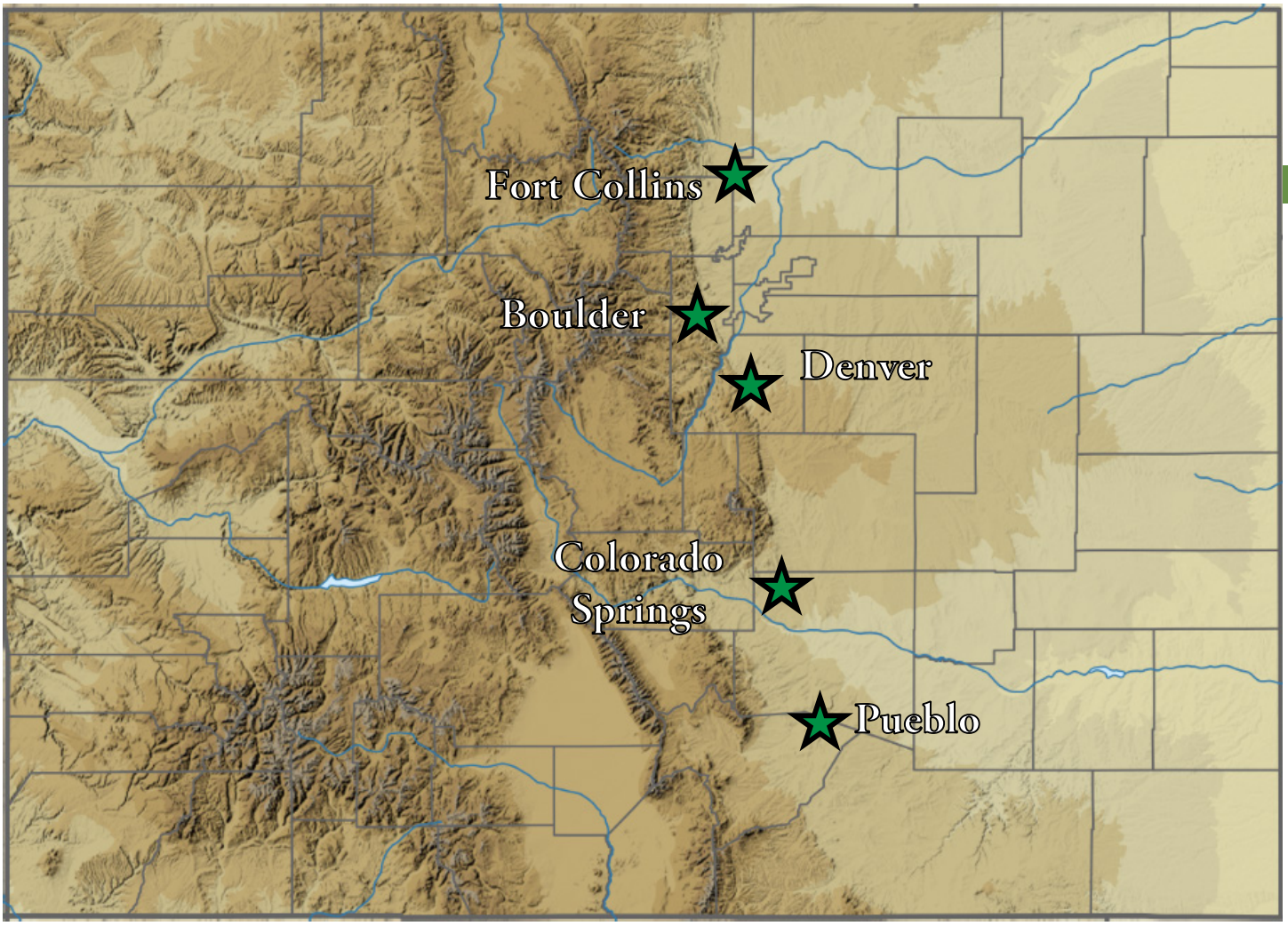

Figure 3.1: A Map of Selected Front Range Cities for this Study

City	Land Area (sq Mi)	Population	Total Mileage of Biking Infrastructure
Boulder	25.7	105,000	168 Miles
Colorado Springs	195.4	488,000	50 Miles
Denver	154.9	716,000	397 Miles
Fort Collins	57.1	170,000	254 Miles
Pueblo	53.6	111,000	19 Miles

Table 3.2: Total Land Area, Population, and Total Mileage of Biking Infrastructure in Each Selected City

The next step was to establish a foundation for this research, which was crucial for contextualizing each city's unique public records including city websites, master plans, and biking policies, to gather initial information. Additionally, an analysis of each city's governmental structure was conducted to understand how biking infrastructure priorities are established. This process uncovered significant differences between cities.

3.1. Archival Review

A key part of this research involved reviewing official archives including bike master plans, urban planning documents, and relevant policy measures. The analysis of policy measures focused on identifying their sources and intended impacts on the community—whether they were primarily for recreational benefits or utilitarian purposes. Budget analysis was another critical part of my research. To understand the financial commitment to biking infrastructure, the publicly available budget documents were examined. Such documents were obtained from transportation plans themselves or gathered from conversations with key informants from each respective city. The goal was to obtain specific budgetary details and identify additional resources to fill information gaps.

3.2. GIS Analysis

I conducted Spatial analysis using ArcGIS and RStudio programs to visualize biking infrastructure within each city and examine the distribution of biking amenities in relation to population density and income. The use of this software was inspired by previous academic journals that referenced spatial analysis for mapping health data (Chandran). By utilizing data from the Colorado Department of Transportation (CDOT), I identified areas with high biking traffic and evaluated how well the infrastructure aligned with each city's master plans. The resources provided valuable insights into the formal visions each city has adopted for biking infrastructure. I used RStudio and ArcGIS programs to prepare maps for each city identifying existing biking infrastructure as well as equity measures indicating access to biking facilities.

3.3. Interviews

To complement my research, I conducted interviews with key stakeholders from five cities: Boulder, Denver, Pueblo, Colorado Springs, and Fort Collins. These individuals, all involved in transportation planning, advocacy, or infrastructure development, provided essential insights into the successes and shortcomings of biking infrastructure expansion, as well as the broader political, economic, and cultural dynamics shaping its development. Throughout this research, I maintained detailed documentation of key contacts and resources. These included city officials, advocacy groups, and experts who offered invaluable insights into each city's biking infrastructure. Their perspectives helped contextualize both quantitative and qualitative data gathered, providing a comprehensive understanding of the factors influencing implementation across Colorado's Front Range.

The interview questionnaire was designed to investigate key themes surrounding bike infrastructure implementation, policy effectiveness, and equity. Questions explored how each city has approached bikeability, the role and impact of its Bike Master Plan, and the factors influencing plan implementation. Additionally, participants provided insights into the equitable distribution of biking infrastructure and the challenges cities face in ensuring access across neighborhoods. By capturing firsthand experiences, the interviews helped identify patterns in policy execution, highlight best practices, and reveal structural barriers to infrastructure development. This qualitative approach enriched the study's findings by incorporating expert perspectives on the political and institutional factors shaping biking infrastructure. Initial contacts were made throughout early January, with interviews conducted from mid-January to February. The interview questionnaire and consent form were shared with the participants prior to the interview including consent for recording, see Appendix for the questionnaire.

Additionally, informants were assured that their names would not be included in the research to ensure the confidentiality of information. Interviews took from thirty to forty minutes and were all conducted over Zoom. They were recorded and transcribed using the embedded transcribing program in Zoom. In addition to the current interviews, I referenced a previous interview with the planners in the city of Pueblo. This earlier interview was conducted several years ago by an honors advisor and followed similar lines of questioning. While most of the information remains accurate, some details may be outdated and were not used in the analysis.

Interview transcripts were systematically analyzed and coded to identify key themes, patterns, and variations across responses. A deductive coding approach was used, guided by categories established in the literature on bike infrastructure implementation, policy change, and equity. Specific codes included political will, funding constraints, community engagement, equity, and social/cultural barriers. To ensure consistency in analysis, different colored markers were used to highlight responses corresponding to these themes, allowing for a clear visual representation of recurring ideas and contrasts across cities.

The mix-method approach enabled a comprehensive examination of the factors influencing bike infrastructure implementation. By integrating qualitative interviews, policy analysis, and spatial data review, the research captured both the procedural and contextual elements shaping biking infrastructure across different cities. The use of thematic coding in interview analysis helped identify recurring challenges and opportunities, while policy document reviews provided insight into the formal frameworks guiding infrastructure development. Additionally, spatial analysis allowed for a visual and data-driven comparison of biking infrastructure distribution and accessibility. These diverse methods collectively strengthened the analysis and offered multiple perspectives on the issue.

IV. Results

This section includes the results from the GIS analysis of bike infrastructure distribution and the statistical analysis of its relationship with population density and income. First, the GIS results highlight spatial patterns of infrastructure availability across cities. Then, statistical findings explore correlations between infrastructure investment, demographic factors, and equity in distribution.

GIS Analysis

The GIS analysis of the spatial distribution of bike infrastructure across Colorado's Front Range cities reveals disparities in access and investment.

By analyzing the relationship between existing bike infrastructure, population density, and median income, this study identified patterns in infrastructure development and potential inequities in distribution. First, the results of the GIS analysis highlight variations in infrastructure mileage per capita and per square mile across different cities, revealing which areas have greater or lesser access to bike infrastructure. This is followed by an examination of spatial clustering, identifying high-concentration zones and infrastructure gaps that may indicate inequities in distribution.

Cities	Average Infrastructure Mileage per Population Density (Sq Mi)	Standard Deviation
Boulder	1.73×10^{-3}	6.40×10^{-3}
Colorado Springs	2.00×10^{-4}	5.44×10^{-4}
Denver	5.30×10^{-4}	1.19×10^{-3}
Fort Collins	4.13×10^{-3}	7.32×10^{-3}
Pueblo	1.53×10^{-4}	6.00×10^{-3}

Table 4.1. A Table Comparing Total Biking Infrastructure Mileage by Population Density per US Census Tracts (sq mi) and its Standard Deviation

4.2 Spatial Analysis Review

Table 4.1 is a summary of the selected city's bike infrastructure and how it has been equitably distributed. Using US Census Tracts and Census Data, as well as existing bicycle infrastructure from each city's Open Data catalog, the cities were measured to find the average infrastructure mileage by population density per Census Tract and includes standard deviation to show variability. Notably, Fort Collins and Denver have the highest averages, but also the most variation. Denver has a lower average, but more consistency than both Fort Collins and Boulder. Colorado Springs and Pueblo have the least infrastructure, with varying levels of accessibility across census tracts.

Spatial analysis provides a critical lens for evaluating the relationship between biking infrastructure and socioeconomic, demographic, and urban form factors. The following maps depict the distribution of biking infrastructure in each city. The spatial analysis was completed using ArcGIS Pro. These maps show the distribution compared to two equity indexes, population distribution and median household income. Both datasets were obtained from the US Census. Despite some cities having existing equity indexes for infrastructure planning, disparities and gaps still occur. By mapping income data at the census tract level alongside biking infrastructure, clear spatial patterns emerge that highlight disparities in accessibility. In Boulder and Fort Collins, these cities have developed an equity index in terms of planning for their constituents, ensuring accessibility is available for all. Conversely, in cities like Colorado Springs, where infrastructure investment is more limited, lower-income neighborhoods often have fewer protected bike lanes and less access to well-maintained routes reflecting a notable disparity in presence of such index.

The following maps are visual displays of each city's existing bike infrastructure, overlayed by median income levels per US Census Tract.

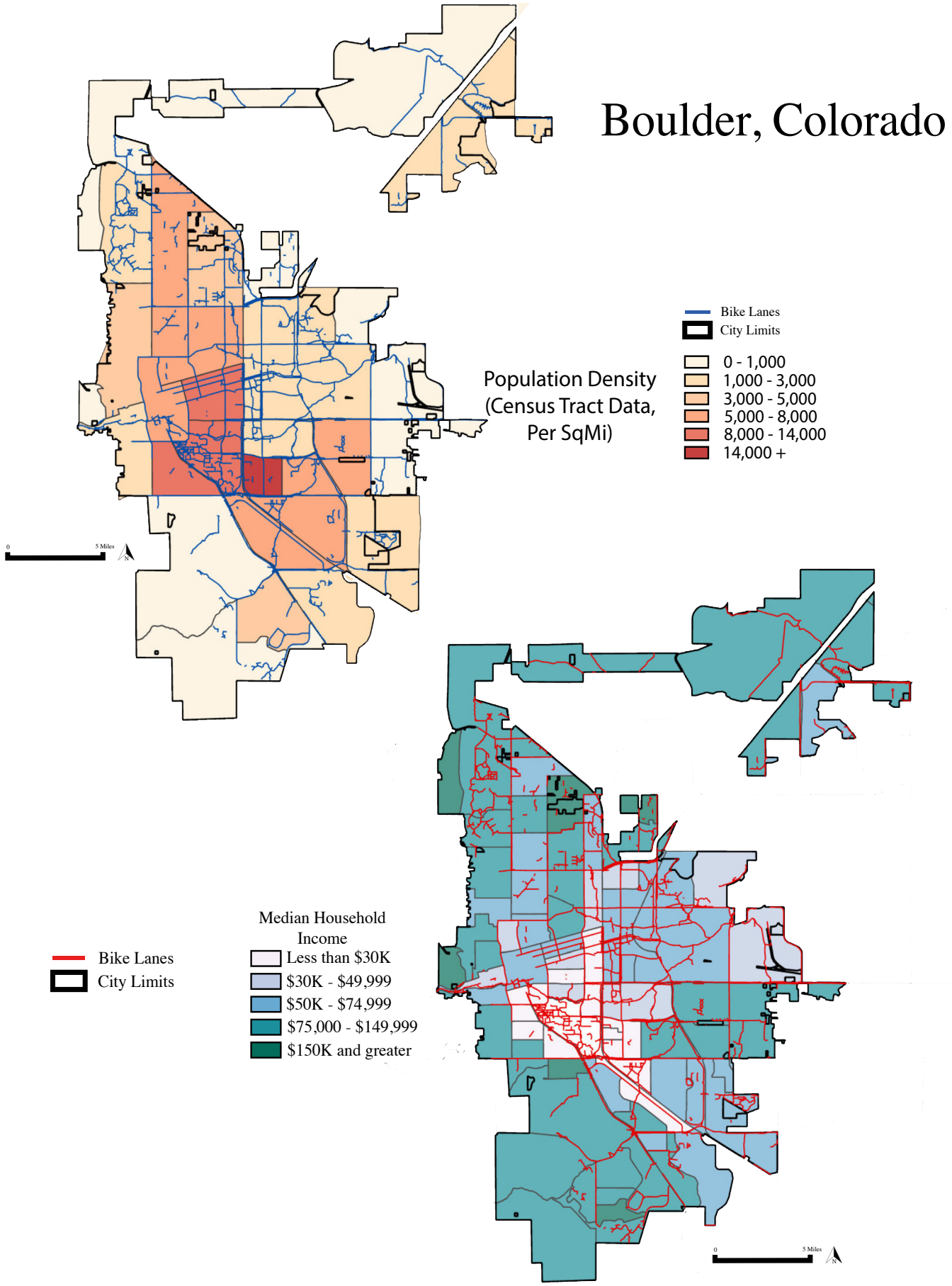

Figure 4.2: Infrastructure and Median Income Data, Population Density per Census Tracts in Boulder

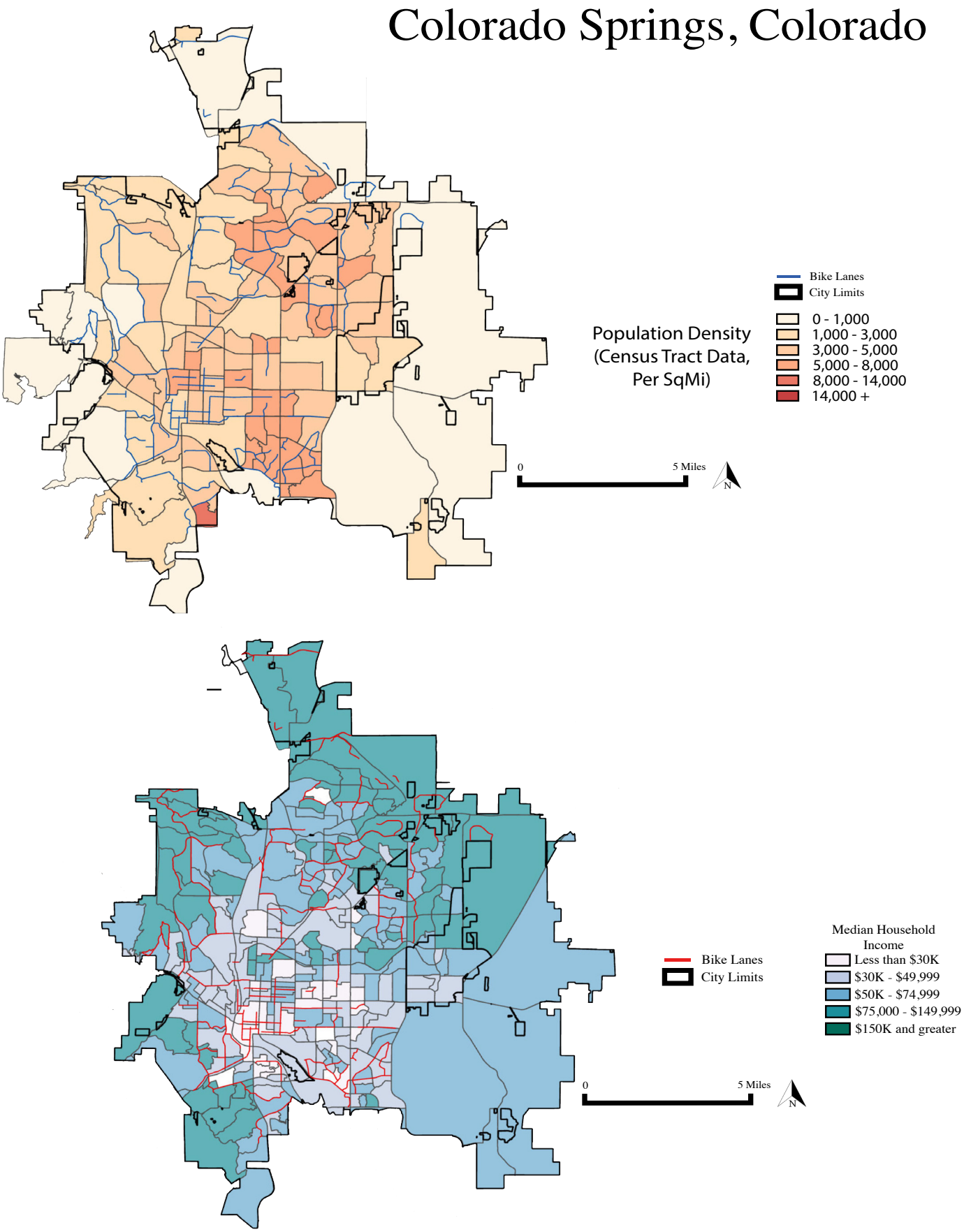

Figure 4.3: Infrastructure and Median Income Data, Population Density per Census Tracts in Colorado Springs

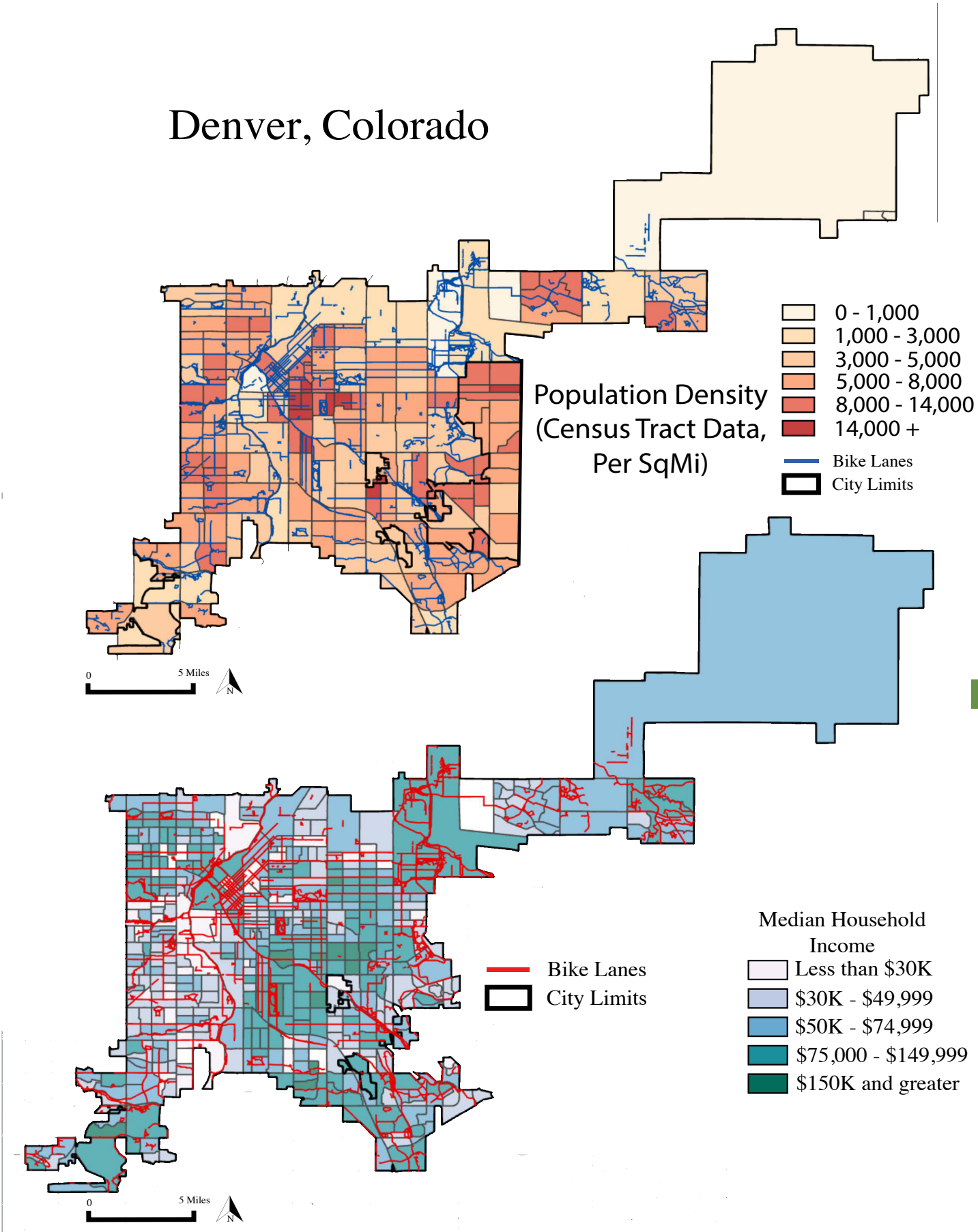

Figure 4.4: Infrastructure and Median Income Data, Population Density per Census Tracts in Denver

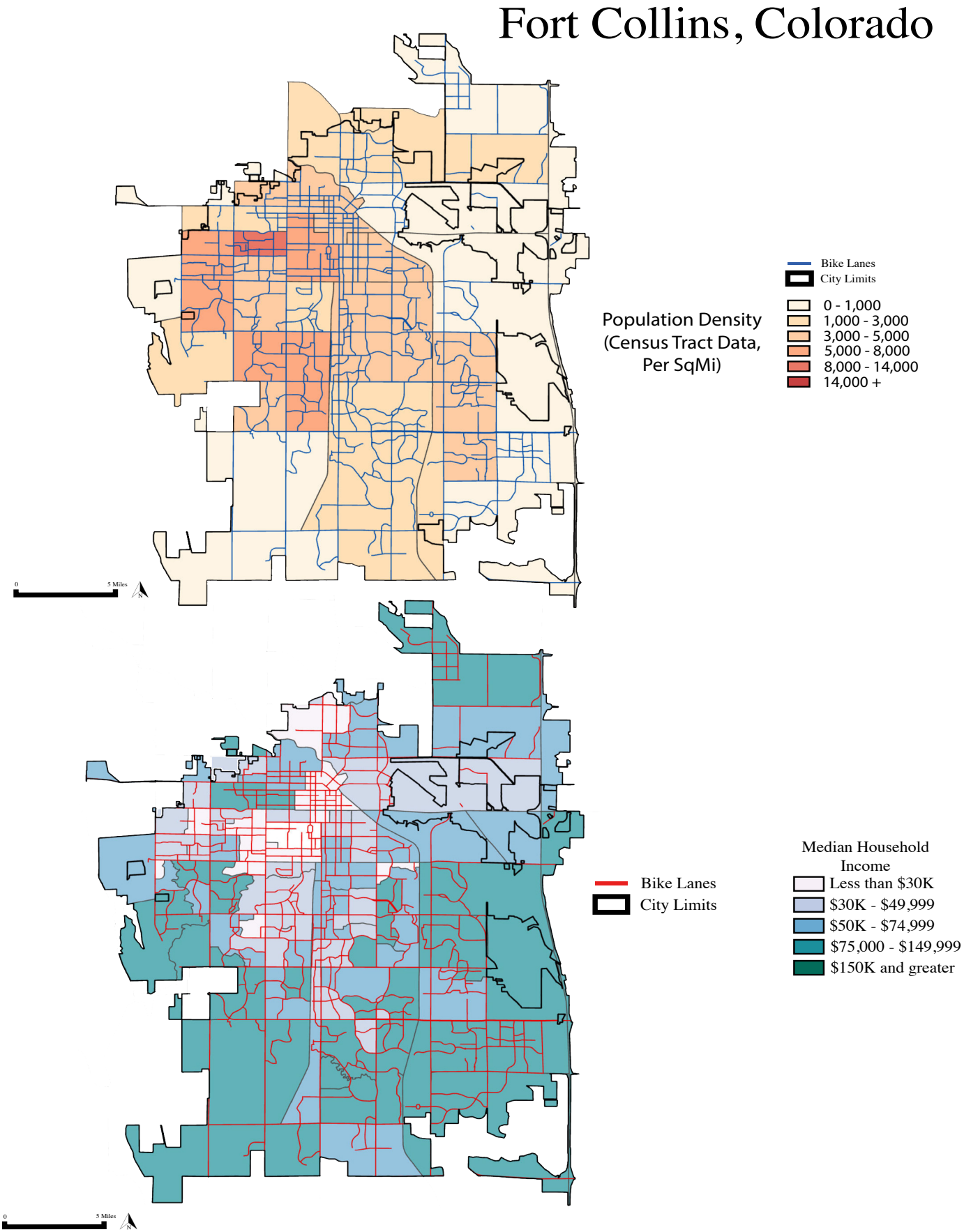

Figure 4.5: Infrastructure and Median Income Data, Population Density per Census Tracts in Fort Collins

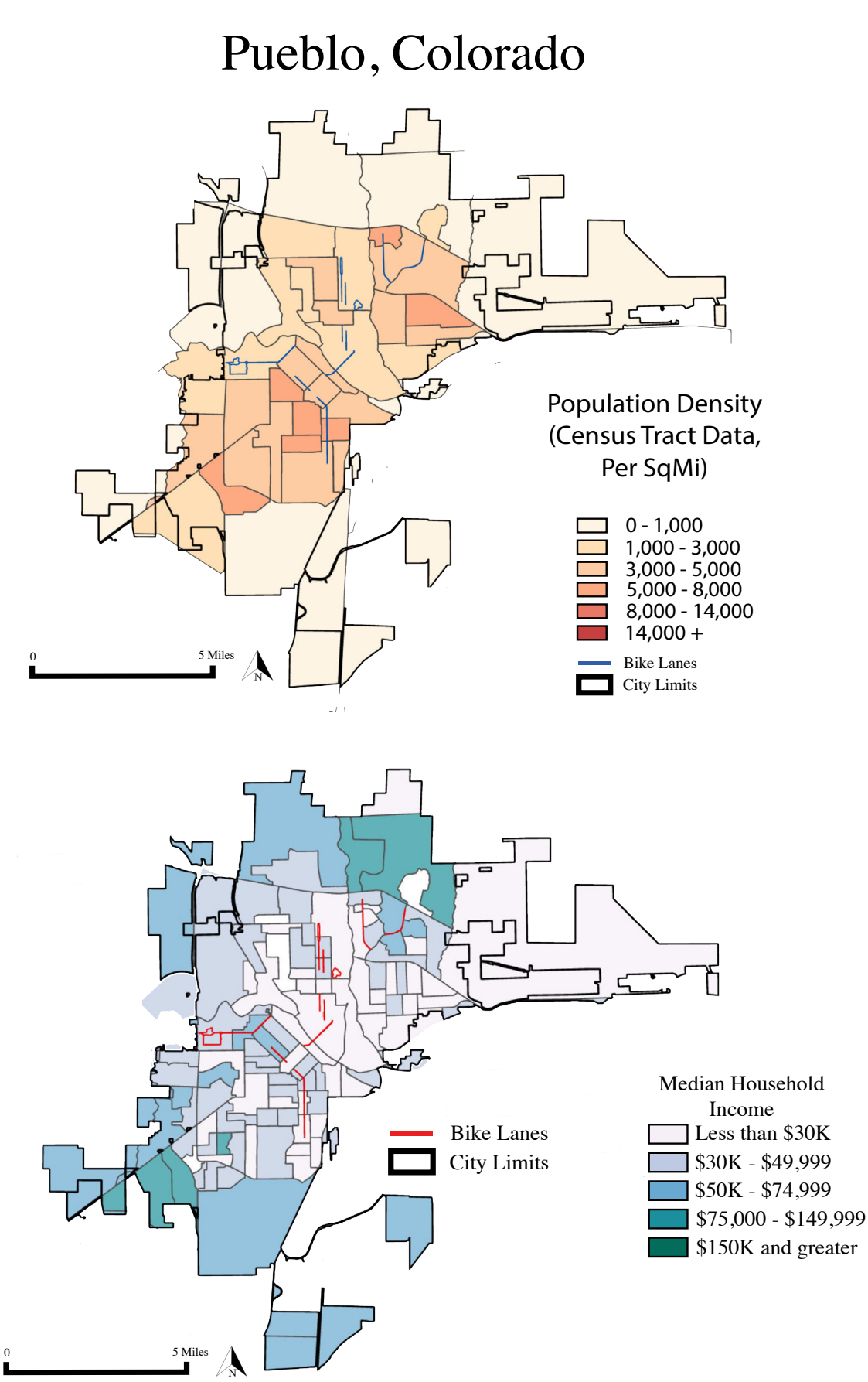

Figure 4.6: Infrastructure and Median Income Data, Population Density per Census Tracts in Pueblo

Similarly, the correlation between population density and biking infrastructure reveals that while higher-density areas in Denver and Boulder are prioritized for infrastructure expansion, lower-density neighborhoods often face connectivity gaps. A choropleth map displaying density in relation to infrastructure further underscores these patterns, showing that bike lanes are concentrated in denser, more politically active neighborhoods while suburban or historically underserved areas remain disconnected. In Fort Collins, spatial analysis has informed efforts to distribute infrastructure more equitably, but challenges persist in balancing demand with funding availability.

These spatial insights reinforce the need for data-driven decision-making in urban planning, ensuring that biking infrastructure investments serve diverse populations and contribute to a more accessible, multimodal transportation system.

4.3 Initial Observations

The results from interviews suggest that budgetary constraints and political will are the top factors that determine the implementation of biking infrastructure. The development of biking infrastructure across cities in Colorado's Front Range has been heavily influenced by economic and political factors. According to interviews, the extent to which cities can implement their bike plans depends not only on policy commitments but also on the availability of financial resources, the priorities of local governments, as well as active community engagement This section synthesizes the factors influencing the implementation of bike master plans based on interview results.

Key factors include the available budget and funding supporting biking infrastructure, the role of city government in shaping these networks, community engagement, and equity considerations, which are described in detail below.

Theme	Codes	Supporting Quotes
Funding & Resource Allocation	Budget constraints, grants, local tax revenue, maintenance costs	"Pueblo depends on grants, but applying for them is competitive, and we don't always have the resources to put together a strong application." — Pueblo Interview
	Competitive grant applications, financial limitations	"We can identify the gaps in the network, but actually closing those gaps requires funding, and that's always the biggest hurdle." — Denver Interview
Political Commitment	City leadership, policy priorities, multimodal investments	"Mayor Hancock's pledge to build 125 miles of bike lanes was ambitious, and we've seen progress. But actual implementation is often slowed by bureaucratic inefficiencies and inconsistent budget allocations." — Denver Interview
	Political influence on transportation planning	"In Boulder, political leadership has consistently supported biking infrastructure, integrating it into broader sustainability goals." — Boulder Interview
Community Engagement & Public Perception	Advocacy, public resistance, outreach efforts	"If constituents are being quiet about things or they're pushing back on the implementation of these bike plans, the elected officials are only going to act accordingly." — Boulder Interview
	Public awareness, engagement in planning	"We tried to engage more diverse communities, especially Spanish-speaking residents, but early engagement was crucial to ensure their voices were heard." — Fort Collins Interview
Equity & Accessibility	Infrastructure disparities, underserved communities, funding distribution	"We have grant criteria that talk about equitable distribution, but in reality, implementation depends on whether neighborhoods actively advocate for improvements." — Pueblo Interview
	Balancing equity with existing high-use areas	"Denver struggles to balance investments between high-demand biking areas like Cherry Creek and lower-income neighborhoods with infrastructure deficits." — Denver Interview
Car-Centric Culture & Resistance to Change	Automobile dependency, infrastructure priorities, complete streets pushback	"One of the struggles is some of our engineers—it's hard for them to grasp the idea of complete streets." — Pueblo Interview
	Cultural resistance to reducing road space for cars	"Many residents oppose bike lanes because they feel like parking and road space for cars is being taken away." — Denver Interview

Table 4.7: A Table Conveying Themes, Quotes, and Codes from Interviews

4.4 Funding Sources for Biking Infrastructure

According to interviews, the financial resources available to a city directly impact the extent and quality of its bike network. Biking infrastructure projects are funded through a mix of local, state, and federal grants, as well as private investments. While cities such as Boulder and Denver have successfully secured substantial funding for biking initiatives, smaller cities like Pueblo often face financial constraints that hinder large-scale infrastructure projects.

4.5 Local Funding and Budget Allocations

The interviews suggest that local funding sources play a crucial role in sustaining and expanding bike infrastructure. Cities allocate portions of their municipal budgets to transportation improvements, which may include dedicated funds for bike lanes, general infrastructure, and maintenance. In wealthier cities such as Boulder and Fort Collins, a greater emphasis is placed on multimodal transportation planning, ensuring consistent investment in biking infrastructure. These cities generate revenue through local sales taxes, transportation bonds, and impact fees levied on developers.

Interviewees from several cities highlighted that local government support and political will significantly shape a city's ability to maintain and expand its bike network:

"*If constituents are being quiet about things or they're pushing back on the implementation of these bike plans, the elected officials are only going to act accordingly***." — Boulder Interview**

"*We keep asking maintenance staff to do more with less funding. New infrastructure is harder to maintain, and yet, we haven't seen a significant increase in our funding***."**
— Fort Collins Interview

4.6 State and Federal Grants

According to interviews, state and federal grants supplement local funding and are often instrumental in expanding bike networks. Programs such as the Colorado Department of Transportation (CDOT) Multimodal Transportation and Mitigation Options Fund (MMOF) and the federal Transportation Alternatives Program (TAP) provide crucial financial support for cities. Denver and Boulder have been particularly successful in securing such grants, using them to fund protected bike lanes, wayfinding systems, and bike-sharing programs. However, interviewees in smaller cities noted that grant accessibility is a major challenge:

"*Pueblo depends on grants, but applying for them is competitive, and we don't always have the resources to put together a strong application. Even when we do, local matching funds are limited*." — Pueblo Interview

"*We can identify the gaps in the network, but actually closing those gaps requires funding, and that's always the biggest hurdle*." — Denver Interview

Challenges in Funding Implementation

Even when cities secure initial funding for infrastructure projects, maintenance remains an issue. Fort Collins, for example, has built a low-cost yet effective biking network by utilizing existing low-traffic streets and adding wayfinding signage to help cyclists navigate more easily. However, snow removal and long-term maintenance of separated bike lanes pose ongoing challenges:

"*We were able to bring some more funding for snow removal for biking and walking facilities with our last budget, but it's still not enough.*"
— Fort Collins Interview

Denver's budgeting-for-outcomes framework also presents complications. While external grants often cover initial construction, long-term improvements and maintenance frequently lack sufficient financial backing. A key informant noted:

"*Mayor Hancock's pledge to build 125 miles of bike lanes was ambitious, and we've seen progress. But actual implementation is often slowed by bureaucratic inefficiencies and inconsistent budget allocations.*"
— Denver Interview

Similarly, in Pueblo, grant funding provides critical financial support, but equity considerations do not always translate into real-world implementation:

"*We have grant criteria that talk about equitable distribution, but in reality, implementation depends on whether neighborhoods actively advocate for improvements*." — Pueblo Interview

Across all cities, funding has shown to be a central determinant of biking infrastructure development and maintenance. While larger cities with stronger multimodal planning cultures, such as Boulder and Denver, have secured steady investments, smaller municipalities struggle with competitive grant applications, political challenges, and maintenance funding gaps. The perspectives from interviewees reinforce the importance of sustained financial backing, not just for new infrastructure but also for ongoing upkeep and accessibility improvements.

4.7 Role Of Governance

The interviews suggest that political commitment at the city level plays a significant role in shaping the development and maintenance of biking infrastructure. Political commitment can be defined as the continued action of agencies and elected officials to fund, prioritize, and overall implement projects even when facing pushback (Kingdon 1984). In cities where local governments prioritize multimodal transportation and sustainability, biking networks tend to be more extensive and better integrated into urban planning efforts. This can be related to political commitment because cities such as Boulder and Fort Collins as they exemplify cities biking infrastructure is embedded in long-term urban planning strategies. City councils in these municipalities have consistently prioritized cycling as a key component of transportation and sustainability policies. Boulder, in particular, has committed to reducing car dependency through investments in biking and pedestrian infrastructure, aligning with broader environmental goals. Fort Collins has taken a similar approach, by integrating biking into transportation planning through dedicated funding, community engagement, and a Platinum-level designation as a Bicycle Friendly Community by the League of American Bicyclists. Continued commitment to prioritization of such initiatives can most definitely be connected to the notion that elected officials act on behalf of their constituents' interests which is seen in these two cities. Political will originates from community support, and can be engaged varying from access to basic needs or overall knowledge about the health and environmental benefits of biking. This aspect is seen through the Kingdon Framework because it can initiate the political and policy windows to move forward towards implementation.

According to the interviews, cities like Pueblo and Colorado Springs have historically prioritized automobile-centric infrastructure, often relegating biking infrastructure to a secondary concern. While both cities have bike plans, their implementation has been slower due to competing transportation priorities, limited political will, and community resistance.

In Pueblo, the process of integrating biking infrastructure has faced significant challenges. While efforts such as Pueblo Active Community Environment (PACE) have advocated for multimodal improvements, internal resistance within city departments has often slowed progress. Engineering staff have sometimes struggled with adopting a "Complete Streets" approach, leading to conflicts over how biking infrastructure should be incorporated into broader transportation plans. A "complete streets" approach is an urban design method that ensures all forms of transportation whether pedestrian, bike, or vehicle can travel safely and accessibly within infrastructure. Additionally, the city's reliance on state and federal grants for funding means that projects must navigate a competitive application process, further delaying implementation.

"*One of the struggles is some of our engineers—it's hard for them to grasp the idea of complete streets*." — Pueblo Interview

4.8 Community Pushback

Beyond institutional barriers, community pushback has also been a factor. Some residents of Pueblo question the need for bike lanes, arguing that road improvements should prioritize automobiles and parking. This sentiment has made it difficult for city leaders to fully commit to expanding Pueblo's bike network, despite the presence of a master plan. While equity considerations are included in grant criteria, the extent to which infrastructure projects reach underserved neighborhoods still depends on whether local advocacy efforts are strong enough to push them forward.

Meanwhile, Colorado Springs continues to face difficulties in integrating biking infrastructure into its transportation strategy. Despite growing interest in multimodal transportation, projects often take a backseat due to political resistance and competing budgetary demands.

Denver occupies a middle ground between cities like Boulder, which aggressively expanded biking infrastructure, and Pueblo, which has struggled with implementation. While Denver has made significant investments, it continues to balance the needs of cyclists and car commuters. The city's size and original car-centric layout contribute to this challenge.

Political support for biking infrastructure has fluctuated over time, shaping the pace of development. Under Mayor Michael Hancock, biking infrastructure saw notable expansion, especially after his 2018 pledge to build 125 miles of new bike lanes. This commitment led to major projects on Broadway and 14th Street, increasing annual funding for biking and pedestrian improvements to $20 million, up from less than $5 million in earlier years. Before Hancock, biking infrastructure received less political focus, despite the adoption of Denver Moves: Bikes in 2011. Funding was limited, and implementation was slow. While recent years have brought progress, political uncertainty remains a challenge.

According to interviews, new leadership could shift priorities, and backlash from businesses and drivers opposing bike lanes continues to create resistance. Denver's biking network depends on sustained political commitment and the ability to navigate competing transportation priorities. As the city grows, future investments in biking infrastructure will hinge on leadership decisions and public support for multimodal transit.

4.9 Community Engagement in Biking Infrastructure Development

According to interviews, community engagement processes play a crucial role in determining the success of biking infrastructure projects, particularly in cities where public support of biking is dividend and uncertain. In Boulder and Fort Collins, strong advocacy efforts for biking have made community support more effective, resulting in greater political buy-in and more consistent infrastructure investment. Fort Collins, in particular, has made significant efforts to engage underrepresented communities, including Spanish-speaking residents and youth, through targeted outreach programs.

Denver and Pueblo face greater challenges in community engagement, which plays a critical role in securing public support for biking infrastructure. In Denver, interviewees emphasized that effective engagement strategies must frame biking improvements in ways that resonate with the diverse needs of communities. Many lower-income neighborhoods prioritize basic infrastructure—such as sidewalks and transit access—over bike lanes, making it essential to align biking initiatives with broader mobility and safety goals to increase buy-in.

In Pueblo, community engagement is key to shifting public attitudes and influencing decision-makers. The city's informant stressed that education and awareness efforts are crucial, particularly for policymakers and engineers who may not fully grasp the benefits of complete streets initiatives. Active outreach and education can help counter misconceptions and demonstrate how biking infrastructure complements—not competes with—other transportation priorities.

Both cities highlight that early and inclusive community engagement can build trust, address concerns, and create a shared vision for multimodal transportation. When biking infrastructure is framed as a tool for equitable access, safety, and mobility, residents and policymakers are more likely to support its implementation. Pueblo has had challenges in community engagement with some of the negative discourse towards biking infrastructure coming internally from governmental officials. This has hindered the city's ability to continue to expand access to its network and reach out to its constituents regarding implementation of biking infrastructure.

4.10 The Role of the Equity Index in Infrastructure Planning

A final key theme that emerged across the interviews was the role of the equity index in shaping biking infrastructure priorities. Use of an equity index when creating an effective bicycle network is key for identifying disparities in the existing bicycle network, and distributing funding equally to ensure accessibility for biking infrastructure is met for all. This can sometimes delay the full extent of the master plan implementations, since cities only have so much funding for implementation and upkeep. These indexes can range from racial demographics to income levels or overall health. Fort Collins, for example, incorporates a Health Equity Index into its project evaluations, allowing planners to identify areas with the greatest need for improvements.

This allowed for Fort Collins to have an incredibly connected bicycle network, rightfully earning their platinum level rating from the League of American Bicyclists. The interviewee noted that while equity-based metrics guide decision-making, prioritization often requires balancing competing demands. Some projects focus on improving high-use infrastructure, where demand is already strong, to maximize impact. Others aim to expand access in underserved areas, where infrastructure is lacking but potential ridership is lower. This creates difficult trade-offs, as funding allocation must weigh the benefits of enhancing existing networks for current users against the need to build new connections that promote long-term accessibility.

Denver faces similar challenges, particularly in balancing investments between well-established biking neighborhoods such as River North and areas with significant infrastructure deficits like Federal Heights. Without such an equity index in place, large gaps in infrastructure implementation and access are incredibly apparent, especially with the use of GIS software. By using an equity index, cities can ensure a better connected network and more accessibility for residents to biking infrastructure.

The experiences of Pueblo and Colorado Springs illustrate the intersection of political will, institutional dynamics, and community perspectives in shaping biking infrastructure. While Pueblo faces internal resistance from city engineers and limited grant funding, Colorado Springs continues to grapple with political inertia and competing transportation priorities. These challenges highlight why, despite having bike master plans, both cities have struggled to achieve implementation at the scale seen in Boulder, Denver, and Fort Collins.

V. Discussion

The findings from this study highlight the critical interplay between political will, budgetary constraints, and community engagement in shaping biking infrastructure implementation across Colorado's Front Range. These factors are not isolated; rather, they function as interconnected components that influence the success or failure of bicycle master plans. This study confirms established frameworks regarding policy change while also contributing new insights into the limitations of implementing biking infrastructure. Additionally, the study identifies the growing role of equity indexes in transportation planning and acknowledges key limitations stemming from the research methodology.

The interviews revealed five key themes influencing biking infrastructure implementation across Colorado's Front Range. Funding and resource allocation determine the extent of infrastructure development, with cities like Boulder and Denver securing multimodal transportation funding through local taxes and grants, while Pueblo struggles with competitive applications and limited matching funds. Political commitment plays a crucial role, as Boulder and Fort Collins integrate biking into long-term sustainability plans, whereas Pueblo and Colorado Springs prioritize automobile infrastructure, slowing bike lane expansion. In Denver, political support has fluctuated, with Mayor Hancock's 2018 commitment to 125 miles of bike lanes marking a high point, but inconsistent budget allocations have hindered sustained progress. Community engagement influences public buy-in, with Boulder and Fort Collins benefiting from strong advocacy, while Pueblo faces resistance from residents and engineers unfamiliar with complete streets concepts. In lower-income neighborhoods, such as those in Denver and Pueblo, residents often prioritize sidewalks and transit over bike lanes, requiring strategic engagement to align biking projects with broader mobility needs.

Equity and accessibility considerations impact planning, as Fort Collins uses a Health Equity Index to direct infrastructure improvements, whereas Denver struggles to balance investments between well-connected areas like Cherry Creek and underserved neighborhoods like Federal Heights. Lastly, car-centric culture remains a major barrier to biking infrastructure adoption. In cities like Pueblo and Colorado Springs, automobiles are deeply ingrained in daily life, making residents resistant to changes that reduce road space for cars. Even in Denver, the backlash to new bike lanes often stems from frustration over lost parking and concerns about congestion. Overcoming these cultural barriers requires strong leadership and public education efforts to shift perceptions about multimodal transportation. Funding and politics emerged as key factors in the implementation of biking infrastructure, alongside the priorities and demands of constituents in each city.

5.1. Political Will, Budget, and Community Engagement in Policy Change

Kingdon's multiple streams framework (1984) offers a useful lens to analyze how biking infrastructure policies gain traction. According to Kingdon, policy windows open when the problem stream, policy stream, and political stream align. The findings from this study reflect this dynamic, demonstrating that cities with strong political support for biking infrastructure, such as Boulder and Fort Collins, tend to have more developed networks. This aligns with prior research showing that political champions can be crucial in advancing multimodal transportation initiatives (Pucher & Buehler, 2008).

However, political support for biking infrastructure does not emerge in isolation—it is driven by public attitudes and priorities. Since biking is often considered a secondary need compared to pressing concerns like housing or public safety, political will may strengthen when broader societal conditions allow. When communities have their basic needs met, they may be more inclined to support biking initiatives, particularly when they are informed about the benefits of active transportation. Public awareness campaigns, advocacy efforts, and exposure to successful biking infrastructure in peer cities can all contribute to shifting public sentiment, ultimately fostering the political momentum necessary for policy change.

Political will alone is insufficient. As Ostrom's Institutional Analysis and Development (IAD) framework (1990) suggests, policy implementation depends on the interactions between various stakeholders, including city officials, advocacy groups, and residents. Even when political leaders express support for biking infrastructure, successful implementation requires coordination across institutions, clear governance structures, and sustained public engagement. Advocacy groups play a crucial role in keeping biking infrastructure on the policy agenda, while city officials must navigate bureaucratic processes and secure funding. Meanwhile, residents' acceptance and use of biking infrastructure influences long-term success, reinforcing the need for inclusive decision-making and community buy-in.

Budget constraints further complicate these dynamics. The literature suggests that wealthier municipalities are more likely to invest in biking infrastructure (Piatkowski et al., 2014), a finding echoed in this study. Boulder and Denver, which have more robust funding streams through local taxes, transportation bonds, and grants, have been able to sustain and expand their biking networks. Conversely, cities like Pueblo struggle to secure funding, particularly due to the competitive nature of state and federal grants. This supports prior research indicating that disparities in funding can exacerbate inequities in transportation access (Hersey, 2016).

Community engagement serves as the third pillar influencing implementation. The study findings highlight the importance of public buy-in in shaping infrastructure priorities. In Fort Collins and Boulder, where strong cycling advocacy networks exist, local governments have responded with sustained investment. This aligns with the literature on the role of grassroots movements in driving urban planning initiatives (Aldred et al., 2016). Meanwhile, in Pueblo, a lack of advocacy and resistance from some community members has hindered progress, demonstrating how political will and financial resources must be complemented by community support to achieve successful implementation.

Importantly, community engagement not only facilitates implementation but also reinforces political will. When residents actively participate in advocacy efforts, they increase social capital by building trust, strengthening networks, and fostering a shared sense of purpose. Public awareness campaigns and grassroots organizing efforts help educate communities on the benefits of biking infrastructure, shifting public opinion and generating demand for policy action. As more residents voice their support, elected officials may feel greater pressure—or gain more confidence—to champion biking infrastructure, illustrating how political will is not static but shaped by ongoing civic engagement.

5.2. The Role of Equity Indexes in Infrastructure Planning

An emerging theme in this study is the role of equity indexes in guiding infrastructure development. Equity indexes—metrics that assess disparities in transportation access based on factors like income, race, and health—are increasingly used to prioritize investments in underserved areas. Fort Collins, for example, employs a Health Equity Index to identify high-need areas, ensuring that funding is allocated where it can have the greatest impact. This practice aligns with previous research suggesting that targeted investments can improve mobility for historically marginalized communities (Pucher et al., 2010).

The study also reveals tensions in balancing equity-driven planning with political and budgetary realities. While equity considerations are often included in grant criteria, interviewees noted that actual implementation still depends on local advocacy and political will. This reflects broader debates in transportation literature regarding the effectiveness of equity frameworks in practice (Piatkowski et al., 2014). Without sustained financial backing and political commitment, equity-based metrics may struggle to translate into tangible infrastructure improvements.

5.3. Study Limitations

While this study provides valuable insights into the factors influencing biking infrastructure implementation, several limitations must be acknowledged. First, the research relied exclusively on interviews with city planners and officials, which may have introduced a bias in perspectives. Individuals directly involved in infrastructure planning may have emphasized institutional and budgetary constraints while underrepresenting grassroots perspectives, such as those of cyclists or underserved communities which might not share the same extensive knowledge on the matter. Future research could address this limitation by incorporating a broader range of stakeholders, including local advocacy groups and residents.

Second, the study's geographic focus on Colorado's Front Range limits the generalizability of findings to other regions. While the cities examined vary in size and political culture, they share similar geographic and economic contexts that may not be representative of broader national trends. Research examining biking infrastructure implementation in different regions, particularly in rural or high-density urban areas, could offer comparative insights.

Finally, while the study draws connections between political will, budgetary constraints, and community engagement, it does not establish causal relationships. Future research could employ quantitative methods, such as regression analysis, to measure the relative impact of each factor on infrastructure development. Additionally, longitudinal studies could track changes in biking infrastructure over time, providing a more dynamic understanding of how policy decisions evolve.

VI. Conclusion & Recommendations

The findings from this study reaffirm the conclusions of previous research while offering new insights into the practical barriers to biking infrastructure implementation. Kingdon's and Ostrom's frameworks remain useful in explaining the complex interplay between political will, policy constraints, and stakeholder engagement. However, this study also highlights the evolving role of equity indexes in transportation planning, demonstrating their potential to guide investment in underserved communities while also exposing challenges in their implementation.

Ultimately, the study underscores the need for sustained political commitment, adequate funding, and robust community advocacy to ensure the successful realization of bicycle master plans. Cities that have managed to integrate these elements, such as Boulder and Fort Collins, serve as models for other municipalities seeking to enhance their biking networks. Addressing the limitations of this research through broader stakeholder engagement and quantitative analysis could further refine our understanding of how to create more equitable and sustainable urban transportation systems.

Based on the findings, the following recommendations are proposed to enhance biking infrastructure implementation across Colorado's Front Range. Cities should utilize spatial analysis using Geographic Information Systems (GIS) or other similar programs to map existing biking infrastructure alongside demographic data to identify gaps in the network and ensure equitable distribution of new investments. By mapping, the gaps in network connectivity and overall infrastructure access become incredibly apparent. The use of spatial analysis software will ensure accurate, up-to-date information that can be easily viewed and modified as needed.

Expanding community engagement efforts is also crucial. The ideas community engagement should focus on making participation accessible to residents of all backgrounds and languages, ensuring that diverse perspectives are included in decision-making processes. It's always recommended to use online platforms and GIS participatory methods to increase access to community members who cannot attend the events in person due to disabilities or distance.

Possibly the most important recommendation is establishing a designated and secure funding source for the implementation of biking master plans. There are several creative ways for this revenue to be generated such as transportation sales taxes, development impact fees, or even the implementation of a Tax Increment Financing program (TIF) will help secure long-term financial support for biking infrastructure. Colorado Springs' use of a flat rate tax on all bicycles has proved to be successful and is something other cities can most definitely benefit from. It is evident for all cities that even having a budget for implementation isn't enough as they need to secure money for maintenance and routine upkeep.

The findings of this research highlight financial resources, political commitment, and community engagement as key determinants of biking infrastructure development. Cities with dedicated funding sources, such as transportation bonds and multimodal investment funds, are better equipped to sustain long-term investments, while reliance on competitive grants poses challenges for smaller municipalities. Political will shapes infrastructure priorities, with cities like Boulder and Fort Collins demonstrating strong, continuous support for multimodal transportation, whereas Pueblo and Colorado Springs tend to deprioritize biking in favor of automobile-centric development.

Community engagement plays a crucial role in influencing political support, as seen in Boulder and Fort Collins, where strong advocacy networks and multilingual outreach efforts have bolstered public participation and policy action. Meanwhile, in cities with limited pedestrian infrastructure, such as parts of Denver, biking infrastructure often takes a backseat to more immediate public facility needs. Additionally, while equity indexes are designed to guide transportation investments in underserved areas, their application remains inconsistent, with some cities effectively incorporating them into planning processes while others struggle due to financial and political constraints.

Additionally, continued collaboration with local advocacy groups will ensure that community needs and priorities are consistently reflected in policy decisions and infrastructure implementation. Strengthening these approaches will create a more inclusive, well-connected, and sustainable biking network across the region.

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Appendix

Consent Form for Interviews

Consent to Participate in Interview for Research Study

You have been asked to participate in a focus group held by Connor Chancey, Environmental Design Program, University of Colorado, Boulder. The purpose of this study is to try and understand the factors limiting the implementation of bicycle infrastructure in 5 identified key Colorado cities.

The interview will last for 30 minutes. About 5 people will participate in this research study.

There are no right or wrong answers to the interview. We want to hear many different viewpoints and would like to hear from everyone. We hope you can be honest even when your responses may not be in agreement with the rest of the group.

In respect for each other, we ask that only one individual speaks at a time in the group and that responses made by all participants be kept confidential.

You can choose whether or not to participate in the interview and stop at any time. Although the interview will be video recorded with your permission, your responses will remain anonymous and no names will be mentioned in the report. The recorded video will be transcribed and used by the research team for the purpose of this research and will not be shared with other people other than Connor Chancey.

If you have any questions, concerns or complaints about the interview, you can email Connor Chancey at connor.chancey@colorado.edu.

You need to state your consent to attend this interview.

Introduction:
Cities are increasingly prioritizing the development of walkable, pedestrian, and bicycle-friendly environments. Many have created and adopted standards and plans that incorporate significant pedestrian and bicycle elements. However, despite the proliferation of these plans, their implementation often stalls. Additionally, there is a noticeable discrepancy in the amount of biking infrastructure available across different cities, as well as an inequitable distribution of such infrastructure among neighborhoods. This study explores the factors that influence the implementation of bike master plans and the creation of bicycle-friendly communities.

Interview Questions

Objectives: Building on the introduction, the objectives of this bicycle project are to:

- **Understand** how municipalities develop and implement strategies to create bike-friendly communities.
- **Examine** the role of master plans in fostering bikeable environments and promoting equitable infrastructure.
- **Investigate** what proportion of action items in master plans remain unimplemented and identify the underlying reasons.
- **Investigate** the underlying factors contributing to inequitable distribution of biking infrastructure in cities.

Questions:
Could you share the story of bikeability in your city? What significant successes has your city achieved over the past 5 to 15 years in creating a bike-friendly community?

How would you evaluate the role of the Bike Master Plan in achieving the goal of creating a bikeable community in Fort Collins? What factors have influenced the implementation of the Bike Master Plan?

How does the Bike Master Plan address the equitable distribution of biking infrastructure across different neighborhoods in Fort Collins? What challenges or successes have you experienced in ensuring equity during implementation?

What lessons have you learned going through the processes of development and implementation of your bike plan?

Is there anything else you would like to share about developing equitable biking infrastructure within communities?

Thank you very much for accepting to take part in this interview.