Pueblos Bicicleteros: Three Essays on Cycling Policy in Mexican Cities

Rebeca Cecilia de Buen Kalman

A dissertation

submitted in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

University of Washington

2021

Reading Committee:

Alison Cullen, Chair

Ann Bostrom

Don MacKenzie

Program Authorized to Offer Degree:

Public Policy and Management

University of Washington

Abstract

Pueblos Bicicleteros: Three Essays on Cycling Policy in Mexican Cities

Rebeca Cecilia de Buen Kalman

Chair of the Supervisory Committee:
Professor Alison C. Cullen
Daniel J. Evans School of Public Policy and Governance

In this dissertation, I investigate cycling policy adoption, design, and implementation in Mexico. In Chapter 2, I research the interactions between driving restrictions and bikeshare usage in Mexico City. The Mexico City government has introduced policies to reduce pollution from cars, including a license-plate based driving restriction and a bikeshare system. When restrictions are in place, people need to find transportation alternatives. In this research, I leverage the random nature of driving restrictions to explore whether people use bikeshare differently when driving is restricted due to poor air quality. I use negative binomial models to study these effects using data from 2016-2019. Results indicate that restricted days exhibit approximately 17% lower bikeshare use (10 - 24% decrease, 95% CI) for non-peak traffic hours compared to regular days. However, ridership

increases during peak traffic hours. Morning ridership increases up to 12.5% (3 – 22% increase, 95% CI) and evening ridership increases up to 16.2% (5 – 27.6% increase, 95% CI). The analysis suggests that the poor environmental conditions may buffer bikeshare system use increases and that bikeshare can be a critical partner in local transportation infrastructure.

In Chapter 3, I researched cycling infrastructure implementation in ten cities in Mexico using a multiple case study research design and thematic analysis. The questions motivating this research were: *What is the role of civil society organizations in the process of infrastructure delivery? Why and how do governments implement cycling infrastructure?* In the first part of this chapter, I analyzed the role CSOs have played in developing cycling infrastructure in Mexican Cities. While the presence or activity of civil society organizations did not guarantee the implementation of cycling infrastructure, this research demonstrated that in most settings, CSOs are not only actively involved in every aspect of infrastructure provision and its institutionalization as a governmental activity but represent an essential presence in ensuring progress and the professionalization of infrastructure design. In the second part of chapter 3, I studied how infrastructure is implemented in each city included in this study: Cuernavaca, Toluca, Oaxaca, Mérida, Aguascalientes, Querétaro, Morelia, León, Puebla, and Guadalajara. I studied the primary laws, organizations, and planning instruments and norms that cities have used to implement cycling infrastructure and policy successfully. I found that high-level mandates in state laws on their own make very little difference in terms of making progress on the ground both for kilometers of infrastructure implemented and its quality. Lack of laws can be a barrier, for example, for garnering funds to build infrastructure, limiting or slowing down the ability to implement projects, but this is not always the case. Specialized agencies (Municipal Mobility Offices and State Mobility Agencies) containing non-motorized mobility departments have proven to be one of the

most important variables promoting the implementation of cycling infrastructure. The agencies responsible for designing and implementing projects are critical for sustaining cycling infrastructure planning and implementation.

Finally, in Chapter 4, I studied the institutionalization of cycling policy in Guadalajara. Over the past 20 years, Guadalajara Jalisco has gone from being a city with few cyclists and no public policy or funding to support cycling as a transportation mode to a nationally and internationally recognized city for its work in advancing cycling mobility. The research questions guiding this case study are: *what were the main factors and events that have led Guadalajara to adopt and implement policies to promote cycling mobility? What is the story behind Guadalajara's adoption and implementation of cycling policy? What evidence exists about the success of these policies?* In this paper, I analyzed the process that led to this urban and institutional transformation of Guadalajara. This analysis identifies the actors and events that have made Guadalajara a reference as a cycling city and presents salient evidence on the impact of these programs. I demonstrate how local actors built a strong, diverse, and highly media driven movement to mobilize sustainable transportation as a new policy issue and successfully pushed for its gradual institutionalization as a core part of Guadalajara's metropolitan urban planning agenda.

TABLE OF CONTENTS

List of Figures iii

List of Tables vi

Chapter 1. introduction 1

1.1 References 10

Chapter 2. Can't Drive today? The impact of driving restrictions on bikeshare ridership in Mexico City 15

2.1 Introduction 15

2.2 Background 16

2.2.1 Local policy context 17

2.2.2 Driving restrictions 19

2.2.3 Bikeshare 21

2.2.4 Pollution warnings 22

2.2.5 Health tradeoffs 23

2.3 Methods 24

2.3.1 Data 25

2.3.2 Dependent variable 26

2.3.3 Independent variables 27

2.3.4 Analysis 29

2.4 Results 32
2.5 Discussion 35
2.6 Conclusion 38
2.7 Appendix 1 40
2.8 Appendix 2 42
2.9 References 46

Chapter 3. Streets for people, not cars: social processes and institutions for cycling infrastructure in mexico 52

3.1 Introduction 52
3.2 Literature review and Hypotheses 54
3.2.1 Infrastructure planning and implementation as cycling policy 55
3.2.2 Cycling infrastructure planning and implementation 57
3.2.3 Defining quality attributes of cycling infrastructure 58
3.2.4 Theoretical discussions surrounding cycling infrastructure 61
3.2.5 Factors affecting cycling planning and implementation 64
3.2.6 Hypotheses 70
3.3 Methods 71
3.3.1 Case selection 72
3.3.2 Participant selection 80
3.3.3 Data Collection 80
3.3.4 Data analysis 82
3.4 Results and discussion part 1: The Role of Civil Society Organizations in the implementation of cycling infrastructure in Mexican Cities 85

3.4.1 Civil society organizations advocating for cycling mobility in Mexico 89
3.4.2 Phases of infrastructure provision 90
3.4.3 Influence of CSOs on infrastructure development 92
3.4.4 Part 1 Conclusion: The role of CSOs in cycling infrastructure provision in Mexican municipalities 120
3.5 Results and discussion part 2: Implementation of cycling infrastructure in Mexican Cities 124
3.5.1 Organizations and institutions 125
3.5.2 State-level laws 125
3.5.3 Implementing agencies 129
3.5.4 Municipal Planning Agencies 130
3.5.5 Municipal Mobility Offices 131
3.5.6 Public Works Departents 132
3.5.7 State-level agencies 133
3.5.8 Cycling infrastructure policies and programs 133
3.5.9 Cycling infrastructure implementation in Mexican cities 136
3.5.10 Part 2 Conclusion: factors affecting the implementation of cycling infrastructure in Mexican Cities 187
3.6 Appendix 1. Interview protocol 197
3.7 Appendix 2 Coding scheme 199
3.8 References 202
Chapter 4. From expressWays to Bikeways: How Guadalajara institutionalized cycling as public policy 214

4.1 Introduction 214
4.2 The role of civil society organizations in the institutionalization of cycling policy 217
4.3 Methods 219
4.4 Local setting 222
4.5 Results and discussion 226
4.5.1 Cycling precedents: Cycling in Guadalajara before 2004 226
4.5.2 2004-2007 Guadalajara's Vía RecreActiva and Bogotá Learning Tours 230
4.5.3 2007 - 2012 Grassroots organizations and mobilization: Ciudad para todos, CITA, GDL en Bici, Colectivo Ecologista de Jalisco 235
4.5.4 2013 – 2020 Institutions for non-motorized mobility planning, cycling policy consolidated 248
4.5.5 Current state of cycling in Guadalajara 255
4.6 Conclusions 260
4.7 Appendix: Live archive of Guadalajara's social movement "Cities for all" 264
4.8 References 264
Chapter 5. Conclusion 271

LIST OF FIGURES

Figure 1. Data collection and manipulation process 26
Figure 2. Negative binomial model results for hourly departures on contingency and normal days. 33
Figure 3. Negative binomial GAM model results for hourly departures on contingency and normal days. 34
Figure 4. Negative binomial interaction model predicting hourly departures for varying levels of ozone on contingency days and non-contingency days. 35
Figure 5. Average pollution on contingency days and non-contingency days. Peak ecobici use hours are shaded. 37
Figure 6. Location of selected municipalities 75
Figure 7. Trips to school and work by bike in the selected municipalities 79
Figure 8. Data collection timeline (January to December 2020) 82
Figure 9. Field interviews by site and by sector of participant 84
Figure 10. Citizen cycling lane during 2012 Bicired National Cycling Conference (photos by Claudina de Gyves) 97
Figure 11. Plan Maestro de Ciclovías de Oaxaca developed by Casa de la Ciudad (Casa de la Ciudad, 2017) 100
Figure 12. Examples of Observatorio de Movilidad Sostenible de Mérida's audit of the Circuito Sur cycling infrastructure project (Monsreal, 2018). 106
Figure 13. Activists and government officials socialize the cycling lane on Avenida 4 Poniente in Puebla (Photos by Fernando Valerdi) 109
Figure 14. Cyclists stage a protest to educate divers. "The cycling lane is not for parking" . Photo by Salomon Gomez 111
Figure 15. "Rescue the San Juanito Cycling Lane". (Image by Salomón Gómez). 112
Figure 16. Members of UCIQ repaint a cycling lane lost through maintenance work (Photo from UCIQ archive). 113

Figure 17. Process for implementing cycling infrastructure in Toluca 139
Figure 18. Evolution of cycling infrastructure in Toluca 141
Figure 19. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Toluca and supporting institutions 142
Figure 20. Processes for implementing cycling infrastructure in Oaxaca 145
Figure 21. Evolution of cycling infrastructure in Oaxaca..... 146
Figure 22. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Oaxaca and supporting institutions. 147
Figure 23. Processes for implementing cycling infrastructure in Aguascalientes 150
Figure 24. Evolution of cycling infrastructure in Aguascalientes 153
Figure 25. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Aguascalientes and supporting institutions. 154
Figure 26. Process for implementing infrastructure in Querétaro 157
Figure 27. Evolution of cycling infrastructure in Querétaro..... 159
Figure 28. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Querétaro and supporting institutions. 160
Figure 29. Processes for implementing cycling infrastructure in Mérida..... 164
Figure 30. Evolution of cycling infrastructure in Mérida 165
Figure 31. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Mérida and supporting institutions. 166
Figure 32. Process for implementing cycling infrastructure in Morelia 168
Figure 33. Evolution of cycling infrastructure in Morelia 170
Figure 34. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Morelia and supporting institutions. 171
Figure 35. Infrastructure implementation process in León 174
Figure 36. Evolution of cycling infrastructure in León 176
Figure 37. Process for implementing cycling infrastructure in Puebla..... 180
Figure 38. Evolution of cycling infrastructure in Puebla..... 181
Figure 39. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Puebla and supporting institutions. 182
Figure 40. Process for implementing cycling infrastructure in Guadalajara 184

Figure 41. Evolution of cycling infrastructure in Guadalajara 185
Figure 42. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Guadalajara and supporting institutions..... 186
Figure 43. Location of Guadalajara, Jalisco 223
Figure 44. Guadalajara Metropolitan Area and urban core 224
Figure 45. Early precedents timeline (1970-2003) 227
Figure 46. Bikes prohibited from the City Center and Family cycling events from the 1970s 228
Figure 47. Via RecreActiva accross Guadalajara Metropolitan Area Municipalities 233
Figure 48. Should the bikeway on Marcelino Barragan stay? 252
Figure 49. Key activism, policy and institutional milestones and events during the study period 254
Figure 50. % of School trips and work trips done by bike in each municipality of the GMA 257
Figure 51. Evolution of cycling infrastructure in the Guadalajara Metropolitan area.... 258
Figure 52. Growth of the MiBici Bikeshare system 259

LIST OF TABLES

Table 1. Descriptive statistics of key variables. The unit of analysis is one hour. 28
Table 2. Effect sizes as rate ratios for selected times of day with 95% 33
Table 3. Variables included each model run to estimate the effect of contingency days on bikeshare ridership. Shaded areas indicate the models included in the discussion... 40
Table 4. Variables included each model run to estimate the effect of pollution on bikeshare ridership. Shaded areas indicate the models included in the discussion. 41
Table 5. Results for the negative binomial model predicting hourly departures 42
Table 6. Results for the negative binomial GAM model predicting hourly departures.... 44
Table 7. Results for the negative binomial pollution interaction model predicting hourly departures 45
Table 8. Anaya-Boig (2021b) Integrated cycling policy framework..... 56
Table 9. Types of bikeways 57
Table 10. Types of non-governmental actors in cycling mobility advocacy..... 69
Table 11. Sampling Frame 74
Table 12. Population trends, area, and GDP comparison across selected cities 76
Table 13. Comparison of weather and topography across cases 77
Table 14. Comparison of vehicle fleets and safety metrics across cases..... 78
Table 15. Leading cycling CSOs in cities studied 90
Table 16. Broad phases of cycling infrastructure development..... 92
Table 17. Successful engagement of CSOs in infrastructure promotion and development across cities 123
Table 18. General comparison of state laws that include cycling..... 128
Table 19. Organizations, institutions, and instruments for developing cycling infrastructure 135
Table 20. Case groupings for discussion 137
Table 21. Variables affecting implementation derived from literature..... 199

Table 22. Infrastructure quality attributes 200
Table 23. Infrastructure planning process 200
Table 24. Other variables that affect cycling 201
Table 25. List of interviewees and data contacts and their roles 221
Table 26. Governernatorial candidate proposals for non-motorized mobility 247

ACKNOWLEDGEMENTS

I would like to thank my advisor and chair, Alison Cullen. Alison has been a fantastic mentor and a steady presence and source of support for the last six years. I would also like to thank my dissertation committee, Ann Bostrom, Don MacKenzie, and Juilian Marshall for their insight and guidance. A special thanks to Don, who facilitated the funding and relationship with the Toyota Mobility Foundation that made this research possible, and who has been incredibly patient and generous with me as I navigated planning and conducting field research for the first time. I would also like to thank Ann for her dedication and support as our PhD program coordinator during my six years at the Evans School.

A very warm thank you to Kelly Husted, Austin Sell, Emily Finchum, Kate Crosman, Charles Lanfear, Ben Brunjes, Grant Blume, Michele Cadigan, and Judy Kalman for their feedback on my research and support in preparing for my dissertation defense. Also to Carrie Evans, Kole Katner, and all of the excellent staff at the Evans school, you are the glue that holds our department together.

I would like to thank Benjamin de Buen for his help translating many of the interview excerpts found in this text, Marcela Vazquez and Liz Mejorada, for helping with locating and varifying data points and providing support while submitting public information requests. This work would not have been possible without the participation of over 100 activists and practitioners who took the time to talk to me and share their insight and experience promoting and implementing cycling policy. Finally, I would like to thank William Chernicoff from the Toyota Mobility Foundation for the support and the independence granted during the development of this research.

Support for this research came from the Toyota Mobility Foundation. Any opinions expressed in this work are those of the author and should not be attributed to any other entity. Any errors are the author's sole responsibility.

On a personal note, I would like to give a very special thanks to Chuck, my mom, dad, brother, and friends for lifting my spirits throughout the process. I also would like to thank David Kalman and Cecilie Hudson for taking care of me and being like my parents for the last six years, and Kelly Husted, who has been my dearest friend during this PhD program and whose emotional and logistical support has been critical for me to get this work done. Finally, a huge thanks to Serena Perez and León Valencia for their friendship and support to keep my parents safe and me sane during the most challenging months of the pandemic.

DEDICATION

This dissertation was researched and written throughout 2020 and 2021. During this time, we experienced a global pandemic, unprecedented social unrest, and increasingly common environmental catastrophes, which evidenced so much of the systematic injustice built into every aspect of the social world.

I dedicate this work to everyone fighting the good fight to make cities places of opportunity for more people, with an honorable mention for my mom, dad and brother, whose encouragement, support, and vision of a possible better world kept me going in spite of it all.

Chapter 1. INTRODUCTION

Pueblo Bicicletero is a common derogatory term in the Mexican lexicon used to describe underdeveloped towns implying that people cannot afford cars and" have no choice" but to bike for mobility. This term signals the historical stigma attached to cycling mobility as an indication of poverty and lack of development. Even though cyclists have existed in Mexico for over 150 years, many Mexican cities have long-standing local cycling 'cultures,' and only recently have cyclists become a target group for public policy. For many years, this mode did not factor into city planning or infrastructure provision, laws did not name cyclists, and few to no public resources were invested in improving cycling conditions.

Over the last 20 years, however, as cycling has been positioned on the public agenda in Mexican Cities as an environmentally friendly, healthy, and efficient mode of transportation, cycling advocates have reclaimed the term, *Pueblo Bicicletero,* inclusively and as a sign of pride. An increasing number of cities have begun to implement various programs to promote and improve cycling mobility, with varying degrees of commitment and success. In this dissertation, I explore some of the key local processes that drive uptake and implementation of policies to support cycling in cities across Mexico and critically analyze the effect of driving restrictions and pollution warnings on bikeshare use in Mexico City.

Contrary to the perceptions of bicycles indicating lack of opportunity, access or development, major cities around the world have renewed their interest in cycling mobility. Cycling culture from European cities like Amsterdam and Copenhagen is touted as a sign of

progress and environmentally sustainable commitment. The increased interest in cycling occurs within a context of many intersecting phenomena surrounding the demand and supply of mobility in cities around the world. First, the combination of population growth, economic growth and urbanization are increasing the demand for urban transportation services. By 2050, roughly 70 percent of the world's population is projected to concentrate in urban areas (UN, 2014). In addition, economic growth associated with more than two billion people entering the middle class is anticipated within the same timeframe.

Urban transportation, and especially car travel, is associated with externalities such as deteriorating air-quality, noise, CO_2 emissions, and congestion. Transportation in urban areas accounted for 2,300 megatons of CO_2 in 2010, which translates to one-quarter of carbon emissions from all parts of the transportation sector, and contributes 22-25 percent of global carbon emissions. Without changes in investments and policy, these emissions are likely to double by 2050 (Replogle and Fulton, 2014). Fulfilling the mobility needs of growing urban populations will require innovative solutions, as existing urban infrastructure and the saturated environment will not be able to support an increase in vehicles on the road if people continue to rely on cars, and motorization continues to grow in accordance with past trends.

Motorized transportation is also a contributor to deteriorating health and loss of productivity. The World Health Organization estimated that seven million premature deaths were attributable to air pollution in 2014, a significant portion of which are the result of motorized urban transportation. Traffic crashes claim more than 1.2 million lives globally every year and are on track to be the fifth-leading cause of death by 2030 (WRI, 2015). In the United States, commuters waste 4.8 billion hours in traffic each year, translating to $101 billion in lost economic productivity (WRI, 2015). Therefore, creating an appropriate supply of mobility

services will be constrained by an increasing need to mitigate the environmental and health impact of transportation systems primarily centered around automobiles and their drivers.

The conventional planning paradigm assumes that the objective of transport is to maximize convenience, travel speed, and distance. However, there has been a progressive shift in thought in transport policy formulation and in the attributes of desirable transportation systems. Currently, the relevance of characteristics such as system reliability, low environmental impact, accessibility and equity have been applied to build a new concept of mobility which recognizes additional costs from increased motorized transportation and more benefits from walking, cycling and public transport (Banister, 2008; OECD, 2015). This new paradigm also acknowledges that mobility is seldom an end in itself, and that the ultimate goal of most transport activity is accessibility, which refers to people's overall ability to reach desired services and activities (Litman, 2012).

Civil society organizations and governments have tried to position the bicycle as the solution to a variety of urban policy problems including congestion, pollution, obesity, increased mobility needs, among others. The scholarly literature supports many of these beliefs about cycling. Cycling is environmentally benign and healthy. There is an existing and growing body of research on the health impacts of bicycling (Bassett et al., 2008; Hamer 2008). This research studies a variety of health outcomes such as obesity rates, cardiovascular health, and morbidity. The health benefits due to physical activity have been found to be more significant than the health risks caused by increases in exposure to air pollution (Tainio et al., 2016; Woodcock et al., 2014; de Hartog et al., 2010) although these may vary across gender and age groups (Woodcock et al., 2014). These studies also indicate that health benefits outweigh risks from traffic injuries, contradicting the common misperception that cycling is dangerous. Furthermore, injury rates are

observed to fall as cycling rates increase, making bicycling safer and providing more significant health benefits (Elvik, 2009).

Despite the promotion of public transport by many cities, this mode continues to lose market share to private vehicles in developing countries. Developed countries, on the other hand, have succeeded in slowing down the trend towards greater reliance on private cars by expanding public transport networks but have been unable to stop or reverse the growth in private vehicle use (OECD, 2015). However, there is mounting evidence that younger generations are more environmentally conscious and inclined toward shared and multi-modal transportation when these are available. Recent observed trends in travel behavior among the millennial generation demonstrate that they are willing and motivated to drive less (Davis et al., 2012, as revised by Faghih-Imani, 2014). Therefore, there appears to be a window of opportunity for providing and encouraging different forms of travel in urban populations.

There is also evidence from travel-behavior data that reveals an opportunity to reduce car use for short trips, especially in core urban areas. For example, in the United States, about 37.6% of private-vehicle and 73.6% of bicycle trips are less than two miles long (Faghih-Imani and Eluru, 2017). Replacing a proportion of the shorter car trips with bicycle trips could bring substantial benefits to individuals, cities, and the environment (Woodcock et al., 2009). By promoting cycling, for example with cycling infrastructure implementation and installing bicycle-sharing systems, cities are focusing on inducing a shift to cycling for urban trips, subsequently aiming to promote active transportation, decreasing traffic congestion and air pollution.

Over the last two decades, cycling has gained prominence in countries accross Latin America, and cities across the region have started to look to cycling . Documented examples of

cities in Latin America where cycling has significantly increased in the last decade, and where cycling cultures are emerging, include Bogotá, Santiago, Mexico City, and Guadalajara (Rodríguez et al. 2017). While always present, this mode has not traditionally been a widespread transportation option in the region due to, among other things, lack of adequate infrastructure, high levels of congestion, stigma, and a lack of a safety culture to protect cyclists (Rodríguez et al. 2017). Additionally, there is a link between mode of transport and socio-economic status in Mexico and some Latin American cities. The identity associated with cyclists is of a low-income traveler, which creates negative connotations with this mode (Cepeda Zorrilla et al., 2019). Moreover, while there has been a rise in demand for better cycling conditions, most Latin American cities still have a low share of cycling and relatively high rates of collisions with cars among cyclists leaving cycling relatively marginalized (Rodríguez et al., 2017).

Policy and governance related to cycling consist of several interrelated elements to shape and promote cycling mobility. There are a few determinants that influence willingness to cycle. These include the built environment (infrastructure, urban form), the natural environment (weather, climate, and topography), socio-economic variables (for example, gender, age, and class), psychological factors (for example, perceptions of crime and traffic safety, meanings and experiences), and aspects related to cost, time, effort and safety (Handy et al., 2014; Heinen et al., 2010; Rérat, 2019).

Policy related to the development of cycling infrastructure is one of many areas of cycling policy to promote and enable cycling (Anaya-Boig 2021a, 2021b). Cycling infrastructure refers to the built environment elements that facilitate and guide cycling mobility, including physical spaces and facilities explicitly for cyclists' use. Cycling infrastructure can be dedicated exclusively to cycling mobility or shared with other modes and practices. Notable examples are

cycle paths and lanes, shared streets, cycle parking, bike signalization, and bike-sharing facilities.

"Build it, and they will come" is a commonly repeated phrase among cycling advocates, referring to the potential of physical cycling infrastructure, especially a network of segregated cycling lanes and paths, for attracting new cyclists (Cervero et al., 2013). Building infrastructure is currently conceived as crucial to increase participation in cycling and to leverage its potential as a sustainable mode of transport (Pucher & Buehler, 2017). Many academic studies back these beliefs about the importance of cycling infrastructure. Research has shown that the lack of good quality cycling infrastructure is a significant barrier to cycling for transportation and shows that quality infrastructure can positively affect cycling.

Empirical studies have repeatedly shown that urban environments with dedicated cycling infrastructure, traffic-calming measures, and moderate to high urban densities are associated with higher cycling rates, although the direction of causality is uncertain (Cervero et al., 2019; Dill & Carr, 2003; Handy & Xing, 2011; Koohsari et al., 2020; Titze et al., 2008; Zhao, 2014). This academic scholarship and advocacy line essentially treats cycling as a technocratic problem assuming that physical infrastructure can address the lack of cycling. Framing cycling as a technical problem rooted in lack of provision often fails to consider the reality of infrastructure delivery. This technocratic lens also fails to acknowledge infrastructure's political nature by redefining structural tensions as "technical issues of supply and shortage" (Cox and Koglin 2021).

To go beyond this lens, many authors urge analysis, practice, and advocacy of infrastructure development in cycling to expand from the material adaptation of spaces and adoption of dominant practices from the global north, especially in geographies with drastically

different street life. Research must acknowledge that infrastructure results from social structures and political processes that can reflect and reproduce systems of inequality (Cox & Koglin, 2021; Castañeda, 2021).

Planning, designing, and implementing policy for cycling mobility often requires divergence from existing practices, new capacities, knowledge, and competencies (McLeod et al., 2020). As city governments take up this practice, many potential factors can enable or constrain their capacity to plan and implement cycling policy, reflecting on the characteristics of the resulting cycling infrastructure. As cycling policy design and implementation emerges as a new area of focus, local governments have few policies, rules, professional norms, best practices, and examples to guide their effort. As a result, cities often experiment with new institutional arrangements to develop and advance their cycling agendas (Anguelovski & Carmin, 2011).

The aim of my dissertation research is to understand how cycling policy has emerged in Mexican cities, the key processes through which cycling policy surfaces and becomes institutionalized and how these interact with existing policies and practices. Part of this work seeks to understand more about the reality of infrastructure delivery in low-cycling environments, and in places with significant social stigma attached to cycling. This research is divided into three papers.

In Chapter 2: *Can't Drive today? The impact of driving restrictions on bikeshare ridership in Mexico City*, I analyze the effect that increased driving restrictions implemented on high pollution days have on bikeshare rider behavior in Mexico City, taking advantage of a series of high-pollution days between 2016-2019. The main research question is: *how does Mexico City's bikeshare system ridership change when driving is restricted?* This research leverages the random nature of high pollution days to explore whether people who usually drive are willing to

incorporate bikeshare into their daily travel, taking into account that air quality poses a substantial health risk and that pollution warnings have been issued. This chapter was recently published in Transportation Research Part D: Transport and Environment (de Buen Kalman, 2021).

Chapter 3 titled *Streets For People, Not Cars: Social Processes and Institutions for Cycling Infrastructure in Mexico*, funded by the Toyota Mobility Foundation, seeks to identify and interpret the factors leading cities to promote cycling as a component of their urban mobility policy and planning through an analysis of the local processes of infrastructure development and the institutions that have been created locally to support this new practice. In a multiple case study research design, I study the influence of three key factors on the development of cycling policy and infrastructure deployment in metropolitan areas: the presence and activity of local civil society organizations (CSOs) to promote infrastructure, the adoption of state-level laws that mandate infrastructure as a responsibility of municipal governments, and the institutional capacity of local government agencies.

This study focuses on two distinct areas. First, I analyze how civil society organizations influence the implementation of infrastructure at the local level. The literature recognizes that CSOs have played a crucial role in bringing urban and cycling mobility to the forefront of public policy in Mexico and Latin America (Sagaris, 2010, 2014; Sosa López & Montero, 2018). Based on the widely accepted premise that a variety of CSOs shape mobility policy on the ground and on the assumption that one of the central policies for which CSOs advocate is cycling infrastructure, the first hypothesis in this research was stated as *Cycling infrastructure is more likely to occur in places where at least one CSO is actively working in favor of cycling infrastructure*. In this chapter, I analyze the numerous ways CSOs mobilize to advocate for

infrastructure and act as collaborators and experts in the production of space for cycling and the institutionalization of cycling infrastructure as a governmental practice.

Next I studied how infrastructure is implemented in each city included in this study. I looked at the primary laws, organizations, and planning instruments and norms that cities have to guide cycling infrastructure implementation for each case, and whether and how these have evolved over time.

Chapter 4 titled: *From Express Ways to Bikeways: How Guadalajara Institutionalized Cycling as Public Policy*, also supported by the Toyota Mobility Foundation, I examine the process through which cycling became institutionalized into a consistent component of metropolitan transportation policy in Guadalajara. The research questions guiding this case study are: *what were the main factors and events that have led Guadalajara to adopt and implement policies to promote cycling mobility? What is the story behind Guadalajara's adoption and implementation of cycling policy? What evidence exists about the success of these policies?* The present case critically analyzes the process through which cycling became institutionalized into a consistent component of metropolitan transportation policy. In this chapter, I show how local actors built a strong, diverse, and highly mediatic movement to mobilize sustainable transportation generally and cycling mobility specifically as a new policy area.

This dissertation contributes to a growing body of research on cycling mobility. My first chapter contributes to the literature examining the impact of events that constrain driving on public bike share use and the literature examining the health impacts of bikeshare use. It provides further evidence that when transportation is constrained, large scale adoption of cycling can occur. By showing the trajectories of ten different places with various levels of institutional development, and how these aspects have affected their ability to provide infrastructure that

meets the specific needs of cycling, in my second chapter show the importance of public management processes and institutions that support implementation, filling an important gap in the literature about cycling infrastructure. I also provide evidence for the crucial role that CSOs play in the provision of infrastructure and the mechanisms through which they impact the process. Finally, the third chapter in this dissertation exploring the experience of Guadalajara provides critical analysis and yields insight into strategies to institutionalize cycling policy that can help improve conditions for cycling, maintain cycling on the public agenda, and increase the attractiveness of this mode of transportation.

Together these three chapters contribute to the literature supporting the design and implementation of sustainable and successful cycling policy and to an understanding of how cities may achieve the increasingly attractive status of a *Pueblo Bicicletero.*

1.1 REFERENCES

1. Anaya-Boig, E. (2021a). Cycling Policies. In International Encyclopedia of Transportation (pp. 241–245). Elsevier. https://doi.org/10.1016/B978-0-08-102671-7.10689-X
2. Anaya-Boig, E., (2021b). Integrated Cycling Policy. A framework proposal for a research-based cycling policy innovation, In: Zuev, D., Psarikidou, K., Popan, C., (Eds.), Cycling Societies: Innovations, Inequalities and Governance. Routledge.
3. Anguelovski, I., & Carmin, J. (2011). Something borrowed, everything new: Innovation and institutionalization in urban climate governance. Current Opinion in Environmental Sustainability, 3(3), 169–175. https://doi.org/10.1016/j.cosust.2010.12.017
4. Banister, D. (2008). The sustainable mobility paradigm. Transport policy, 15(2), 73-80.
5. Bassett, D. R., Pucher, J., Buehler, R., Thompson, D. L., & Crouter, S. E. (2008). Walking, cycling, and obesity rates in Europe, North America, and Australia. Journal of physical activity and health, 5(6), 795-814.

6. Castañeda, P. (2021). Cycling case closed? A situated response to Samuel Nello-Deakin's "Environmental determinants of cycling: Not seeing the forest for the trees?" Journal of Transport Geography, 90, 102947. https://doi.org/10.1016/j.jtrangeo.2020.102947
7. Cepeda Zorrilla, M., Hodgson, F., & Jopson, A. (2019). Exploring the influence of attitudes, social comparison and image and prestige among non-cyclists to predict intention to cycle in Mexico City. Transportation Research Part F: Traffic Psychology and Behaviour, 60, 327–342. https://doi.org/10.1016/j.trf.2018.10.009
8. Cervero, R., Caldwell, B., & Cuellar, J. (2013). Bike-and-Ride: Build It and They Will Come. Journal of Public Transportation, 16(4), 83–105. https://doi.org/10.5038/2375-0901.16.4.5
9. Cervero, R., Denman, S., & Jin, Y. (2019). Network design, built and natural environments, and bicycle commuting: Evidence from British cities and towns. Transport Policy, 74, 153–164. https://doi.org/10.1016/j.tranpol.2018.09.007
10. Cox, P., & Koglin, T. (2021). Theorising infrastructure: 21.
11. de Hartog, J. J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the Health Benefits of Cycling Outweigh the Risks? Environmental Health Perspectives, 118(8), 1109–1116. https://doi.org/10.1289/ehp.0901747
12. de Buen Kalman, R. (2021). Can't drive today? The impact of driving restrictions on bikeshare ridership in Mexico City. Transportation research part D: transport and environment, 91, 102652.
13. Dill, J., & Carr, T. (2003). Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them. Transportation Research Record: Journal of the Transportation Research Board, 1828(1), 116–123. https://doi.org/10.3141/1828-14
14. Elvik, Rune. "The non-linearity of risk and the promotion of environmentally sustainable transport." Accident Analysis & Prevention 41.4 (2009): 849-855.
15. Faghih-Imani, A., Eluru, N., El-Geneidy, A. M., Rabbat, M., & Haq, U. (2014). How land-use and urban form impact bicycle flows: evidence from the bicycle-sharing system (BIXI) in Montreal. Journal of Transport Geography, 41, 306–314. https://doi.org/10.1016/j.jtrangeo.2014.01.013
16. Faghih-Imani, A., Hampshire, R., Marla, L., & Eluru, N. (2017). An empirical analysis of bike sharing usage and rebalancing: Evidence from Barcelona and Seville. Transportation

Research Part A: Policy and Practice, 97, 177–191. https://doi.org/10.1016/j.tra.2016.12.007

17. Hamer, M., & Chida, Y. (2008). Active commuting and cardiovascular risk: a meta-analytic review. Preventive medicine, 46(1), 9-13.
18. Handy, S. L., & Xing, Y. (2011). Factors Correlated with Bicycle Commuting: A Study in Six Small U.S. Cities. International Journal of Sustainable Transportation, 5(2), 91–110. https://doi.org/10.1080/15568310903514789
19. Handy, S., van Wee, B., & Kroesen, M. (2014). Promoting Cycling for Transport: Research Needs and Challenges. Transport Reviews, 34(1), 4–24. https://doi.org/10.1080/01441647.2013.860204
20. Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by Bicycle: An Overview of the Literature. Transport Reviews, 30(1), 59–96. https://doi.org/10.1080/01441640903187001
21. Koohsari, M. J., Cole, R., Oka, K., Shibata, A., Yasunaga, A., Hanibuchi, T., Owen, N., & Sugiyama, T. (2020). Associations of built environment attributes with bicycle use for transport. Environment and Planning B: Urban Analytics and City Science, 47(9), 1745–1757. https://doi.org/10.1177/2399808319845006
22. Litman, T. (2012). Toward More Comprehensive and Multi-modal Transport Evaluation. Victoria Transport Policy Institute.
23. McLeod, S., Babb, C., & Barlow, S. (2020). How to 'do' a bike plan: Collating best practices to synthesise a Maturity Model of planning for cycling. Transportation Research Interdisciplinary Perspectives, 5, 100130. https://doi.org/10.1016/j.trip.2020.100130
24. OECD (2015) A New Paradigm for Urban Mobility How Fleets of Shared Vehicles Can End the Car Dependency of Cities https://www.itf-oecd.org/new-paradigm-urban-mobility
25. Pucher, J., & Buehler, R. (2017). Cycling towards a more sustainable transport future. Transport Reviews, 37(6), 689–694. https://doi.org/10.1080/01441647.2017.1340234
26. Replogle, M. A., & Fulton, L. M. (2014). A Global High Shift Scenario.
27. Rérat, P. (2019). Cycling to work: Meanings and experiences of a sustainable practice. Transportation Research Part A: Policy and Practice, 123, 91–104.

28. Rodríguez, M., Pinto, A. M., Páez, D., Ortiz, M. Á., Buis, J., & Márquez, J. C. (2017). Cómo impulsar el ciclismo urbano: Recomendaciones para las instituciones de América Latina y el Caribe. Inter-American Development Bank. https://doi.org/10.18235/0000660
29. Sagaris, L. (2010). From sustainable transport development to active citizenship and participatory democracy: The experience of Living City in Chile: From sustainable transport development to active citizenship and participatory democracy. Natural Resources Forum, 34(4), 275–288. https://doi.org/10.1111/j.1477-8947.2010.01312.x
30. Sagaris, L. (2014). Citizen participation for sustainable transport: The case of "Living City" in Santiago, Chile (1997–2012). Journal of Transport Geography, 41, 74–83. https://doi.org/10.1016/j.jtrangeo.2014.08.011
31. Sosa López, O., & Montero, S. (2018). Expert-citizens: Producing and contesting sustainable mobility policy in Mexican cities. Journal of Transport Geography, 67, 137–144. https://doi.org/10.1016/j.jtrangeo.2017.08.018
32. Tainio, M., de Nazelle, A. J., Götschi, T., Kahlmeier, S., Rojas-Rueda, D., Nieuwenhuijsen, M. J., de Sá, T. H., Kelly, P., & Woodcock, J. (2016). Can air pollution negate the health benefits of cycling and walking? Preventive Medicine, 87, 233–236. https://doi.org/10.1016/j.ypmed.2016.02.002
33. Titze, S., Stronegger, W. J., Janschitz, S., & Oja, P. (2008). Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. Preventive Medicine, 47(3), 252–259. https://doi.org/10.1016/j.ypmed.2008.02.019
34. United Nations (2014) https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.Pdf
35. Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., ... & Franco, O. H. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. The Lancet, 374(9705), 1930-1943.
36. Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. Bmj, 348, g425.
37. World Resources Institute (2015) http://www.wri.org/blog/2015/03/strategies-sustainable-cities-demystifying-transport-demand-management.

38. Zhao, P. (2014). The Impact of the Built Environment on Bicycle Commuting: Evidence from Beijing. Urban Studies, 51(5), 1019–1037. https://doi.org/10.1177/0042098013494423

Chapter 2. CAN'T DRIVE TODAY? THE IMPACT OF DRIVING RESTRICTIONS ON BIKESHARE RIDERSHIP IN MEXICO CITY

2.1 INTRODUCTION

The Mexico City government has introduced multiple policies to reduce emissions and congestion from motor-vehicles, including a license-plate based driving restriction and a bikeshare system. In Mexico City, driving restrictions are extended during high pollution episodes creating an exogenous shock to the fleet of cars on the road. When these restrictions come into effect, some people need to find alternative ways to travel and may incorporate bikeshare as part of their journey. This paper leverages the random nature of driving restriction days to estimate the effects of these restrictions on bikeshare use by studying the changes in system-level bikeshare ridership in Mexico City during driving restriction days in 2016-2019.

License-plate-based driving restrictions are one of the most common policies used by local governments in cities across the globe to mitigate air pollution and congestion. For example, Mexico City, Sao Paulo, Beijing, Paris, Medellin, Quito, Tianjin, New Delhi, Buenos Aires, Bogotá, Lima, and Santiago de Chile have enacted restrictions of varying levels and durations (Guerra & Millard-Ball, 2017). The long-term effectiveness of these policies to reduce driving and pollution in the long term is widely contested (Davis, 2008; de Grange and Troncoso, 2011; Guerra and Millard-Ball, 2017; Zhang et al., 2017). However, in the short term, driving restrictions change transportation behaviors in various ways, including reshuffling car travel to different days (Guerra and Millard-Ball, 2017) and shifting to other modes (Gallego et al., 2013; Yang et al., 2018).

More recently, bikeshare systems have become common around the world as a component of urban transportation systems. Bikeshare facilitates the use of bicycles for short trips or as first and last-mile connections to other modes (Fishman, 2016; Fishman et al., 2015; Fishman and Schepers, 2016; Ricci, 2015). Cities implementing public bikeshare systems include Mexico City, Paris, New York, Chicago, Buenos Aires, Medellin, and Santiago. These systems are promoted as efficient, healthy, and environmentally friendly travel alternatives, especially for short urban trips (Fishman and Schepers, 2016; Shaheen et al., 2010; Wang et al., 2014; Xu, 2019). Bikeshare systems are used as substitutes and complements to walking, public transportation, and, to a lesser extent, driving (Fishman, 2016; Fishman et al., 2015; Fishman and Schepers, 2016; Ricci, 2015)

Previous research has shown that when other transportation choices are limited, people may opt to incorporate bikeshare as part of their commute (Fuller et al., 2019; Fuller et al 2012). However, the effect of driving restrictions on bikeshare ridership has not been previously studied. To address this gap, this research poses the following question: *Do driving restrictions lead people to incorporate bikeshare into their travel when driving is off-limits, but air pollution levels are high?* This study contributes to the research on bikeshare use and the impact of policies that constrain transportation choices on bikeshare ridership. Additionally, this research contributes to the literature that assesses the health impacts of bikeshare systems. Lastly, this research explores whether pollution warnings affect cycling behavior.

2.2 BACKGROUND

The aim of this research is to estimate the effect of pollution-related driving restrictions on bikeshare ridership in Mexico City. The following literature review focuses on presenting the

local policy context, examining the literature on the effectiveness of driving restrictions to change driving behaviors to identify if and how the driving restriction can plausibly lead to changes in bikeshare use, and identifying the variables that impact the use of bikeshare systems. Because driving restrictions are issued when air pollution is high and often include pollution warnings, previous research on the effectiveness of warnings is also reviewed to understand how these might also affect bikeshare behavior to enable a discussion of how these two policies act together. Finally, a brief review of the potential health tradeoffs associated with switching to bikeshare is presented to facilitate a discussion on health impacts and future research.

2.2.1 *Local policy context*

In Mexico City, the transportation sector is the most significant and fastest-growing source of air pollution, a concerning trend because of its adverse health impacts (Molina, 2004). Approximately 5.5 million cars circulate in the city every day, and the fleet has recently grown at a rate of over 4% every year (CAME, 2019).

Over the years, the Mexico City government has introduced policies in attempts to reduce congestion, increase urban mobility, and reduce emissions from motor vehicles. Notably, license plate restrictions were introduced in 1989, under the *Hoy no Circula* (HNC) program (translated roughly as "Can't Drive Today"), which aims to curb air pollution from transportation. Under this program, vehicles that fail to pass bi-yearly emissions tests are banned from driving at least one weekday every week and two Saturdays per month. The last digits of their license-plate determine the days on which cars are forbidden.

More recently, Mexico City has also sought to promote cycling with policies that include a public bikeshare system called *ecobici*, which was launched in 2010. The *ecobici* bikeshare

system is part of a broader strategy to promote cycling and non-motorized transport in the city. The system currently has 480 bike stations, 6,800 bikes, and more than 170,000 subscribed users (ecobici, 2019). The system has been touted as an efficient, healthy, and environmentally friendly transportation alternative to move around Mexico City, serving as a complement to the massive transportation network.

The Mexico City government has also developed an air quality monitoring system that tracks ambient air concentrations of criteria air pollutants that have adverse human health and environmental effects. Tracked contaminants include ground-level ozone (O_3) and particulate matter (PM_{10} and $PM_{2.5}$) for every neighborhood in Mexico City. The Metropolitan Air Quality Index (*Índice Metropolitano de la Calidad del Aire*, or IMECA) reports daily air quality based on each of these pollutants and assigns a score that is aimed to help citizens interpret and respond to the current levels of pollution. Values within intervals of the IMECA are assigned a specific meaning. Scores <100 indicate no risk to health; scores of 101–150 reflect health risks for vulnerable populations, mainly young children and older adults; scores of 151–200 indicate that the air quality harmful to the entire population; IMECA values > 200 indicate a state of emergency (Borbet et al., 2018, CAME, 2019b).

The highest measured value for a particular pollutant will determine the IMECA value for that day. Environmental contingencies are declared as a measure to protect public health when the IMECA is expected to surpass 150 points. During contingency days, the restriction is extended to banning driving an additional day per week, totaling two restricted weekdays and one weekend day every other Saturday for all cars subject to the regulation. The extra weekday on which a given car is restricted is also determined by the last digit of the license-plate (SEDEMA, 2019). The IMECA index is updated every hour and is available to the public

through various outlets. Communication of the IMECA index to the public is increased during environmental contingencies (Borbet et al., 2018, CAME, 2019b).

The extended driving restriction on high pollution days is arguably a random exogenous shock to the fleet of cars on the road subject to the HNC regulation. This shock is the basis of the empirical approach used in this research because it is used as an assignment strategy for research subjects. This readily available source of variation (high pollution days) selects the variable of interest (cars that are banned) while other factors remain stable, and therefore mimic a randomized trial and allow for a natural experiment research design ((Angrist & Pischke, 2008).

2.2.2 *Driving restrictions*

The evidence of the effectiveness of driving restriction policies to reduce driving, alleviate congestion, or improve air quality appears to be weak (Davis, 2008; de Grange and Troncoso, 2011; Guerra and Millard-Ball, 2017; Zhang et al., 2017). Previous research on the HNC program has found no concrete evidence that the program improved air quality or reduced driving in the long run (Davis, 2008, 2017).

Behavioral responses to the driving restriction in the short term include getting around the ban by reshuffling discretionary non-work travel car travel to different times or days to get around the ban. Even though the program is widely enforced, drivers also can get around the restrictions by disobeying or cheating (Davis, 2017; Guerra & Millard-Ball, 2017).

The research into the effectiveness of HNC emphasizes the difficulty that Mexico City's authorities have faced to get drivers to switch to lower-emitting forms of transportation (Davis, 2017; Guerra & Millard-Ball, 2017). Public transportation in Mexico City is widely available and includes a metro system, a Bus Rapid Transit system, a Light Rail, an extensive bus system, and the bikeshare system. Public transport is perceived to be slow, unsafe, and uncomfortable by

drivers, and many Mexico City residents seem to prefer private vehicles when they can afford them (Davis, 2017).

The effect of driving restrictions on transportation choices is still ambiguous. In Mexico City, the specific reduction in car trips and the switches to other modes remain unexplored in the academic literature. Evidence from Beijing indicates that in the short-to-medium term, the restriction reduces traffic and can also lead people to substitute their car trips with other modes like bus, taxi, and, to a lesser extent, rail (Wang et al., 2014). In Santiago de Chile, an extended driving restriction due to environmental contingencies reduced car trips by 5.5% and increased metro ridership by 3% (de Grange & Troncoso, 2011b).

The literature in this section suggests that there are many possible responses to the driving restriction in Mexico City. For people who own a second car or can afford a taxi, the restriction may not lead to a significant change in travel behavior. Non-essential trips are likely to be shifted to other days and times of the week. For trips that cannot be reshuffled, some people may switch to public transportation, which could include bikeshare as a full substitute or as a complement to another mode as a part of their journey. An indirect pathway for bikeshare ridership to change also exists, where people who usually drive shift to transit, and normal transit users opt for bikeshare to avoid larger than average crowds. Given that the literature suggests that non-discretionary work-related travel is most likely to be substituted rather than reshuffled, the effects of the driving restriction on other modes like bikeshare is hypothesized to be most significant at peak commuting times.

2.2.3 *Bikeshare*

In recent years, bikeshare systems have become popular all over the world. Bikeshare systems have been associated with social and environmental benefits such as reducing congestion and emissions from transport and improving accessibility, physical activity, and health (Fishman & Schepers, 2016; Shaheen et al., 2010; Wang et al., 2014; Xu, 2019).

However, research on bikeshare from around the world consistently finds that it is difficult to attract drivers to these systems. While bikeshare generally seems to have positive impacts regarding increased connectivity to public transit, bikeshare trips mostly substitute journeys made previously by walking and riding public transportation (Fishman, 2016; Fishman et al., 2015; Fishman & Schepers, 2016; Ricci, 2015). In line with the academic literature, recent *ecobici* user surveys indicate that only 10 percent of users are substituting driving and most people have shifted from public transportation (31 percent) and walking (36 percent) (Rivera et al., 2017).

Weather and seasonality are consistently found to affect bikeshare usage. In numerous studies, weather variables were found to be correlated with both the use of bicycles and the duration of trips undertaken (Gebhart & Noland, 2014). Moderate weather conditions (higher temperatures and low humidity) appear to increase the number of trips and travel time. On the other hand, cold, wind, rain, and humidity have been found to reduce both the number of trips and their duration (Gebhart & Noland, 2014).

Studies that examined temporal usage also highlighted time of day as an essential predictor of bikeshare system usage. Broadly, bikeshare usage is higher for weekdays compared to weekends, suggesting use on weekdays for commuting purposes, although usage patterns vary across locations (Caulfield et al., 2017; El-Assi et al., 2017; Faghih-Imani and Eluru, 2016;

Noland et al., 2016; Zhou, 2015). In the case of *ecobici*, user surveys suggest that the system is primarily used for commuting, with nearly 50 percent of respondents citing this as their primary use of the system (Rivera et al., 2017).

Other events that constrain the primary mode of transportation for a population have been found to have unintended short-term effects on travel behavior. Previous research suggests that restricting transport options can increase population levels of physical activity by promoting the use of bikeshare (Fuller et al., 2012, 2019).

The literature reviewed here suggests that weather (temperature, precipitation) and seasonality (hour, weekday, month, and year) are important drivers of bikeshare ridership and should therefore be included as controls when modeling the effects of the driving restriction since they can influence ridership when restrictions are in place. This literature also suggests that when people face driving restrictions, a constraint to their primary mode of transportation, bikeshare can be an attractive alternative. Finally, the fact that bikeshare is largely used for commuting indicates that the effects of the driving restriction will likely be most prominent during peak travel times.

2.2.4 *Pollution warnings*

In addition to policies and programs to reduce emissions from transportation, the Mexico City government has adopted additional strategies to reduce negative health impacts associated with poor air quality, including public awareness campaigns. When pollution reaches unsafe levels, in addition to restricting driving, the Mexico City Government issues air quality warnings that suggest that people should not engage in outdoor activities. Therefore, warnings may be an important component of people's decision as to whether to include cycling as part of their transportation routine when driving is restricted.

For air quality warnings to be effective, people need to be aware of them, to know what they mean, and to have an understanding of how to use them to reduce exposure (Borbet et al., 2018). The air quality reports developed by the Mexico City Government through the IMECA index provide guidelines to reduce outdoor activities during severe pollution events. Previous research to assess the effectiveness of this program found that 53% of the general population was aware of the air quality index. However, behavior modification was less influenced by IMECA index reports than by personal perceptions of air quality (Borbet et al., 2018). Pollution warnings issued with driving restrictions are therefore likely to discourage people from using bikeshare, potentially buffering any effects from the driving restriction. The effects of pollution warnings may also be to reduce non-essential bike trips, for example, trips outside of work-related commuting times.

2.2.5 *Health tradeoffs*

Shifting from car to bicycle as a travel mode may imply certain health tradeoffs. These tradeoffs include benefits from increased physical activity and potential risks due to increased exposure to injury and air pollution. Several studies have estimated the health benefits and risks of cycling (de Hartog et al., 2010; Rojas-Rueda et al., 2011; Tainio et al., 2016; Woodcock et al., 2014). Overall, air pollution exposures experienced by car drivers have been found to be modestly higher than those experienced by cyclists (de Hartog et al., 2010). However, increased physical activity results in higher ventilation rates for cyclists than for car drivers leading to increasing inhaled doses of air pollution. In these studies, the health benefits due to physical activity are more significant than the health risks caused by increases in exposure to air pollution (Tainio et al., 2016; Woodcock et al., 2014), although these may vary across gender and age groups (Woodcock et al., 2014).

2.3 METHODS

This paper uses a natural experiment design to examine the impact of driving restrictions and pollution warnings on the use of the Mexico City' Bikeshare system, *ecobici.* A natural experiment research design is where random assignment of study subjects to different treatment groups occurs outside of the control of the researcher, while other factors remain balanced. This situation can be leveraged to answer a research question by mimicking a randomized control trial ((Angrist & Pischke, 2008). In this research, the days on which pollution is high and driving restrictions are doubled is considered an exogenous random assignment of driving constraints. The random variation comes from two sources. First, the day of the week on which pollution is high is exogenous and arguably random. Second, for cars subject to the regulation, the days when they are constrained is based on the last digit of their license plate. This random assignment of cars that are prohibited from driving presents a unique research opportunity to assess whether constraining driving can lead to changes in the usage of the bikeshare system, taking into account that air quality is poor.

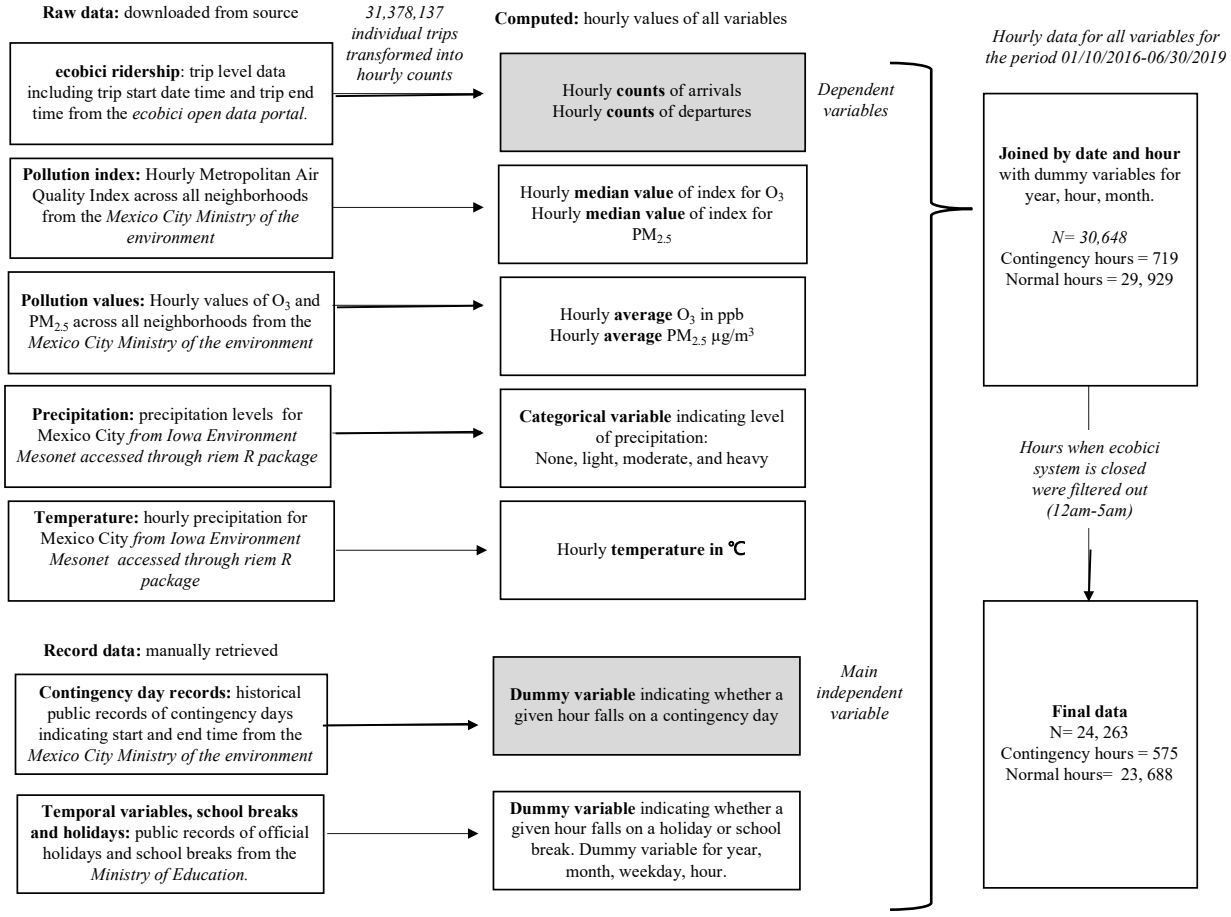
The unit of analysis in this study is an hour of bikeshare system operation. Contingency days—when driving was additionally restricted—are used as the treatment condition, while normal days were considered the control condition. The following section describes the sources of data, the data collection and manipulation process, and the modeling approach used in this analysis.

2.3.1 *Data*

A variety of publicly available data sources were used to compile an hourly longitudinal dataset of bikeshare rides linked to the state of the local driving restriction policy. Variables identified in the literature review that have been found to have an impact on bikeshare ridership or willingness to engage in physical activity were also linked to the data as controls. These include temperature and precipitation (El-Assi et al., 2017; Gebhart & Noland, 2014), concentrations of air pollutants (Kelly et al., 2012), and temporal controls such as weekdays and holidays to account for seasonal variation in bikeshare use (Caulfield et al., 2017; El-Assi et al., 2017; Faghih-Imani and Eluru, 2016; Noland et al., 2016; Zhou, 2015).

The data sources and the overall data compilation process is outlined in Figure 1 and discussed in further detail below. The period of study is January 1, 2016, to June 30, 2019, and the data for each of the following variables was obtained for this period of time and computed into hourly values.

Figure 1. Data collection and manipulation process



2.3.2 *Dependent variable*

Bikeshare trip data for the *ecobici system* was directly obtained from the *ecobici* website (*ecobici*, 2019). The raw trip data include time, date, and station ID for the start and end of each trip during the selected period. The data also include the gender and age of the user but do not include individual identifiers or information on how frequently users take trips.

From these data, the count of total system-level trips by hour was computed as counts of either hourly arrivals or departures for the entire bikeshare system and used as the dependent

variable. The trip data used to compile hourly counts include over 31 million trips made between January of 2016 and June of 2019. Given that the *ecobici* system is closed between 12 am, and 5 am, these hours were excluded from the analysis. When the trip data was turned into hourly counts when the system is open, the sample size is reduced to N=24,263 hours, where 525 hours are contingency-hours (treatment), and 23,688 are normal hours (control).

2.3.3 *Independent variables*

The main explanatory variable is the historical record of periods when environmental contingencies were declared, and driving restrictions were, therefore, extended. These data were obtained from the Mexico City Environment Ministry (SEDEMA, 2019). The records include the start date and time of the contingency. An hourly dummy variable was constructed based on this information indicating whether a given hour falls on a contingency day.

Hourly precipitation levels and temperature values were obtained using the riem R package, which allows the retrieval of weather data from Automated Surface Observing System stations around the world through the Iowa Environment Mesonet website (Salmon, 2016). The hourly temperature was included in °C, and precipitation is a categorical variable indicating the level of rainfall: none, light, moderate, and heavy. While these data are mostly reliable, each of these data sets had 297 missing values, representing 0.9% of the data. These were interpolated by using the value of the previous hour as an approximation.

Hourly ozone levels in ppb and $PM_{2.5}$ pollution in $\mu g/m^3$ data were obtained from the Mexico City Atmospheric Monitoring system (SEDEMA, 2019), which reports hourly pollution levels for all monitoring stations in Mexico City. The hourly average across stations of these values was computed and included in the final data set.

Hourly values of the IMECA index for ozone were obtained from the same source. The values of the IMECA index dictate when pollution warnings are issued and outdoor physical activity is discouraged. Given that contingencies are mostly declared due to high levels of ozone, the IMECA index was used as another indicator of pollution. To be conservative, the median value across neighborhoods was included as an indicator of the index level in the dataset (SEDEMA, 2019).

Federal and school holidays during the study period were also obtained using the yearly calendars issued from the Secretary of Public Education between 2016 and 2019 (SEP 2015, 2016, 2017, 2018, 2019). Additional dummy variables were constructed for hour-of-day, day-of-week, and month-year. These variables were added to the data as additional controls for temporal variation in ridership. The hourly dummy variables are also included to interact with contingency day status because the effect of the restriction on ridership is expected to depend on the time of the day. Month and year account for seasonal variation in ridership and potential changes due to system rollout.

Table 1. Descriptive statistics of key variables. The unit of analysis is one hour.

Variable (hourly units)	Mean	SD	Max	Min
Departures (counts)	1290.4	906.82	4193	1
Arrivals (counts)	1288.52	901.3	3952	3
Temperature (°C)	17.16	5.11	32	-1
Contingency (dummy variable)	1.02	0.15	2	1
Holiday (dummy variable)	1.21	0.41	2	1
IMECA (index)	33.54	29.99	181	1
O_3 (ppb)	35.01	26.35	138.35	0.88
PM_{10} (μ/m^3)	47.28	22.08	179.56	5.25
$PM_{2.5}$ (μ/m^3)	23.88	12.48	143.36	2.33

2.3.4 *Analysis*

This study aims to understand the effects of driving restrictions on bikeshare ridership using a natural experiment research design. A secondary objective was to assess whether people respond to pollution warnings and change their ridership behavior when these are issued.

The number of bikeshare trips made is count data, representing system-level hourly counts of trips. Negative binomial models are used to model over-dispersed count data and are commonly used to model ridership counts in transportation studies (Jang, 2005). Given that the outcome variable used in this analysis is an over-dispersed count, this type of model is more appropriate than ordinary least squares or Poisson regression models. The general form of the Negative binomial is as follows:

$$y_i \sim NegBinomial(\mu_i, \alpha)$$

$$\mu_i = \exp(X_i \beta)$$

Where the expected count y for hour i is equal to μ_i, the exponentiation of the linear combination of the covariates (x_i) and their coefficients (β). The coefficients may be interpreted as changes in the expected log-count of rides per unit change of the covariate, or, when exponentiated, as factor increases in the expected count of rides. α is a parameter adjusting the variance—and thus standard errors— for overdispersion.

The "treatment" variable in the model is a dummy variable indicating whether an hour of the day falls on a contingency day. Contingency day effects on bikeshare ridership were hypothesized to vary at different hours of the day because peak commuting hours that are more likely to include work-related trips are expected to have greater changes than the rest of the day. This difference suggests interaction effects between contingency and hour. The standard negative

binomial model uses hourly dummy variables to estimate this interaction. Due to the limited number of contingency hours in the data set (525) and the large number of parameters, there may be insufficient statistical power to detect an effect from this interaction.

To explore this possibility, in addition to the standard negative binomial, an alternate specification was also included that is similarly flexible while using fewer parameters. The alternate specification is a generalized additive model (GAM) that uses a spline for hours, which relates hour of the day to ridership using a non-parametric smoothing function allowing for non-linearity across hour effects while requiring fewer degrees of freedom than the dummy model (Woods, 2017).

The compiled data set described in the previous section was read into R. Then, using the R functions 'glm.nb()' and 'gam()' from the MASS and mgcv packages, respectively, both forms of the negative binomial models were estimated for different combinations of the predictor variables (Venables and Ripley 2002; Woods, 2017).

For each of these specifications (negative binomial and GAM), four different models were run with hourly departures as the dependent variable indicating trip counts and with the main explanatory variable being the variable indicating whether a given hour falls during a contingency day. Covariates for temperature, rain, holiday, weekday, month, and year are included in every model because of their suggested relevance as determined in the literature review. The controls for pollution levels (O3 and PM2.5) and the pollution index (IMECA) were varied to find the best fit for the pollution covariates. Given that the pollution levels and their respective indices are strongly correlated, only one was included. A table summarizing the variables included in all model runs is included in Appendix 1.

The models were compared using AIC and BIC for choosing the best pollution predictor subsets. Both criteria in both model specifications strongly prefer the models that included controls for the year, month, rain, holiday, weekend, and the pollution levels for O_3 and $PM_{2.5}$. Contingency day was interacted with hour because, as expected, the effect of the contingency strongly varies by the hour of the day, given that there are hours when transportation choice is more inelastic.

The results of the standard negative binomial for predicting hourly departures with the stated covariates are included in the following section. However, the results for the effect of contingency day on bikeshare ridership across all of the specifications and sets of covariates tested are very similar.

There is also a possibility that once a contingency day is announced, people are more aware of pollution and may choose to limit their physical activity. To explore this possibility, the effects of pollution warnings on bikeshare ridership are explored separately in an interaction model. This model is used to test whether pollution has an independent effect on ridership before and after the declaration of a contingency day. This was done with a negative binomial model that includes an interaction between the contingency and pollution variables. In this discussion, the results presented are for the model with an interaction between contingency and ozone levels.

The negative binomial models (both the standard model and the GAM) model the log of the expected count as a function of the predictor variables. The raw estimated negative binomial regression coefficients for both specifications of the model can be found in the regression table in Appendix 2.

2.4 RESULTS

Figure 3 and Figure 4 show the expected values of bikeshare ridership in the standard and GAM models, respectively. The figures show the change in ridership between a contingency day and a non-contingency day, holding all other variables constant, with a shaded area indicating the 95 percent confidence interval. Note the depicted intervals take into account all uncertainty in the model, not just uncertainty in the contingency day parameter, so there may be significant differences even where the intervals for the two lines overlap.

Both figures indicate that contingency days exhibit generally similar bikeshare use patterns to regular days. However, some differences are observed. Compared to regular days, *ecobici* ridership on contingency days appears to be higher during morning and evening commuting hours (between 7- 9 am and 6 - 8 pm). For example, the GAM model predicts 12.5% higher system volume at 8 am and 16.3% higher volume at 7 pm. This pattern is reversed in the late morning and early afternoon. For example, at 12pm, the GAM model predicts a 17% lower system volume. The largest increase is observed between 6 and 8 pm. While the predicted hourly ridership patterns are similar between the models, the GAM model shows more precise effects of the contingency, as a result of increased power from fewer parameters. The full effect sizes are estimated as rate ratios for selected hours and presented in Table 2. For example, the first rate ratio of 1.064 indices the standard negative binomial model predicts 6.4% higher ridership at 8 AM on contingency days as compared to normal days.

Table 2. Effect sizes as rate ratios for selected times of day with 95%

Negative Binomial model			
	8 am	12 pm	7 pm
Point Estimate	1.064	0.790	1.097
Lower Bound	0.886	0.655	0.907
Upper Bound	1.278	0.954	1.328
Negative Binomial GAM Model			
	8 am	12 pm	7 pm
Point Estimate	1.125	0.831	1.162
Lower Bound	1.033	0.761	1.055
Upper Bound	1.222	0.905	1.276

Figure 2. Negative binomial model results for hourly departures on contingency and normal days.

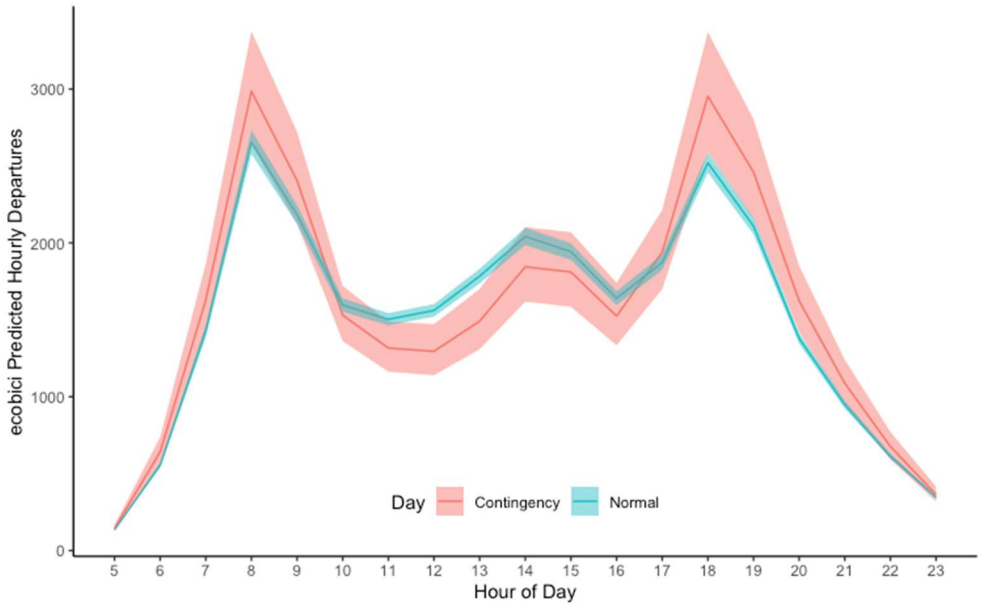
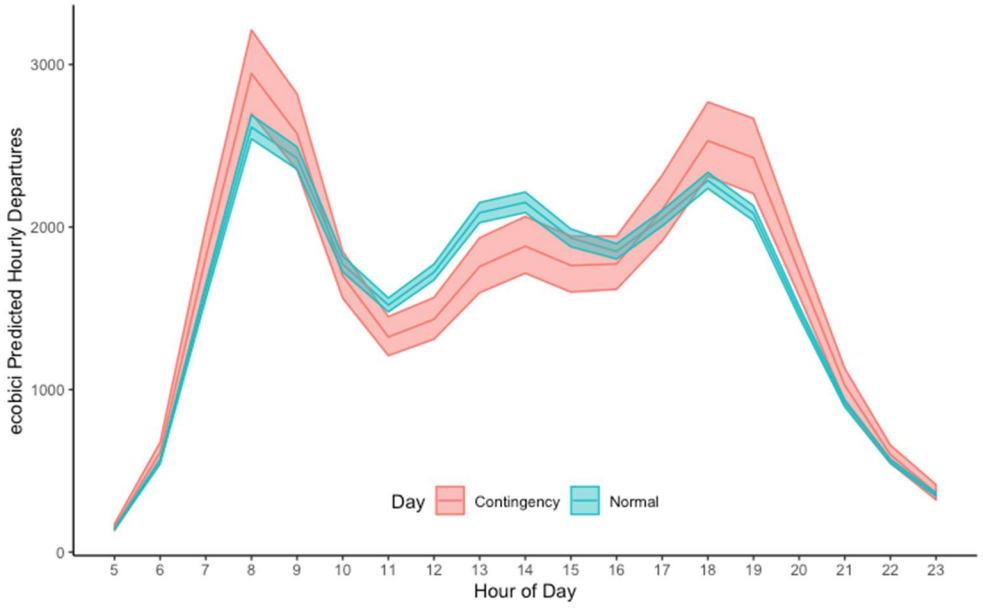
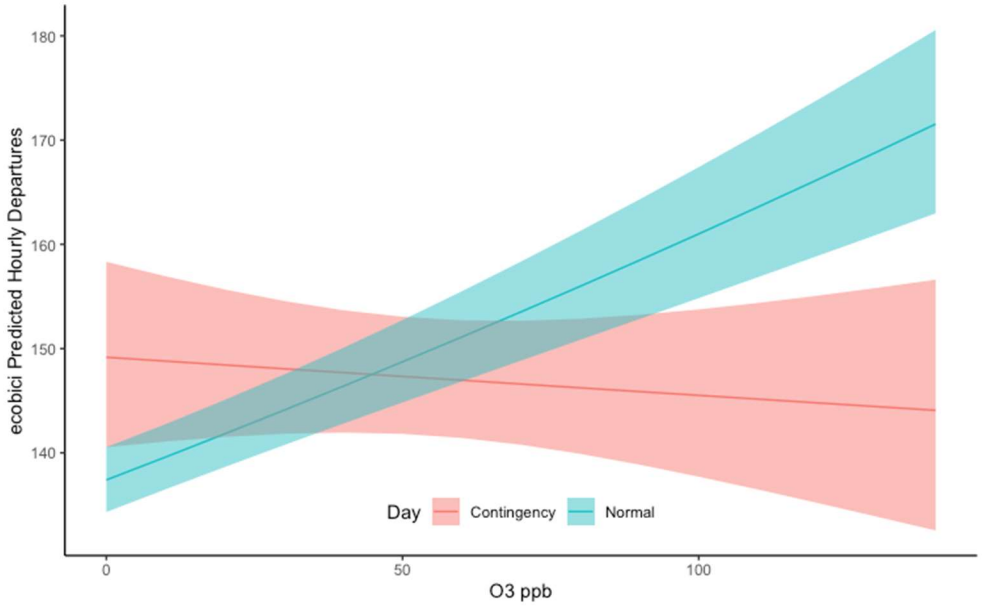


Figure 3. Negative binomial GAM model results for hourly departures on contingency and normal days.



The negative binomial with an interaction between contingency day and ozone level is similarly plotted in Figure 3. This plot shows that when contingency days are in effect, people suppress their use of bikeshare. It is worth noting that, in the data, non-contingency days only exceed 120 ppb ozone on four occasions, so the modeled plot likely exaggerates ridership for higher levels of ozone during normal days.

Figure 4. Negative binomial interaction model predicting hourly departures for varying levels of ozone on contingency days and non-contingency days.



2.5 Discussion

This study assesses the effect of pollution related driving restrictions on bikeshare system use in Mexico City. The aim is to indirectly explore the extent to which driving restrictions lead to people incorporating bikeshare into their daily transportation routine. In this section, the implications of the findings from the modeling exercises in the previous section are discussed.

The analysis shows that there is an overall increase of bikeshare trips in Mexico City during contingency days, but the difference in ridership counts varies throughout the day. The overall ridership follows a similar pattern on both normal days and contingency days, which is expected because people are likely to maintain similar daily routines and patterns. The increase in ridership on contingency days is concentrated during morning and evening peak commuting times when transportation choice is more inelastic, as previously hypothesized. However,

ridership significantly decreases in the late morning when it is more likely that trips are non-essential and when other transit options are less saturated.

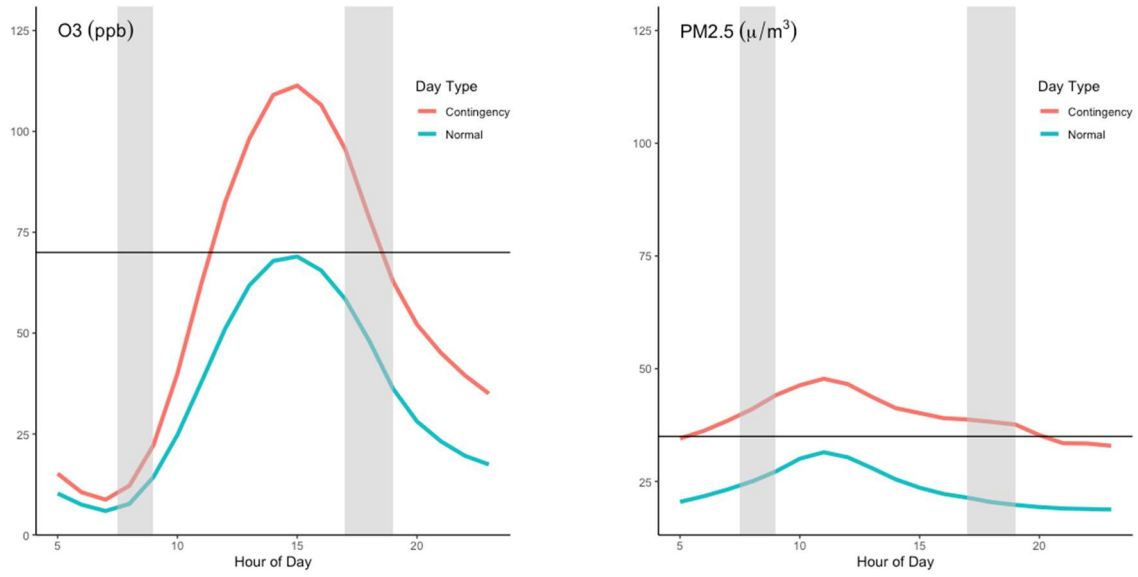
Given that driving restriction days occur during high air pollution episodes when health warnings are issued to discourage people from engaging in physical activity, the observed results make intuitive sense. One plausible explanation is that people who usually drive and find their usual transportation choice restricted but still need to commute will choose to use bikeshare during contingency days. However, in general, people will try to minimize their biking when air quality is averse to health, possibly due to an increased awareness of health risks following pollution warnings. This idea is supported by the interaction model that estimates the effect of pollution levels on ridership, which shows that bikeshare trips are suppressed when pollution warnings are issued along with driving restrictions.

There are two potential policy implications of these findings. The first is that even though bikeshare has historically struggled to attract drivers, it appears that when driving is constrained, people may incorporate bikeshare into their commutes. However, further research is needed that tracks individual's mode shift behaviors to disentangle the possible mechanisms through which the observed changes occur. One option is that people who usually drive opt for bikeshare, but another plausible explanation is that drivers opt for other modes like public transit and transit users prefer to use bikeshare when their usual mode is more crowded than average. Also, the observed effects of the restriction are likely suppressed by poor air quality, which may discourage biking on contingency days. These results suggest that constraining driving can, at least in the short term, get people to add bikeshare to their commute.

The second policy implication is that pollution warnings seem to be working to suppress physical activity. When contingencies are declared, and health warnings are issued, bikeshare

users may become more aware of pollution and avoid physical activity. This result also suggests that pollution warnings are effective in changing people's behavior.

Figure 5. Average pollution on contingency days and non-contingency days. Peak ecobici use hours are shaded.



An important limitation of this study is that there are a relatively small number of contingency days, limiting the statistical power of this analysis. This means that the effects are potentially more substantial but are not statistically discernable with the current data.

A second limitation is that it is not possible to fully assess the health tradeoffs of switching from driving to cycling during days with high pollution. For this to be possible, more data on the physical activity of users would be needed, as well as the actual levels of exposure to pollution that people experience during their cycling and driving commutes. Street-level air pollution concentrations are likely to be higher than levels in the data available from the air quality monitoring system used in this analysis.

Street-level air quality data are not available, so it is not possible to determine whether the observed increase in bikeshare use caused a change in exposure. The net health impact of this change also depends on whether bikeshare users are achieving recommended activity levels and how transportation activity contributes to overall physical activity levels. Given that some people chose to bike during high pollution days, future research should assess individual behavior changes and individual exposures at the street-level.

In the hypothetical situation where a driver engages in physical activity that they would not have done otherwise and that contributes to their recommended physical activity levels, most of the literature would suggest that in most cities, the benefits from additional physical activity may outweigh the health risks from air pollution. For example, Tainio et al. (2016) estimated the tipping point and break-even point for when the risks of increased exposure to PM2.5 outweigh the benefits from physical activity for different average cycling times and background PM2.5 concentrations. The tipping point is the level of physical activity after which additional physical activity will no longer bring additional benefits. The break-even point is the amount of physical activity that will cause negative health effects. For a background concentration of 50 μ g/m3, the tipping point was estimated to be around one and a half hours of cycling per day (Tanio et al., 2016). The average levels from the Air Quality Monitoring system for O_3 and $PM_{2.5}$, the pollutants for which contingencies are issued, are shown in Figure 4. At least for the background levels of $PM_{2.5}$, it is possible that the benefits of physical activity outweigh the negative effects of exposure to air pollution.

2.6 CONCLUSION

This research investigates the effect of driving restrictions on bikeshare ridership in Mexico City. Driving restrictions are activated during high pollution episodes when health

warnings are issued. The results show that bikeshare usage increases during peak commuting hours when transportation is more inelastic and decreases during times when travel is less essential. Further analysis suggests that bikeshare users are more perceptive to air pollution following health warnings, supporting the idea that the effect of driving restrictions on bikeshare use is hampered by the poor air quality.

Given that bikeshare has struggled to attract drivers, the analysis suggests that some drivers may be willing to incorporate bikeshare into their transportation choices when their usual choice is restricted, in spite of the high air pollution, although confirming this hypothesis merits further research. This is nonetheless an encouraging finding showing that bikeshare can be a critical partner in local transportation infrastructure.

This study contributes to the literature examining the impact of events that constrain driving on public bike share use and the literature examining the health impacts of bikeshare use. It provides further evidence that when transportation is constrained, large scale adoption of cycling can occur. Previous research on this topic has studied the effect of transit strikes on bikeshare ridership. This research contributes to this literature by studying driving restrictions, which had not been previously studied.

While this study starts to fill an important gap in the literature, future research could examine individual mode shifts to assess whether the observed changes the system level is coming from people who usually drive, which would be an important contribution given that bikeshare has historically struggled to attract drivers. Individual behavior could also be tracked over time to see if the driving restriction encourages people to use bikeshare more often.

2.7 APPENDIX 1

Table 3. Variables included each model run to estimate the effect of contingency days on bikeshare ridership. Shaded areas indicate the models included in the discussion.

Model	Type	contingency	precipitation	temperature	weekend	holiday	O3	PM2.5	IMECA
1	Negative binomial	●	●	●	●	●	●	●	
2	Negative binomial	●	●	●	●	●	●		
3	Negative binomial	●	●	●	●	●		●	
4	Negative binomial	●	●	●	●	●			●
5	GAM Negative binomial	●	●	●	●	●	●	●	
6	GAM Negative binomial	●	●	●	●	●	●		
7	GAM Negative binomial	●	●	●	●	●		●	
8	GAM Negative binomial	●	●	●	●	●			●

Table 4. Variables included each model run to estimate the effect of pollution on bikeshare ridership. Shaded areas indicate the models included in the discussion.

Model	Type	contingency	precipitation	temperature	weekend	holiday	O3	IMECA
1	Negative binomial	●	●	●	●	●	●	
2	Negative binomial	●	●	●	●	●	●	
3	Negative binomial	●	●	●	●	●		
4	Negative binomial	●	●	●	●	●		●

2.8 APPENDIX 2

Table 5. Results for the negative binomial model predicting hourly departures

Term	Estimate	Standard error	Statistic	p-value
(Intercept)	4.647	0.025	185.995	0
temp	0.009	0.001	9.040	<0.0001
2017	0.037	0.006	5.990	<0.0001
2018	-0.048	0.006	-7.786	<0.0001
2019	-0.078	0.008	-9.773	<0.0001
February	0.048	0.011	4.324	<0.0001
March	0.045	0.011	3.949	<0.0001
April	0.077	0.012	6.212	<0.0001
May	0.022	0.013	1.687	0.092
June	0.034	0.012	2.799	0.005
July	0.129	0.013	9.979	<0.0001
August	0.150	0.013	11.456	<0.0001
September	-0.030	0.013	-2.322	0.020
October	0.061	0.012	4.934	<0.0001
November	0.021	0.012	1.775	0.076
December	-0.085	0.012	-7.315	<0.0001
6am	1.415	0.015	96.474	0
7am	2.362	0.015	160.729	0
8am	2.996	0.015	202.682	0
9am	2.802	0.015	187.454	0
10am	2.496	0.015	162.234	0
11am	2.443	0.016	151.187	0
12pm	2.490	0.017	144.043	0
1pm	2.625	0.018	142.649	0
2pm	2.753	0.019	145.167	0
3pm	2.690	0.019	142.976	0
4pm	2.501	0.018	137.326	0
5pm	2.614	0.017	149.849	0
6pm	2.893	0.017	173.086	0
7pm	2.700	0.016	166.143	0
8pm	2.264	0.016	139.556	0
9pm	1.883	0.016	115.680	0
10pm	1.446	0.016	89.002	0
11pm	0.881	0.016	54.974	0
contingencyContingency	0.041	0.071	0.572	0.567

rainModerate Rain	0.037	0.032	1.155	0.248
rainNo Rain	0.111	0.018	6.155	<0.0001
holidayTRUE	-0.255	0.007	-38.139	0
weekendTRUE	-0.896	0.005	-173.475	0
O3	0.002	0.000	9.346	<0.0001
PM2.5	-0.001	0.000	-6.502	<0.0001
6am:contingencyContingency	0.070	0.098	0.713	0.476
7am:contingencyContingency	0.076	0.098	0.777	0.437
8am:contingencyContingency	0.062	0.093	0.666	0.505
9am:contingencyContingency	0.043	0.094	0.459	0.646
10am:contingencyContingency	-0.090	0.092	-0.969	0.333
11am:contingencyContingency	-0.179	0.095	-1.890	0.059
12pm:contingencyContingency	-0.235	0.096	-2.449	0.014
1pm:contingencyContingency	-0.225	0.097	-2.323	0.020
2pm:contingencyContingency	-0.148	0.097	-1.532	0.126
3pm:contingencyContingency	-0.121	0.098	-1.240	0.215
4pm:contingencyContingency	-0.127	0.098	-1.303	0.192
5pm:contingencyContingency	-0.022	0.098	-0.221	0.825
6pm:contingencyContingency	0.099	0.097	1.015	0.310
7pm:contingencyContingency	0.093	0.097	0.953	0.341
8pm:contingencyContingency	0.102	0.097	1.046	0.295
9pm:contingencyContingency	0.076	0.098	0.780	0.435
10pm:contingencyContingency	0.039	0.098	0.397	0.691
11pm:contingencyContingency	-0.010	0.098	-0.107	0.915
Log-likelihood	-175332.00			
Deviance explained	80.9%			

Note on interpretation: Because this model has an interaction term between hour and contingency, the effect of contingency on ridership is different at every hour of the day. That is, the effect of contingency is equal to the partial derivative of log(departures) with respect to contingency. For example, at 6pm (hour 19) the expected difference in log(counts) is:

$$\beta(\text{contingency}*6\text{pm}) + \beta\,(\text{contingency}) = 0.099 + 0.041 = 0.14$$

If we exponentiate this, it is equal to 1.15, that is 15% higher ridership at 6pm during a contingency day compared to a non-contingency day.

Table 6. Results for the negative binomial GAM model predicting hourly departures

coefficients	Estimate	Std. Error	z value	p.value
(Intercept)	6.871	0.024	290.702	< 2e-16
temp	0.009	0.001	9.092	< 2e-16
2017	0.036	0.006	5.867	4.43E-09
2018	-0.048	0.006	-7.721	1.16E-14
2019	-0.078	0.008	-9.663	< 2e-16
February	0.047	0.011	4.217	2.48E-05
March	0.044	0.011	3.826	1.30E-04
April	0.076	0.012	6.048	1.47E-09
May	0.021	0.013	1.557	1.20E-01
June	0.033	0.012	2.696	0.00703
July	0.129	0.013	9.816	< 2e-16
August	0.150	0.013	11.272	< 2e-16
September	-0.030	0.013	-2.338	1.94E-02
October	0.060	0.012	4.839	1.31E-06
November	0.020	0.012	1.699	8.93E-02
December	-0.085	0.012	-7.256	3.99E-13
contingencyContingency	0.015	0.017	0.886	3.76E-01
rainModerate Rain	0.036	0.032	1.111	2.66E-01
rainNo Rain	0.111	0.018	6.107	1.02E-09
holidayTRUE	-0.255	0.007	-37.735	< 2e-16
weekendTRUE	-0.899	0.005	-171.718	< 2e-16
O3	0.002	0.000	9.196	< 2e-16
PM2.5	-0.001	0.000	-6.345	2.23E-10
Log-likelihood	-175658			
Deviance explained	80.4%			

Table 7. Results for the negative binomial pollution interaction model predicting hourly departures

Term	Estimate	Std. Error	z value	p value
(Intercept)	4.576	0.024	193.786	< 2e-16
2017	0.038	0.006	6.152	7.66E-10
2018	-0.051	0.006	-8.162	3.31E-16
2019	-0.090	0.008	-11.626	< 2e-16
6am	1.419	0.015	96.764	< 2e-16
7am	2.367	0.015	161.485	< 2e-16
8am	3.004	0.015	204.562	< 2e-16
9am	2.813	0.015	189.851	< 2e-16
10am	2.507	0.015	164.758	< 2e-16
11am	2.457	0.016	153.760	< 2e-16
12pm	2.510	0.017	147.274	< 2e-16
1pm	2.653	0.018	147.117	< 2e-16
2pm	2.783	0.018	150.630	< 2e-16
3pm	2.713	0.018	148.531	< 2e-16
4pm	2.511	0.018	142.425	< 2e-16
5pm	2.612	0.017	155.106	< 2e-16
6pm	2.881	0.016	179.118	< 2e-16
7pm	2.675	0.016	171.330	< 2e-16
8pm	2.231	0.016	143.543	< 2e-16
9pm	1.845	0.016	118.464	< 2e-16
10pm	1.405	0.016	90.243	< 2e-16
11pm	0.842	0.015	54.400	< 2e-16
contingencyContingency	0.080	0.029	2.767	0.00567
O3	0.002	0.000	8.928	< 2e-16
temp	0.016	0.001	19.932	< 2e-16
rainModerate Rain	0.043	0.032	1.329	0.18377
rainNo Rain	0.076	0.018	4.238	2.26E-05
holidayTRUE	-0.208	0.006	-36.291	< 2e-16
weekendTRUE	-0.893	0.005	-171.615	< 2e-16
contingencyContingency:O3	-0.002	0.000	-4.220	2.44E-05
Log-likelihood	-175636			
Deviance explained	80.5%			

2.9 REFERENCES

1. Angrist, J. D., & Pischke, J.-S. (2008). Mostly harmless econometrics: An empiricist's companion. Princeton University Press.
2. Borbet, T. C., Gladson, L. A., & Cromar, K. R. (2018). Assessing air quality index awareness and use in Mexico City. BMC Public Health, 18(1), 538. https://doi.org/10.1186/s12889-018-5418-5
3. Carter, N. (2006). Party Politicization Of The Environment In Britain. Party Politics, 12(6), 747–767. https://doi.org/10.1177/1354068806068599
4. Caulfield, B., O'Mahony, M., Brazil, W., & Weldon, P. (2017). Examining usage patterns of a bike-sharing scheme in a medium sized city. Transportation Research Part A: Policy and Practice, 100, 152–161. https://doi.org/10.1016/j.tra.2017.04.023
5. Comision Ambiental de la Megalopolis (CAME). Afrontando el reto de la movilidad sustentable en la ZMVM https://www.gob.mx/comisionambiental/es/articulos/afrontando-el-reto-de-la-movilidad-sustentable-en-la-zmvm?idiom=es [accessed December 1, 2019]
6. Comision Ambiental de la Megalopolis (CAME)b. IMECA: Índice MEtropolitano de la Calidad del Aire. https://www.gob.mx/comisionambiental/es/articulos/imeca-indice-metropolitano-de-la-calidad-del-aire?idiom=es [accessed December 1, 2019]
7. Davis, L. W. (2008). The Effect of Driving Restrictions on Air Quality in Mexico City. Journal of Political Economy, 116(1), 38–81. https://doi.org/10.1086/529398
8. Davis, L. W. (2017). Saturday Driving Restrictions Fail to Improve Air Quality in Mexico City. Scientific Reports, 7(1), 41652. https://doi.org/10.1038/srep41652
9. de Grange, L., & Troncoso, R. (2011a). Impacts of vehicle restrictions on urban transport flows: The case of Santiago, Chile. Transport Policy, S0967070X11000825. https://doi.org/10.1016/j.tranpol.2011.06.001
10. de Grange, L., & Troncoso, R. (2011b). Impacts of vehicle restrictions on urban transport flows: The case of Santiago, Chile. Transport Policy, S0967070X11000825. https://doi.org/10.1016/j.tranpol.2011.06.001

11. de Hartog, J. J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the Health Benefits of Cycling Outweigh the Risks? Environmental Health Perspectives, 118(8), 1109–1116. https://doi.org/10.1289/ehp.0901747
12. ecobici, Gobierno de la Ciudad de Mexico. Que es ecobici? https://www.ecobici.cdmx.gob.mx/es/informacion-del-servicio/open-data [Accessed December 1, 2019]
13. El-Assi, W., Salah Mahmoud, M., & Nurul Habib, K. (2017). Effects of built environment and weather on bike sharing demand: A station level analysis of commercial bike sharing in Toronto. Transportation, 44(3), 589–613. https://doi.org/10.1007/s11116-015-9669-z
14. Faghih-Imani, A., & Eluru, N. (2016). Incorporating the impact of spatio-temporal interactions on bicycle sharing system demand: A case study of New York CitiBike system. Journal of Transport Geography, 54, 218–227. https://doi.org/10.1016/j.jtrangeo.2016.06.008
15. Fishman, E. (2016). Bikeshare: A Review of Recent Literature. Transport Reviews, 36(1), 92–113. https://doi.org/10.1080/01441647.2015.1033036
16. Fishman, E., & Schepers, P. (2016). Global bike share: What the data tells us about road safety. Journal of Safety Research, 56, 41–45. https://doi.org/10.1016/j.jsr.2015.11.007
17. Fishman, E., Washington, S., & Haworth, N. (2015). Bikeshare's impact on active travel: Evidence from the United States, Great Britain, and Australia. Journal of Transport & Health, 2(2), 135–142. https://doi.org/10.1016/j.jth.2015.03.004
18. Fuller, D., Luan, H., Buote, R., & Auchincloss, A. H. (2019). Impact of a public transit strike on public bicycle share use: An interrupted time series natural experiment study. Journal of Transport & Health, 13, 137–142. https://doi.org/10.1016/j.jth.2019.03.018
19. Fuller, D., Sahlqvist, S., Cummins, S., & Ogilvie, D. (2012). The impact of public transportation strikes on use of a bicycle share program in London: Interrupted time series design. Preventive Medicine, 54(1), 74–76. https://doi.org/10.1016/j.ypmed.2011.09.021
20. Gamble, J., Snizek, B., & Nielsen, T. S. (2017). From people to cycling indicators: Documenting and understanding the urban context of cyclists' experiences in Quito,

Ecuador. Journal of Transport Geography, 60, 167–177. https://doi.org/10.1016/j.jtrangeo.2017.03.004

21. Gardner, W., Mulvey, E. P., & Shaw, E. C. (n.d.). Regression Analyses of Counts and Rates: Poisson, Overdispersed Poisson, and Negative Binomial Models. 13.
22. Gebhart, K., & Noland, R. B. (2014). The impact of weather conditions on bikeshare trips in Washington, DC. Transportation, 41(6), 1205–1225. https://doi.org/10.1007/s11116-014-9540-7
23. Guerra, E., & Millard-Ball, A. (2017). Getting around a license-plate ban: Behavioral responses to Mexico City's driving restriction. Transportation Research Part D: Transport and Environment, 55, 113–126. https://doi.org/10.1016/j.trd.2017.06.027
24. Jang, T. Y. (2005). Count Data Models for Trip Generation. Journal of Transportation Engineering, 131(6), 444–450. https://doi.org/10.1061/(ASCE)0733-947X(2005)131:6(444)
25. Kelly, F. J., Fuller, G. W., Walton, H. A., & Fussell, J. C. (2012). Monitoring air pollution: Use of early warning systems for public health: Monitoring and communicating air quality. Respirology, 17(1), 7–19. https://doi.org/10.1111/j.1440-1843.2011.02065.x
26. McLeod, S., Babb, C., & Barlow, S. (2020). How to 'do' a bike plan: Collating best practices to synthesise a Maturity Model of planning for cycling. Transportation Research Interdisciplinary Perspectives, 5, 100130. https://doi.org/10.1016/j.trip.2020.100130
27. Mexico City Atmospheric Monitoring system, hourly pollutants. Mexico City Environment Ministry SEDEMA (2019) http://www.aire.cdmx.gob.mx/default.php [Accessed December 1, 2019]
28. Mexico City Environment Ministry SEDEMA (2019). Historico de contingencias. http://www.aire.cdmx.gob.mx/descargas/ultima-hora/calidad-aire/pcaa/pcaa-historico-contingencias.pdf [Accessed December 1, 2019]
29. Molina, L. T. (2004). Improving Air Quality in Megacities: Mexico City Case Study. Annals of the New York Academy of Sciences, 1023(1), 142–158. https://doi.org/10.1196/annals.1319.006

30. Noland, R. B., Smart, M. J., & Guo, Z. (2016). Bikeshare trip generation in New York City. Transportation Research Part A: Policy and Practice, 94, 164–181. https://doi.org/10.1016/j.tra.2016.08.030
31. Ricci, M. (2015). Bike sharing: A review of evidence on impacts and processes of implementation and operation. Research in Transportation Business & Management, 15, 28–38. https://doi.org/10.1016/j.rtbm.2015.03.003
32. Rivera, F., Antero Reyes, D., Brumón Martínez, I., & Mendoza Ortega, R. C. (n.d.). Encuesta ecobici 2017 (p. 38). Secretaria de Medio Ambiente. Retrieved December 1, 2019, from https://www.ecobici.cdmx.gob.mx/sites/default/files/pdf/encuesta_de_p2017_v3-w_baja_web.pdf
33. Rojas-Rueda, D., de Nazelle, A., Tainio, M., & Nieuwenhuijsen, M. J. (2011). The health risks and benefits of cycling in urban environments compared with car use: Health impact assessment study. BMJ, 343(aug04 2), d4521–d4521. https://doi.org/10.1136/bmj.d4521
34. Ryan, D. (2015). From commitment to action: A literature review on climate policy implementation at city level. Climatic Change, 131(4), 519–529. https://doi.org/10.1007/s10584-015-1402-6
35. Sagaris, L. (2010). From sustainable transport development to active citizenship and participatory democracy: The experience of Living City in Chile: From sustainable transport development to active citizenship and participatory democracy. Natural Resources Forum, 34(4), 275–288. https://doi.org/10.1111/j.1477-8947.2010.01312.x
36. Sagaris, L. (2014). Citizen participation for sustainable transport: The case of "Living City" in Santiago, Chile (1997–2012). Journal of Transport Geography, 41, 74–83. https://doi.org/10.1016/j.jtrangeo.2014.08.011
37. Secretaria de Medio Ambiente (SEDEMA). Hoy No Circula. https://sedema.cdmx.gob.mx/programas/programa/hoy-no-circula [accessed December 1, 2019]
38. Secretary of Public Education (SEP) 2015 – 2016 Academic Calendar (2015) https://www.gob.mx/sep/articulos/calendario-escolar-2015-2016-9409 [Accessed January 20, 2020]

39. Secretary of Public Education (SEP) 2016 - 2017 Academic Calendar (2016) https://www.gob.mx/gobmx/articulos/calendario-escolar-2016-2017 [Accessed January 20, 2020]
40. Secretary of Public Education (SEP) 2017- 2018 Academic Calendar (2017) https://www.gob.mx/sep/articulos/calendario-escolar-para-el-ciclo-escolar-2017-2018 [Accessed January 20, 2020]
41. Secretary of Public Education (SEP) 2018 – 2019 Academic Calendar (2018) https://www.gob.mx/sep/articulos/consulta-el-calendario-escolar-para-el-ciclo-escolar-2018-2019 [Accessed January 20, 2020]
42. Shaheen, S. A., Guzman, S., & Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future. Transportation Research Record: Journal of the Transportation Research Board, 2143(1), 159–167. https://doi.org/10.3141/2143-20
43. Sosa López, O., & Montero, S. (2018). Expert-citizens: Producing and contesting sustainable mobility policy in Mexican cities. Journal of Transport Geography, 67, 137–144. https://doi.org/10.1016/j.jtrangeo.2017.08.018
44. Tainio, M., de Nazelle, A. J., Götschi, T., Kahlmeier, S., Rojas-Rueda, D., Nieuwenhuijsen, M. J., de Sá, T. H., Kelly, P., & Woodcock, J. (2016). Can air pollution negate the health benefits of cycling and walking? Preventive Medicine, 87, 233–236. https://doi.org/10.1016/j.ypmed.2016.02.002
45. Wang, L., Xu, J., & Qin, P. (2014). Will a driving restriction policy reduce car trips?—The case study of Beijing, China. Transportation Research Part A: Policy and Practice, 67, 279–290. https://doi.org/10.1016/j.tra.2014.07.014
46. Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: Health impact modelling study. BMJ, 348(feb13 1), g425–g425. https://doi.org/10.1136/bmj.g425
47. Xu, D. (2019). Burn Calories, Not Fuel! The effects of bikeshare programs on obesity rates. Transportation Research Part D: Transport and Environment, 67, 89–108. https://doi.org/10.1016/j.trd.2018.11.002
48. Zhang, W., Lin Lawell, C.-Y. C., & Umanskaya, V. I. (2017). The effects of license plate-based driving restrictions on air quality: Theory and empirical evidence. Journal of

Environmental Economics and Management, 82, 181–220. https://doi.org/10.1016/j.jeem.2016.12.002

49. Zhou, X. (2015). Understanding Spatiotemporal Patterns of Biking Behavior by Analyzing Massive Bike Sharing Data in Chicago. PLOS ONE, 10(10), e0137922. https://doi.org/10.1371/journal.pone.0137922

Chapter 3. STREETS FOR PEOPLE, NOT CARS: SOCIAL PROCESSES AND INSTITUTIONS FOR CYCLING INFRASTRUCTURE IN MEXICO

3.1 INTRODUCTION

This study explores the local-level processes that lead to the development of cycling infrastructure as a practice implemented by governments in Mexican cities and investigates the factors that enable and constrain implementation. Over the last decade, cycling has gained prominence in many cities across countries in Latin America. Documented examples of cities in Latin America where cycling has significantly increased in the last decade and where new cycling cultures are emerging include Bogotá, Santiago, Mexico City, and Guadalajara (Rodríguez et al. 2017). While always present, this mode has not traditionally been a widespread transportation option in the region due to, among other things, lack of adequate infrastructure, high levels of congestion, and a lack of a safety culture to protect cyclists (Rodríguez et al. 2017).

Additionally, there is a link between mode of transport and socio-economic status in Mexico and some Latin American cities. The identity associated with cyclists is a low-income traveler, which creates negative connotations with this mode (Cepeda Zorrilla et al., 2019). Moreover, while there has been a rise in demand for better cycling conditions, most Latin American cities still have a low share of cycling and relatively high rates of collisions involving cyclists making cycling a marginalized mode (Rodríguez et al., 2017).

There has also been a recent rise in the uptake of policies to promote cycling nationally and subnationally. This research is particularly interested in the widespread adoption of cycling

laws and regulations at the national, state, and local levels and infrastructure development in cities across the region. These laws recognize and prioritize cycling as a mode of transportation, establish rules for cyclists and motorized vehicles to share roadways, and create an initial framework for municipalities to prioritize and undertake the development of cycling infrastructure. For the most part, these laws include high-level and usually vague mandates but lack details about how to plan, fund, and develop infrastructure locally.

Infrastructure for cycling mobility is less than ten years old in most Mexican Cities. The recent nature of cycling infrastructure as an area of policy implementation means that local governments have created new capabilities in this area. As cycling emerged as an area of policymaking and implementation and many local governments implemented cycling infrastructure for the first time, local governments did so with few policies, rules, professional norms, best practices, and examples to guide their effort. As a result, cities began experimenting with new institutional arrangements to develop and advance their cycling agendas (similar, for example, to areas like climate adaptation) (Anguelovski & Carmin, 2011).

This study explores the factors and local-level processes that have led to cycling infrastructure policy and planning in Mexican Cities. This study emphasizes that cycling infrastructure development is a specialized area beyond just adapting streets with lanes and signage with business as usual planning and implementation done by traffic engineers (McLeod et al., 2020). Cycling infrastructure requires, among other things, that governments learn new technical skills, develop codes and standards, and create coordination mechanisms across planning, designing, and implementing agencies.

To date, there is much literature identifying the need for cycling infrastructure in cities and for policy to address this need. Nevertheless, few studies address the development of

infrastructure and the challenges faced at a local and practical level, especially in places where governments lack previous experience planning and implementing infrastructure for cycling. Given that many cities are starting to promote cycling mobility, the experience in similar places can be valuable to practitioners and scholars in this field. Therefore, this research focuses on the operational level of policy to gain insight into the barriers and possible solutions to the implementation of cycling infrastructure. Cox and Koglin (2021) emphasize that academic researchers must investigate and map how cycling infrastructure is planned and negotiated (Cox and Koglin 2021).

In this chapter, I compare the motivations, trajectories, and experiences of mid-sized cities in Mexico to understand how cycling infrastructure emerges as an area of policy implementation and the challenges and lessons that emerge as governments engage with this new practice. Given that civil society organizations (CSOs) have played a crucial role in these trajectories, I also explore how CSOs affect the process of infrastructure provision. The following section includes a literature review on policy and planning infrastructure for cycling mobility, the quality attributes of cycling infrastructure, the theoretical discussions surrounding cycling infrastructure, the factors affecting cycling planning and implementation, and the hypotheses that guided this study. Then the methods for this study are presented, followed by the results, discussion and conclusion.

3.2 Literature review and Hypotheses

This section provides definitions for cycling infrastructure and policy and describes the different elements of the infrastructure planning process. After introducing the main components of cycling policy, where infrastructure is just one potential area of intervention (section 3.2.1), I review the common pathways for cycling infrastructure implementation and planning (section

3.2.2). Then, I offer a brief review of the attributes considered necessary for the quality of cycling infrastructure (section 3.2.3) and the theoretical discussions in the literature surrounding cycling infrastructure (section 3.2.4) to contextualize the value and need for this research. I review the literature to identify potential variables that may enable or constrain the ability of local government to implement cycling infrastructure (section 3.2.5), which is the main focus of this research, to justify the variables studied here as potential drivers of infrastructure implementation. I end this section with the hypotheses that drive the inquiry in this work (section 3.2.6).

3.2.1 *Infrastructure planning and implementation as cycling policy*

There are a few different determinants that influence willingness to cycle. These include the built environment (infrastructure, urban form), the natural environment (weather, climate, and topography), socio-economic variables (for example, gender, age, and class), psychological factors (for example, perceptions of crime and traffic safety, meanings and experiences), and aspects related to cost, time, effort and safety (Handy et al., 2014; Heinen et al., 2010).

Policy and governance related to cycling consist of several interrelated elements to shape and promote cycling mobility. Anaya-Boig (2021b) also noted that cycling policy should be integrated into a comprehensive strategy for cycling mobility and broader transport policy. In this research, I focus on the processes involved in developing bikeways, acknowledging that these are only one component of cycling infrastructure that requires other elements to be fully functional (like cycle parking). Table 8 summarizes common types of cycling policy with examples based on the framework developed by Anaya-Boig (2021b).

Developing cycling infrastructure is one of many cycling policies to promote and enable cycling (Anaya-Boig, 2021a). Cycling infrastructure refers to the built environment elements that

guide cycling mobility, including physical spaces and facilities, explicitly for cyclists' use. Cycling infrastructure can be dedicated exclusively to cycling mobility or shared with other modes and practices. Examples include bicycle paths and lanes, shared streets, cycle parking, bike signalization, and bike-sharing facilities.

Table 8. Anaya-Boig (2021b) Integrated cycling policy framework

Infrastructure	Regulations	Planning instruments	Governance	Communication	Social/Cultural movements	Education
Built environment elements, including physical spaces and facilities, explicitly for cyclists' use	*Laws and regulations (at local, state, national level) that determine the terms and conditions for cycling mobility*	*Planning in itself is a road map for policymaking; the planning or strategy document would be the guide that encompasses all*	*Interaction between the state or formal government and other organizations in the delivery of public services*	*Policy representations of cycling and cyclists/* *diffusion of cycling policy*	*Cultural processes of construction of cycling identity*	*Exchange of information, to provide or contribute to the skills or knowledge of the people involved*
Segregated cycling lanes and cycling paths	Street design codes	Bike (non-motorized mobility) master plan	An administrative structure that implements cycling policy	Communication of projects	Cycling events	Bike schools for citizens
Shared streets	Traffic regulations	Municipal development plan	Public agencies	Promotion campaigns	Social movements	Traffic education for cyclists and drivers
Bike parking	Urban mobility laws	Sustainable urban mobility plans	CSOs	Framing of cyclists	Social norms	
Bike-share	Urban development laws		Participation in planning			
Signalization						

A bikeway, like a bicycle facility, is "[a]ny road, street, path, or way which in some manner is specifically designated as being open to bicycle travel" (Seher, 2011). Table 9 contains definitions of different types of bikeways.

Table 9. Types of bikeways

Type of cycling facility	Definition (Buehler & Dill, 2016)
Bike lanes or Cycle lanes	Lane for cycle traffic separated from motorized travel by white lines painted on the roadway and situated between motorized travel lanes and car parking or the sidewalk.
Bike tracks or Cycle tracks or protected or separated bike lanes	Separate lane for cycle traffic on or adjacent to roadways, but physically separated from motorized traffic by a curb, concrete barriers, or by a space buffer with bollards. Often provide direct connections along roadways and protection from traffic.
Bike paths or cycleways	Bicycle paths are physically separated from roadways and typically run through parks or waterfronts, often not following the road network. These are often shared with other non-motorized travelers like pedestrians, skaters, scooters.

3.2.2 *Cycling infrastructure planning and implementation*

Infrastructure for cycling can be implemented through various processes and at different levels, although governments develop most at the local (municipal) level. Infrastructure is often planned and implemented on an individual-route or opportunistic basis, which can incrementally build a network over time (although this is not always the case). When this occurs, planning captures a window of opportunity. Assunçao-Denis and Tomalty (2019) classify opportunistic development into *process opportunity* approaches, and *spatial opportunity* approaches. Process opportunities are where governments 'piggyback' off existing public works projects to tag on cycling facilities. This can be project-based or following a legal mandate where governments include cycling infrastructure as a mandatory element of new and maintenance road projects. They also include private development opportunities where private developers include funding for cycling infrastructure in new developments, sometimes through legal requirements included in local development codes (Assunçao-Denis and Tomalty, 2019). *Spatial opportunity* approaches are when discrete cycling infrastructure projects are implemented on strategic roads or taking advantage of geographical features like riverbanks and train tracks (Assunçao-Denis and Tomalty, 2019). In this research, *political opportunity* emerges as another type where civil

society organizations or politicians rally around a specific emblematic project. A typical case of political opportunity is when governments make cycling lanes official after civil society organizations paint them as a form of protest.

Implementation can also follow a network planning process and strategic prioritization of routes. Planning can be done at the more fundamental level of broadly mapping origins and destinations or through more comprehensive, deliberate, and data-driven approaches that identify routes according to criteria like existing bike trips, connection to public transit routes, and strategic origins and destinations (trip attractors like universities and commercial hubs). For example, some cities develop Bicycle Master Plans to guide their efforts and gradually work towards an infrastructure network as part of a larger cycling promotion strategy. Following the strategic planning process, executive projects are developed with the specific design, budget, and other practical details and deployed according to high-priority lanes and specific funding opportunities.

Effective planning and implementation for cycling require the coordination and integration of many agencies and hierarchies of government. These include planning agencies, transport, and mobility agencies, Public Works Departments, and urban development agencies. Therefore, effectively implementing infrastructure also requires establishing shared goals and governance structures across organizations McLeod et al. (2020).

3.2.3 *Defining quality attributes of cycling infrastructure*

The design needs of any given infrastructure are usually context-specific. Therefore, cycling networks unavoidably consist of combinations of different types of infrastructure, which, in theory, should respond to the local street and network context, different needs of cyclists, and

geographic opportunities (McLeod et al., 2020). In most cities, quiet and low-speed streets without segregated infrastructure may accommodate cyclists and meet most of their needs (Buehler & Dill, 2016; McLeod et al., 2020).

When planning for cycling mobility, cities must provide different facilities for cyclists, considering that different people have varying skill and comfort levels (Dill, 2009; Dill & McNeil, 2013). There is a long-standing debate between *segregationists*, those who prefer segregated off-road facilities such as bike paths, and, *integrationists* those who prefer facilities on-road to support *vehicular cycling (*where bikes can use roads as if they were cars) (Aldred, 2012; Forsyth & Krizek, 2010; Parkin & Koorey, 2012). However, it is now widely acknowledged that most people prefer physically separated infrastructure (Adam et al., 2020; Buehler & Dill, 2016; Dill & Carr, 2003; Heinen et al., 2010; Pucher & Buehler, 2017). For example, Dill and Carr (2003) showed a positive relationship between bicycling infrastructure and bicycles in U.S. metropolitan areas after controlling for other influential variables like weather (Dill & Carr, 2003). Buehler and Pucher (2012) found that segregated infrastructure had a positive effect on bike commuting patterns (Buehler & Pucher, 2012), while Parkin, Wardman, and Page (2007) showed that bike users would prefer segregated infrastructure even if it increased travel time. These preferences are strong among more vulnerable cyclists or people who are less likely to cycle like women, children, and the elderly (Akar et al., 2013; McLeod et al., 2020)

Best practice guidance on developing quality infrastructure frequently includes attributes such as coherence (continuity of the network and connection to destinations), directness (infrastructure provides cyclists with short and fast routes), attractiveness (infrastructure is furnished, illuminated, and provided with signage), traffic safety (design ensures safety of all

users), and comfort (allows cycle traffic to circulate smoothly, includes flat surfaces, minimum of inclines) as essential quality attributes of bicycle infrastructure (Hull and O'Holleran 2014; McLeod et al. 2020). Other attributes include spatial integration (infrastructure is integrated into various spatial contexts – urban, suburban, downtown), experience (whether the experience of riding is enjoyable or stressful) and, value (access to commercial areas or services) (Hull and O'Holleran 2014; McLeod et al. 2020).

Design principles seeking safety from traffic crashes should incorporate other local concerns like public safety principles and local practices. For example, the usefulness of cycling paths isolated from public view may be limited if cyclists do not feel safe (Adam et al., 2020; Pucher et al., 2010). Additionally, fitting quality characteristics of cycling infrastructure may be particular to geographic context. For example, in cities with warmer weather, shaded routes tend to be desirable (McLeod et al., 2020). Given the many attributes that determine the quality of infrastructure, there are often tradeoffs between desirable attributes. Some prospective routes may perform well for some attributes while not catering to many cyclists due to deficits in another quality attribute (McLeod et al., 2020). Lack of safety (real or perceived) is widely regarded as one of the most substantial barriers to cycling (Hull and O'Holleran 2014). Separated cycling facilities, such as cycle tracks, are likely to represent the safest routes when measured in terms of crashes, though actual cycling risk may be concentrated at intersections or associated with falls or collisions with vehicles or other objects (Parkin & Koorey, 2012).

More recent debates have emerged about equity and accessibility as essential attributes of cycling infrastructure. Cycling advocates have asserted that low-income and minority populations have disproportionately low access to infrastructure such as bikeways (Braun et al., 2019). Research in the South American context has found that low-income populations have

disproportionately low access to bikeways in Santiago, Bogotá, Rio de Janeiro, and Curitiba (Braun et al., 2019; Mora et al., 2021; Parra et al., 2018; Tucker & Manaugh, 2018). Therefore, aside from physical attributes, consideration should be given to who benefits from investment in cycling infrastructure and who is left out when evaluating infrastructure.

3.2.4 *Theoretical discussions surrounding cycling infrastructure*

"Build it, and they will come" is a commonly repeated phrase among cycling advocates, referring to the potential of physical cycling infrastructure, especially a network of segregated cycling lanes and paths, for attracting new cyclists (Cervero et al., 2013). Building infrastructure is currently conceived as crucial to increase participation in cycling and leverage its potential as a sustainable mode of transport (Pucher & Buehler, 2017). Additionally, advocates point out that planning approaches have historically largely marginalized walking and cycling in favor of motorized transport modes (Koglin, 2015; Urry, 2004). Therefore, cycling advocates and enthusiasts often posit that cycling infrastructure or programs will increase the number of cyclists.

Many academic studies back these beliefs about the importance of cycling infrastructure. Research has shown that the lack of good quality cycling infrastructure is a significant barrier to cycling for transportation and shows that quality infrastructure can positively affect cycling. Empirical studies have repeatedly shown that urban environments with dedicated cycling infrastructure, traffic-calming measures, and moderate to high urban densities are associated with higher cycling rates, although the direction of causality is uncertain (Cervero et al., 2019; Dill & Carr, 2003; Handy & Xing, 2011; Koohsari et al., 2020; Mertens et al., 2017; Pucher et al., 2010; Titze et al., 2008; Zhao, 2014). Nello-Deakin (2020) has gone as far as to argue that this research area has reached a point of saturation such that new research is unlikely to deliver any new

policy-relevant insights for understanding aspects of the built environment that may encourage cycling. This academic scholarship and advocacy line essentially treats cycling as a technocratic problem assuming that physical infrastructure can address the lack of cycling. However, framing cycling as a technical problem rooted in lack of provision often fails to consider the reality of infrastructure delivery. This technocratic lens also fails to acknowledge infrastructure's political nature by redefining structural tensions as "technical issues of supply and shortage" (Cox and Koglin 2021).

To go beyond this lens, many authors urge analysis, practice, and advocacy of infrastructure development in cycling to expand from the material adaptation of spaces and adoption of dominant practices from the global north, especially in geographies with drastically different street life. Research must acknowledge that infrastructure results from social structures and political processes that can reflect and reproduce systems of inequality (Cox & Koglin, 2021). Castañeda (2021) proposes creating new and local frames of reference for cycling research, engaging the critical evaluation of the effects of cycling best-practices on "already uneven urban landscapes" and elevating the technical and grassroots innovations produced by people in cities of the South to develop a "broader understanding of the kinds of politics implicated in the promotion of cycling, beyond issues of political will" (Castañeda, 2021).

Gartner (2016) distinguishes between policies that arise from local perspectives from those imposed from afar. The former is sensitive and responsive to existing conditions, while the latter consolidates inequitable power relations. Participation or consultation can help remediate the gap between these directions. However, the mechanisms employed in participation processes are rarely a serious attempt to bridge the gap. Gartner points to the need for "a more representative and inclusive knowledge of infrastructure development" (Gartner, 2016 p. 378).

“Infrastructure orders and governs the actions it makes possible.” Therefore, building infrastructure opens potential lines of action and closes others (Cox & Koglin, 2021, p.15). Cox and Koglin (2021) review the literature examining the social and political dimensions of infrastructure and bring these dimensions to the forefront of cycling infrastructure analysis. At the heart of these ideas is the understanding that material infrastructures are not just their material dimension because social processes produce them. Power and social selectiveness "does not just concern the distribution of infrastructure provisioning, but inequalities are further produced through the design and form of implementation." For example, bikeways that permit the use of certain cycle vehicles and not others (traditional tricycles) or those limiting their viability to cyclists with a particular skill level.

Amin (2014) also reveals that infrastructure has a moral, political dimension. Infrastructure embodies and enacts symbolic power and social selectiveness built into the system, privileging certain groups over others and reflecting the dominant regimes if these regimes are left unexamined (Amin, 2014). For example, cyclists usually ride within mobility systems dominated by automobility (Mrkajić & Anguelovski, 2016). In general, infrastructure provision has historically prioritized motorized transport and cars, displacing other modes to "marginal and leftover spaces" (Cox & Koglin, 2021). Cycling infrastructure is often determined once motor traffic needs have been prioritized, without addressing the fundamental asymmetry of power that makes cycling unattractive or unsafe. Therefore, implementing cycling infrastructure is not necessarily an indicator of a paradigm change on its own and requires inquiry into how it is developed and whether it presents a radical challenge to automobility (Cox & Koglin, 2021).

3.2.5 *Factors affecting cycling planning and implementation*

Planning, designing, and implementing policy for cycling mobility often requires divergence from existing practices, new capacities, knowledge, and competencies (McLeod et al., 2020). As cycling policy emerges as a new area of policymaking and implementation, local governments have few policies, rules, professional norms, best practices, and examples to guide their effort. As a result, cities often experiment with new institutional arrangements to develop and advance their cycling agendas (Anguelovski & Carmin, 2011). As city governments take up this practice, many potential factors can enable or constrain their capacity to plan and implement cycling policy, reflecting on the characteristics of the resulting cycling infrastructure.

Picon (2018, p. 263) conceives infrastructure as the result of the "interactions between a material basis (for example street space and resources), professional organizations and stabilized sociotechnical practices and social imagination." Therefore, understanding and contextualizing cycling infrastructure within a city can be helped by understanding these interactions. Through those involved in conceptualization planning infrastructure, the politics of infrastructure development links the human to the material components. This context seems especially relevant in cities where cycling is an emerging area of policy, and practices and processes are continuously developing (Picon, 2018).

To theorize what might shape the development and implementation of cycling-related policy, and more specifically, infrastructure, I draw on both the literature exploring such factors in sustainable urban mobility and broader environmental and climate-related policies. Depending on the context and how they manifest themselves, these factors can either act as barriers, meaning factors weakening or limiting the design and implementation of policies, or their opposite, success factors. It is worth noting that the categories described below are not mutually

exclusive and that several types of barriers and enablers will overlap in a given context. Also, many of these factors are not static and develop over time as cycling becomes a more established and institutionalized area of policy in local governments.

3.2.5.1 Laws and regulations

The presence or absence of laws can shape and constrain action. Laws and regulations determine the terms and conditions for cycling mobility by granting rights and responsibilities to citizens, public entities, and organizations. They can also restrict potentials and impose limitations. For example, the legal capabilities of local governments will structure their ability to implement policies and programs. Laws and regulations that directly or indirectly impact cycling are emitted at different administrative levels: international, national, state, and local (municipal). These levels have a hierarchy, and different administrative levels regulate different aspects. The hierarchy and overlap of regulations are often a source of ambiguity, such as not assigning clear roles and responsibilities or lacking harmonization across administrative levels. Cycling laws and regulations are often not well known (or perhaps not taken seriously) by policy-makers and decision-makers, so their implementation is not guaranteed (Bardal et al., 2020; Ryan, 2015). Public administrators in planning and implementation can be trained to be aware of legal frameworks and implement them. For example, Public Works Department officials with no previous experience building cycling infrastructure can be trained and sensitized to understand better how to implement cycling facilities.

There are many examples of regulations that impact cycling. Street design and urban planning codes and guidelines regulate, among other things, how and when cycling infrastructure should be built, and specify the technical characteristics of cycling infrastructure and signage. Highway codes and road safety regulations dictate how cyclists can use the streets and where

they are restricted. These can be protective or punitive of cyclists. Some traffic regulations include strict penalties for cyclists that ride outside of infrastructure or fail to follow a rule. Rules for car driving and parking around cycling and cycling infrastructure are also standard. For example, some cities create regulations that impose penalties on cars that park in cycling lanes. Cycling policy is also affected by regulations outside the cycling realm, for example, by participation laws that can influence citizen participation in planning processes. Urban development laws and regulations can include provisions for new developments to include cycling infrastructure.

Legal barriers manifest themselves when the measures lack or have weak support in existing laws and regulations. In the case of cycling, in many places, cyclists and cycling infrastructure do not exist in legal frameworks, leaving them outside of the purview of government. The extent of local government powers is critical to their ability to implement policy, meaning that governments will be limited in their ability and power to take actions outside of their legal competencies (Bai, 2007; Bulkeley, 2010; Martins & Ferreira, 2011; Ryan, 2015).

Within the realm of legal competencies, urban mobility-related issues often require actions outside the scope of the legal powers of local government. For example, there are often streets under state or federal-level jurisdiction within city limits, and therefore cannot be intervened by a local municipality. Many other transport, spatial and land-use planning competencies that affect local mobility issues are also outside of municipal-level jurisdictions or subject to multiple jurisdictions and levels of government (Ryan, 2015). Scholars have called this the problem of 'fit,' the discrepancy between the scale and scope of urban policy problems and the extent of local government authority (Bulkeley, 2010; Lankao, 2007).

3.2.5.2 Organizations and governance

In addition to the legal capabilities of local governments, organizational resources are also crucial to explaining policy development and implementation (Holgate, 2007; Ryan, 2015). Variables that fall within the organizational realm include funding, human resources, data and information management, and the collaboration within and between institutions designing and implementing the policies. Implementing policy in new areas like cycling requires organizational mandates or new organizations with legal competencies and responsibilities necessary to develop activities. However, it is relatively common for these new mandates to be assigned without corresponding funds for implementation, creating a mismatch between local governments' scope of legal and policy competencies and their material capability to carry them out (Larson, 2002; Ryan, 2015). Vague organizational responsibility, lack of capacity, and tensions within or between organizations can represent substantial barriers to policy implementation (Bardal et al., 2020). Resource barriers appear when resources such as funding, knowledge, or technology for a measure are missing or insufficient (Bardal et al., 2020).

3.2.5.3 Political support

Political support refers to the backing of policies by organized interest groups or democratic institutions at the national, regional, or local government levels. A large body of literature focuses on the opportunities for political leadership in promoting local policies, emphasizing the role of the 'political entrepreneur' or champion. However, this literature also acknowledges that policy entrepreneurs are often limited in their scope. Broader institutional capacity is necessary to overcome common administrative and political difficulties (Bulkeley, 2010; Lankao, 2007; Martins & Ferreira, 2011).

Additionally, research focuses on the influence of interest groups from business and civil society to explain policy development. This influence can be positive due to the presence of civil society organizations (CSO), a professionalized and organized environmental movement advocating for policy or businesses that can benefit from implementation. Research has shown that cycling advocacy groups can positively impact convincing local governments to invest in infrastructure and allocate more space for bicycles (Aldred & Jungnickel, 2014; Buehler & Handy, 2008; Sosa López & Montero, 2018).

In Mexico, three distinct types of non-government actors have been involved in promoting and increasing cycling mobility policy: International organizations (non-governmental organizations NGOs and aid organizations), local NGOs, and grassroots activists or *colectivos* (Table 10). Over the last two decades, cycling organizations have become ubiquitous globally, and Mexico is no exception. Cycling advocacy organizations have emerged in cities around the country to demand that governments provide safe conditions for cycling mobility. The role of international NGOs as actors promoting policy in Mexico has been studied by Montero and Sosa Lopez (2018), who show how these actors leverage their status as experts and non-state actors ("citizens") to engage with policymakers, public agencies, and the public to both advocate for and contest mobility policy.

One example of a grassroots activity that many advocacy organizations engage in to initiate dialogue with the government about the need to improve conditions for cycling is *critical mass*. This protest began in San Francisco in 1992 and spread across the globe as an exercise of reclaiming the streets from cars for people. As stated by Furness (2010) "By allowing bicyclists to experiment with spontaneity, playfulness, and dominant uses of public spaces, Critical Mass is

a critical practice that, for better or worse, sparks a necessary dialogue about the role of the bicycle in a world increasingly dominated by cars" (Furness, 2010).

Table 10. Types of non-governmental actors in cycling mobility advocacy

Organization type	Examples	Distinguishing characteristics
International NGOs and international aid organizations	World Resources Institute (WRI) Mexico, Institute for Transportation and Development Policy (ITDP), GIZ	Large international advocacy organizations
Grassroots organizations or *Colectivos*	Mochila Rodante, Observatorio de Movilidad Sostenible de Mérida	Grassroots organizations or clubs. Members participate voluntarily. Not all *Colectivos* are policy-oriented, but the focus here is on *Colectivos* who do public and government-facing advocacy work
Local NGOs	Colectivo Ecologista de Jalisco, Bicivilízate, Fundacion Tlaloc	Legally established Mexican NGO (*Asociacion Civil*). Often funded to do professional or consulting work or provide services. Some members are professionally affiliated, while others are voluntary. They often start as C*olectivos* (so the difference between these is fuzzy) that become legally established and sometimes professionalized.

Source: Modified from Sosa López & Montero, 2018

Organized interest can also block policy implementation. Organized neighborhood groups, business owners, or other lobby organizations can organize and block cycling infrastructure projects. For example, Ryan et al. in Buenos Aires found that bicycle manufacturers and retailers supported cycling policies, while associations of taxi owners and employees tried to block them (Ryan, 2015). Ryan (2015) also notes that the role of political parties in developing urban climate policy is under-researched, which could include cycling policy. The degree of politicization, meaning whether the issue at hand is electorally relevant between political parties, may be a significant indicator of the social relevance attributed to an issue by a particular polity (Carter, 2006; Ryan, 2015).

3.2.5.4 Culture

Culture relates to existing norms and values among citizens and society. These pre-existing conceptions and norms can impact the ability and willingness to implement and accept cycling-related policies (Aldred, 2013; Bardal et al., 2020). Culture is relevant in cycling policy at different stages of the development and implementation process. For example, planning cultures in agencies accustomed to planning for expanding motorized traffic will translate some of their usual practices when planning and implementing cycling mobility. Therefore, bicycle infrastructure planning and implementation occur within agencies where the existing culture impacts cycling policy development.

Culture is also relevant at a broader societal level, shaping public acceptance of cycling-related measures. The concept of bicycle culture captures a range of factors that determine local norms and perceptions around cycling. For example, in some settings, bikes often have the negative connotation of being used by "poor people" and signifying a lack of status. Cycling advocacy organizations often work to change these perceptions as part of their advocacy. In Copenhagen and London, cycling groups improved the bicycle's image through communication campaigns (Aldred, 2013; Carstensen et al., 2015). The historical context surrounding the status given to the car and economic growth in which a city develops also impacts possibilities of social acceptance of the bicycle as a means of transportation and the willingness to implement policies to support cycling mobility (Aldred & Jungnickel, 2014; Carstensen et al., 2015; Gössling, 2013; Koglin, 2015).

3.2.6 *Hypotheses*

In this research, I study how cycling infrastructure has materialized as a practice in Mexican Municipalities as many of these cities implement this type of infrastructure for the first

time. The literature has not explored the factors that enable and constrain infrastructure development in places where cycling is an emerging form of policy. As the review above suggests, some institutions can emerge to enable and guide infrastructure development. I focus this research on three of these factors that the literature suggests play important roles. First, as seen in the previous section, research has shown that cycling advocacy groups positively impact infrastructure implementation by convincing local governments to invest in infrastructure and allocate more space for bicycles (Aldred & Jungnickel, 2014; T. Buehler & Handy, 2008; Sosa López & Montero, 2018). Therefore, *I expect that places with strong advocacy organizations are more likely to implement infrastructure (H1)*. Second, given that laws and regulations determine the terms and conditions for cycling mobility by granting rights and responsibilities to citizens, public entities, and organizations rights and responsibilities *I expect that cities that have developed laws that mandate infrastructure development are more likely to develop cycling infrastructure (H2).* Finally, organizational resources are also crucial to explaining policy development and implementation (Holgate, 2007; Ryan, 2015). Therefore, I *expect cities with specialized agencies to implement these mandates are more likely to implement cycling infrastructure (H3).*

3.3 METHODS

Using a multiple case study research design, I developed this using semi-structured interviews and secondary sources, including public information requests, policy documents, regulations, press releases, and government web pages. The data collected were examined using content analysis to identify the themes and variables that explain the process and current state of cycling infrastructure development in Mexican cities and the influence of institutions and local actors that affect this process.

3.3.1 *Case selection*

There is considerable variation in state and municipal policy and practices supporting cycling infrastructure in Mexican cities, including the legal and institutional frameworks backing implementation and the local experience developing infrastructure. To capture this variation and include a variety of local-level experiences, I selected the case study cities for this research based on two components: local spending of federal funds on cycling infrastructure between 2011-2017 and the presence or absence of a legal framework that legitimizes and supports policy initiatives for cycling as an alternative mode of transportation, a state-level cycling law or a mobility law (Table 11). Choosing a balanced set of cases with varying legal mandates sought to ensure various institutional structures were represented in the selected cities, acknowledging that a variety of planning and policy instruments and institutions need to be captured to draw conclusions.

Given that detailed data on infrastructure projects for cities was not widely publicly available at the time of designing this research and would need to be part of the data collection in the field, I selected expenditures from federal funds on cycling infrastructure between 2011 and 2017 as a proxy for infrastructure development for the selection of cases (Handy and McCann 2010)[1]. For case selection purposes, I interpreted investment in cycling infrastructure as a signal of the presence or absence of local implementation of cycling policy to ensure that the selected

[1] In Mexico, the Institute for Transportation and Development Policy (ITDP) develops a yearly analysis of how the local governments of Mexico's 59 cities spend the funds that they have available on transportation infrastructure projects. The objective is to track whether municipal governments choose to make investments in sustainable urban mobility, given that, in theory, this has become a national and, in many places, state-level priority. Their expenditures analysis is based on a publicly available database that is compiled by the Ministry of Finance (Secretaria de Hacienda y Credito Publico) and contains yearly budgets and expenditures at the state and municipal level for all of the funds that municipalities can use to develop infrastructure projects. Federal funds are the main source of income for most cities and are also the main source of funding for mobility projects (ITDP, 2017). The database clearly indicates the type of project (for example whether the infrastructure is built for cycling, cars, public transportation, pedestrians, etc.) and where the funds come from and where they are spent. The data is also adjusted for inflation to make investments comparable across years.

cities captured a representative range of cases. Once in the field, I gathered data on the cycling infrastructure developed in each city over the last ten years (to the extent possible). For the final classification of the cases in this study, federal expenditures were substituted with on-the-ground infrastructure development measures, including km, type, and location of cycling infrastructure implemented in the municipality over the last ten years. Figure 6 shows the location of the municipalities included in this study: Cuernavaca, Toluca, Oaxaca, Querétaro, Aguascalientes, Mérida, León, Morelia, Puebla and Guadalajara. Table 12 compares the selected cities in terms of population size, area, and GDP per capita, and Table 13 shows the weather and geography of selected cases. Finally, Table 14 compares the recent growth of the vehicle fleet and variables related to safety and safety perception.

The variation in federal funds spending reflects the interest and implementation efforts at the local level in developing cycling infrastructure with some limitations. Local governments have complete control over their finances. Article 115 of the Mexican Constitution defines municipal faculties and gives them a primary role in providing public services, including those related to urban development within their jurisdiction (Mexico, 1961). This means that when local governments spend on cycling infrastructure or develop policies and capabilities around cycling, they choose to do so. They can develop cycling infrastructure with local funds, funds from the federal government received through the state or specialized funds for municipal improvement. While most states receive over 85% of their available budgets from federal funds (ITDP, 2016), state funds are not accounted for in the ITDP data. For example, municipalities with higher fiscal capacity levels may be spending local funds on cycling infrastructure that is not captured in ITDP's federal fund analysis making these a limited proxy of implementation of cycling. Another limitation is that some of the federal fund expenditures are marked as spent at

the state level, so it is impossible to know in which municipality the funds were spent, and therefore they cannot be attributed to any specific city (ITDP, 2016)[2]. Therefore, I only used this limited proxy for case selection. The following analysis used more detailed infrastructure data that I collected in the field during this research.

Table 11. Sampling Frame

	Spend more of the total mobility budget on transportation on cycling infrastructure	Spend less of the total mobility budget on transportation on cycling infrastructure
Law	Mérida Morelia Toluca Guadalajara	León Oaxaca
No Law	Puebla	Cuernavaca Aguascalientes[3]

[2] For the available years, investment in cycling projects, the state-level funds that cannot be tracked to any specific metropolitan area, have represented between 0 and 12% of total yearly expenditures on cycling infrastructure.

[3] Aguascalientes passed a Mobility Law and a Bike Law that came in 2018. Because the data for expenditures goes to 2017 it is grouped in the "no law" category because this law was not effective for the time period where the expenditure data was available.

Figure 6. Location of selected municipalities

I computed the 2011-2017 spending of federal funds on cycling infrastructure as a percentage of total spending on all mobility infrastructure over the same period. Likewise, I categorized cities by their state mobility/cycling law status: those adopted before 2020 (Law) and those that have not yet adopted laws (No Law). I chose state capital cities[4], which tend to be regional economic and population hubs within larger metropolitan areas, with between 200,000 and 1.5 million people in the municipal core.

[4] The one exception is León because it has a larger economy than Guanajuato, the State Capital of Guanajuato and is more comparable to other cities in the selected cases.

Table 12. Population trends, area, and GDP comparison across selected cities

	Aguascalientes	Mérida	León	Puebla	Cuernavaca	Querétaro	Morelia	Toluca	Oaxaca	Guadalajara
					Population (2020)					
Metropolitan area (Inhabitants)	1,140,916	1,316,088	1,924,771	3,199,530	1,028,589	1,648,703	988,704	2,353,924	713,925	5,268,642
Municipality (Inhabitants)	948,990	995,129	1,721,215	1,692,181	378,476	1,049,777	849,053	910,608	270,955	1,385,629
					Population growth (1990-2020)					
Metropolitan area (% increase population)	108.4%	109.0%	98.3%	60.0%	90.7%	196.8%	87.7%	124.9%	26.6%	75.4%
Municipality (% increase population)	87.45%	78.72%	95.80%	119.43%	34.55%	129.98%	72.26%	86.75%	115.53%	-16.03%
					Area					
Full metropolitan area (Km^2)	1,822	3,044	1,767	2,392	209	2,427	1,771	2,411	634	3,561
Municipality (Km^2)	1,178	883	1,760	543	1,190	683	1,192	426	90	151
Growth of urbanized metro area (2010-2018)	34%	38%	50%	8%	7%	37%	32%	18%	24%	38%
					Economic					
GDP per capita (MXN$) (2017)	163,090	114,383	119,344	91,565	102,144	186,049	89,157	91,916	60,774	146,333

Table sources: SEDATU/CONAPO/INEGI, 2018; CGPV, 1990; CPV, 2020; INEGI 2020; CEFP, 2019; Zubicaray et al., 2021

Table 13. Comparison of weather and topography across cases

	Aguascalientes	Mérida	León	Puebla	Cuernavaca	Querétaro	Morelia	Toluca	Oaxaca	Guadalajara
					Environment					
Min Temp / Max temp (F)	32 /92	57 / 103	38/ 93	37 / 85	44/93	36 / 91	35/ 89	26 / 80	42/ 93	33/ 93
Wet season	June - October >25% chance of wet day	May to mid-October > 38% chance of wet day	June - September > 31% of wet day	May to early October > 38% of wet day	May to early October > 40% of wet day	June - October > 31% chance of wet day	June - Octobe, > 38% chance of wet day	May - October > 40% chance of wet day	May - October > 40% chance of wet day	June - September > 40% chance of wet day
Hot Season	April - June, average high > 83 F	April -June, with an average high > 94°F	April - June, with an average high > 85°F	March - June, with an average high > 77°F	March- May, with an average high > 85°F	April - June, average high > 83°F	April - June, average high > 81°F	March-June with an average high > 72°F	March-May, average high > 87°F	March-May, average high > 87°F
General urban topography (within 10 miles)	Flat	Flat	Modest elevations	Modest elevations	Large elevations	Modest elevations	Areas with modest to large elevations	Flat	Areas with modest to large elevations	Flat

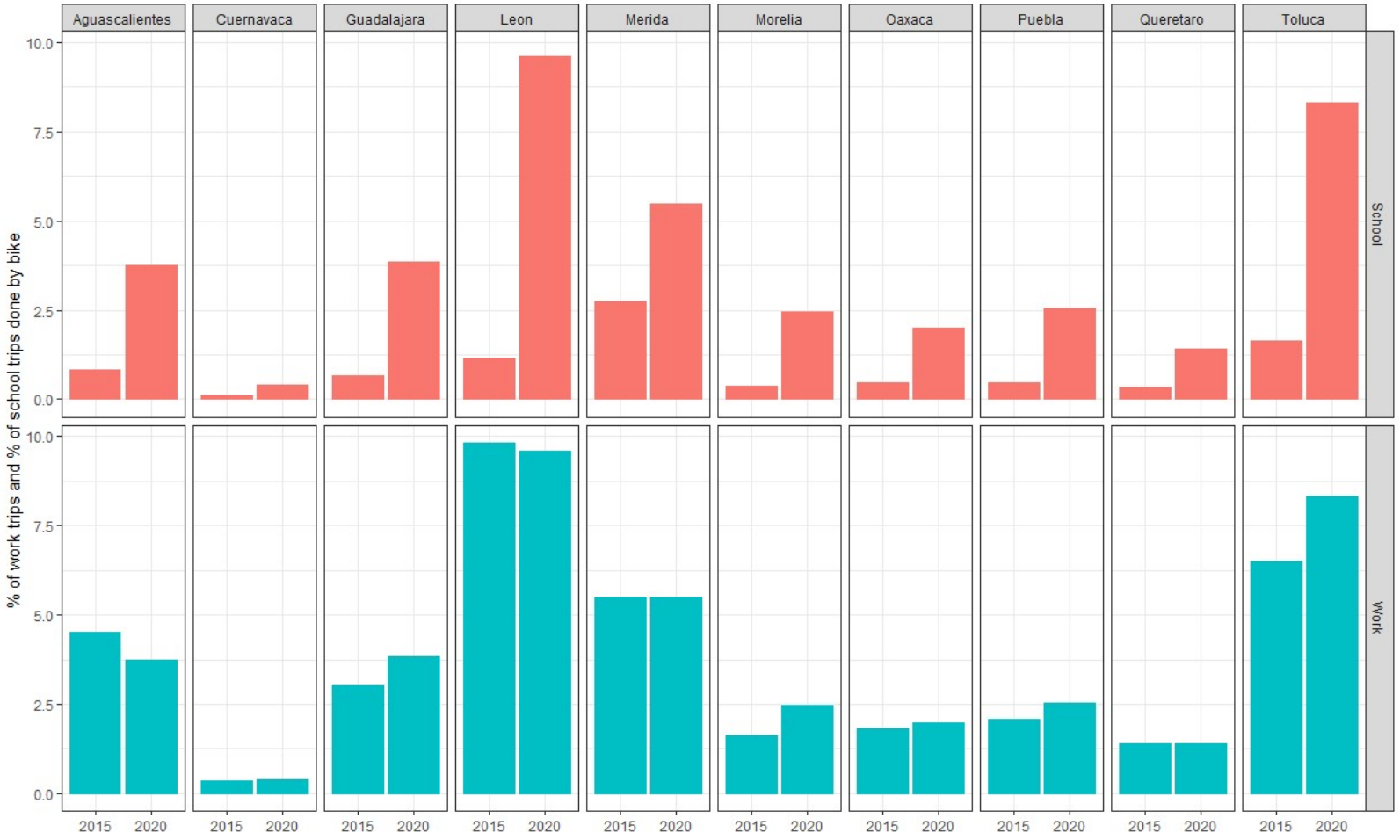
Table sources: Weatherspark, 2021

Table 14. Comparison of vehicle fleets and safety metrics across cases

	Aguascalientes	Mérida	León	Puebla	Cuernavaca	Querétaro	Morelia	Toluca	Oaxaca	Guadalajara
					Motorization					
Total registered vehicles	547,500	697,309	684,800	1,069,764	739,579	605,542	670,506	1,030,893	297,786	2,514,649
Metro Area Increase (2000 - 2020)	257%	377%	278%	44%	396%	293%	331%	283%	103%	244%
					Safety					
Cycling collisions state (2019)	83	331	654	104	91	96	167	106	38	212
Cycling collisions metro area (2019)	64	123	166	62	30	66	66	26	26	123
Perception of insecurity (% ppl who feel highly insecure)	51%	23%	77%	89%	87%	47%	73%	77%	64%	77%
Crime prevalence per 100,000 inhabitants	37,180	19,595	44,479	35,177	30,632	37,227	22,650	31,748	29,437	33,202

Table source: ENVIPE, 2020; INEGI, 2020a; INEGI, 2020b

Figure 7. Trips to school and work by bike in the selected municipalities



Source: INEGI 2016, 2021

3.3.2 *Participant selection*

To select interview participants, I targeted managers at government agencies, including the Urban Mobility Office or equivalent, the Public Works Department, local-decision-makers, local academics, and CSOs. Purposeful selection ensured the representation of a variety of perspectives. I also implemented a snowball sampling strategy to identify interview subjects. I identified local actors through an internet search of organizations, implementing agencies, thought leaders, and policy documents for each site. Once contacts were established with interviewees, I asked them if they would be willing to provide contact details of other people they considered necessary to interview for this study and provide referrals. I contacted approximately 107 people, and 103 accepted to participate. I conducted 99 interviews because four people who had accepted to participate either canceled or were unable to schedule. Many interviewees declined when I first contacted them but accepted after referrals, which significantly improved the response rate in this research. Finally, during interviews, approximately ten more names were mentioned as key informants that I could not contact due to not having access to their email or phone number.

3.3.3 *Data Collection*

The primary data source was in-depth interviews with participants, consisting of semi-structured open-ended questions. Qualitative research aims for analytical generalization targeted towards acquiring deep insight within the specific context of the research, in contrast to statistical generalization (Denzin & Lincoln 2005; Luker, 2008).

Between January and March of 2020 I visited seven field sites: Toluca, Guadalajara, Cuernavaca, Mérida, Morelia, Puebla, and Aguascalientes. Adapting to the circumstances

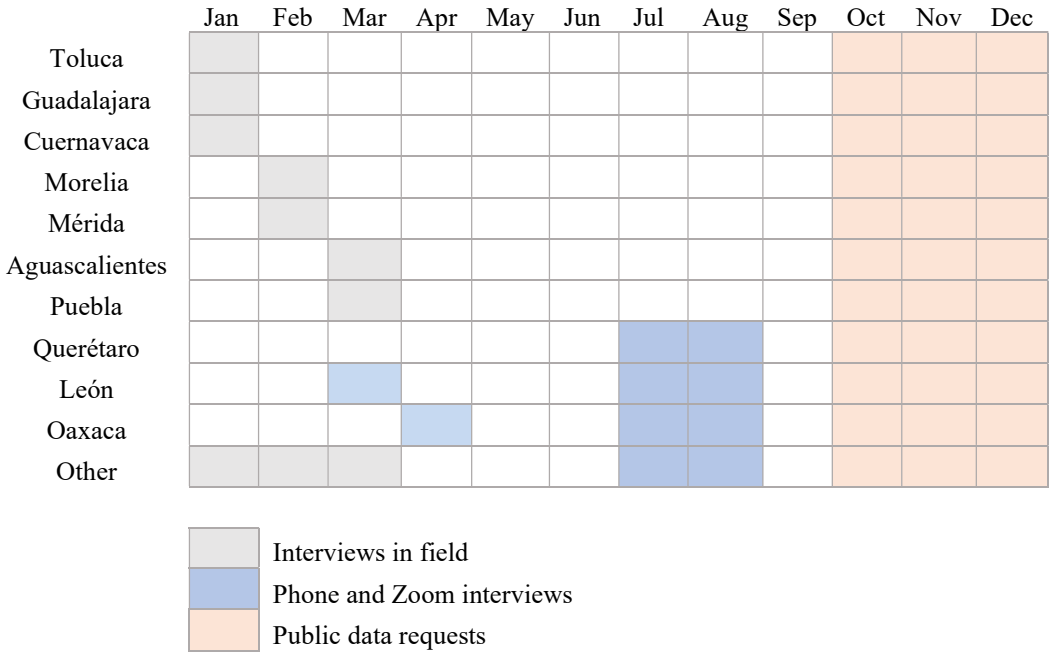
brought by the COVID-19 pandemic, the remaining data collection was done between July 2020 and December 2020 and was conducted over Zoom and by phone. Between July and September 2020, I conducted 22 additional interviews with informants in Oaxaca, León, and Querétaro and four interviews with Members of the National Cycling Network, *Bicired*. Figure 9 summarizes the interviews I conducted by the city and sector of the informant. In total, I conducted 99 interviews for this study. In addition to the interviews conducted between September and December 2020, I submitted public information requests to each city in my set of cases to obtain additional information about their cycling facilities, with a response rate of about 35%. This low response rate may have been due to diminished capacity resulting from the closure of government offices during the COVID-19 pandemic.

Interviews were between 40 min and 90 min in length, where the average interview lasted approximately one hour. I designed the interview guide to prompt participants to consider all the variables that influence their ability to implement cycling infrastructure and discuss the factors that affect its implementation (Appendix 1. Interview protocol). I asked participants about the processes and policies that support implementing cycling infrastructure in their city and their perceptions about the drivers for developing infrastructure. Then, I asked them about a successful cycling infrastructure implementation effort that has taken place in their city and about what typically goes into its development. I also asked participants to talk about failure in infrastructure development. Participants were probed about the general quality of the infrastructure in their city and asked to point to examples of the best, worst and typical types of infrastructure.

While assessing the quality of a city's cycling infrastructure would require a systematic audit, these questions were oriented towards understanding the general strengths and weaknesses

of the existing local network or collection of cycling paths and lanes, and the trajectories of cities building infrastructure, and whether any standards were set for its development. As part of the open-ended questions, participants discussed the challenges and opportunities in promoting, planning, designing, and implementing cycling infrastructure. The detailed interview protocol used in this research is in Appendix 1. Of the 99 interviews, 94 were audio-recorded with permission. Figure 8 shows the timeline for interview data collection. I wrote notes during and after the interview for those that did not permit audio recording and two where the recording device failed. Finally, recorded interviews were transcribed for qualitative coding. I transcribed 60 interviews, and 39 were outsourced to a professional service.

Figure 8. Data collection timeline (January to December 2020)



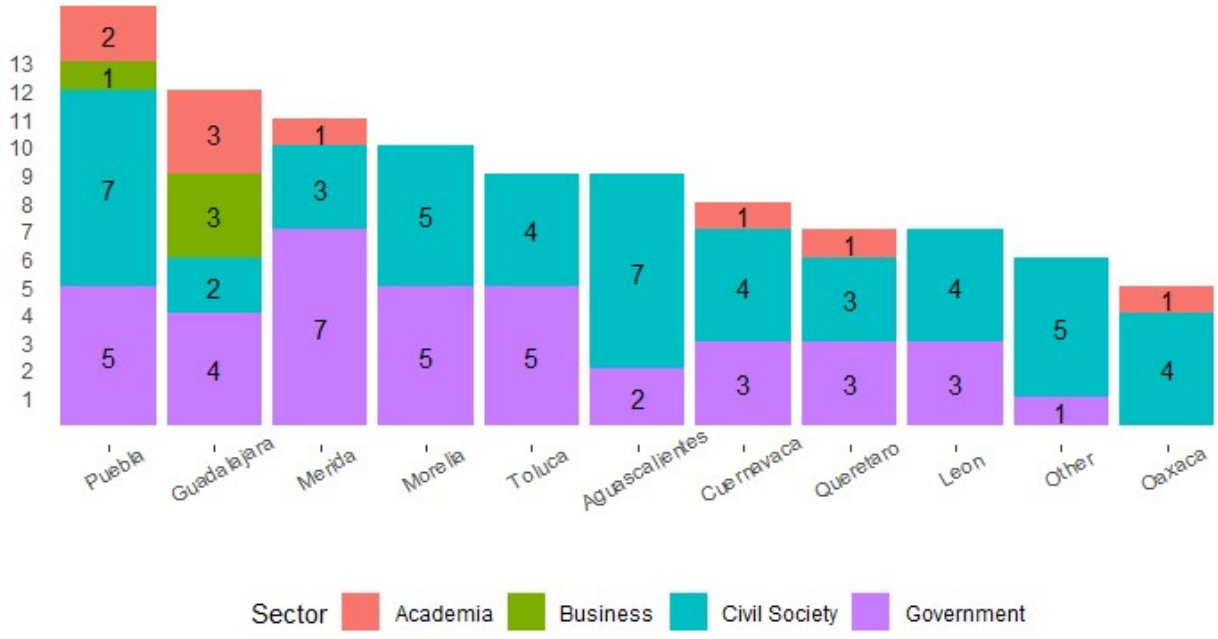
3.3.4 *Data analysis*

First, I developed case memos about each city to reconstruct the local process in each place to gain a general understanding and map the local institutions, organizations, and

implementation processes. I also mapped the characteristics of the infrastructure implemented in each place in these memos, its origins, planning process, strengths, and weaknesses. In addition to case memos, I also conducted a thematic analysis of the interview data to identify and analyze themes within the qualitative data. Thematic analysis is commonly applied in qualitative transportation research (Adorno et al. 2018; Bean, Kearns, and Collins 2008; Wilson and Mitra 2020; Xylia and Silveira 2018). The transcripts from the interviews were reviewed in detail by writing each case study. During this process, I also identified factors that emerged related to the research questions to develop a codebook.

The codebook was based on concepts and variables identified in the literature review and complemented by a thorough reading of the interview transcripts and writing about each case to identify additional codes. Once the coding scheme was completed, I coded the interviews with the finalized set of codes (Appendix 2 Coding scheme). I used the coding to query the data, develop the analysis in each case, identify common themes, and gain depth into similarities and differences across cases. I wrote analytic memos to describe similarities and differences in infrastructure development processes, views of infrastructure quality and to assess further how and why cities varied on common themes. I used secondary sources including policy documents, laws, plans, codes, organizational bylaws, reports, and media coverage to complement the analysis on institutions and to fact-check and validate interview data. Policy documents were reviewed and compared across cases and included in the assessment of each case. Media and reports were used to fact-check and compliment participant responses.

Figure 9. Field interviews by site and by sector of participant



In the sections that follow, I discuss the results of this research in two sections where I analyze the role of CSOs, laws, and organizations as laid out in my hypotheses. In the first section, I focus on H1 and explore whether and how CSOs affect developing infrastructure in the municipalities studied and show that they play a pivotal role throughout the life cycle of infrastructure development. Then, I look into the institutional side of infrastructure development to explore whether and how cities have implemented cycling infrastructure, the typical implementation process in each place, and whether these have improved over time and emphasize the role of laws (H2) and specialized agencies (H3). I conclude this section with a general discussion of the main factors that enable and constrain infrastructure development in Mexican municipalities.

3.4 Results and discussion part 1: The Role of Civil Society Organizations in the implementation of cycling infrastructure in Mexican Cities

The literature recognizes that civil society organizations have played a crucial role in bringing sustainable mobility to the forefront of public policy in Mexico and Latin America (Sagaris, 2010, 2014, 2015; Sosa López & Montero, 2018). CSOs in urban mobility represent a wide variety of activist organizations. These range from grassroots bicycle activist groups (Gamble et al., 2017) and movements challenging urban planning paradigms (Sagaris, 2014) to more professionalized NGOs, like the Institute for Transportation and Development Policy (ITDP) and World Resources Institute (WRI), with international ties and high levels of legitimacy as experts in the field, which Sosa Lopez and Montero call "expert-citizens" (Sosa López & Montero, 2018).

Based on the widely accepted premise that a variety of CSOs shape mobility policy on the ground and on the assumption that one of the central policies for which CSOs advocate is cycling infrastructure[5], the first hypothesis in this research was stated as *cycling infrastructure is more likely to occur in places where at least one CSO is actively working in favor of cycling infrastructure*. This chapter focuses on cycling infrastructure because CSOs recurrently request it, and the cycling mobility literature has identified cycling infrastructure as an essential component for cyclist safety and people's willingness to bike. However, infrastructure is by no means a one-size-fits-all solution to the problem of cyclist safety, nor does infrastructure necessarily guarantee an increase in cycling numbers.

[5] Infrastructure is central to advocate demands, but not always the exclusive focus of their advocacy. Different organizations have different views on the need for infrastructure. The focus here is narrow but the advocacy and views of actors are on a spectrum.

Little is known about the local-level processes that shape infrastructure development in places where this is a new area of governmental activity. Also, as local activists request infrastructure and engage with governments to produce it, CSOs encounter challenges related to infrastructure development beyond the construction of "political will" and play active roles in planning and developing various policies that support cycling infrastructure development.

This section outlines the numerous ways CSOs mobilize to advocate for infrastructure and act as collaborators and experts in the production of space for cycling and the institutionalization of cycling infrastructure as a governmental practice. In the cases studied here, local governments started with few policies, rules, professional norms, best practices, and examples to guide their initial experimentation with cycling infrastructure (Anguelovski & Carmin, 2011). In this emergent field, cyclist CSOs bring experiential and technical knowledge through which they frame cycling infrastructure and planning as a specialized field and support the institutionalization of this agenda. In this process, they play a part in developing the institutions that sustain the implementation of cycling infrastructure.

The presence of CSOs in a given place is not sufficient to guarantee the implementation of cycling infrastructure. All cases studied had active cycling activist organizations, but some had no infrastructure (Cuernavaca) or marginal and piecewise infrastructure development (Oaxaca and Toluca). Cuernavaca has many active CSOs, including *Movimiento Bicicletero de Cuernavaca*, Mexico's oldest cycling advocacy organization, who has advocated for cycling policy for over thirty years with no tangible success. Cycling infrastructure planning and development also predates civil society organizations in León, where the municipal government has implemented over 190 km of cycling infrastructure to date. In León, local officials developed a Cycling Infrastructure Masterplan in 1997 and have consistently built cycling infrastructure for

over twenty years and across numerous mayoral administrations, for at least a decade before the first pro-cycling civil society organization in León, *Saca las Ruedas Ponte la Bici* began to promote cycling in 2010. However, I will argue here that in most cases, CSOs have played a pivotal role in getting governments to acknowledge cyclists as legitimate users of road space and have pushed for cycling infrastructure to become a responsibility of the local government.

Cycling and cyclists have a long history in Mexican Cities. The use of bikes peaked in the 1950s and declined through the 1980s as cars became increasingly popular. However, many people, primarily low-income laborers and informal street vendors, continue to use bikes as a daily transportation mode. Despite this, when cycling social movements took off in Mexico in the 2000s, cyclists were essentially "invisible" from a government perspective because they did not factor into policies, laws, and regulations guiding the planning and control of transportation. Local governments lacked both planning capabilities and legal responsibilities to include cycling into land use and transportation plans. Planning and building cycling infrastructure in these early days was a deviation from standard practices, and moving forward has required progressive changes in policy to address barriers.

Therefore, in many cities, local advocates started to shape visions and narratives for change through various protest-based and collaborative tactics. These included activities to make the need for better street conditions for cycling visible, providing technical support as municipalities developed capabilities in this new area, developing audits and evaluations of infrastructure, helping to socialize infrastructure (where advocates explain changes in street distribution to affected stakeholders), and advocating for policy changes to institutionalize the cycling agenda. Through these interactions, cycling CSOs have also made a case for local

governments to understand cycling infrastructure as a specialized practice that requires planning and deliberate implementation.

In this section, I focus on local organizations to show some of their explicit tactics and ways through which they seek to influence cycling policy. While CSOs are not a prerequisite to cycling infrastructure development, nor does their presence guarantee that it will be implemented, in the vast majority of cases, they have been instrumental in promoting cycling infrastructure and working with local governments on various aspects of infrastructure development. CSOs can influence many parts of implementing infrastructure, and in this section, I will show how CSOs seek to affect infrastructure provision, offer examples of these activities across the cities included in this study, and show instances of success. This discussion speaks to *why* and *how* organizations seek to affect change and shows different points where organizations have affected infrastructure provision outcomes.

In addition to local cycling movements, many national and international influences drive the reconceptualization of cycling for mobility as a legitimate area of transportation policy and the impetus for building cycling infrastructure in cities. The international climate agenda, the Sustainable Development Goals, famous "success" stories in cities like Bogotá (Rosas-Satizábal & Rodriguez-Valencia, 2019), Seville (Marqués et al., 2015), and Copenhagen (Gössling, 2013), and the advocacy and support of international organizations (Sosa López & Montero, 2018) are some of the factors that influence the local cycling agenda from the top down. These can influence governments, organizations, and individuals that participate in the policy process in various ways. In this discussion, I acknowledge the influence of these factors but I focus on the local processes led by CSOs.

3.4.1 *Civil society organizations advocating for cycling mobility in Mexico*

The discussion in this section will focus on the work of local NGOs and *Colectivos* (which I broadly call civil society organizations or CSOs) in the ten cities included in this study (Table 10). International NGOs will be included to the extent to which they are relevant to the work of local organizations. In this research, I rely on the testimony of local actors, NGO and *Colectivo* members, and public managers in implementing organizations and officials (present and past), to examine the role of CSOs in promoting cycling policy relevant to the development of cycling infrastructure. The intention is to explore and document the process, activities, and potential mechanisms through which these civil society organizations impact the development of cycling infrastructure and the institutionalization of this practice in their cities. In this discussion, I am taking the position that cycle planning should be considered a distinct and specialized field of practice, integrating skills and knowledge from domains such as urban design, engineering, safety, and politics, as well as experiential knowledge from users (Hull & O'Holleran, 2014; McLeod et al., 2020).

Before developing this discussion, it is worth noting that there are some differences between the municipalities used as cases that impact the ability of these organizations to affect the adoption, implementation, and quality of cycling infrastructure (Table 12, Table 13, Table 14). First, the municipalities vary in characteristics that matter for people's perception of the viability of cycling for mobility and cannot be controlled for in this study. For example, they have slight differences in their geographic characteristics like weather and topography (El-Assi et al., 2017; Gebhart & Noland, 2014), their levels of crime and crime perception (Handy et al., 2014; Heinen et al., 2010; Rérat, 2019), their local transportation systems, including pre-existing levels of cycling and social stigma attached to cycling (Cepeda Zorrilla et al., 2019), and the

openness of local government to work with them and take them seriously, all of which are outside of the control of CSOs.

Additionally, cycling activist CSOs in each city vary, for example, in the local movement's size and strength, internal dynamics, level of professionalization, understanding of public policy and government processes, and attitudes towards the government. The systematic measurement of these characteristics is out of the scope of this research, although I will sometimes allude to self-reported qualities of local civil society organizations. This discussion explores how these organizations affect cycling infrastructure implementation, provides examples from the cases under study, and shows how they are a driving force, even if they are not the only driver. The CSOs in cities change and evolve; this discussion focuses on each city's longest-standing and most active and influential groups (Table 15).

Table 15. Leading cycling CSOs in cities studied

City	Most prominent Cycling CSOs (present and past)
Cuernavaca	Movimiento Bicicletero de Cuernavaca, Mochila Rodante, Intrepidas
León	Ponte las Ruedas, Saca la Bici and Mujeres en Bici León, León Capital Ciclista
Morelia	Bicivilízate, En Bici Michoacan
Mérida	CicloTurixes, Observatorio de Movilidad Sostenible de Mérida
León	Ponte las Ruedas Saca la Bici, Mujeres en Bici León
Aguascalientes	Bicicálidos, Aguas con la Bici
Oaxaca	Oaxaca por la Movilidad, Casa de la ciudad
Guadalajara	GDL en Bici, Ciudad para todos, Citta, GDL 2020
Puebla	Puebicla, cadena, bicionudos
Querétaro	Saca las Ruedas, Union de Asociaciones Ciclistas de Querétaro

3.4.2 *Phases of infrastructure provision*

The implementation of cycle-facilities policies ranges from painted lines on roads and physically segregated cycle tracks to the Dutch concept of “cycle-inclusion, " where city and

planning systems actively integrate cycling (Sagaris, 2015). More mature cities usually have more integrated and forward-thinking planning and implementation (McLeod et al., 2020). Infrastructure planning and provision is a process that can be broadly divided into different phases. To aid the discussion of how CSOs affect the provision and development of cycling infrastructure, I structure the discussion around these broad phases, which emerged as themes in my analysis (Table 16). When a government entity builds or designs a bicycle facility, officials/authorities/administrators must have the resolve and determination to make this decision to do so (*decision*). Committing to a cycling infrastructure project usually requires mayoral support for the project and the investment of public funds to implement it. At the beginning of these cases, the decision to plan or implement cycling infrastructure deviates from usual activities and often results from political pressure and specific proposals from CSOs. Then plans must be made to decide the location, whether as a single project or within a planned network, and the infrastructure needs to be designed and built (*planning and implementation*).

Cycling infrastructure is often placed on valued street space, which requires changing its everyday uses. The *socialization* of these projects, where authorities engage with local stakeholders like neighbors and businesses to explain the project and allow people to voice concerns, can also be a crucial step, especially in places where cycling infrastructure is relatively rare. Once implemented, governments have the responsibility to maintain it properly (*maintenance*). The infrastructure can also be monitored to assess its impact and ensure it remains unobstructed and well maintained (*monitoring*). These phases are not always implemented in order, nor does every instance of infrastructure development include each of these steps; cycling infrastructure planning and provision is an iterative and responsive progression, and so is the activity of CSOs who seek to affect this practice. In addition to directly

impacting the process of infrastructure provision, CSOs also work to change the legal and administrative framework to be more supportive of cycling infrastructure development (*laws and regulations*). This last step matters because, as I argue in the second part of this chapter, more profound levels of institutionalization are related to more deliberate planning and implementation of cycling infrastructure and are needed to sustain this practice over time.

Table 16. Broad phases of cycling infrastructure development

Phase	Description
Decision	Decision to develop infrastructure and devote funds
Planning routes and networks	Planning of routes or networks. This often involves the development of an infrastructure master plan with a proposed network for the city based on cyclist flows and strategic origins and destinations.
Implementation Socialization	Specific design, development and construction of the project. Talking to neighbors, business-owners and other stakeholders who will be affected by the project to help increase acceptability of the project
Maintenance	Repainting and fixing broken parts of the implemented projects, often as a form of protest
Monitoring	Ensuring that the infrastructure remains unobstructed, for example by parked cars. Cycling counts and use. Ensuring lanes do not disappear.
Laws and Regulations	Changing the legal framework to support cycling mobility

3.4.3 *Influence of CSOs on infrastructure development*

Cycling CSOs advocate for a variety of policies related to urban mobility generally and cycling mobility specifically. CSOs commonly advocate for the provision of cycling infrastructure as a core component of the urban mobility system. In this section, I explain the tactics through which local organizations seek to affect the provision and quality of infrastructure implementation using various examples found in my case studies. I provide evidence supporting the hypothesis stated above that CSOs affect the implementation of infrastructure and show the more nuanced ways they affect this process.

These tactics are broadly divided into 1) visibilizing, protest or contestation tactics where CSOs position themselves in contrast to the government to bring attention to their demands, or 2) collaborative co-production tactics where organizations position themselves as experts and work with governments to develop policy outside of formalized and government-led public participation processes. At the end of this discussion, I provide a comparative table showing how the tactics described here showed up across the cases in this study (Table 17).

3.4.3.1 Decision: constructing cycling infrastructure as part of the mobility system

In all of the cases studied here, one of the first challenges expressed by CSO members was the necessity to engage with the government and find ways for their demands and their needs to be taken seriously. They sought to be recognized as legitimate users of the road and components of the transportation system. In Mexican Cities, where cycling has historically not factored into public policy, activists have highlighted the need to provide cycling infrastructure and built political momentum for government action. These activities, like public bike rides and organized events where citizens paint cycling lanes, have brought public and governmental attention to cyclists. CSOs also collect data about cyclists, their habits, and their needs to justify their demands, often providing the first data on cyclists for their cities.

3.4.3.1.1 Public bike rides: Rodadas

At the most basic level, across the cities studied, CSOs began by making the marginalization of cycling and cyclists and the lack of adequate infrastructure visible to the local government and to the public. In all of the cases studied here, one of the first activities these organizations developed were public bike rides, locally called *rodadas*, which in many cases turned massive. These bike rides started as small protest rides that emulate *critical mass* rides

and became organized family-friendly rides as they grew in popularity (Furness, 2010). In the cities studied here, many of these rides have been happening every week for over ten years and were the starting point for all cycling social movements to engage with governments in the cases studied.

For example, as of 2011, *Fundación Tláloc* and its large group of volunteers developed activities "*to make urban cycling more attractive and visible to citizens*". They began by

> *Creating spaces where people could cycle safely to showcase the city's potential as a place to cycle and to help them gain confidence in their ability to cycle (Activist, Toluca, 01/14/2020).*

These activities included massive night bike rides, *rodadas*, on Wednesday nights and Sunday afternoons. At their peak in 2015, these rides each attracted up to 1,000 people every week. During the height of the *rodadas* in Toluca, new advocacy groups formed, as people attending got to know each other, that would join forces with Tlaloc to advocate for this cause (for example, *Bicionarias,* a group in Toluca that promotes cycling among women and children). With the growth of the local cycling movement in Toluca ignited by these bike rides, the activists began conversations with the mayor about potentially developing infrastructure in the city. The relationship between the municipal government and advocacy groups, ignited by the success of the public bike rides, led to Toluca's first cycling lane on Avenida Hidalgo in 2014.

> *We [the Municipal Government of Toluca] started to have discussions with Fundación Tláloc on the idea of promoting cycling as a means of mobility. It wasn't until the following year [after the rodadas gained traction] that the mayor became interested and said: "This is what we need to do; you have my support."... When this new mayor arrived, [she] said, "Yes, these [civil society] organizations are on to something; people want this, and working on this issue is worthwhile".... We had many discussions about where to start. At the time, we decided to start with cycling infrastructure. Because citizens and organizations involved with cycling suggested that what we needed to do was respond to everyday cyclists... So, we started a project for a bicycle lane on the road (Public Official, Toluca, 01/15/2020)*

Bicicálidos in Aguascalientes organized the most massive *rodada* in the country starting in 2008, with 5,000 people riding each week at the peak of its popularity around 2014. Their *rodada* attracted much attention from the press because they would often stop traffic for an hour due to the success of this event. They used this collapse as a way to get local authorities to listen to their demands. However, they acknowledge that the success of this ride was because people enjoyed the event and were not always there to protest, which is the case across all cities where *rodadas* became massive.

> *The rodada was like a muscle that intimidated public officials. I remember going to City Hall looking for someone. I would turn up and say "I'm looking for such and such." "Who's asking?" "Tell them I represent Bicicálidos." The assistant would leave, and the high-ranking official would come right out and show me into his office, offer me a seat and something to drink. Because the rodada was like a muscle pumped upon steroids. Because [even though] thousands of people were riding [every week], they were not necessarily participating as a protest to change the city. Nonetheless, [the rodada] gave us access to the municipal government and gave us a chance to start talking about infrastructure projects. (Activist, Aguascalientes, 03/04/2020).*

Rodadas were also spaces where people interested in cycling met and new groups formed, and some of these groups also became activists (although many were just for leisure). However, *rodadas* did not gain traction in all of the cities included in this study. For example, in Cuernavaca the *rodadas* organized by *Mochila Rodante* usually only attracted a few dozen riders each week and did not lead to any fruitful collaborations with the municipality to implement infrastructure. In León, the municipal government already had a cycling agenda since 1997, long before the *rodadas* started in 2010, and these bike rides did not change their approach. However, cyclists and managers interviewed across cases (for example, in Aguascalientes, Morelia, Querétaro, Guadalajara, Toluca, and Puebla) claim that these rides, their popularity with the public, and the attention garnered for local activists triggered attention for local cycling policy,

even if they were only to make visible the need to establish an agenda. Public officials also acknowledge the influence of CSOs in sparking the cycling policy agenda.

> *From a public policy perspective, [cycling] emerged because of a citizen [cycling]movement … and this is in a city where people don't tend to organize for civil matters. They started with their weekly rodada. Then they highlighted the importance of using bicycles [in meetings with the municipality]. [With the rodada] governments began to see that it was a social movement and that was gaining strength, and we started to acknowledge that we needed to do something about it. (Public official, Aguascalientes, 03/04/2020)*

3.4.3.1.2 Citizen cycling lanes

Another activity commonly carried out by cycling CSOs to make the lack of infrastructure visible to local authorities is citizen cycling lanes, where activists paint cycling lanes themselves. In many cases, the local government repainted and claimed some of this citizen infrastructure and made them official municipal-owned cycling lanes. This tactic has also been used in other parts of the world (Smith, 2019).

For example, in Guadalajara, in 2011, some of their first kilometers of cycling infrastructure came from citizen-initiated projects. *Ciudad Para Todos* and *GDL en Bici* convened citizens to paint a cycling lane on *Avenida Santa Margarita* in the Zapopan municipality. The government had established this street as a priority in its 2011 Non-motorized Mobility Plan because of the large volume of local cyclists. The second citizen cycling lane was painted on *Avenida Inglaterra*, a main thoroughfare. Citizens gathered to paint it themselves because, despite this governmental priority on paper, no signals or other infrastructure had been provided to protect cyclists. Shortly after citizens painted these cycling lanes, the government made them permanent and invested resources in improving them or re-making them.

In 2012 during the National *Bicired* cycling conference in Oaxaca, one of the activities developed by the conference participants was to paint a citizen cycling lane on *Calle Reforma* in the Oaxaca city center (Figure 10). This cycling lane was later repainted and made official by the

Oaxaca municipal government, although the lane has mostly disappeared over time due to lack of maintenance.

Figure 10. Citizen cycling lane during 2012 Bicired National Cycling Conference (photos by Claudina de Gyves)

3.4.3.1.3 CSO surveys

Municipalities lack data about cyclist numbers, who cycles, and their needs. The lack of data can be a barrier when justifying the need for infrastructure. In many cases, for example, in León, Mérida, Aguascalientes, and Guadalajara, CSOs have surveyed cyclists, and infrastructure comes up as a constant need to improve everyday cyclists' trip conditions. Cyclist CSOs use these surveys to justify the need for infrastructure in conversations with government officials, and sometimes, these surveys are picked up and published by the local government or used by public managers to justify the need for cycling infrastructure in their proposals to decision-making bodies. The data collected by CSOs is also used as a means to highlight the need for data collection itself, underscoring the latent demand for cycling and the potential for more people to cycle.

> *I'm reviewing surveys I took from 40 different locations in the city. I did 40 surveys at each location, and everyone had the same demand [infrastructure]. We counted the number of riders from 6 am to 10 pm to see if a bike path was viable in that location. That's how we know who uses bicycles and what they use them for. [We collect] reason for using it, who is using it, gender, age, whether they use high visibility helmets or vests. And when we asked if they want to add anything, they all say that more safe bike paths are needed. They also say that taxis and public transportation vehicles need to respect bike lanes. But we have hard evidence that cyclists want more lanes and paths. When we are done, we will hand this information over to [the Municipal Planning Agency] (Activist, Aguascalientes, 03/04/2020).*

3.4.3.2 Planning routes and networks

CSOs provide both experiential and technical expertise to local authorities at various policy-making stages for cycling mobility. A notable example is in the infrastructure planning stage, where they work with municipalities to develop cycling network plans (Sagaris, 2015).

When a cycling lane is going to be implemented, one of the first decisions is where to place it. Planning can be for a single isolated project or as part of a planned network. Sometimes CSOs advocate for a cycling lane in a specific location. However, cycling infrastructure implementation is considered to be more mature when it responds to a planning process that builds towards a network connecting origins and destinations (McLeod et al., 2020).

In many cities, the first cycling network proposals are developed by civil society organizations, either as independent efforts or by supporting the local government. In Oaxaca, Aguascalientes, Morelia, and Toluca, these proposals have been used as a starting point for government-endorsed cycling infrastructure plans. The network proposals leverage cycling advocate's knowledge of origin, destinations, popular routes among cyclists, and the specific needs of cyclists. Citizen proposals for cycling infrastructure networks are also a starting point for more deliberate planning and implementation processes to be taken up by municipal governments.

In Morelia, for example, the first documented proposal for a cycling infrastructure network was sketched by the NGO *Bicivilízate*, by drawing out cycling routes roughly based on their own technical expertise. The Municipal Planning Agency developed the second proposal in 2018, working off the first proposal and improving it based on data and technical studies they developed internally on trip demand and safety needs for cyclists. They identified priority areas, among which are flows of students from downtown to the local university. They partnered with the Mexico City-based NGO *Republikla* and used GIS mapping exercises with cyclists in the area to identify strategic routes (IMPLAN Morelia, 2017). From this point on, Morelia's infrastructure was based on strategic planning, working towards a network.

In 2017 *Casa de la Ciudad* developed a mapping exercise to identify strategic cycling routes in the City of Oaxaca and proposed a network of cycling infrastructure for Oaxaca as a basis for a cycling masterplan called *Plan Maestro de Ciclovías de Oaxaca* (Casa de la Ciudad, 2017). The network was developed through multiple participatory mapping sessions with cyclists and civil society organizations. In 2019, this network was complemented with additional routes identified by the *Colectivo Mundo Ceiba* and compiled into a Cycling Infrastructure Masterplan, *Plan Maestro de Ciclovías de la Casa de la Ciudad.* The Municipality of Oaxaca will implement the first cycling lane proposed in this plan in 2021 (Figure 11).

Figure 11. Plan Maestro de Ciclovías de Oaxaca developed by Casa de la Ciudad (Casa de la Ciudad, 2017)

Source: Casa de la Ciudad (2017)

In 2013, the Municipal Planning Agency in Puebla drafted Puebla's first Sustainable Urban Mobility Program (IMPLAN Puebla, 2013). This was the first planning instrument that included a proposed cycling infrastructure network and indicators to monitor performance. The proposed network was developed jointly with local CSOs (including *Bici Urbana, Puebicla, and Bicionudos*). The program was one of the first planning efforts where the Municipal Planning Agency and civil society organizations came together to work on cycling policy. Even if it was never implemented, developing the plan helped establish connections between the Municipal Planning Agency and CSOs. It was the first time that Puebla municipality wrote an official plan that contemplated cycling infrastructure. A new legally binding plan was developed a couple of years later.

These examples show how cycling organizations are often the first proponents of cycling infrastructure networks that later become institutionalized, and they also assist in the elaboration of these plans when they are developed or improved upon by the local government. In this way, CSOs also push for more deliberate planning of infrastructure where routes are identified based on cyclist needs and prioritized in a way that seeks to connect cycling routes to key origins and destinations in the city. Once these plans are included in government instruments, they also form the basis of CSO advocacy because once there is a plan, CSOs seek to hold governments accountable. By advocating for and participating in these planning processes CSOs also contribute to the understanding of cycling as a specialized field that requires deliberate planning and expertise, rather than something that can be implemented “on the fly”. These collaborations also help CSOs gain legitimacy as experts.

3.4.3.3 Implementation: project development, design, construction

Advocates also bring expertise and knowledge about the design and specialized needs of cycling infrastructure to the implementation stage, which can lead to technical improvements of projects being designed and implemented. Within local governments, cycling infrastructure has not always been understood as a specialized field and often falls in the hands of traffic engineers whose primary experience is designing roads and who have no previous training or references on how to implement cycling infrastructure. This mind frame is often reflected in the infrastructure they build (thinking of car traffic over cyclist safety). For example, cycling lanes are often placed on sidewalks, where saving parking places is given priority over scarce pedestrian space. Cycling lanes are built on traffic islands where they lock in cyclists instead of on the right side of the road where they are considered safer and give cyclists access to origins and destinations (ITDP/I-CE, 2011).

Some CSOs who are more technical also participate in the design and implementation of infrastructure. For example, in some places, when CSOs started to be called by the government to support the planning and development of infrastructure to fill gaps in government expertise and capacity, these organizations began to specialize. In this process, they also made this specialized capacity evident and pointed to the need for expertise to develop these projects because they are different from other road infrastructure. In Morelia, *Bicivilízate* members realized the government's lack of expertise and saw this as an opportunity to have input.

> *When we started working for the municipal government, experts began calling us. We held a meeting with Bicivilízate members, many of whom expressed nervousness [for being considered an expert], so I took the microphone to tell them it was our chance to be heard. We were getting calls from our local and state governments for technical advice. It was a golden opportunity because if we thought we didn't know anything, they must know even less if they turned to us for expertise. Some of us took it upon ourselves to build technical capacity, given our tendency towards studying. We learned and acquired technical*

knowledge. For me it was like a challenge and I decided to turn up to these meetings with something to say. I dove deep into cycling infrastructure manuals like Ciclociudades and NACTO and the literature and read everything I could about technical aspects [of infrastructure] (Activist, Bicivilízate, 02/22/2020).

In the cities studied, initial efforts by local governments to implement infrastructure often had errors. For example, governments built elevated cycling lanes, infrastructure on or next to traffic islands, infrastructure that was too narrow (for example, in Mérida and Puebla, many cycling lanes are less than 70cm wide), or did not meet other internationally established standards (ITDP/I-CE, 2011). While these errors are understandable with pioneering or experimental efforts, they are indefensible today, given how much knowledge and practice have advanced (Sagaris, 2015). In some cases, these errors persist despite experience and pressure from CSOs.

When technical errors were made in initial efforts, in many places like Puebla, Morelia, and Mérida, cycling organizations even found themselves in the difficult position of protesting infrastructure they had previously advocated for when local authorities built infrastructure that they perceived to counter their objectives. In some cases like León and Querétaro many of these errors persist despite the inputs of CSOs. However, in other places like Puebla and Morelia, governments have improved their infrastructure over time and institutionalized mechanisms to avoid these problems in future projects, mainly due to the pressure and with the support of cycling CSOs.

CSOs seek to affect implementation in many different ways. In the early stages of implementation, CSOs check the project renders against established best practices and give recommendations for improvements, or at minimum, report design errors that endanger cyclists and pedestrians. For example, in 2017 the *Observatorio de Movilidad Sustentable de Mérida*

(OMSM) did an audit of the *Circuito Sur* project in Mérida. They initially held meetings with the Municipal Planning Agency to explain why some of the proposed projects did not meet the necessary standards and might lead to unintended consequences, including unsafe conditions for cyclists or lack of use. When the project was implemented they developed an audit report of the built infrastructure to assess how it held up against international best practices citing NACTO and ITDP's Ciclociudades Manual. Interviewees from OMSM provided this audit report as an example of their advocacy around infrastructure development (excerpts included in Figure 12).

In Puebla, the members of the activist group *Cadena* advocated for improvements to cycling projects and made proposals to the Puebla Municipal Government. They staged protests against building *Hermanos Serdan* elevated cycling path, arguing that this infrastructure would not improve cycling mobility in the city because it locks in cyclists for long stretches at a time. They also pointed out that this infrastructure excludes certain types of traditional cycling vehicles, like tricycles, and could also put cyclists at risk of being robbed. They were not able to stop the project but proposed modest improvements that saved 700 trees planned to be removed in the initial project. They also recommended improvements to other cycling projects with modest success. For example, the cycling lane *Parque Lineal Universitario* was proposed as a cycling lane along a traffic island, and they advocated for this lane to be redesigned to go on the right side of the street. They were not successful in changing the location, but they were able to propose other changes that improved the design of this lane, like slightly increasing the width and adding safety features to intersections.

Finally, cycling CSOs also participate in building and institutionalizing capacity for local governments to avoid design flaws that endanger cyclists. In 2016, Morelia's Municipal Planning Agency staff also started developing guidelines for implementing cycling infrastructure

(SEMOVEP, 2019). At the time, the sub-director of the Municipal Planning Agency was *Bicivilízate's* founder and former president. In these guidelines, they developed technical specifications for infrastructure (bike lanes, bike parking, signage) based on international manuals and best practices (for example, guidelines by NACTO and ITDP's *Ciclocioudades* manual).

The guidelines were developed to ensure that the infrastructure built in the municipality would meet specific standards and be functional and safe for cyclists (rather than planned in such a way as to minimize inconveniences for drivers). The guidelines also establish overarching planning principles stressing that streets should be designed to protect the most vulnerable users, cyclists, and pedestrians. The development of these standards followed a participatory process to include feedback from cycling groups and general members of civil society. These guidelines were also an attempt to institutionalize knowledge that cycling groups have been accumulating over time and ensure that past errors in infrastructure design were not repeated. They also incorporated international best practices. In May 2016, these guidelines were approved by the City Council, but they remained a voluntary instrument. In June 2019 these guidelines were incorporated into municipal building codes and made mandatory in a Technical Street Design Code (*Norma Técnica de Diseño de Calles*) (SEMOVEP, 2019).

Figure 12. Examples of Observatorio de Movilidad Sostenible de Mérida's audit of the Circuito Sur cycling infrastructure project (Monsreal, 2018).

"The cycling lane on Calle 185 includes awkward crossings for cyclings across high-speed roads and lacks signaling. The cycling lane is bidirectional and has less than 70cm for each direction when international manuals suggest 1.5m to ensure safe conditions. The sewer grate is too coarse and can present danger for cyclists" (Monsreal, 2018).

"The project fails to contemplate traditional cyclists and street dynamics. For example, in this image, a tricycle - a cycling vehicle typical on the streets of Yucatán - continues to use the opposite side of the street to where the cycling lane was built" (Monsreal, 2018).

"The cycling lane is too narrow to allow for tricycles and cyclists to share the infrastructure because the grass area blocks the possibility of cyclists to overtake. The grass area also locks in cyclists for long stretches of road, also against standards suggested by international manuals" (Monsreal, 2018).

3.4.3.4 Socialization

Implementing cycling infrastructure usually involves redistributing street space, for example, through the loss of a car lane or street parking, which can be politically contentious. Socializing infrastructure (term used by local practitioners) is the process of engaging with stakeholders to renegotiate uses of space. Socializing is not always necessary because not all projects are equally contentious. For example, sometimes, infrastructure is implemented in areas where neighborhood associations have made formal requests for infrastructure or areas with enough space, so local stakeholders/participants do not perceive the new projects as a loss. In cities where redistribution is contentious, socializing cycling infrastructure projects has become common as governments have gained experience implementing cycling lanes.

Cycling infrastructure is a relatively recent development in most Mexican cities. In many cases, drivers are unfamiliar with cycling infrastructure and are used to driving and parking in areas that have been redesignated for bikes. Therefore, they must learn to navigate the streets in their new configurations. Conveying these changes requires engagement and negotiation with stakeholders who might feel like they are losing from the implementation of a new cycling project. In most cities, initial implementation plans did not include socialization as a component and sometimes faced opposition by neighbors and business owners. Cycling CSOs stepped in this task to ensure that the infrastructure did not fail.

For example, in Puebla, some of the first cycling infrastructures that were built at the street level (*Avenida 4 Poniente*) were not socialized with neighboring businesses. Business owners and workers only found out about the cycle lane project when implementation started and immediately protested. Activists quickly organized and went to the location the next day to talk to people and explain the objectives and benefits of the cycling lane. They also repainted parts of the lane to signal that this was now a designated space for bicycles. They engaged with drivers

that arrived in the area and explained how they should park in the changed street. They were soon joined by government officials from Puebla's Municipal Planning Agency (Figure 13). This socialization effort was effective; in the following days, local business' protests stopped, and cars were no longer invading the cycle lane from then forward. Following this event, public agencies became more aware of the impact and importance of socializing cycling projects to improve their acceptability. Since then, socialization has become an institutionalized practice in cycling infrastructure planning in Puebla, and cycling infrastructure projects are socialized and negotiated with stakeholders from the early planning stages.

Figure 13. Activists and government officials socialize the cycling lane on Avenida 4 Poniente in Puebla (Photos by Fernando Valerdi)

The *Hidalgo* Cycling track was the first cycling lane *implemented* in Toluca since the last one was built in the 1970s. This bikeway directly resulted from advocacy efforts by cycling CSOs in the city, led by *Fundación Tláloc*. This project was a proposal they had presented across multiple municipal administrations and was executed once they started working with a mayor who endorsed their proposals. When the project was implemented, the local government had not contemplated socializing the project, and local activists stepped in to support the process when the need arose during the development of this project.

> *As a municipal authority, [the Hidalgo cycle track] took a lot of investment and was exhausting. Once that infrastructure was developed, we realized that we had to explain to people what the construction was all about and describe the road adaptations it would require. It was exhausting because it took a lot to convince the people who live on Hidalgo street. They were used to parking on the space that the bike lane would be taking up. Not everyone understands the concept of public roads being for everyone. Fundacion Tláloc and its volunteers were crucial in this process. They knocked on doors and talked to people (Official, Toluca Municipality, 01/16/2020).*

However, socialization and education is also done by local cycling groups as a form of protest. For example, in Morelia, in 2021, the local government built a new cycling lane on *Avenida Madero*. After the lane was inaugurated, it continued to be used as parking. This led to protests by a local CSO*, En Bici Michoacan*, who sought to educate the public and demand that the lane be kept clear, perceiving that the local government was not doing its job (Figure 14). These examples provide evidence to more nuanced ways in which CSOs drive the development of infrastructure beyond requesting it to local government, for example, by working with governments to increase the acceptability of projects (which are often contentious), and developing public-facing activities to ensure that drivers adapt their behaviors to the new street configurations.

Figure 14. Cyclists stage a protest to educate divers. "The cycling lane is not for parking" . Photo by Salomon Gomez

3.4.3.5 Maintenance

CSOs play a pivotal role in the preservation of cycling infrastructure. Lack of maintenance of cycling infrastructure is a consistent problem across the cases studied. Municipalities often implement cycling projects but do not plan for their maintenance, especially when they lack a comprehensive cycling strategy. This is a common issue across the cities studied with multiple examples in all cases that have cycling infrastructure. Incoming governments fail to look after projects implemented by previous administrations. Lack of maintenance can lead to losses of hard-gained spaces by cyclists disappearing, becoming fragmented or losing protective qualities for which they are built in the first place. Cycling infrastructure is also lost through the maintenance of roads, where road improvement projects remove infrastructure and do not replace it.

Cycling CSOs often fill this gap by bringing attention to the lack of maintenance and the loss of infrastructure by wear and tear or road repairs. As infrastructure users, they know routes

well and report potholes, loss of paint, and other maintenance issues. When local authorities fail to respond, activists often do maintenance work themselves, often as an act of protest to make this lack of government support visible. This goes from reporting issues like uncovered potholes to more significant maintenance issues like painted cycling lanes disappearing over time.

For example, in Morelia, local activists from the CSO *En Bici Michoacán* advocated for many years to rehabilitate the cycling lane on *San Juanito Itzicuaro,* which had fallen into disrepair and was continuously invaded by cars. In early 2021, they partnered with five other organizations to hold community events to repaint the cycling lane on *San Juanito Itzicuaro* between March and April of 2021 (Figure 15). They also presented a petition to the municipality to invest in the repair of this infrastructure. In May of the same year, the Morelia city council unanimously approved the rehabilitation of this cycling lane as a direct result of this citizen pressure. This example shows how CSOs do not only work to create space for cycling, but they also fight to maintained hard-earned spaces.

Figure 15. "Rescue the San Juanito Cycling Lane". (Image by Salomón Gómez).

Figure 16. Members of UCIQ repaint a cycling lane lost through maintenance work (Photo from UCIQ archive).

In Querétaro, activists affiliated with *Union de Asociaciones Ciclistas de Querétaro* use various methods to pressure authorities to maintain cycling infrastructure. These include formal petitions submitted to the local government to include maintenance as part of their cycling policy, reports of minor details like potholes directly through the municipality or by publicly reporting on social media, and staging maintenance events themselves. A salient example of this pressure was a recent case where the municipality repaved a road and removed the cycling lane, which was repainted by activists (Figure 16). This space would have been lost had local activists not stepped in to reclaim it. Once activists started painting, the municipality repaired it within a few days.

> *About six months ago, they did roadworks on a street that already had a bike lane. They adapted and then recarpeted it. Months went by, and they hadn't reinstated the bike lane. We were wondering, "What happened to the bike lane? Why doesn't anyone respect it anymore?" They simply hadn't added any form of demarcation or signaling. Two of our peers grew tired of the situation and painted the lines where the bike path used to be out of their own initiative.*

In the end, the government finally repainted the bike lane. Why? Because they look bad when citizens do the work they fail to do. We often have to take it to that extreme. (UCIQ Activist, Querétaro, 08/25/2020)

3.4.3.6 Monitoring

Infrastructure once built is rarely monitored by municipalities. This is another task which CSOs take on and make visible. For example, they develop audits of the quality and current state of infrastructure, map infrastructure to track the state of the network, and monitor the use of cycling infrastructure. Some of these activities involve data collection that even the local government lacks and eventually uses in planning and policymaking. Monitoring is important because, as explained above, hard-won spaces for cycling can disappear and cannot be taken for granted. Information about the existing network is also helpful for planning. Tracking the quality of bikeways is also used to hold governments accountable when they are planning future projects. Audits can make past mistakes in infrastructure or fixable errors visible, and cyclists point to the quality of the existing network to demand improvements.

For example, in Mérida, where cycling infrastructure development efforts have been fragmented and dispersed across government administrations and institutions, the local CSO *Observatorio de Movilidad Sostenible de Mérida* diligently tracks the location and characteristics of cycling infrastructure across the city. They track projects implemented and also do periodic audits to assess the state of previous projects. This data is used by the Municipal Planning Agency who currently lacks the capacity to monitor infrastructure and does not have any proprietary data on the state of local infrastructure in the city. In Aguascalientes, local activists developed a methodology to evaluate cycling infrastructure systematically. In 2020 they evaluated the entire existing network and handed over the report to the Municipal Planning Agency.

It's mainly us citizens [who carry out evaluations]. We track basic aspects, for example, whether there's a drain [blocking the path]. We look at several dimensions: width, the type of physical separation, horizontal and vertical signaling. Public lighting, shade. Whether the public lighting is meant for bikes or cars. We assess all these things. I circle and map them, and I also have a GoPro so [I tape the audits and] hand the video over to Public Works for them to watch—I'm usually speaking as I go. That way they don't have to go from their office all the way to the bike path or lane to see understand our comments. I usually talk about the quality of the asphalt, point out drains, point to places where I might fall. That's how I come back with recommendations so they don't have to go anywhere. (Aguascalientes Bike Mayor, Aguascalientes, 03/05/2020)

3.4.3.7 Laws and public institutions

In Mexican municipalities, CSOs have played an essential role in institutionalizing cycling mobility as an area of government policy, including planning and implementing infrastructure. Among the activities depicted here, the ability to affect laws and institutions is one of the most important because having a legal basis for infrastructure and agencies with responsibilities and resources to implement policies is the only way cycling infrastructure can become a sustained governmental activity. CSOs propose legal and institutional changes, and in some cases, activists join the government to pursue projects, become advocates on the inside, provide experiential and technical expertise they have built as cyclists and activists, and work to institutionalize the agenda they developed as activists.

Urban mobility is an emergent concept in Mexico's legal framework. Until recently, laws concerned with the movement of vehicles and goods were those governing transport and roads. Over the last decade, the concept of mobility has permeated into national, state, and local frameworks (Sosa López & Montero, 2018). The fundamental difference between laws governing streets under a paradigm of mobility compared to roads and transport is the recognition of *people's right to be mobile* over the movement of vehicles. The mobility paradigm

includes an overarching principle to prioritize pedestrians, cyclists, and public transportation in policy and planning (Banister, 2008). Within this conceptual change is a reorganization of users of the street through a new hierarchy (often called the "Inverted Mobility Pyramid," implying that it is a 180-degree shift from the status quo). The adoption of mobility laws in many states includes, among other things, the first legal recognition of cyclists as part of the urban mobility system and mandate for municipalities to build infrastructure to keep cyclists safe.

Governments and public agencies must adhere to their legally mandated competencies. Deviations from their officially mandated responsibilities are not always possible. The lack of a supporting legal framework can therefore be a barrier to advancing the cycling mobility agenda.

Laws that include new mandates should also assign responsibilities to the organizations that implement these mandates. For municipalities to take on these new responsibilities, the new mandates should permeate their bylaws and administrative structure. The changes in paradigm should also be reflected in local traffic laws and manuals. It is often the case, for example, that municipalities start to build infrastructure but have no legal recourse to keep drivers from parking in it.

In many cases studied here, for example, in Morelia, Puebla, Guadalajara, Toluca, and Aguascalientes, CSOs have sought to change laws and advocated for the creation of agencies to address cycling mobility. In these instances, advocates have directly participated in drafting either full versions of new laws or specific reforms and the design of institutions at the state and local levels. Mobility as a guiding principle can be incorporated into many different types of laws. Here I focus on the most important instruments at the state level that govern the transportation system that have been changed to include the concept of cycling mobility (state mobility laws and state cycling promotion laws) and the creation of implementing agencies. I

provide examples of instances where CSOs have been the driving force behind changes in the legal framework regardless of the impact of these changes on implementation, which will be discussed in the next section.

In 2013 the newly elected Governor of Jalisco, Aristóteles Sandoval, presented a Mobility Law proposal to the Jalisco Congress. The proposed law would override the Jalisco Transport and Roads Law (*Ley de Vialidad y Transporte del Estado de Jalisco*). The proposed law was a long-standing request from civil society organizations in Guadalajara, who wanted a deep reform that would give cyclists and pedestrians rights and priority of way on roads. Before the Governor presented this proposal, activists had testified multiple times before Congress to ask for this change. Once the law proposal was put forward, civil society organizations made detailed proposals for provisions to prioritize non-motorized mobility. This included giving legal standing to bikes as vehicles and cyclists as road users and integrating cycling in road design and prioritization of planning.

The requests from civil society also included stable funding for non-motorized mobility and a commitment to implementing a bikeshare system. Civil society organizations were critical of the new law because it did not include most of their proposals, deeming the change from a Transport Law to a Mobility Law a symbolic name change rather than a substantive one. The only thing included relative to cycling was a prohibition to drive and park in cycling lanes. However, in 2017 the Mobility Law was reformed, including the rights and protections for cycling and cyclists requested for the first version of the law. The law also included specific sanctions against motorists who violate the rights of cyclists. This new version of the law also included a mandate for local governments to build cycling infrastructure such as secluded cycling lanes and bike parking facilities.

In 2015 activists in Toluca worked with legislators to work on a state-level Mobility Law. The law was largely based on the law passed in Jalisco (which Guadalajara activists criticized as not being strong enough to really make a difference). The law included the "inverted mobility pyramid" which gives priority to cyclists and pedestrians on the street and mandates that municipalities are obligated to include cycling as part of their planning programs (art. 5) and build cycling infrastructure and public bike parking facilities (art. 27). However, the law does not create clear responsibilities for actors or indicate how new infrastructure should be funded. Following the passage of the Mobility Law, the mayor of Toluca Marta Hilda Gonzalez Calderón, with the advice of the CSO *Fundación Tláloc*, introduced a proposal for changes in the municipal rules giving the Toluca municipal government attributes to promote cycling and to regulate cyclists. The rules included the faculties and obligations for municipal authorities to promote cycling, build and monitor cycling infrastructure, laid out the rules that drivers and cyclists should follow on the road, and gave the municipal police the authority to enforce these rules. While the municipality has these responsibilities on paper, there is no clear obligation for any agency within the municipality to implement them.

In many cities, including Puebla, Querétaro, Guadalajara, Morelia, and Aguascalientes, advocates have also proposed new government agencies that the local government has adopted. In some cities like Morelia, Aguascalientes, Guadalajara, and Puebla, activists have even been recruited to work within these agencies and sometimes to direct them. For example, in Querétaro, activists led an initiative to create an agency that could implement cycling-related projects mandated in their Cycling Law.

> *At the time, the institution or offices that could take advantage of such laws [the new cycling law] did not even exist… we started reaching out to ITDP, WRI, IMT, and with every possible citizen and university organization out there. We suggested the powers that this office should have. We managed to*

summon support from congressman Marcos Aguilar Vega, and when he became mayor, the Department of Mobility was created within the Municipal Government of Querétaro, which has begun to produce policies related to this topic (Activist, Querétaro, 08/31/2020).

In Morelia, the creation of the Office for Mobility and Public Space (*Secretaria de Movilidad y Espacio Publico, SEMOVEP*) in the municipal structure in 2018 was the direct result of advocacy from the CSO *Bicivilízate*. This organization had advocated for a municipal agency to oversee urban mobility for many years and even proposed the agency's competencies. They had met with the incoming mayor to discuss this proposal, and once he took office, he invited someone from *Bicivilízate* to lead it.

In Aguascalientes, local cycling and mobility advocates from *Biciescuela, Bicicálidos and Aguas con la Bici* drafted a Mobility Law proposal in 2017. The law passed unanimously in 2018 because it had the Governor's direct support since these activists had also worked on his political campaign. The content of the law was based on similar state laws in places like Guadalajara. The Mobility Law aimed to prioritize the most vulnerable users of the road placing pedestrians and cyclists at the top of a new mobility pyramid, being given "*first priority and preference in the use of road space and in the distribution of budgetary resources*" (IMPLAN Aguascalientes, 2015).

A new state-level agency (*Coordinación General de Movilidad*, CMOV) was created within the law, and a local cycling advocate was appointed to lead it. The creation of this agency required a restructuring of the state executive branch and added new responsibilities and functions to include, among other things, cycling mobility. Additionally, the law mandated creating a twelve-member citizen observatory (*Observatorio Ciudadano de Movilidad*) to oversee the development and implementation of urban mobility policy in Aguascalientes. The

observatory is responsible for providing information and expertise, giving specific recommendations, and overseeing that goals set out for CMOV are accomplished.

A Cycling Promotion Law, also drafted by local activists, was also passed in 2018. In 2019, the municipality of Aguascalientes published an urban mobility regulation that includes all of the principles established in the state law. Finally, the state-level agency is developing a street design norm with legally binding parameters for the design and implementation of cycling infrastructure.

3.4.4 *Part 1 Conclusion: The role of CSOs in cycling infrastructure provision in Mexican municipalities*

In this section, I developed the case for the pivotal role CSOs have played in developing cycling infrastructure in Mexican Cities. The first hypothesis driving this research was: *Cycling infrastructure is more likely to occur in places where at least one CSO is actively working in favor of cycling infrastructure*. While the presence or activity of civil society organizations does not guarantee that cycling infrastructure will be implemented, throughout this section, I have shown that these organizations are actively involved in every aspect of infrastructure provision and its institutionalization as a governmental activity. Given the novel and sometimes contentious nature of the processes in which they participate, CSOs do not always succeed in their efforts and often influence the process through small and incremental wins.

While CSOs are a key driver of cycling infrastructure and its institutionalization, their success depends on their ability to engage with government officials and have allies working on the inside. While advocates provide various forms of support, making an impact requires the government counterpart to be willing to accept proposals and make changes and their capacity to

do so within the constraints of local governments. The effectiveness of citizen groups also depends on their ability to navigate a complex planning system.

Civil society organizations drive infrastructure planning and development in a myriad of ways. They advocate for infrastructure development at all different stages of the process. They foster the demand by making cyclists visible and creating recreational spaces for cyclists, making a case for government provision of infrastructure and building political capital for government action. At a fundamental level, CSOs have helped to reconceptualize the bicycle as a mode of transportation that should be included in the same planning processes and instruments as, for example, cars and buses. Additionally, they play the roles of technical experts filling a vital void since, in these emerging contexts, expertise on cycling infrastructure planning is lacking. CSOs monitor infrastructure quality and use, advocate for its maintenance and continuous improvement. They assist in developing government institutional capacity and help socialize projects to increase the acceptance and useability of cycling infrastructure at the street level. They also ensure the maintenance of hard-earned spaces for cycling and keep this issue on the public agenda across changing government administrations. Because cycling infrastructure is still an emerging practice in most cases studied, civil society organizations' continued presence and pressure remain necessary to maintain cycling on the public agenda.

Civil society organizations build strategic alliances through their continued engagement and seek commitments from public managers, candidates, and elected officials who advocate for cycling-friendly policies. They work with legislators and governments to change the laws and organizational structures. CSOs give continuity and institutional memory to this area of policy across changing government administrations, therefore contributing to the gradual institutionalization of this new governmental practice. Finally, civil society organization

members sometimes join the government and work on their policy agenda from the inside, leveraging their experiences and technical expertise acquired while advocating for improving cycling mobility. Table 17 summarizes the activities of CSOs across the different stages of cycling infrastructure.

Table 17. Successful engagement of CSOs in infrastructure promotion and development across cities

	Activities to make cycling infrastructure need visible (*rodadas*, painting lanes, surveys)	Co-production of planning instruments or advocate-led network proposals	Advocacy during implementation: audits and advocating for good design	Socialization: promoting acceptability and infrastructure use	Maintenance: advocating for maintenance, making lack of maintenance visible	Monitoring: monitoring the state of the network	Successfully participating in the drafting of laws that support cycling infrastructure	Advocating for specialized agencies to implement
Cuernavaca								
Toluca	•	•	•	•				
Oaxaca	•	•					•	
Querétaro	•				•			•
Aguascalientes	•	•				•	•	•
Mérida	•		•			•		
León	•							
Morelia	•	•	•	•	•	•	•	•
Puebla	•	•	•	•	•	•	•	•
Guadalajara	•	•	•	•	•	•	•	•

3.5 Results and discussion part 2: Implementation of cycling infrastructure in Mexican Cities

Understanding the development of cycling infrastructure across case studies requires knowledge of local actors, institutions, administrative structures, instruments, and coordination mechanisms through which actors organize and guide implementation. In most of the cities included in this research, governments implemented cycling infrastructure for the first time during the period studied (2008-2021). In some cases, there was a progressive process of institutionalization where local actors formalized the responsibility to build infrastructure into government policies and created mechanisms to ensure deliberate planning and implementation processes that sustain this practice. In others, implementation happened on a project-by-project basis where each one had its rationale.

In this section, I identify the central institutions and organizations that support the emerging practice of building infrastructure and the experiences of people who work within or alongside them to understand how cycling infrastructure is typically implemented in each place. Then, in the following section, I systematically compare cases to see how each of these institutions appears and affects implementation in each of the cities studied. I also provide an assessment of the infrastructure built so far, including context on infrastructure characteristics and quality, based on interviewees' testimonies, field visits (where possible), photos, and evaluations done by local civil society organizations. A systematic comparison of the infrastructure across locations was outside the scope of this research. Therefore, the focus is on the characteristics that emerged as themes in the interviews and whether evidence collected indicates that governments

implementing infrastructure, even if mistakes were made in the early stages, have established mechanisms to ensure that the more recent infrastructure development avoids past or well-known mistakes.

3.5.1 *Organizations and institutions*

In Mexico, states and municipalities are responsible for guaranteeing the constitutional right to mobility (Mexico, 1961). The federal law establishes general parameters and assigns states and municipalities obligations, giving them the freedom to establish their own administrative and legal structures to implement public policies to comply with federal mandates. Therefore, when it comes to mobility, implementation structures and guidelines are found within state and municipal jurisdictions.

3.5.2 *State-level laws*

A few different laws exist at the state level that govern transportation and mobility and where mandates and provisions for building cycling infrastructure might be found. These include Transport and Roads Laws, Urban Mobility Laws, and in a few states Bike Promotion Laws. Other laws include some principles related to cycling, for example, Land Use Laws or Urban Development Laws. I focus on the laws that govern transportation and mobility because these are the main entities that will assign responsibilities related to cycling within local mobility systems, which is the core of this research. Table 18 presents a comparison between laws in each case.

In most cases, where state legislatures have passed Urban Mobility Laws, these overwrite Transport and Roads Laws. This change reflects a shift in the focus of the legal framework. Laws governing streets under a paradigm of mobility compared to roads and

transport is the recognition of *people's right to be mobile* over the movement of vehicles. The mobility paradigm includes an overarching principle to prioritize pedestrians, cyclists, and public transportation in policy and planning. Within this conceptual change is a reorganization of the priority of users of the street through a new hierarchy (often called the "Inverted Mobility Pyramid," implying that it is a 180-degree shift from the status quo where the car dominates planning and use of the street). The adoption of Mobility Laws in many states includes, among other things, the first legal recognition of cyclists as part of the urban mobility system and mandate for municipalities to build infrastructure to keep cyclists safe. Interestingly, some laws and agencies involved in the governance of transport have been renamed to include the word ‘mobility’ without changing the actual scope of governance.

Over the last decade, many state laws have been reformed to incorporate the concept of mobility and the overarching principle of governing people’s movement rather than the movement of vehicles. Many states incorporated specific mandates and responsibilities for state and municipal authorities to build cycling infrastructure with these changes. These laws are essential shifts for the planning and implementation of cycling infrastructure because, in most cases, government entities exclusively adhere their activities to the responsibilities attributed to them by law. Without a legal mandate, any agency building cycling infrastructure is doing so as an exercise of experimentation rather than an institutionalized practice that can be sustained. The law grants responsibilities to states and municipalities, and with this mandate, both state and municipal agencies can implement policies on the streets under their jurisdiction. Table

18 displays a comparison of the laws that include cycling mobility in each of the states where the cities in this study are located.

Table 18. General comparison of state laws that include cycling

	Morelos *Cuernavaca*	Jalisco *Guadalajara*	Michoacan *Morelia*	Puebla *Puebla*	Oaxaca *Oaxaca*	Guanjuato *León*	*Querétaro Querétaro*	*Yucatán Mérida*	*Edo. De Mexico Toluca*	*Aguascalientes Aguascalientes*
Does the State have a mobility law, a roads and transit law or a bike law that includes cycling?	Roads and Transport Law	Mobility Law	Bike Law	Roads and Transport Law	Mobility Law and bike Law	Mobility Law	Bike Law	Bike Law / Roads and Transport Law	Mobility Law	Mobility and Bike law
Implementation manual?	Only traffic regulations	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Include concepts of infrastructure for non-motorized mobility?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Acknowledges that pedestrians and cyclists should be prioritized in policies and programs	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Does the law include a mandate for State and Municipal authorities to build cycling infrastructure?	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Establishes general parameters for development of cycling infrastructure?	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Financing mechanisms for cycling infrastructure	No	Yes	No	No	No	No	No	No	No	No
Specifies planning instruments to support cycling infrastructure	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Mobility comisión in the legislative body?	No	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes

3.5.3 *Implementing agencies*

Following laws, governmental structures need to be modified to implement mandates. Laws create obligations and assign responsibilities, but their existence does not guarantee that those responsibilities will be carried out. State and local agencies must be assigned the responsibilities and resources to implement legal mandates found within state laws governing urban mobility. For cycling infrastructure to be implemented and sustained as a governmental activity as mandated by state law, state and municipal agencies must have the explicit authority to carry out this activity. Table 19 compares the implementing agencies across the cases studied.

Different levels of government manage streets and roads within municipalities. Some streets within a municipality are state-controlled, some are municipal. Larger interstate highways are usually under federal jurisdiction, but it is on streets under state-and municipal authority where most cycling infrastructure is developed. Sometimes there is coordination between the state and the municipality, but this is not always the case.

In the cases studied here, there are a variety of agencies that participate in building cycling infrastructure. In many cases, the agencies involved have evolved and changed during the period studied (2008 – 2021). Additionally, in each place, there can be more than one possible pathway for implementing cycling infrastructure. In some cities, infrastructure is implemented due to a deliberate planning process, whereas in others, projects are implemented on an individual basis. Mayors and governors have much control over the agenda implemented in their administration and often have significant say over the projects that are implemented. This means, for example, that they can adopt the cycling agenda as their own and support the

implementation of projects during their administration or veto the agenda, regardless of the progress made to institutionalize this practice.

The implementation of infrastructure requires the coordination of a few different types of agencies. This discussion will focus on the main ones that participate in the direct planning, design, and implementation of cycling infrastructure, including Municipal Planning Agencies, and Urban Mobility Offices, and Public Works Departments. Occasionally, state-level Mobility Agencies and the state-level Public Works will also implement projects. There are projects that involve the federal government's participation, but since these are less common, I do not discuss them here.

3.5.4 *Municipal Planning Agencies*

Municipal Planning Agencies are decentralized institutions that are in charge of long-term planning. Some of the municipalities studied here, like León and Aguascalientes, have had these agencies since the early 2000s, wherein others, they are more recent, like Morelia, where the agency was established in 2016. Guadalajara is a notable exception because they are a step ahead and have a Metropolitan Planning Agency coordinating within and across municipalities in the Guadalajara Metropolitan Area. Municipal Planning Agencies are in charge of long-term planning for urban development and municipal services, and they also assist in the coordination across agencies for planning and implementation of municipal policies. In the cases studied here, as cycling started to permeate into the public agenda, Municipal Planning Agencies were often the first governmental bodies to include non-motorized mobility as a guiding principle of their work. In many cases, Municipal Planning Agencies were also places where local advocates

found allies that supported the notion of including cycling into governmental practices and started to work to include cycling into institutional policies.

For the most part, these agencies do not have the capability or legal responsibility to implement projects. However, they are important for developing the planning agenda and influence what projects a municipality will implement in the long term. A notable exception is León, where the Planning Agency holds central power and develops all the projects in-house together with Public Works. Planning agencies usually develop high-level plans and then specialized offices in the municipality develop the more specific projects detailed in those plans. For example, it is usually within the Municipal Planning Agency where cycling infrastructure networks are developed and incorporated into planning instruments. Then the actual projects within these plans are developed implemented by other agencies like Mobility Offices and Public Works Departments.

3.5.5 *Municipal Mobility Offices*

Municipal Mobility Offices are a recent addition to municipal structures that have emerged across the country as the concept of mobility has permeated into national policy. Mobility Offices are usually centralized offices of the municipal government responsible for planning and developing municipal projects related to urban mobility, including cycling infrastructure. The earliest these offices appear in the cases studied is 2015 in Querétaro and Guadalajara. Mobility Offices are often places where cycling advocates work, and in those cases, they go above and beyond to implement projects and institutionalize the cycling agenda. For example, in Guadalajara, Puebla, and Morelia, cycling advocates have permeated within these

agencies in leadership roles where they have established cycling as one of their priorities and worked to create rules and practices that exist beyond their tenures.

Mobility Offices across cities vary in the power they have. Some have leverage over budgets and strong oversight capabilities, while others develop projects and hand them over to Public Works for implementation without any meaningful feedback as they build the projects. For example, in Morelia, the local Mobility Office has a say in approving budgets for projects, giving them extra leverage to ensure that projects meet their standards. In León, the Mobility Office exists but only participates in cycling projects by suggesting improvements to the Municipal Planning Agency, which has no obligation to incorporate observations and usually does not.

3.5.6 *Public Works Departents*

In most cases, Public Works Departments are responsible for building and control the municipal project's budgets, giving them significant power during implementation. For projects developed outside of the Public Works Department, once the project details are established, either by the Planning Agency or the Mobility Office, they hand over the project to the Municipal Public Works who either implement the project in-house or contract it out supervise deployment.

Occasionally Public Works is the sole agency responsible for developing, designing, and implementing projects. For example, this is common when cycling infrastructure is implemented as an “add-on” to road improvement projects or as a single project. Also, not all municipalities have mobility offices or planning agencies, and in those cases, Public Works are the sole implementer of these types of projects.

There is often a tension between Mobility Offices and the traffic and roads staff within the Public Works Department, which are typically conformed by career public servants who are "old-school" traffic engineers and architects and are typically a lot older than their Mobility Office counterparts. These two agencies inevitably have to work together on projects, but they do not always agree on the overall priorities of cycling projects. Following a longstanding approach to implementation, Public Works Departments tend to prioritize vehicular flows, which can interfere with the specialized needs of cycling infrastructure (path dependency). They are also often the sole implementers of projects but are not always trained in the implementation of infrastructure projects. This is a tension that is highlighted across cases and ultimately impacts the way cycling infrastructure is built.

3.5.7 *State-level agencies*

Occasionally state-level agencies will also implement cycling infrastructure on streets under their jurisdiction. In Mérida and Aguascalientes, state agencies have played a significant role in developing urban cycling infrastructure. When cycling is implemented through the state, this is usually planned by the state-level transportation or mobility office and then implemented by the state-level infrastructure agency. Some state-level agencies are named mobility agencies but have not changed their functions to include the development of cycling infrastructure (For example, in Oaxaca and Toluca). These agencies are not considered here because they are not involved in cycling projects, even if their name indicates they should be.

3.5.8 *Cycling infrastructure policies and programs*

Cycling infrastructure development plans are found within many different types of instruments. These include Bike Masterplans, Non-motorized Mobility Strategies, and

Sustainable Mobility Plans. These plans can vary in detail and range from a general strategic statement that cycling infrastructure will be implemented and prioritized, a proposed cycling infrastructure network, and a detailed plan that includes specific projects and budgets. Many examples are found across the cities studied. However, it is important to point out that plans are sometimes developed and presented to the public but not implemented.

Table 19. Organizations, institutions, and instruments for developing cycling infrastructure

	Cuernavaca	Oaxaca	Toluca	AGS	Querétaro	León	Mérida	Morelia	Puebla	Guadalajara
Law	None	Bike Law	Mobility Law	Bike Law and mobility law	Bike Law	Mobility Law	Bike Law	Bike law	None during period studied	Mobility Law
Municipal Planning Agency	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal Mobility Office	No	No	No	No	Yes	Yes	No	Yes	Yes	Metropolitan Planning
State Agency	No	Yes	No	Yes	No	No	Yes	Yes	Yes	No
Cycling network in Government Plan	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Infrastructure design standards	No	No	No	No	No	No	No	Yes	Yes	yes
Advocates in decision-making roles?	No	No	No	Between 2018 and 2020	No	No	Since 2018	Since 2018	Since 2018	Since 2015
Km implemented	0		36							
Implementation process	None	Piecewise usually Spatial opportunity or political opportunity	Piecewise usually political opportunity	A mix of deliberate and piecewise	A mix of deliberate and piecewise	Deliberate	A mix of deliberate and piecewise	Deliberate	Mix but more recently deliberate implementation	Deliberate
Funding mechanisms										
Stable funding?	No									
		Occasional projects, no work towards network, no standards	Occasional project, no work towards network, no standards	Ocasional project, no work towards network, no standards	Many km implemented but they are not maintained, and they were not built to any standards	Many km implemented but they are not maintained, and they were not built to any standards	Many km implemented but they are not maintained and they were not built to any standards	Strategic planning, higher standards, and oversight but low implementation	Strategic planning, higher standards, and oversight (recently) First infrastructure did not meet standards	Strategic planning, higher standards, and oversight

3.5.9 *Cycling infrastructure implementation in Mexican cities*

To organize the discussion about infrastructure implementation, I classified cases by whether or not they have developed institutionalized and deliberate planning processes and the number of km of infrastructure they have implemented (Table 20). Deliberate planning implies that infrastructure implementation follows an institutionalized planning process and is working towards a specific goal. Deliberate planning also has institutions in place to guide the process (even though this has changed over time in some places). For example, the places with the most advanced institutions have also developed design standards to ensure that infrastructure meets criteria accepted as best practices or at least avoid dangerous and counterproductive practices that endanger cyclists or lead them to ride outside designated lanes. The planning process has reached a more mature stage in the cases grouped into the "deliberate" category. The remaining cases are grouped in the piece-wise implementation category, implying that projects are implemented in various ways but without an established plan or strategy. To further classify cases, I divided them by the amount of infrastructure that has been built so far to distinguish between cities that have more experience implementing these projects. The evidence presented regarding the infrastructure implemented shows the projects implemented to date. In many cases, there is a monotonic increase of km. However, as I discuss in each section, the maintenance of cycling infrastructure remains a challenge. Therefore, these figures should be interpreted with caution (as implemented infrastructure rather than existing infrastructure) since some previously implemented projects may have disappeared or lost functionality.

Table 20. Case groupings for discussion

	Less km built	More km built
Deliberate implementation	Morelia	León, Guadalajara, Puebla
Piecewise implementation	Cuernavaca, Toluca, Oaxaca	Aguascalientes, Querétaro, Mérida

3.5.9.1 Piecewise implementation, few km built: Cuernavaca, Toluca, and Oaxaca

The cases under this category have no (Cuernavaca) or minimal (Toluca, Oaxaca) cycling infrastructure. In Toluca and Oaxaca, occasional projects have been implemented because civil society organizations rally around projects and seek out project-based institutional support that is not sustained once these specific projects are implemented. On the institutional side, even though Oaxaca and Toluca are within states with cycling laws, these mandates have not trickled down into the organizational structure of implementing agencies. Because they are few and based on individual projects, the bikeways implemented have not started to conform to a network. However, in Oaxaca, one of the few bikeways built is a 10 km path that connects Oaxaca, an economic hub, to 4 of the neighboring municipalities; interviewees claim it is widely used and functional for certain types of trips. It is worth noting that Oaxaca is a much smaller city than Toluca (Table 12) and also has calmer city street dynamics due to its smaller size and deep traditions. Toluca is a more prominent, urban economic hub with close ties to Mexico City, while Oaxaca remains a smaller and more traditional town making these two places inherently different.

3.5.9.1.1 Cuernavaca

Cuernavaca has no cycling infrastructure; their transport laws do not mention cyclists or enable organizations to implement infrastructure. A small local cycling movement has tried to advocate for better conditions for cycling, which so far has not been successful. Cuernavaca is also hillier and has a warmer climate than most of the municipalities studied here.

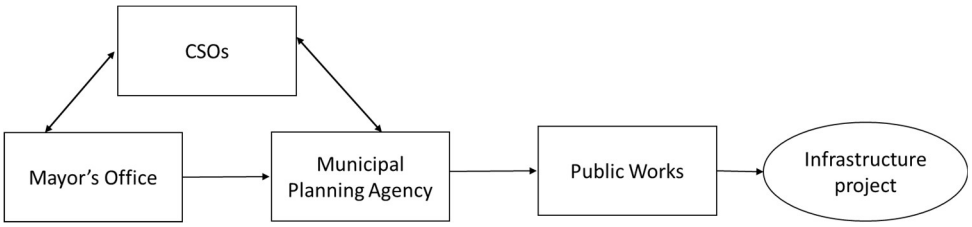
3.5.9.1.2 Toluca

Toluca has approximately 36 km of cycling infrastructure. The first cycling lane in Toluca was built in the 1970s on *Paseo Tollocan*. This cycling path was initially 12 km long. Over time, however, the path has been fragmented to accommodate the growing amount of car traffic and turns, which has made this cycling lane discontinuous (literally missing large sections), dangerous and dysfunctional. Many parts of the path are obstructed with garbage and rubble. The following infrastructure that was built was a 2.3 km segregated cycling lane on *Avenida Hidalgo*. This cycling lane connects the center of Toluca with *Ciudad Universitaria,* where one of Toluca's most prominent university campuses resides. Since it was built, it has decayed, having received minor maintenance.

The few infrastructure projects that have been implemented in Toluca since 2010 have been the direct result of work between the local government and CSOs. Under the State of Mexico Mobility Law, since 2015, cycling infrastructure should be implemented by municipalities within the state (Gobierno del Estado de Mexico, 2015). However, in Toluca no specialized agencies have been created with the responsibility to carry out this mandate. The Municipal Planning Agency in Toluca has been created and dismantled at the will of each government administration. The Municipal Planning Agency in Toluca was active between 2012 and 2015 and then reinstated in 2020.

In Toluca, individual projects have been developed based on specific opportunities where activist proposals have gained political support. The most successful project implemented so far was the *Hidalgo* segregated cycling track built in 2013, which started as a citizen proposal that the mayor Marta Hilda Calderón embraced at the time. Civil Society Organizations also participated in the planning and design of the lane, together with the Municipal Planning Agency, and then the project was implemented by Public Works (Figure 17).

Figure 17. Process for implementing cycling infrastructure in Toluca



Calderón created a working group to coordinate planning and implementation across agencies and build a cycling agenda. However, when she left office, the incoming administration dropped the entire cycling agenda, and there was no governmental activity to support the development of cycling infrastructure until 2021. The non-motorized mobility agenda was added to the Municipal Environment Agency, but they had no leverage to coordinate with other agencies to make progress on this agenda.

> *Even if we [the Environment Agency] are willing to include active mobility in our planning ... if we don't work with Public Works, if we don't work with the Planning Agency, with Transportation.... If we don't work together efficiently, we will only make marginal progress; we will not have the impact that we could have if we manage to work together, which is what we had [when we worked on the Hidalgo Cycling Lane]. (Public Official, Toluca, 01/15/2020)*

In 2021 Civil society organizations proposed cycling infrastructure as a measure during the COVID-19 pandemic. The mayor in turn accepted the proposal and reoriented funds from his municipal budget for implementation. The lanes were planned by the recently reinstated

Municipal Planning Agency and built by the Municipal Public Works Department. However, they were met with protests and partially removed a week after they were inaugurated, exemplifying how in Toluca, cycling infrastructure development is still intensely contentious. The spatial and temporal evolution of cycling infrastructure in Toluca is included in Figure 17. The evolution of institutions supporting cycling infrastructure implementation and the cumulative km of infrastructure development in Toluca is presented in Figure 19.

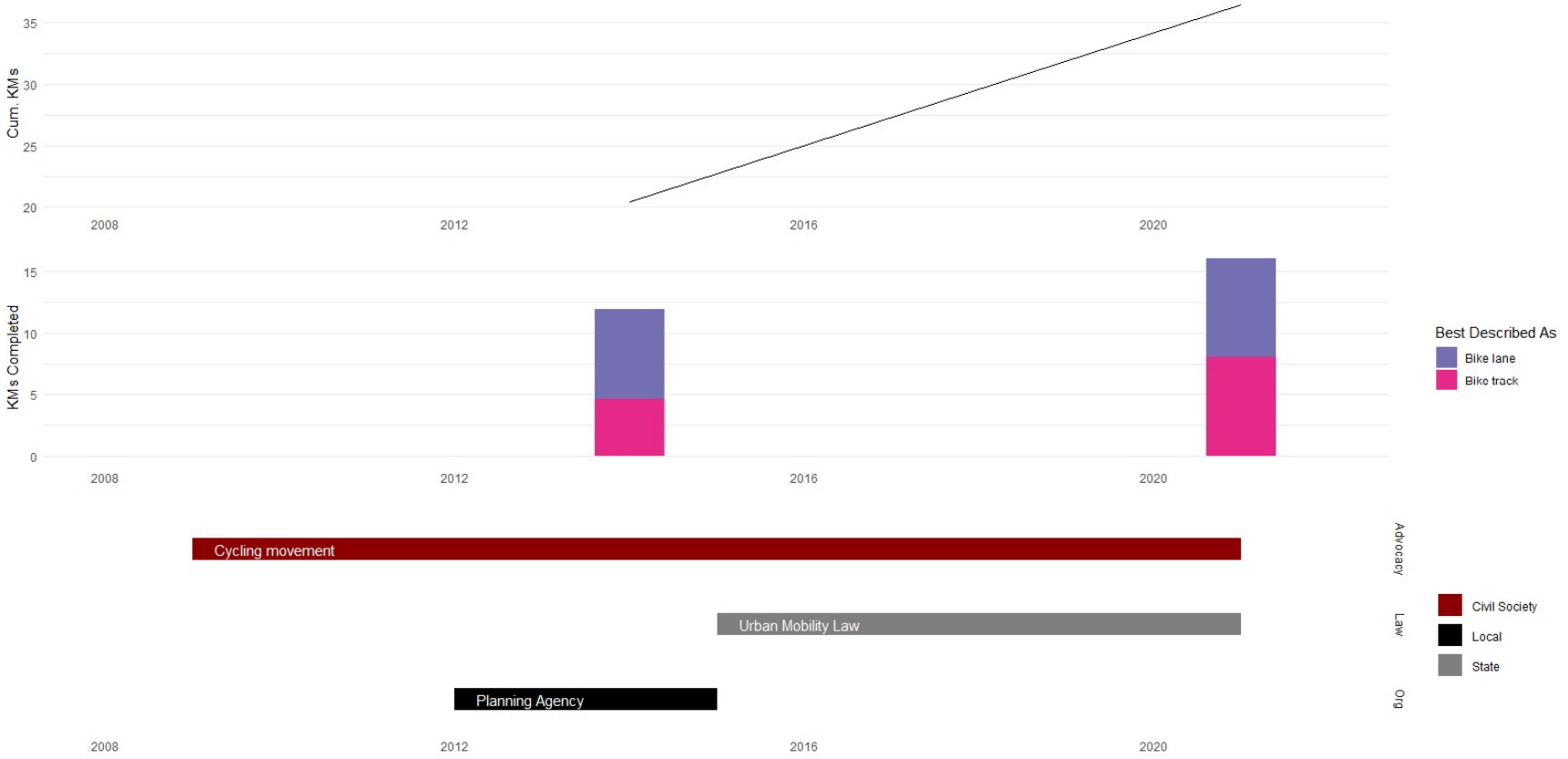
Figure 18. Evolution of cycling infrastructure in Toluca

2010

2015

2021

Figure 19. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Toluca and supporting institutions [6]



[6] The infrastructure data for Toluca was compiled and shared by Adrian Chavarria

3.5.9.1.3 Oaxaca

In 2021, 14.7 km of cycling infrastructure had been implemented in Oaxaca, all developed within the previous ten years. The *Ciclovía Arco Sur-Este*, an approximately 10 km cycling path between Oaxaca and El Tule, existed for many years but was repaired in 2012. This cycling lane follows the path of old train tracks. The exact time this cycling lane was first built is unclear, but it was completely rebuilt and renovated between 2012 and 2015 by the state government. The type of infrastructure that comprises this path changes across the 10 km length, but most of it is a wide bidirectional path located on a traffic island. The *Ciclovía Arco Sur-Este* is the most functional cycling infrastructure in the municipality since many people in the surrounding area use this lane to travel to the city center.

> *In Oaxaca there is infrastructure that is not connected as part of a network. There are segments or sections of infrastructure that do not connect to long, medium or short distances. There are isolated sections that are very short. There is only one section that works more efficiently that is a cycling path that connects central Oaxaca with el Tule [a monumental tree on the outskirts of the city of Oaxaca]. It crosses three or four metropolitan municipalities and connects well with the central municipality. And it starts right on the edge of the historic center of town, which is, de facto, a slow speed zone. It's not declared as such, but people tend to drive slow. So once you get to where the bike path ends, you are entering the center of Oaxaca, where you can ride a bicycle without requiring a dedicated path to get around. So, it's the only section or the only branch of planned infrastructure that actually works (Public Official and former activist, Oaxaca, 4/28/2020)*

So far, planning and implementing infrastructure in Oaxaca has not followed an extensive government-led planning process, nor has it followed a government-led strategic approach. Oaxaca has a Cycling Law since 2013, which actors claim is symbolic mainly because none of the oversight structures that the law mandated when it was passed in 2013 have never been created (Gobierno de Oaxaca, 2013). There is no Municipal Planning Agency and no Municipal Mobility Office. There is a State level Mobility Agency, although this agency is responsible for motorized

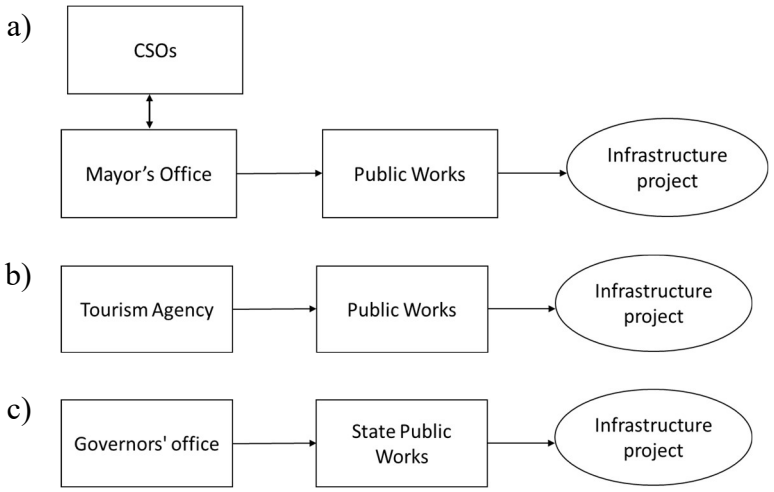
transportation and has no specialized areas dedicated to infrastructure for non-motorized mobility, indicating a lack of understanding of what a mobility office should do.

> *People in charge of putting government structures on paper—in writing—don't seem to understand that there needs to be some level of correspondence between the name they give an agency and what it actually does. So you have a mobility office that does not "do" mobility. It patrols transit, which is not mobility. That mismatch is common, and it also affects coordination because it makes accountability unclear. For example, activists go to the state mobility department to hold them accountable for mobility, which is not one of their areas, will be told that "we are not in charge of bicycles and pedestrians." Therefore, government structures need to change, and not just change their name. This means more than just adding the word mobility to something that is called "department of transportation." Structural changes are needed on the inside with designated agencies or offices responding into these issues with technical staff who understand these issues. (Public Official and former activist, Oaxaca, 4/28/2020)*

The infrastructure developed to date in Oaxaca has been planned on an opportunistic basis. The first cycling lane in Oaxaca was a direct result of an intervention by local activists. In 2012 during the National *Bicired* Cycling conference in Oaxaca, one of the activities developed by the conference participants was to paint a citizen cycling lane on *Calle Reforma* in the Oaxaca City Center. This cycling lane was later repainted and made official by the Oaxaca Municipal Government, although the lane has mostly disappeared over time due to lack of maintenance. The first government-implemented infrastructure for cycling in Oaxaca built by the state government through federal funds accessed through the *Fondo Metropolitano* was the *Ciclovía Arco Sur-Este* an approximately 10 km cycling path between Oaxaca and El Tule, built between 2012 and 2015. In 2015, the state government Tourism Agency intervened two streets in the city center, *García Vigil* and *Macedionio Alcalá*, and included small cycling infrastructure portions. This intervention was not related to any local efforts by civil society (since these are relatively calm streets that do not lead to anywhere strategic), nor was their coordination with the municipality. The intervention included two small cycling tracks, 600 m on *García Vigil* and 200 m on *Macedonio Alcalá*. In

addition to the cycling lanes and paths implemented so far, the Municipal Government of Oaxaca has also implemented a program to install bike parking across the city with more than 100 facilities built between 2012 and 2015. This program was developed with *Casa de la Ciudad, Mundo Ceiba* and other Civil Society Organizations.

Figure 20. Processes for implementing cycling infrastructure in Oaxaca



The spatial and temporal evolution of cycling infrastructure in Oaxaca is included in Figure 21. The evolution of institutions supporting cycling infrastructure implementation, along with the cumulative km of infrastructure development in Oaxaca, is presented in Figure 22.

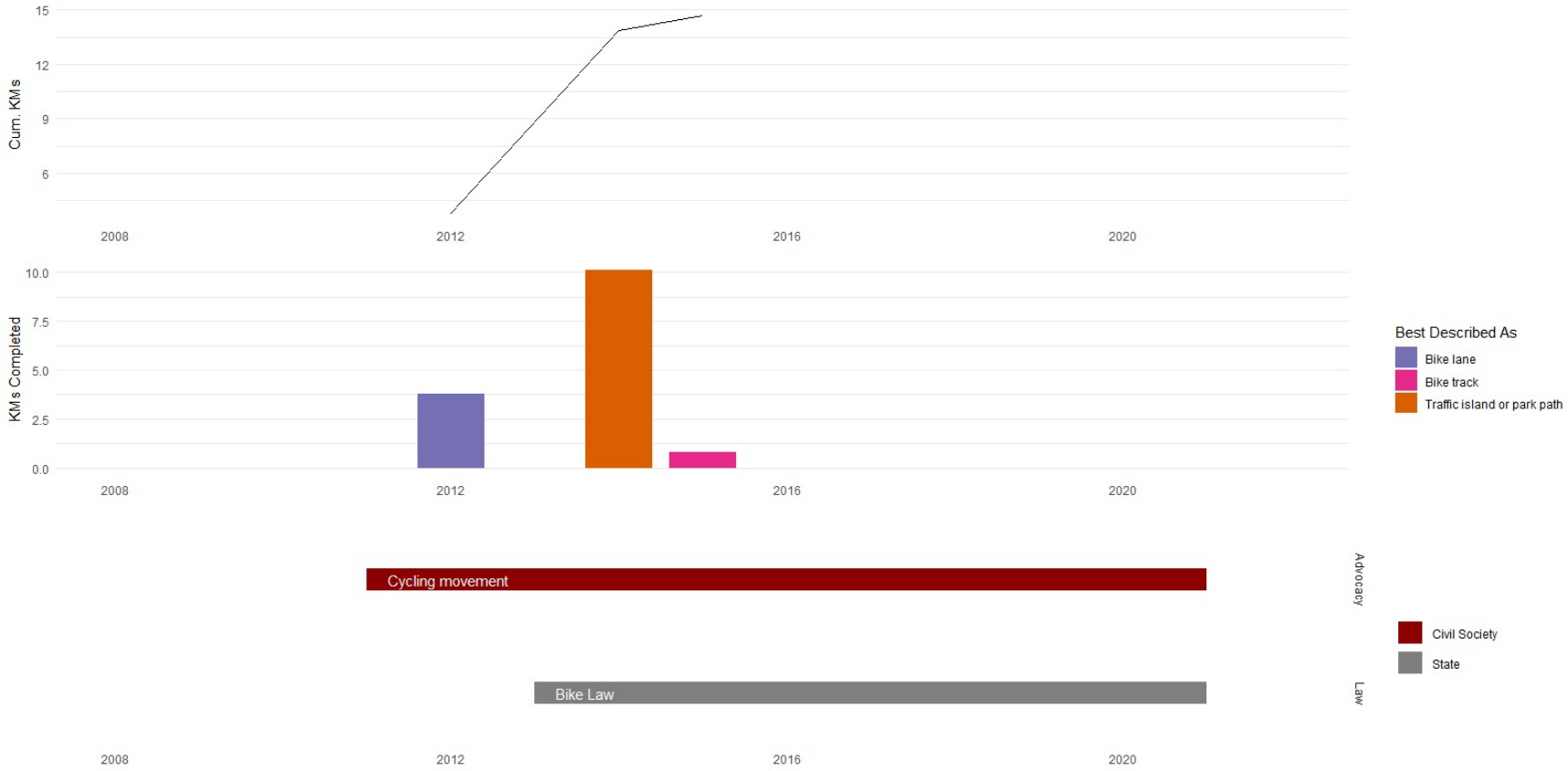
Figure 21. Evolution of cycling infrastructure in Oaxaca

2010

2015

2021

Figure 22. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Oaxaca and supporting institutions[7].



[7] The infrastructure data used for Oaxaca figuresFigure 19 was compiled and shared by Claudina de Gyves

3.5.9.2 Piecewise implementation, more km built: Aguascalientes, Querétaro, Mérida

Aguascalientes, Querétaro, and Mérida have different trajectories of implementing cycling infrastructure. They have in common that they have implemented many km of infrastructure, yet these cities still do not have established procedures or design standards to guide implementation. The result is that the infrastructure that has been implemented so far is highly uneven (of many different types, varying quality, and highly fragmented). There is also a mix of implementing agencies in these places that do not always coordinate, and this reflects on the infrastructure implemented to date because rather than following an institutionalized process, implementation is primarily done like patchwork with different actors contributing various pieces and with no consistent approach or body to take responsibility for maintenance. These places also have in common a lack of continuity in implementation. They have also lacked oversight over the quality of the infrastructure developed and have in common that local advocates and practitioners acknowledge that most of the infrastructure built to date is plagued with errors that make the infrastructure dangerous or hard to use. For example, cycleways are too narrow, located in the middle of the street with minor protections, along or on top of traffic islands that are hard to access, etc. Aguascalientes and Querétaro have experienced periods where more infrastructure has been built because of social pressure. However, when this pressure died down, so did the infrastructure implementation. In Mérida, most of the implementation has responded to localized demands where there is a lot of travel by bike within and between peri-urban neighborhoods, and urban infrastructure is more recent.

3.5.9.2.1 Aguascalientes

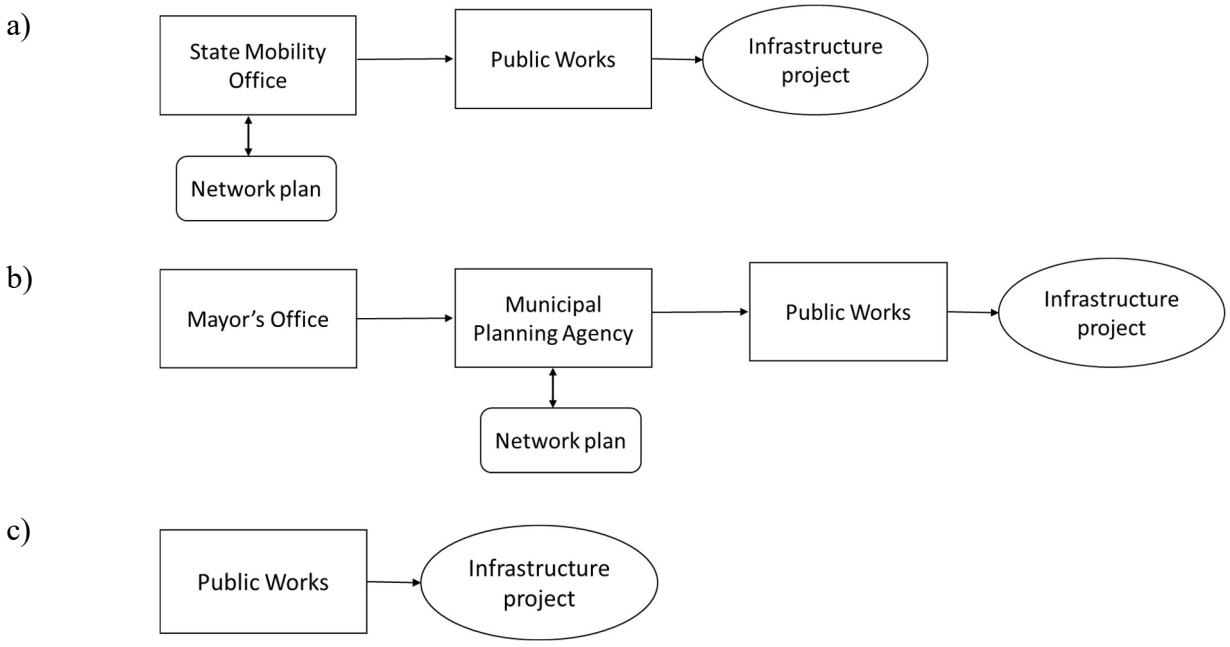
Aguascalientes has implemented 70.7 km of infrastructure. Issues with the existing cycling network are related to the spatial distribution, the design, and the state of maintenance and use of the city's existing cycling facilities. Local CSOs have developed systematic audits of the entire network and point to many issues, including that many of the existing infrastructures are highly irregular. First, the network is fragmented, and many cycling lanes have arbitrary beginnings and endings on high-speed roads, which exposes cyclists. Many of the cycling lanes are unusable because they are used for parking or otherwise obstructed, forcing cyclists to weave in and out of traffic when they are trying to use it. Parking in cycling infrastructure is common and usually goes unsanctioned. Lanes are also rarely maintained, meaning that in many parts of the network, it is hard to tell that there was a cycling lane there. The current state administration in Aguascalientes had promised to build 43.8 km between 2018 and 2021. These projects were widely announced and celebrated because local CSOs had long advocated for them, but less than 50% has been implemented as the current administration's government is coming to an end, citing the budget as a constraint[8].

Aguascalientes has a Municipal Planning Agency since 2001, and the Municipal Planning Agency has actively included cycling in city planning instruments since 2015. In 2018 Aguascalientes passed an Urban Mobility Law through which a new State-level Mobility Agency was created (Gobierno de Aguascalientes, 2018). There are two main pathways through which infrastructure is typically implemented in Aguascalientes. At the local level, the Municipal Planning Agency generates the routes and technical projects which are carried out by the Public

[8] Implementation was haulted in early 2020, before the pandemic

Works Department, given the instruction to do so by the mayor. At the state level, the Mobility Agency develops plans that are implemented by the state-level Public Works Agency.

Figure 23. Processes for implementing cycling infrastructure in Aguascalientes



Agencies designing infrastructure do not have any established guidelines to build infrastructure and lack the capacity to socialize infrastructure, leading to contentious encounters.

> *When it came to building cycling infrastructure, we found that it has a lot to do with design processes, which we do not have. Evidently, there is a shortage of people who can generate participative design—executive projects are put together, then the contractor arrives, and neighbors try to stop construction. Some projects have been halted, and we then have to come in to try to reach an agreement, which isn't really in our powers, but there was no provision for managing cyclist infrastructure development with affected neighbors. The problem is that it reduces parking on public roads. (Public Official, Aguascalientes, 03/05/2020).*

In 2015, the Municipal Planning Agency developed a proposal for a 287 km network of cycling routes that would be prioritized based on previously studied cycling traffic flows and trips (IMPLAN Aguascalientes, 2015). This plan was included in the long-term strategy for the

municipality, although very little has been implemented so far. While most recent infrastructure development usually follows a planning process through the Municipal Planning Agency or the State Mobility Agency, there have been times where Public Works have decided unilaterally to implement cycling infrastructure within roadworks projects without the involvement of these agencies. This is perhaps a symptom of the lack of coordination across agencies, reflecting on the current network since state and locally developed infrastructure are not well coordinated.

> *When it came time to pave a new street downtown, the people from Public Works decided they would paint the lane even if it wasn't part of the plan. There were complications because it's not just about putting bike lanes everywhere, but about generating infrastructure. We weren't thinking about that street because … it was surrounded by housing with garages and we didn't think it would work. When they arbitrarily painted the bike lane, the people who lived there were not happy. And on the day of the inauguration, rather than a positive event, it became negative because of the bike lane. You have to think about where you put [cycling infrastructure] and what is its purpose and speak to the people who live around it to make sure it's not perceived negatively. It's a matter that needs to be solved from many perspectives. (Public Official, Aguascalientes, 03/04/2020).*

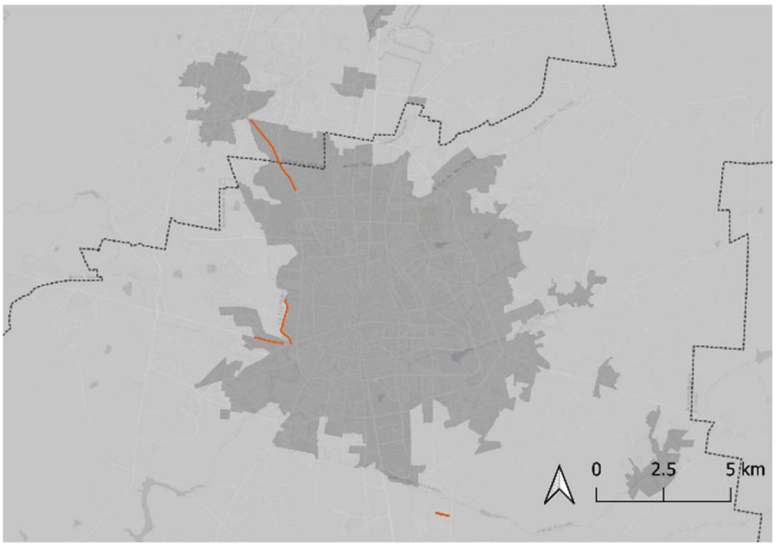
Several challenges have arisen during implementation processes in Aguascalientes, which negatively impact the quality of the infrastructure. There are numerous instances where the Public Works Department has modified projects because they are used to prioritizing car traffic and often do not understand the specific needs of cycling infrastructure. These occur because neither of the planning agencies (Municipal Planning Agency and State Mobility Agency) have any actual oversight over implementing agencies (state and local Public Works or companies they contract out to). Civil society often fills this void by reporting issues with infrastructure and asking for changes.

Local organizations have also developed extensive infrastructure audits that they turn over to the local government to advocate for changes and improvements, which are sometimes addressed and sometimes ignored. The spatial and temporal evolution of cycling infrastructure in

Aguascalientes is included in Figure 24. The evolution of institutions supporting cycling infrastructure implementation, along with the cumulative km of infrastructure development in Aguascalientes, is presented in Figure 25.

Figure 24. Evolution of cycling infrastructure in Aguascalientes

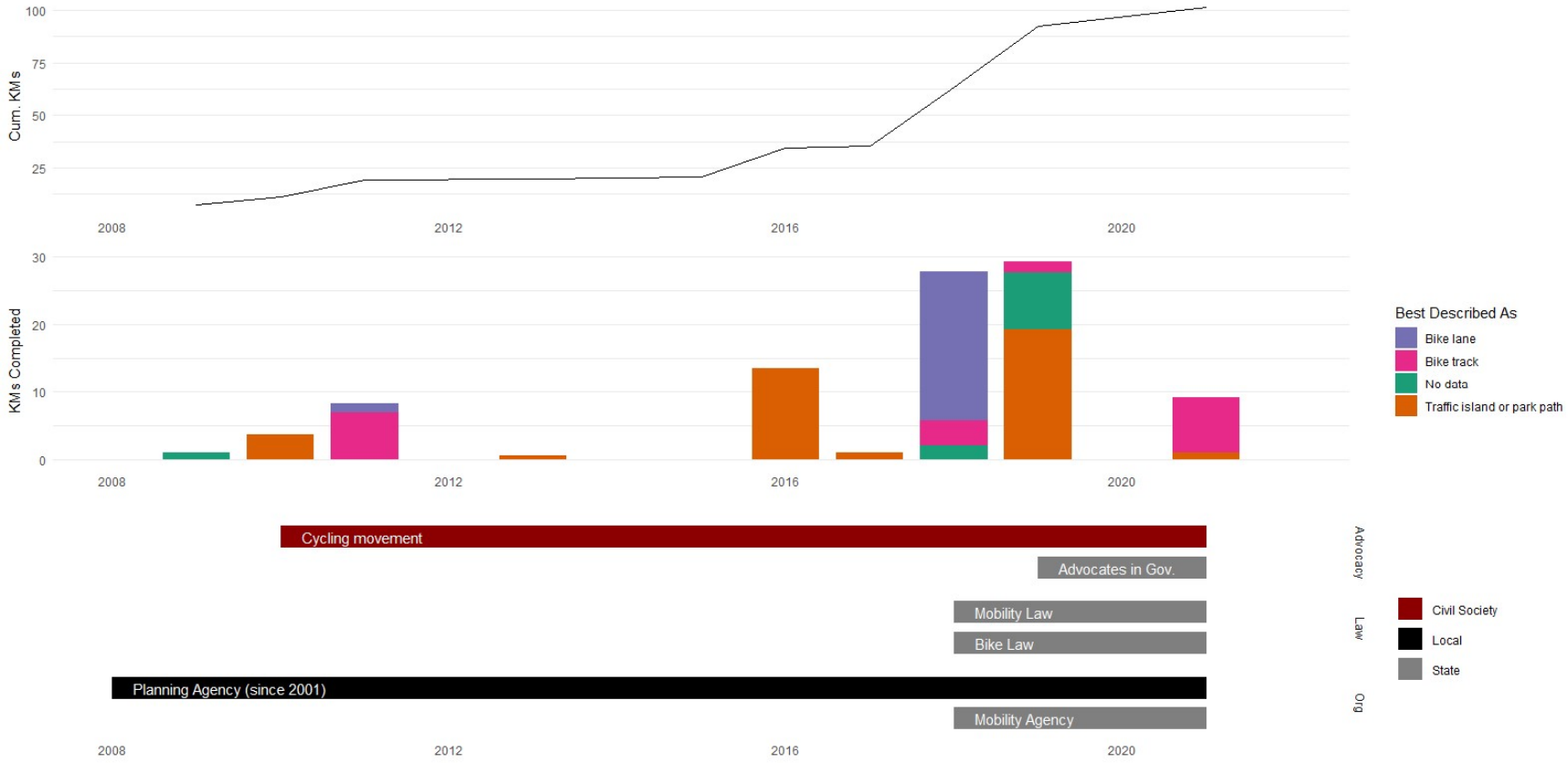
2010



2015

2021

Figure 25. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Aguascalientes and supporting institutions[9].



[9] The infrastructure data for Aguascalientes was compiled and shared by Josafat Martinez

3.5.9.2.2 Querétaro

Querétaro has implemented approximately 250 km of cycling infrastructure. In terms of km in a single municipality, Querétaro has the most extended network of any cases studied. The bulk of this infrastructure was built between 2015 and 2018 by the municipal government under mayor Marcos Aguilar. He was enthusiastic about promoting cycling infrastructure and set a policy goal of building 250 km of infrastructure for cycling during his tenure as mayor (Municipio de Querétaro, 2015). Querétaro is included in the "piecewise" implementation category because even though the local government has some planning capabilities, the implementation of cycling infrastructure has not been sustained, and there are no minimal mechanisms to ensure the quality and permanence of the cycling infrastructure that has been built so far.

> *Out of 100% of cyclist paths in Querétaro—the city has around 200 km of bikeways—only 20 or 30% are good, and the rest are bad or really bad. Why? For example, they may have painted a bike lane on a road but the paint eventually disappeared, or the government recarpeted it and ended up covering the paint themselves, or it's invaded by cars. If the authorities don't look after the development of these projects, regardless of the law, those lanes are going to disappear because of roadworks or because someone erased the paint or because they get invaded [by cars], and that damaged the paint. Others were not properly made in the first place and using them is riskier than not using them. When the lane is in a risky place for you, you choose not to use it (Activist and researcher, 08/24/2020).*

Before 2015 there were approximately 50 km of infrastructure, developed as individual projects with the support of previous mayors and implemented by the Public Works Department. The project through which the local government promoted these 200 km worth of cycling lanes was called *Ciqrovía*[10] (Municipio de Querétaro, 2015). This project included an investment of

[10] wordplay between the word Querétaro and the world Ciclovía (cycling lane)

255 million pesos and proposed a network of 250 km of cycling infrastructure. The *Ciqrovía* project, launched in 2015, included the development of a proposed Cycling infrastructure network. This plan was the basis for all of the infrastructure that has been built over 2015-2018 but nothing new has been built in more recent years. In Querétaro, the Municipal Mobility Office plans routes and technical specifications for the cycling network, and Public Works implements the road projects.

The rapid implementation of the *Ciqrovía* project left many cyclists unsatisfied because of the low quality of the lanes. Most of the infrastructure was implemented as painted cycling lanes and shared lanes with motor traffic. Public works teams often painted lanes over existing concrete without repairing potholes or even cleaning gravel off the ground before applying paint. Some of the areas that were painted as cycling lanes never received signaling or signage to indicate a cycling lane. The following government administration[11] has barely done any infrastructure maintenance. The local government has also yet to connect the network, leaving many of the existing cycling lanes isolated from key urban destinations. Many of these cycling lanes are consistently used for parking, especially in those where signage is missing.

> *So, the infrastructure is in terrible shape and the current government has not done any work on it. You start to notice that there is, in fact, very little road maintenance, that those bike paths that are built are not adequately planned, there is no connectivity between them. They are like placebos that politicians build to keep us quiet. (Activist, Querétaro, 08/31/2020).*

Querétaro was the first Municipality in the country to have a Cycling Law, although cycling has never been incorporated into the primary laws governing transportation in the state (Gobierno de Querétaro). Querétaro has a Municipal Mobility Office since 2015 which has legal

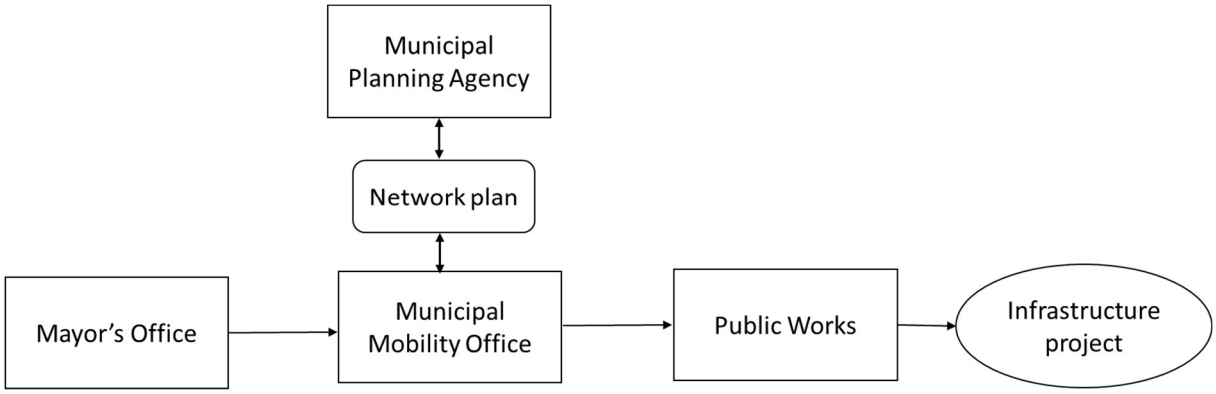
[11] up to late 2020 when most of these interviews were carried out

competencies related to developing cycling infrastructure. Before the Municipal Mobility Office was created, no specialized agency at the state or local level had any legal competencies in this area. While the Municipal Mobility Office has competencies that include planning for urban mobility and developing executive projects for cycling infrastructure, the agency structure does not include a specific area in charge of non-motorized mobility, and the responsibilities for developing these projects are spread across different areas. The Mobility Office is in charge of planning, regulating, and designing cycling infrastructure, and then they hand off the projects to Public Works, who handle the implementation by building them directly or through external contracts. They have no control over the budget that Public Works entirely control for every project or any oversight mechanisms, making it hard to ensure that projects are built according to design.

> *There is a difficult situation because all the planning is supposed to be done at the Mobility Office, but it doesn't have the resources so it is executed by Public Works, and it's a complicated triangulation. (Activist, Querétaro, 03/04/2020)*

The creation of the Mobility Office was the direct result of citizen participation and advocacy and the support of a local legislator, Marcos Aguilar, who later became mayor and developed most of Querétaro's cycling infrastructure during his tenure.

Figure 26. Process for implementing infrastructure in Querétaro



The Municipal Planning Agency, created in 2002 was the first agency in the municipality to work on cycling infrastructure projects. When the cyclist movement became more active in Querétaro in 2014, as cycling activists became more involved in seeking out government support, and without having an agency that had the mandate to support or develop cycling policy, they found their first allies within the Municipal Planning Agency, who were interested in the topic and often willing to advocate internally on their behalf. Once there was an explicit governmental commitment to developing cycling infrastructure in 2015, the Mobility Office was created. The Municipal Planning Agency took a secondary role, mainly providing research and planning and sharing expertise developed in the previous years. The spatial and temporal evolution of cycling infrastructure in Querétaro is included in Figure 27. The evolution of institutions supporting cycling infrastructure implementation, along with the cumulative km of infrastructure development in Querétaro, is presented in Figure 28.

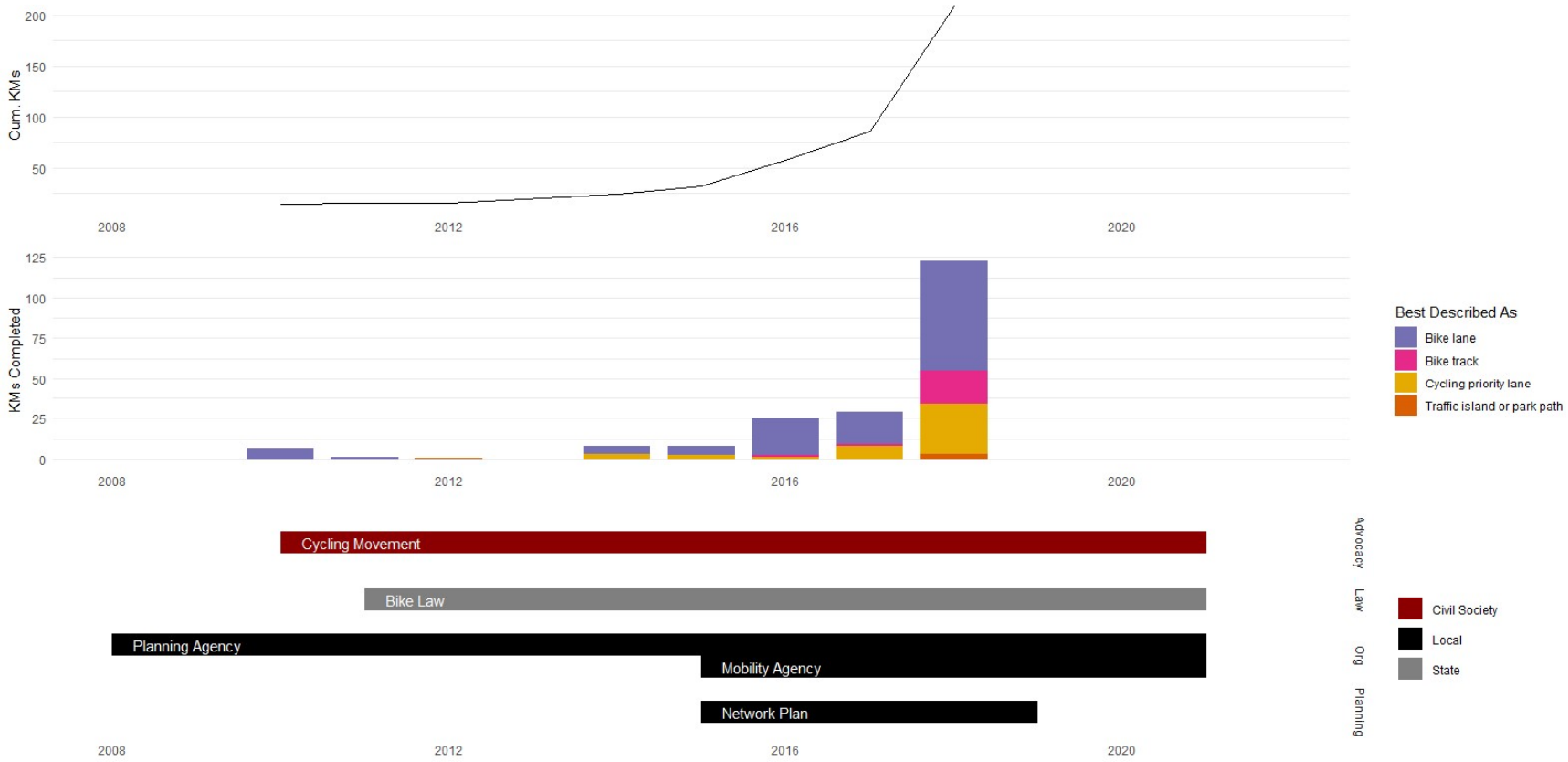
Figure 27. Evolution of cycling infrastructure in Querétaro

2010

2015

2021

Figure 28. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Querétaro and supporting institutions[12].



[12] The infrastructure data from Querétaro was compiled and shared by Ricardo Arredondo

3.5.9.2.3 Mérida

In Mérida, most of the cycling infrastructure that was built before 2020 was built in the periphery, where people use bikes to travel within and between their neighborhoods (*comisarías*). While this peri-urban infrastructure responds to local demand because daily travel by bike between *comisarias* is a common activity, it serves a different purpose than a cycling network within the city to facilitate trips to areas where most people work, in more central parts of Mérida. As of 2014, when roads between *comisarías* were given maintenance or repaved, cycling infrastructure was added with "leftover" roadwork resources.

> *[The state of our infrastructure] is quite varied. Varied verging on bad. It took off in 2014 during Hernán Barrera's first term. We had about 30 kilometers of infrastructure in our precincts, at most. While he was mayor, as part of a policy that aimed to strengthen precincts from a social development perspective, he decided to increase municipal road infrastructure. Some of these projects, aside from repaving, included the addition of cycling lanes on road shoulders. In some places, where they had generous road rights, they built bike lanes. But they lack the necessary safety and design features. They are not wide enough, are often two ways, and in many cases, the width of the lane varies… So far these actions are not part of any plan. It's more out of coming across an opportunity and seeing that there is space to do it. (Activist, Mérida, 02/10/2020).*

Additionally, most of these cycling paths were built without following any specific technical design guidelines, and therefore vary widely in their quality, safety, and useability, and many are not given maintenance and are fragmented or mostly gone.

> *The existing bike paths are limited to one lane, and many have pointed out that they don't have enough lighting or signs, or that they are linked to places that don't lead anywhere. These comments are helping improve future interventions. (Public Official, Mérida, 02/12/2020)*

According to *the Observatorio de Movilidad Sostenible de Mérida*, a Civil Society Organization that develops periodic audits of cycling infrastructure and monitors cyclist

fatalities, many of these lanes start abruptly on dangerous high-speed intersections and are focal points for collisions with vehicles (Monsreal and Mendoza, 2021). Part of the problem is that the local government does not have any program or capacity to monitor built infrastructure or standards for its development, so many decisions are left up to the Public Works Department. Cycling infrastructure within the central part of the city is more recent. In 2020 the State Mobility Agency built 70 new km of infrastructure in Mérida, adding up to over 150 km.

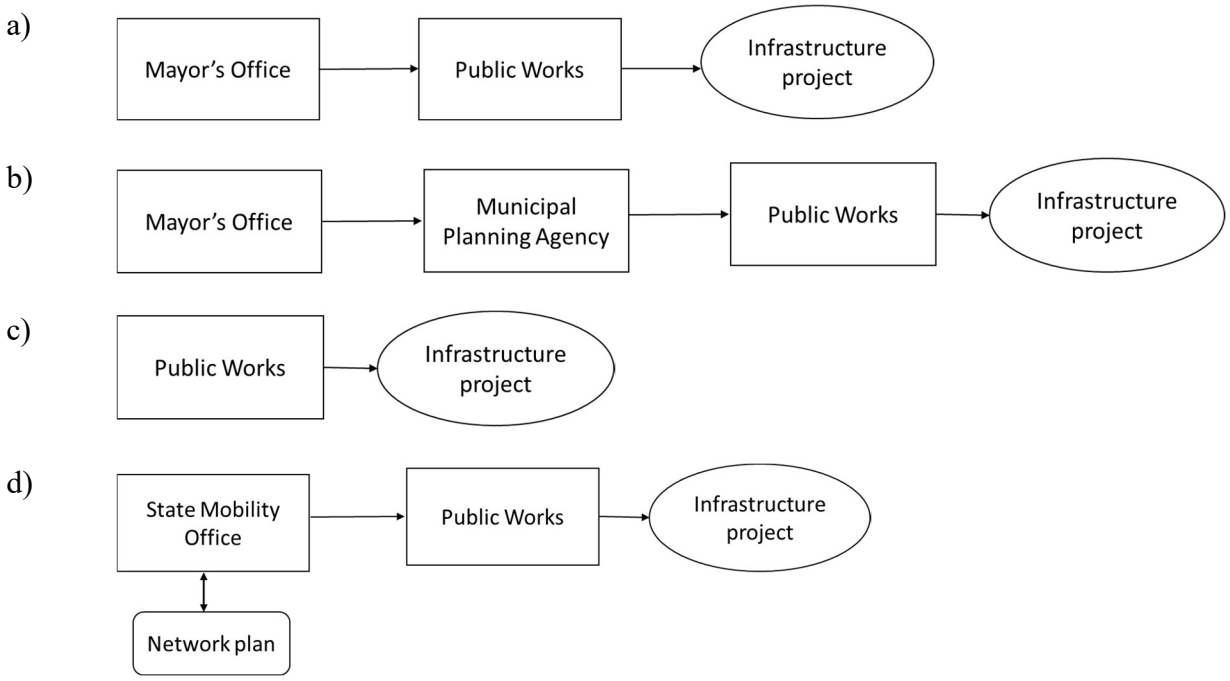
The legal framework supporting the development of non-motorized mobility both in Mérida and in the State of Yucatán has been limited until recently. The relevant legal framework mainly focused on regulating the technical properties of roads and highways. Until 2021, cycling infrastructure development and regulation did not exist in this law. Since 2013, Yucatán has had a State-level Bike Law (Gobierno de Yucatán, 2013). The Bike Law creates a legal responsibility for municipal governments to integrate cycling into their urban development and planning and the mandate to build cycling infrastructure. The Bike Law also mandated creating a state-level council to oversee its implementation and a program that would follow the law and provide implementation guidelines. However, none of the follow-up steps have been taken so far, leaving the law without any mechanisms for its implementation and making it unenforceable.

In Mérida, the main agencies involved in planning and developing cycling infrastructure are the Mayor's Office, Mérida's Municipal Planning Agency (since 2015), and the State-level Mobility Agency (since 2018). The construction of infrastructure is usually implemented by the municipal or state-level Yucatán Agencies for Public Works (depending on who is planning the project).

Most of the cycling infrastructure that has been built so far in Mérida (except for the most recent projects implemented in 2020) has been done without any organized planning process and is primarily decisions made by authorities, usually the Mayor of Mérida. This process reflects on much of the current infrastructure: fragmented, uneven in its design, and implemented when opportunity and political will arises, rather than based on a planning process and design that responds to an assessment of urban trip demands and cyclist needs. This also means that infrastructure is often financed with resources from specific street and road development projects rather than having municipal resources for building infrastructure based on a prioritization of projects. Sometimes, even the Public Works Department decides to add cycling infrastructure on the spot without the knowledge of the Planning Agency – an indication of the lack of coordination and communication between the agencies involved in the development of cycling infrastructure.

More recently, planning instruments have been developed to guide infrastructure implementation in the core urban area. In 2016 a Non-motorized Mobility Plan was developed by the state government through an external consultant (MOMOV, 2016). The plan proposed an extensive cycling infrastructure network. This plan was developed in 2016, but it was shelved until 2018, when the state agency used it to plan cycling infrastructure implemented in 2021. It is worth noting that the more recent infrastructure in Mérida shows a vast improvement in quality and design than anything that has been implemented before (and also meets minimum design standards like width). This is largely due to the internal capacity and specialized areas in the new State Mobility Agency and interest from the team in the State Agency, who saw this project through from beginning to end.

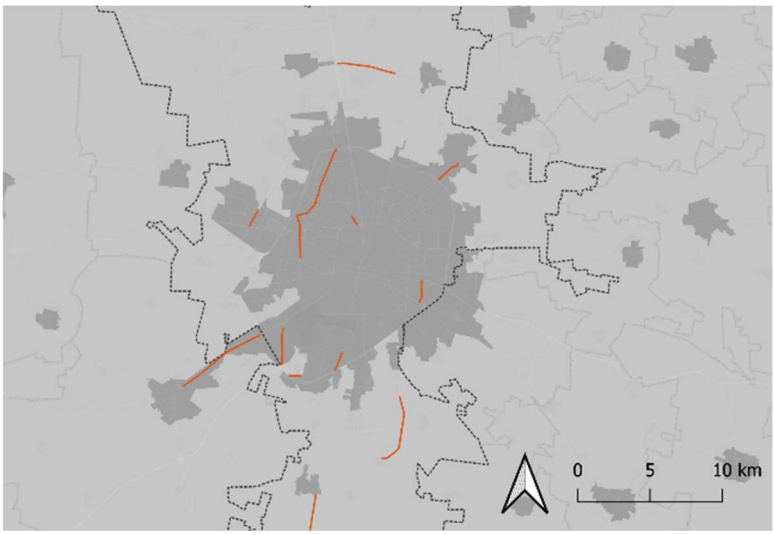
Figure 29. Processes for implementing cycling infrastructure in Mérida



The spatial and temporal evolution of cycling infrastructure in Mérida is included in Figure 30. The evolution of institutions supporting cycling infrastructure implementation and the cumulative km of infrastructure development in Mérida is presented in Figure 31.

Figure 30. Evolution of cycling infrastructure in Mérida

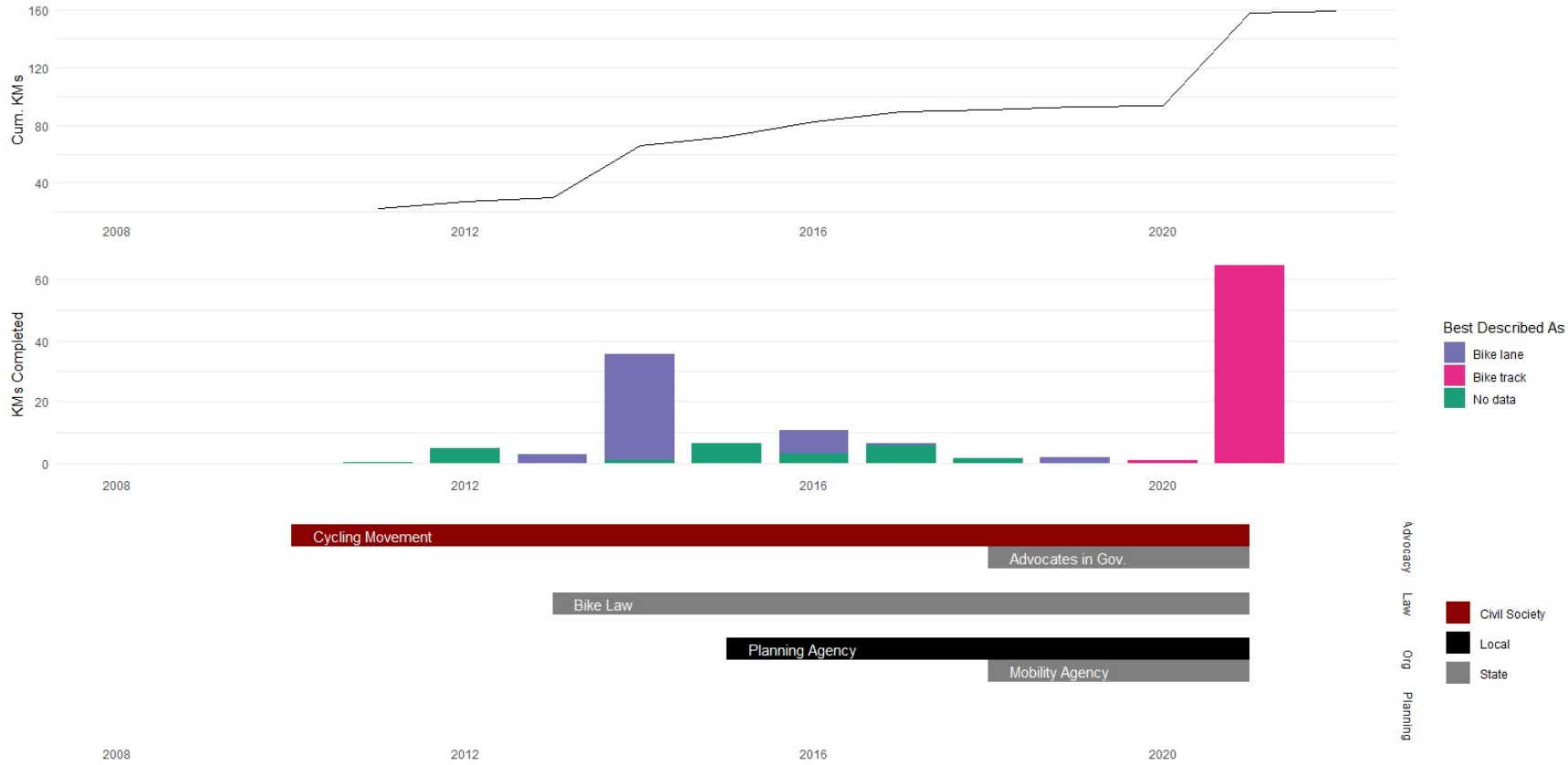
2010



2015

2021

Figure 31. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Mérida and supporting institutions.[13]



[13] The infrastructure data From Mérida was compiled and shared by Eduardo Monsreal and Freddy Mendoza from the Observatorio de Movilidad Sostenible de Mérida

3.5.9.3 Deliberate implementation, less km built: Morelia

3.5.9.3.1 Morelia

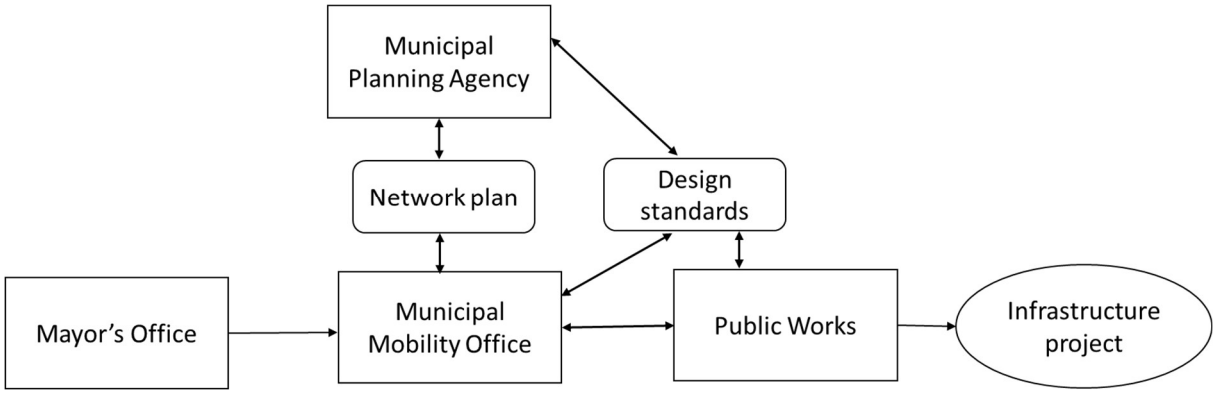
In Morelia, the cycling infrastructure implemented to date includes 37.6 km cycling priority lanes (shared with motor traffic), 10 km of cycling paths (that are considered recreational since they are in a park), and 16 km of an interurban path connecting Morelia to the neighboring Municipality of Patzcuaro. While Morelia's infrastructure is modest in terms of length, most of it has been built over the last three years and developed following their Street Design Norm, which ensures minimum standards for all the infrastructure built in the municipality (IMPLAN Morelia, 2019). In that last year, the first 12.3 km of physically separated urban cycling infrastructure was built. Morelia is interesting because there has been a strong focus on institutional development that has set a solid ground for implementation, previous to implementing a significant amount of projects.

> *Based on my understanding of how cycling policy is developed in each city—I think Morelia completed the first stage, or the green stage, and is now starting a maturity stage. Not only on a legal level but on a practice level, which is very different. You can have mobility laws but if you don't have government bodies that have the power to enforce laws, they become irrelevant. The city is now entering a period of maturity. (Activist, Morelia, 02/22/2020)*

Morelia has a Bike Law since 2014, reformed in 2016 (Gobierno de Michoacan, 2016) . Infrastructure for cycling is relatively recent in Morelia. In recent years, through the Municipal Planning Agency (created in 2016) and the Municipal Mobility Office (created in 2018), planning for cycling mobility has become part of their institutional activities. The first documented proposal for a cycling infrastructure network for Morelia was developed "primitively" by the local civil society organization *Bicivilízate*, by sketching out cycling routes roughly based on their technical expertise and then handed over to the Municipal Planning

Agency. The Municipal Planning Agency developed the next proposal directly based on data and technical studies they developed internally on trip demand and safety needs for cyclists. The Municipal Planning Agency and the Municipal Mobility Office partnered with the NGO *Repubikla* and used GIS to implement mapping exercises with cyclists in the area to identify strategic routes (IMPLAN Morelia, 2017). They identified priority areas, among which are flows of students from downtown to the local university. From this point on, Morelia implemented cycling infrastructure based on strategic planning, studied demand, and has aimed for networked infrastructure. A non-motorized mobility project portfolio exists within the Municipal Mobility Office, based on the trip and mapping they have developed over the years, where projects that are high priority have all technical specifications and budgets ready to receive funding. It is worth noting that the implementing agencies in Morelia both have former cycling activists in decision-making roles. Two of the founding members of the local civil society organization *Bicivilízate* moved into public manager roles. In 2016 one of these activists took on the role of subdirector of the Municipal Planning Agency, and the other became the first director of the Mobility Office in 2018.

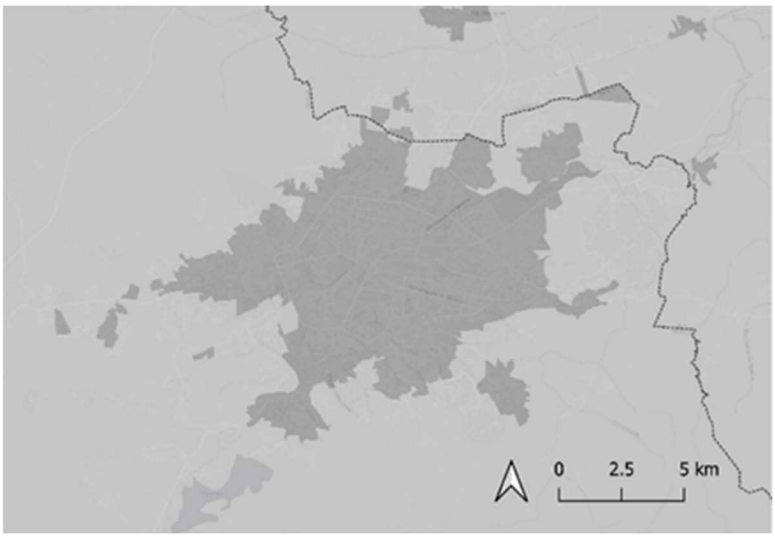
Figure 32. Process for implementing cycling infrastructure in Morelia



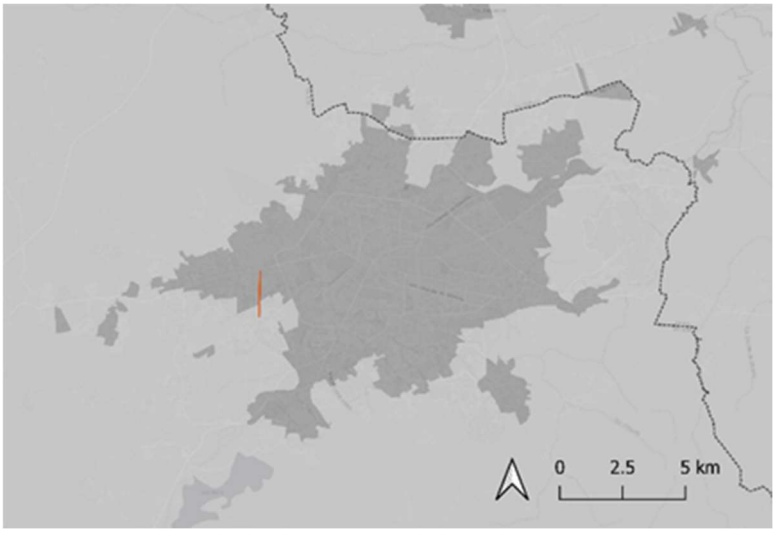
The spatial and temporal evolution of cycling infrastructure in Morelia is included in Figure 33. The evolution of institutions supporting cycling infrastructure implementation and the cumulative km of infrastructure development in Morelia is presented in Figure 33.

Figure 33. Evolution of cycling infrastructure in Morelia

2010



2015



2021

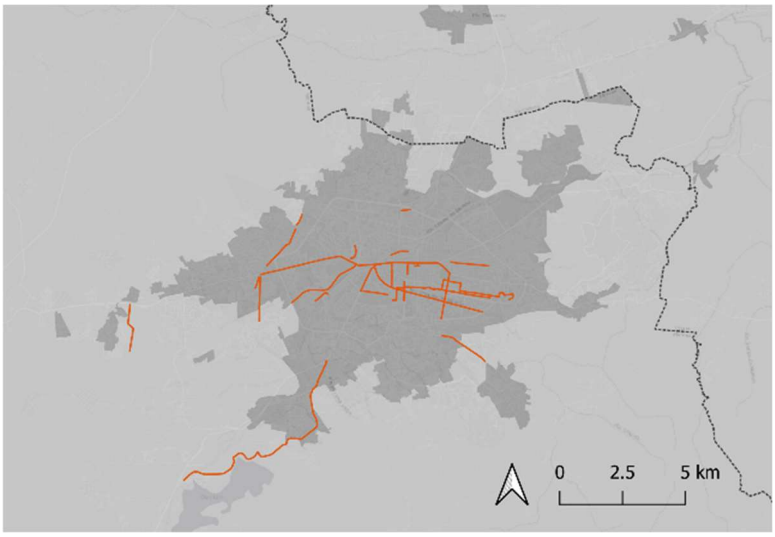
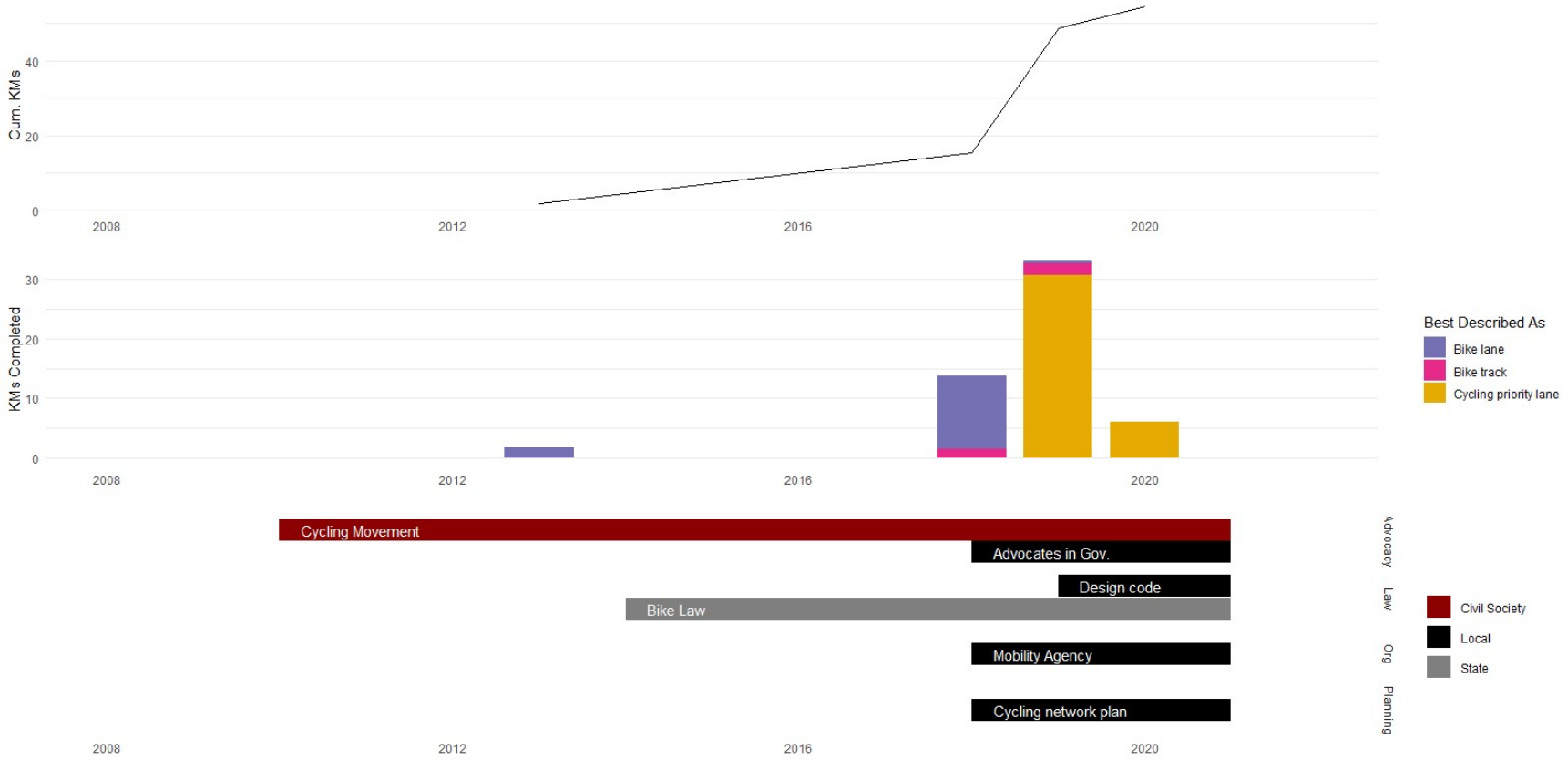


Figure 34. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Morelia and supporting institutions.[14]



[14] The infrastructure data from Morelia was compiled and shared by Juan Manual Berdeja from SEMOVEP

3.5.9.4 Deliberate implementation, more km built: León, Puebla, Guadalajara

León, Puebla, and Guadalajara are cities where cycling infrastructure implementation has become a sustained practice. In Guadalajara and Puebla, local authorities have developed oversight capabilities and institutions that help ensure that the built infrastructure meets minimum, locally defined standards. However, there are significant qualitative differences between these cities that must be taken into account. León is a city with extensive experience implementing cycling infrastructure, but the quality of its extensive network is signaled out consistently by advocates and experts as unsafe and counterproductive to supporting cycling. León is included in this category because, despite the criticisms towards its cycling network, this practice is deeply rooted in government structures and implemented across government administrations. Puebla is a city where, over time, they have improved and institutionalized their planning and implementation processes, which shows in the infrastructure built today. Guadalajara is often the national reference when it comes to cycling in Mexico, and on top of an extensive network, they have built solid institutional structures to sustain implementation. Because Guadalajara is a unique case and a common reference, I developed this case further in Chapter 4.

3.5.9.4.1 León

León was the first city in Mexico to develop cycling infrastructure plans and build a network. By 2010, when most cities in this study started developing their first cycling lanes, León already had 90 km of cycling infrastructure. Over the past few years, the local government has built 100 additional km. León is also unique since there has been a consistent government commitment to building cycling infrastructure followed by dedicated resources and implementation.

However, the quality of this network is widely perceived by activists as unsafe for users because 95% of these cycling lanes are built on traffic islands between high-speed roads. This means that cyclists are stranded on paths for considerable lengths and cannot safely and easily access the cycle path from their origins and destinations. The width of cycling lanes varies and, in many cases, can be narrow and hard to navigate for newer users. For more experienced users, the street is often a more practical choice, and cyclists are often seen on the road's right lane when a cycling lane is available on the same road on a traffic island. A notable characteristic of León's infrastructure is that the design and style have not changed or improved in over 20 years of building infrastructure. Local activists attribute this to the first lanes being built where they found desire paths from cyclists getting away from traffic by using traffic islands. After that, instead of improving its methods, the municipality continued to build its infrastructure in the same way.

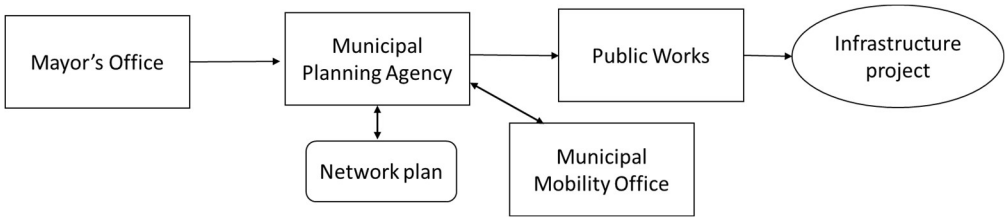
> *Most bike paths have been built on the median strip. People in cars complain that cyclists don't use bike paths. They complain that they ride on the street when there's a designated bike path on the median strip. But often, those bike paths are too narrow or they might have too many obstacles, like trees. So the more daring cyclists take the road if they're in a hurry and don't want to wait. Some parts of the bike path are too narrow so if you get stuck behind a slow rider, they get frustrated and move to the road. (Public Official, León, 03/18/2020).*

León has a long history of urban planning that incorporates transportation. Solid and effective but often rigid institutions characterize the municipality. León was the first in Mexico to have a Municipal Planning Agency as a decentralized entity of the Municipal government (which exists since 2000). The Municipal Planning Agency assists the municipal government with planning for urban mobility and does most of the planning and oversight of their cycling infrastructure development. They developed and continuously updated the Cycling Infrastructure

Masterplan and dictate and oversee its implementation. Their policies also predate international manuals, and their procedures have never been updated to include these guidelines, which, among other things, means that over the years, León has not improved the design or form of its cycling infrastructure. Since 2016, a mandate to build cycling infrastructure is also included in León's Mobility Law (Gobierno de Guanajuato, 2016).

The León Municipal Mobility Office was added to the municipal structure in May 2014. All cycling infrastructure in León is prioritized through the Cycling Infrastructure Masterplan, which includes a proposed infrastructure network for the city. The first version of the Cycling Masterplan was developed by the Municipal Planning Agency in 1997 and was updated in 2009 and 2016. The 2016 update included a proposed network of 545 km for the city, where 111 were already built from projects included in the previous plans (IMPLAN León, 2016).

Figure 35. Infrastructure implementation process in León



Implementation of cycling infrastructure in León is profoundly institutionalized and sustained over governmental administrations. All projects that are implemented stem from the Municipal Cycling Infrastructure Master Plan project portfolio. Cycling lane implementation projects are prioritized based on budget availability and the projects in the master plan. The project design and executive details are contracted out but based on the Municipal Planning Agency guidelines. The local Mobility Office and Transit Department provide comments to the design, and Public Works implement the construction project or contract them out and oversee the construction.

> *I got to León asking which streets could be modified. When I asked which streets were state streets, they said none. All streets in León and everything in León is under municipal jurisdiction. If the state government wants to put in a bike path, the municipal government does it. The state government provides the funding, and the municipal government takes care of building it. It gives them great capacity to execute projects. (Former Official, León, 01/17/2020).*

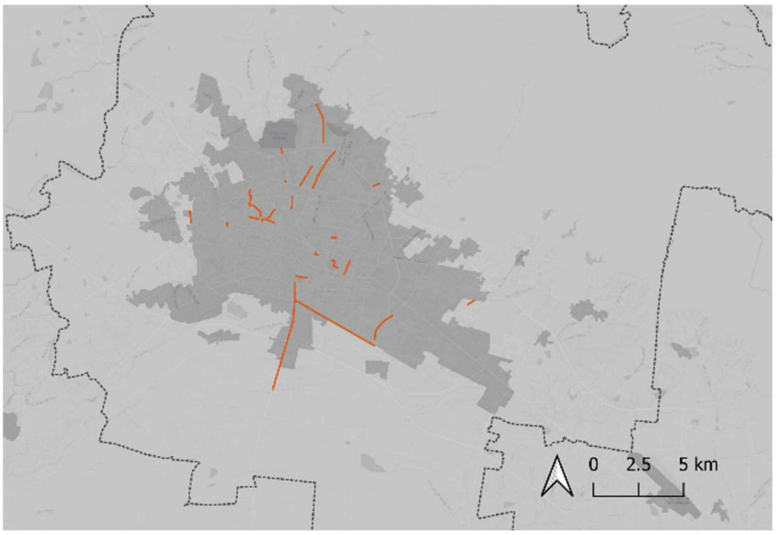
People in planning and decision-making roles in León do not identify as cyclists[15]. This is something that advocates signal as being a contributing factor to the style of León's cycling infrastructure. Cycling policy predates all activist groups in León, making it a unique case in this regard, where cycling policy has historically been conceived and implemented from the top down.

Cycling mobility is engrained in the local culture, tied mainly to its small neighborhood structure that enables short trips and large leather and shoe industry, where workers have traditionally traveled by bike. The number of everyday cyclists is something that people point to as a distinguishing characteristic of this city, although elitist attitudes towards cycling and cyclists seem to be the norm, and many point to this elitism as a root cause of the poor quality of León's infrastructure for cyclists. The relatively large number of cycling trips also predates policy interventions. The spatial and temporal evolution of cycling infrastructure in León is included in Figure 22. The evolution of institutions supporting cycling infrastructure implementation and the cumulative km of infrastructure development in León is presented in Figure 23.

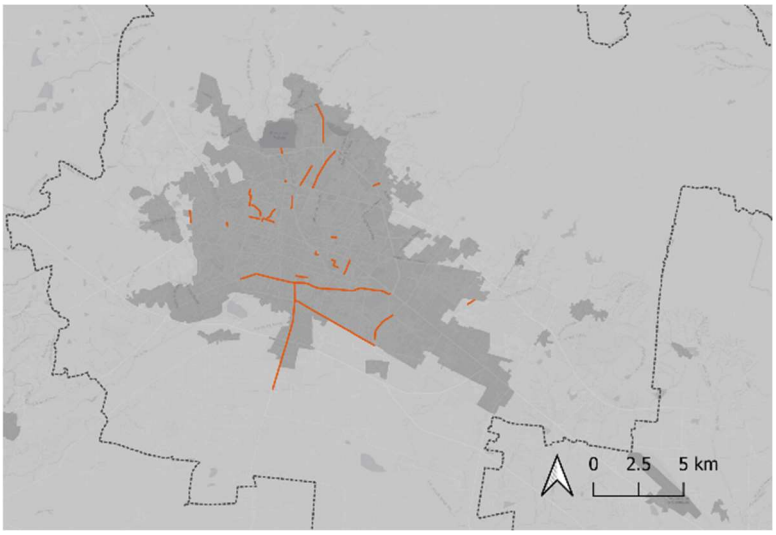
[15] This is something directly stated by interviewees in these roles as well as activists who work with them

Figure 36. Evolution of cycling infrastructure in León

2010

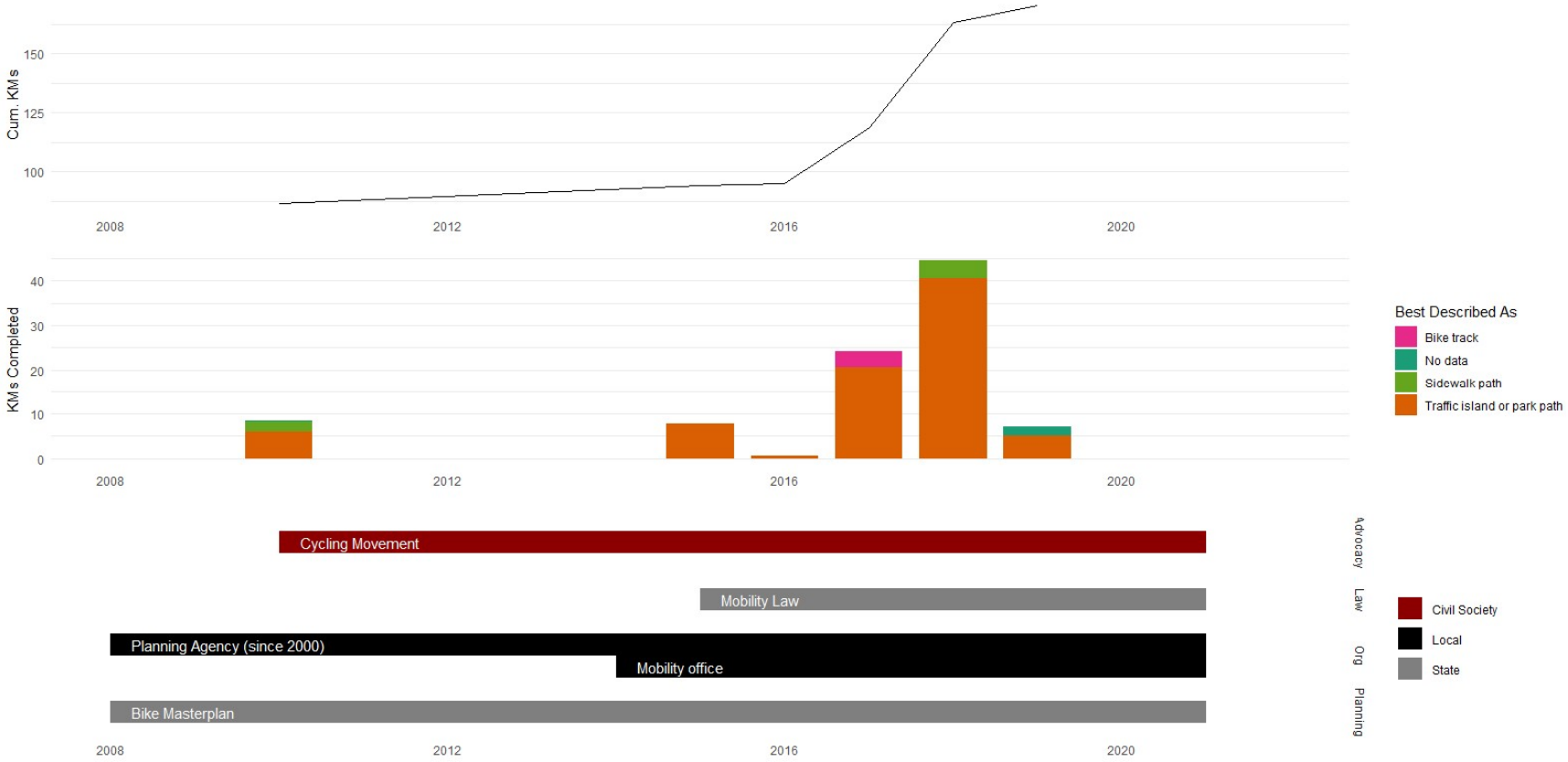


2015



2021

Figure 23. Cumulative and yearly infrastructure implemented between 2008 and 2021 in León and supporting institutions[16]



[16] The infrastructure data from León was compiled and shared by the León Municipal Mobility Office

3.5.9.4.2 Puebla

As of 2021, Puebla has approximately 105 km of infrastructure. Between 2010 and 2018, 81.15 km of cycling infrastructure were built in Puebla. This initial infrastructure contains significant flaws. For example, a large portion of what was built in the initial period is considered to not be functional for promoting bike mobility. It is either designed for recreation (in parks) still not well connected (on long elevated cycle tracks and traffic islands that lock cyclists in), or considered to be dangerous for cycling because it is too narrow or located alongside traffic islands on high-speed roads without adequate protection for cyclists. However, most recent works have sought to consolidate a network and have achieved a much higher technical standard. At the local level, Puebla now has a locally developed Street Design Norm that all cycling infrastructure must meet to ensure quality and safety (Municipio de Puebla, 2017). The most recent 40 km of infrastructure have been built to meet this norm, which is now legally binding.

Puebla has a Municipal Planning Agency since 2011, which is the first institution within the local government that started to plan for cycling infrastructure. In 2013 as local cycling activism picked up and grew in Puebla, and public managers within the Municipal Planning Agency started to reach out to activists to establish shared goals and work on policies together. The Municipal Planning Agency also planned and implemented some of the early cycling infrastructures in Puebla, although activists considered these efforts to be flawed. Following these early experiences and to capitalize the knowledge of local activists, the Municipal Planning Agency led the development of a local Street Design Norm to create guidelines to build infrastructure and avoid past mistakes. The norm includes technical specifications for pedestrian and cycling infrastructure to ensure these are developed to prioritize non-motorized modes. The

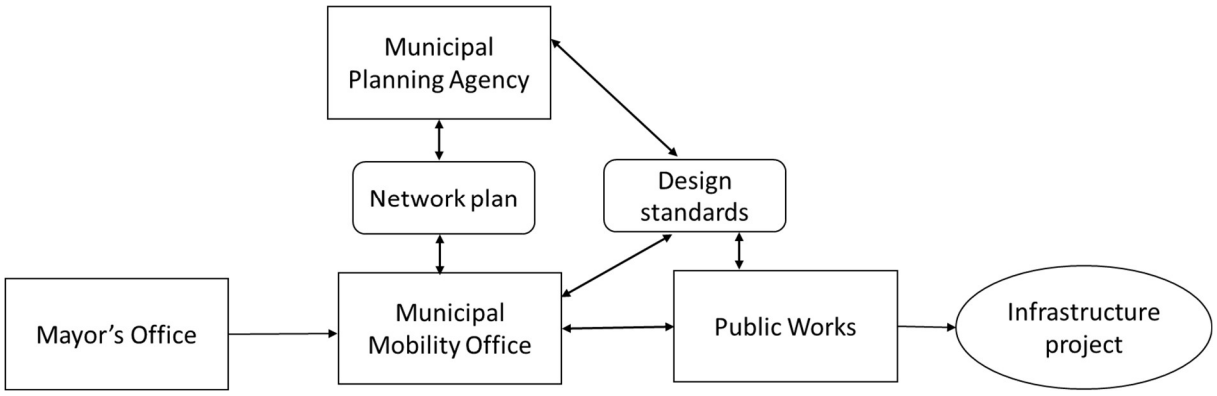
city council approved the norm in 2017 and is mandatory for all street-level mobility infrastructure within the Puebla municipality.

With many different initiatives to promote cycling underway (bikeshare, via recreativa, infrastructure), intense activism around the topic of cycling and a mayor who was supportive of the mobility agenda and willing to institutionalize mobility as an area of government, and Urban Mobility Plan was developed for the municipality of Puebla. This plan included the creation of a Municipal Mobility Office to allow mobility to become a permanent area and function of the local government. In early 2017 the Mobility Office of the Puebla Municipality was created. This office is mandated to plan, regulate, oversee, educate, monitor, and evaluate all mobility related actions in the municipality. This change directly responded to a long-standing request from the activist community, who had identified a fragmented institutional structure as an impediment to improving cycling mobility on the streets. The Mobility Plan was submitted to a vote and approved by the City Council, making it a binding document, and the Municipal Planning Agency has the responsibility to monitor and update on progress every year. When the municipal Mobility Office was created, many of the activists who had advocated for its creation and who had worked alongside the Planning Agency to develop relevant policy (like the Mobility Plan and the Norm) joined the Mobility Office as technical and leadership staff.

Currently, cycling infrastructure in Puebla is planned by the Mobility Office, implementing routes laid out in the 2016 Mobility Plan, with the final decision made by the mayor. The Mobility office designs the project, which is then implemented by Public Works (either directly or through a contractor). The Mobility Office in Puebla does not have any leverage over the Public Works Department, but they have developed internal mechanisms to

accompany the projects that are built. They have also developed internal training to socialize the street norm to the Public Works Department.

Figure 37. Process for implementing cycling infrastructure in Puebla



The spatial and temporal evolution of cycling infrastructure in Puebla is included in Figure 38. The evolution of institutions supporting cycling infrastructure implementation, along with the cumulative km of infrastructure development in Puebla is presented in Figure 39.

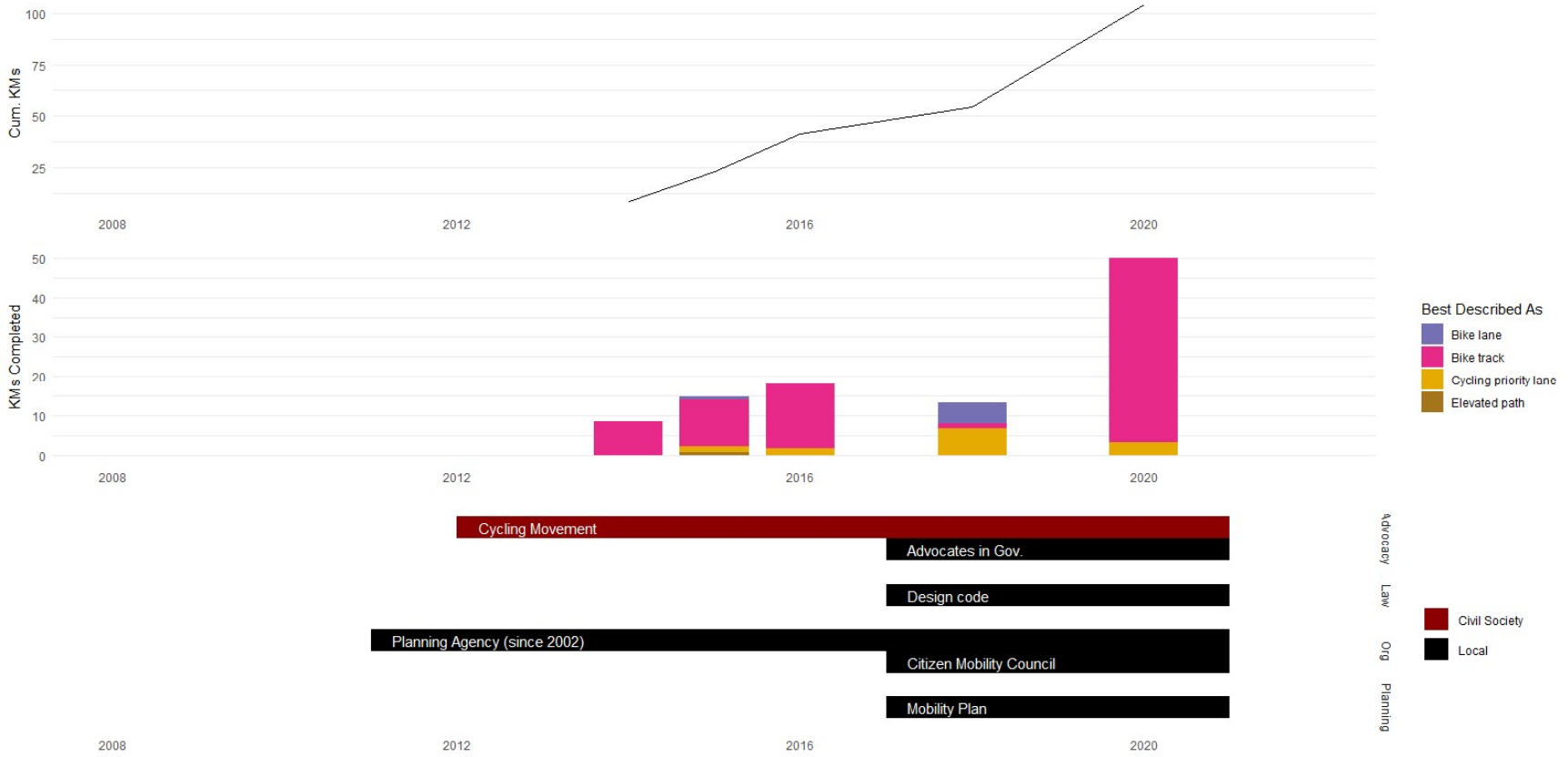
Figure 38. Evolution of cycling infrastructure in Puebla

2010

2015

2021

Figure 39. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Puebla and supporting institutions.[17]



[17] The infrastructure data for Puebla was compiled and shared by the Puebla Municipal Mobility Office.

3.5.9.4.3 Guadalajara

Guadalajara has become a national reference for cycling policy and infrastructure development, which is supported by the most complete set of institutions and organizations among the cases studied. However, Guadalajara is not comparable to many of the cities included here, mainly because of its larger size and population and the metropolitan scale of its policies and planning. The process through which Guadalajara has reached this more advanced stage is covered as its own chapter (Chapter 4). However, it is included because it is cited as a reference by advocates and practitioners in every other case studied here.

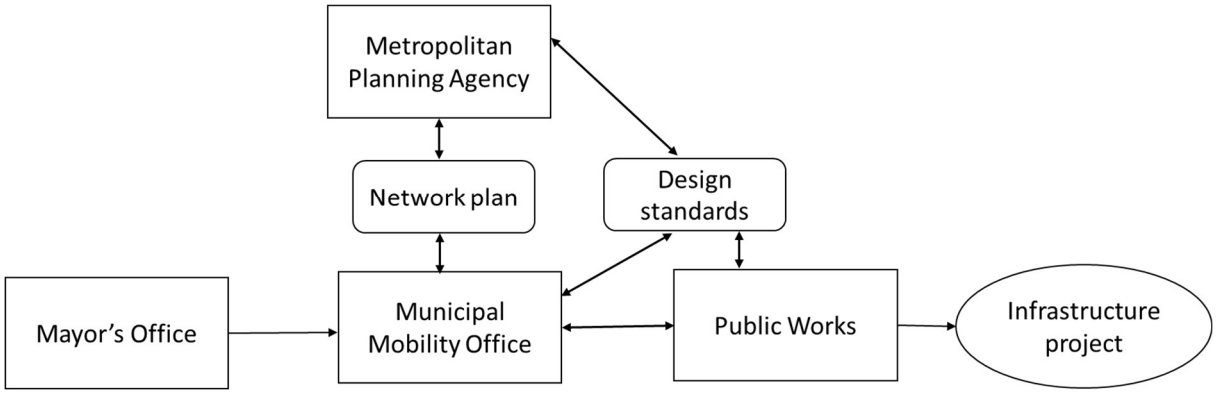
In 2010, following two years of civil society mobilizations on urban mobility, including specific requests to develop a master plan for non-motorized mobility, the government of Guadalajara commissioned a Non-Motorized Mobility Plan (Gobierno de Jalisco, 2010a). In this plan, a 1,500 km cycling network was designed for the metropolitan area and set 380 km of cycling lanes that were considered priorities for its deployment. The plan also included priorities for improving pedestrian infrastructure and creating quality public spaces. Even though it was not implemented for a few years (and has never fully materialized), this document has been the basis of the cycling infrastructure planning and construction in the following years. The Plan also included the first technical guidelines for building cycling infrastructure in Guadalajara, which have provided minimal standards and technical guidance for all the infrastructure that has been built over the last decade Gobierno de Jalisco (2010b).

Guadalajara was the first state to have a mobility Law, which passed in 2013 and was reformed in 2017 (Gobierno de Jalisco, 2013). In 2013 the newly elected governor presented a Mobility Law proposal to the Jalisco Congress with a few initial mentions of cycling and cyclists, which had been absent in transportation laws. In 2017 the mobility law was reformed,

this time to include the rights and protections for cycling. The law also included specific sanctions and actions against motorists who violate the rights of cyclists and a mandate for local governments to build cycling infrastructure such as secluded cycling lanes and bike parking facilities. Most importantly, the new version of the law includes a funding mechanism for non-motorized mobility[18].

The initial infrastructure for cycling was planned and built by the state Government. However, since 2015 Guadalajara, Zapopan, Tlaquepaque, and Tlajomulco have their own Mobility Offices through which infrastructure is planned and projected. Since 2018 the Metropolitan Planning agency also oversees the joint non-motorized mobility agenda and coordinates infrastructure development across municipal borders. Guadalajara also has had an agency since 2019 that implements and monitors mobility infrastructure and includes a yearly budget for cycling infrastructure maintenance.

Figure 40. Process for implementing cycling infrastructure in Guadalajara

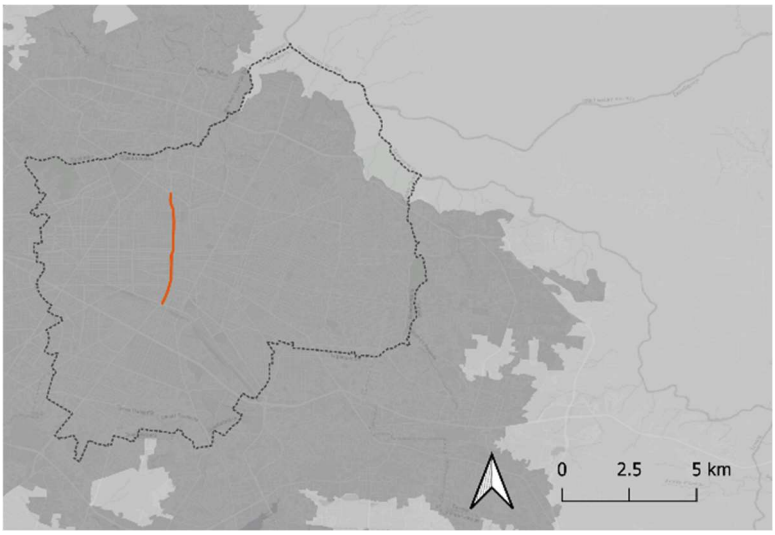


The spatial and temporal evolution of cycling infrastructure in Guadalajara is included in Figure 41. The evolution of institutions supporting cycling infrastructure implementation, along with the cumulative km of infrastructure development in Guadalajara is presented in Figure 27.

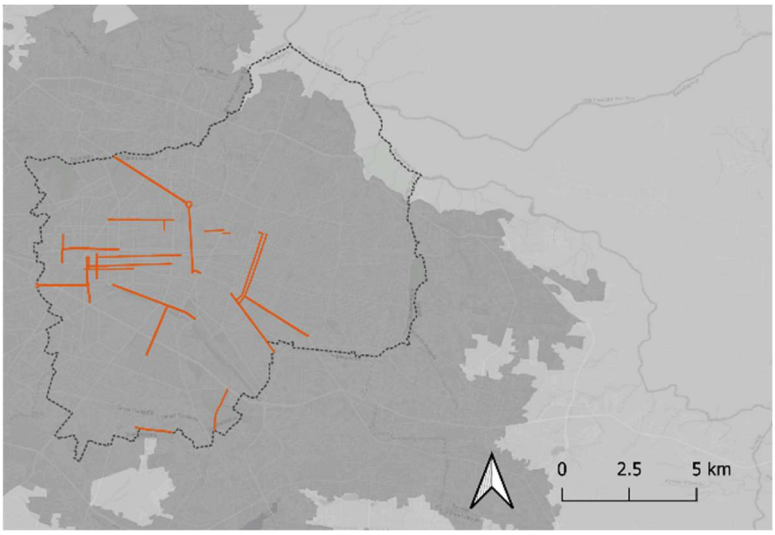
[18] *"45% of the income recieved by the state from traffic violation ticketing will be designated to non-motorized mobility infrastructure"* (Jalisco Mobility Law, p.20).

Figure 41. Evolution of cycling infrastructure in Guadalajara

2010

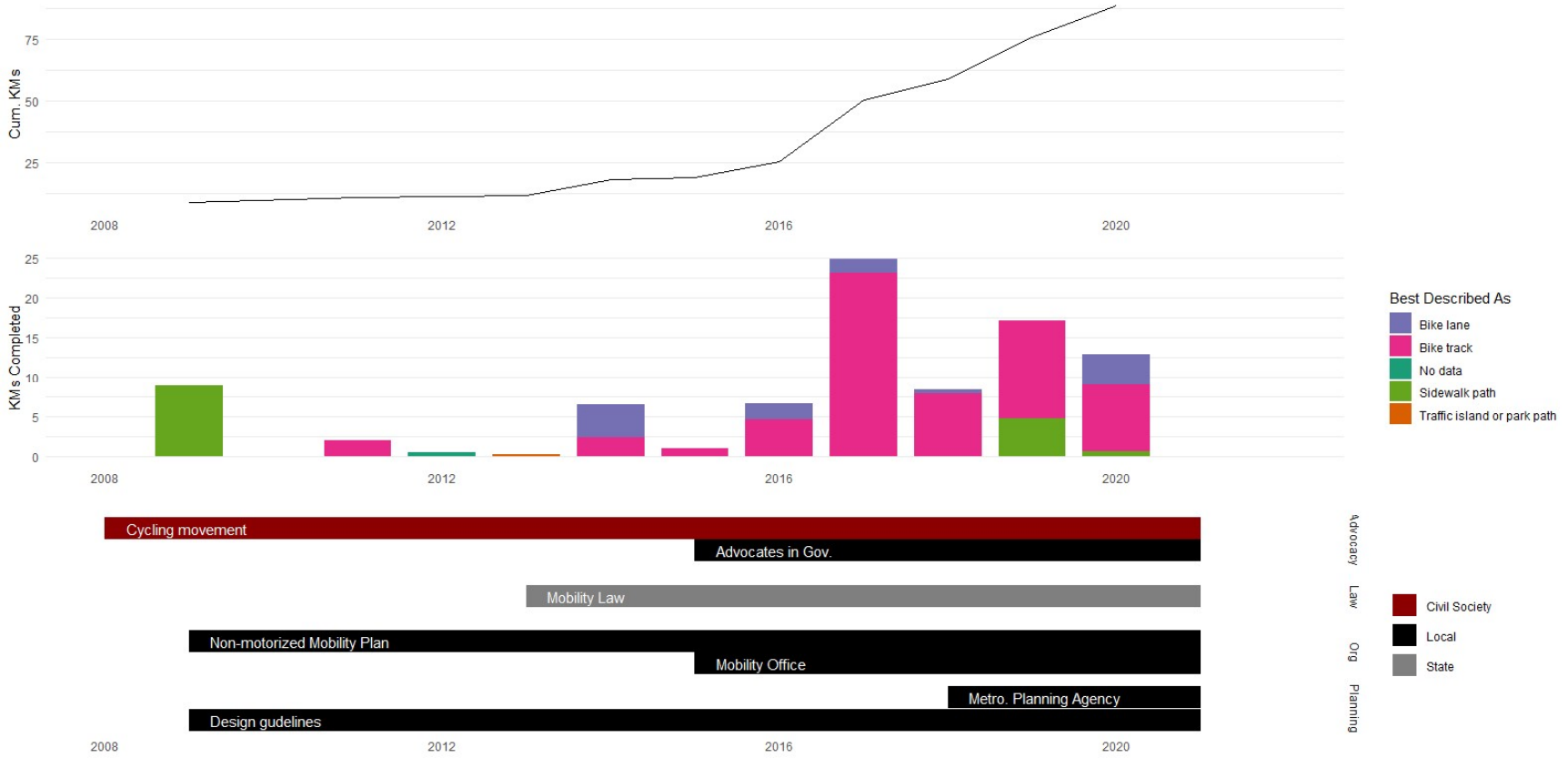


2015



2021

Figure 42. Cumulative and yearly infrastructure implemented between 2008 and 2021 in Guadalajara and supporting institutions[19].



[19] The infrastructure data from Guadalajara was compiled and shared by the Guadlajara Municipal Mobility Office. To be comparable with other cities this diagram only includes infrastructure implemented at the city level and excludes infrastructure in other municipalities within the metropolitan area.

3.5.10 *Part 2 Conclusion: factors affecting the implementation of cycling infrastructure in Mexican Cities*

In this section, I studied how infrastructure is implemented in each city included in this study. I categorized the cases between those with deliberate planning and implementation versus those with a more piecewise approach. Deliberate implementation means that cycling is planned and implemented with an established planning process, whereas piecewise means that implementation is less organized and not always strategic. I studied the primary laws, organizations, and planning instruments and norms cities have to guide cycling infrastructure implementation for each case. I also grouped cases to distinguish those who have built more infrastructure from those who have built less to separate the cities with more experience implementing projects. Additionally, I explored other factors that influence implementation in each place. Through this process, I distilled how different factors affect implementation and infrastructure outcomes. In this section, I will conclude with some of the key themes that emerged throughout this analysis.

Two hypotheses guided the development of this research. The first was that *cities in states with laws mandating infrastructure would implement more infrastructure than those without one*. In this research, I found that high-level mandates in state laws on their own make very little difference for making progress on the ground. This is both in terms of the amount of kilometers of infrastructure implemented and their quality. Lack of laws can be a barrier, for example, for garnering funds to build infrastructure, limiting or slowing down the ability to implement projects, but this is not always the case. On the other hand, the presence of laws by no means guarantees that their mandates will be carried out. For example, Toluca has had a Mobility Law since 2015, and Oaxaca has had a cycling law since 2013, and implementation of

cycling infrastructure in these places has been minimal. Puebla, until 2021 did not have a state-level law supporting cycling infrastructure but has developed local organizations and institutions that sustain and guide implementation locally and has reached a relatively high level of institutionalization and maturity. For laws to make a difference, their mandates must trickle down into the organizational structures of states and municipalities.

The second hypothesis that drove this inquiry was that *cities with a dedicated department for implementing cycling projects are more likely to implement cycling infrastructure.* Specialized agencies (municipal Mobility Offices and state Mobility Agencies) containing non-motorized mobility departments are among the most important variables affecting the implementation of cycling infrastructure. The agencies responsible for designing and implementing projects are vital for sustaining cycling infrastructure planning and implementation. However, beyond the presence or absence of these agencies, the internal capacity they build and the level of oversight they can have over projects is also determinant for their ability to implement cycling infrastructure projects and ensure their quality.

Staff in Mobility Offices can gain experience and garner relationships with other organizations needed to implement infrastructure (Public Works, for example). When these agencies bring in specialized and enthusiastic professionals, they play a crucial role in creating relationships across the agencies required to plan, design, and implement cycling infrastructure. Importantly, these people are often cyclists and cycling advocates themselves and understand cycling infrastructure needs from a user perspective. They also learn from previous experiences and improve and institutionalize their processes over time (for example, developing local street design codes). Importantly, these institutions tend to house managers with specialized knowledge

about cycling infrastructure, which is often undervalued or not recognized as necessary when implementing infrastructure projects to the detriment of these projects.

> *The issue with governments, which is replicated all over the country, is that pedestrian and cycling infrastructure is vastly undervalued. Public service architects and civil engineers think they can take on bike paths simply because they are architects. However, the criteria for a bike path are very different from those of a highway. Even if it's just a few bits of metal, designing bike parking is very different from a parking lot. It is a recurring mistake, [specialized cycling knowledge] is undervalued. You can always tell when someone is not a cyclist by looking at the infrastructure they build (Activist, Morelia, 02/22/2020)*

When these organizations are lacking, infrastructure development is more fragmented (disconnected, randomly placed, astrategic) and usually opportunistic (piggybacking off of public works projects, politically motivated emblematic projects, activist driven) or follows a variety of possible implementation paths that do not speak to each other. This lack of clear responsibility for implementing infrastructure leads to bits and pieces built across locations that do not lead or connect anywhere.

Other interesting themes emerged during this research that have a tangible impact on the infrastructure built across cities. Across cases, there is tension between mobility agencies and Public Works Departments By their very nature, Mobility Offices are much more on board with the idea of cycling than Public Works Departments. Mobility Offices are new in the municipal structure (the earliest found here was instated in 2015), whereas Public Works Departments have longstanding trajectories. Mobility Offices have relatively little leverage and small budgets because they are in charge of planning and designing projects, whereas Public Works Departments (in all the cases studied here) control the entire budget for municipal Public Works. There is also a generational divide: Mobility Office managers are more often young multimodal professionals, and Public Works managers are older, usually career public servants, accustomed

to planning to accommodate car traffic which has historically been their primary objective and institutional responsibility when building roads. In places with more deliberate processes in place, Mobility Offices have cultivated this relationship and sought ways to manage this asymmetry.

For example, Morelia and Puebla developed a legally binding Street Design Norm on which Public Works officials receive training. In Guadalajara, they have developed standards that are not legally binding but have been extensively socialized across implementing agencies and are regularly enforced. In these places, even if the mobility offices do not control the budget, they accompany the construction process. In Morelia, the Mobility Office has the final say in the mobility projects approved by Public Works, even if they do not control the budget. In contrast, in Mérida, Aguascalientes, and Querétaro, the Mobility Offices do not have oversight capabilities over the Public Works Departments, leaving projects solely in the hands of public works officials who do not always understand their specific needs.

> *One thing that would help make more sense of the way infrastructure is built in Mérida is that no entity looks after mobility. Infrastructure projects have largely been guided by a traditional public works rationale, which responds to criteria that are not necessarily related to sustainable mobility. So, in Mérida, there is an urgent need to strengthen municipal institutions around mobility issues. Their powers and responsibilities, and accountability need to be defined within an operative structure. (Public Official, Mérida, 02/12/2020)*

Opposition tends to show up on a project-by-project basis, usually in disputes over local parking places. Even if the opposition is localized, it still impacts what municipalities can do or they lead to renegotiations of project designs, ultimately impacting what can be built. Examples of this are found in Toluca, Aguascalientes, Guadalajara, Morelia and Puebla. While there is no sizeable, organized opposition coalition in any of these cases, cycling infrastructure in these

municipalities is often contentious. Opposition can be mitigated by engaging neighbors and socializing projects to increase their acceptability before construction begins.

> *When it came to building cycling infrastructure, we found that it has a lot to do with design processes, which we do not have. Evidently, there is a shortage of people who can generate participative design—executive projects are put together, then the contractor arrives and neighbors try to stop construction. Some projects have been halted, and we then have to come in to try to reach an agreement, which isn't really in our powers, but there was no provision for managing cyclist infrastructure development with affected neighbors. The problem is that it reduces parking on public roads (Public Official, Aguascalientes, 03/05/2020).*

Another generalized barrier that emerged is that cycling for mobility is still perceived by many people as having low-economic status, and conversely, driving is a symbol of status.

> *Much like anywhere else, one of the things that needs to change is removing the idea that cars represent status. It's a general perception. In the city of Oaxaca, people from the city are closed and can be very elitist. You can tell if someone is from the city of Oaxaca or not just by talking to them. There is a common notion, shared with other cities, that cars represent status. Walking and riding bicycles are considered equivalent to low socioeconomic status. I think this is cultural. In other words, in our collective imagination, we need to work towards changing this understanding. (Public official and former activist, Oaxaca, 4/28/2020)*

With respect to implementing projects, this stigma came up as a higher-level barrier for projects to be accepted and for people within municipalities to risk developing projects that constituents would be reluctant to accept. In Guadalajara, one of the claims they made in terms of why they have been successful in implementing cycling policy is that they changed the public image of the cyclist, from a low-income worker to a middle-class cyclist by choice.

> *Since 2007 we started to create an aspirational image of cycling. A cyclist as someone who is environmentally responsible, someone who is doing good things for the city. That helped even if its superficial to say. Upper class kids on bikes made more people interested in cycling. (Activist and former public official Guadalajara, 01/21/2020)*

The infrastructure that is built for cycling arguably affects the perception of cyclists. In León, for example, even if they build a lot of infrastructure, most interviewees consider that the built infrastructure lacks dignity because it is built within a classist auto-centric culture. In León, planners do not identify as or with cyclists and many point to this as one of the reasons that the infrastructure, even if voluminous, is consistently built with poor quality. León also exemplifies how even cities that build large volumes of infrastructure are not necessarily shifting their mobility paradigm and potentially perpetuating cyclists' marginal status through the infrastructure they build.

Significant qualitative differences emerge between cities that have managed to advance infrastructure implementation into a sustained activity of the local government and those that implement the occasional cycling lane but do so without developing institutions to support this activity to ensure its quality as a safe and integral part of the mobility system. In most cases, this is a policy area that is still nascent and largely dependent on political will. In every municipality studied, the mayor holds much central power that determines whether or not the agenda moves forward.

In Oaxaca, Toluca, and Cuernavaca, which were grouped into the low- and piecewise implementation category, there is little institutional support for cycling infrastructure development, leading them to implement none (Cuernavaca) or minimal (Toluca and Oaxaca) cycling infrastructure. Whatever has been built in these cities has been done when political pressure by civil society organizations has been enough to make local governments take action (Oaxaca and Toluca), or when a project-based opportunity arose (for example, in Oaxaca where the local tourism agency implemented small portions of infrastructure). In these cases, there are a few small segments of infrastructure where some are functional, and some are not, but no work

towards a network connecting origins and destinations or organizations responsible for sustaining implementation. Given that there is no organization responsible for implementing, even when there are allies in government, there is a low capacity to develop projects.

> *Government is complicated because, in my experience, they are overwhelmed. Overwhelmed in technical capacities, human capacity, and financial capacity. Any way you look at it, they are overwhelmed. So what they do is look after the day-to-day to keep the city running. Focusing all their energy on keeping the city going sidelines any potential for other projects, such as the potential to develop cycling and pedestrian infrastructure or improving public transportation. Many of us find ourselves saying: "We know we need to do something about this, but we just can't get to it," or "Later, later." As they say, we do what is urgent to the detriment of what is important. Many public servants don't know how to respond to "we want more bikes on the street." "Sure, but how do you it?" Governments lack people who have that training. They are starting to become more common… but there is not enough people with the capacity for these issues—pedestrian mobility, cycling, and such. So there are disparities in communication because there are different perspectives (Public Official and former activist, Oaxaca, 4/28/2020)*

The next category of cases included Aguascalientes, Mérida, and Querétaro, cities that have implemented more than the occasional project and have some institutions that support implementation, but this practice is still done in a piecewise manner. Planned networks have been developed in all of these cases and partially implemented in all three places, but projects do not always follow established plans. All of these cases have a Municipal Planning Agency, but the implementing agencies vary. Mérida and Aguascalientes have a state-level agency that implements projects in the municipality, but no municipal entity responsible for implementing this work, and no precise coordination mechanism between the state and the municipality, which leads to highly uneven infrastructure implemented in bits and pieces.

> *The problem is that we often generate separate projects with stretches of bike paths and lanes that lead nowhere. That means that changing your car for a bicycle is not worth it because you can't go anywhere interesting. It's very limited…. At the moment, the solution is often shared lanes for bicycles, but that is dangerous in many cases. (Public Official, Aguascalientes, 03/04/2020).*

In these cases, the lack of coordination between the many actors implementing infrastructure goes beyond the building phase. Coordination mechanisms are needed, for example, to sustain and maintain the infrastructure that has already been built. In places with less deliberate planning and implementation where many agencies overlap in this activity, lack of coordination becomes a challenge.

> *In the end, all public works carried out by the state [government] in the city is delivered to the municipal government, who must be interested in receiving the infrastructure to some degree. If they are not interested, they are unlikely to provide maintenance. Some municipal governments say: "You give us infrastructure, which requires maintenance, but maintenance is not in the budget." So, those institutional relationships need a lot of work. (Public Official, Aguascalientes, 03/04/2020).*

Querétaro has a municipal Planning Agency and a Municipal Mobility Office. In all three cases, the planning and design are done in specialized agencies and handed over to public works, but the agencies that design the projects lack oversight over the work that the Public Works Department implements. In these cases, Public Works lack expertise on the specific needs of cycling infrastructure and change projects as they work. Also, none of these places have local design standards for infrastructure. Combining these aspects means that the infrastructure built does not meet minimum safety and usability standards in these cases. The fragmented approach also means that no entity takes responsibility for maintenance, and many implemented projects are either lost or become unusable over time.

> *It's one thing for the mayor to say " I want you to do this project for me and then for the director to pass it on to the projects department …. They tell [the builder] which street and then they carry out the project, they go to the builder and they do it. That's one way. Another way is to say: "we have these standards." We can make changes by including these criteria before the project is executed. (Public Official, Mérida, 02/10/2020)*

The next set of cities analyzed were those with the more deliberate implementation of cycling infrastructure. These cases all have Municipal Planning Agencies and more recently have created Municipal Mobility Offices that design projects and oversee implementation. All of them are working towards a planned network through which projects are prioritized.

Morelia, the one city with strong institutional support for building cycling infrastructure but relatively low implementation so far, is unique. In Morelia there has been significant institutional development that, at least in this early stage, has been prioritized over implementing a lot of projects. Notably, they have developed a legally binding Street Design Norm that all cycling projects must meet. The mobility office also has oversight capabilities and coordinates with public works to ensure that projects meet locally developed standards, a signal of higher maturity in implementation processes.

León is also a unique case because despite having a long history of building infrastructure and a deeply institutionalized planning and implementation process that is sustained across government administrations, they still do not have any local standards, and their infrastructure is considered dangerous and impractical by most standards (as noted by most of the people interviewed here).

> *León has long been said to be one of the first cyclist cities. And that we are investing a lot in cycling infrastructure. But now, other cities are getting ahead and investing in more inclusive and better-designed infrastructure while we continue to do the same as before. We need to react and want to change and improve conditions for cycling mobility. We need to figure out what things are not working. (Former Official, León, 01/18/2020).*

In León, the Mobility Office has no oversight and minimal input over the plans that are designed and implemented by the Public Works Department.

> *People in cars complain that cyclists don't use bike paths. They complain that they ride on the street when there's a designated bike path on the median strip.*

Most bike paths have been built on the median strip. But often those bike paths are too narrow or they might have too many obstacles, like trees. So many cyclists take the road if they're in a hurry and don't want to wait. Some parts of the bike path are too narrow so if you get stuck behind a slow rider, they get frustrated and move to the road. (Public Official, León, 03/18/2020)

Finally, Puebla and Guadalajara have developed institutions and standards to guide implementation and have reached a point where implementation is sustained and less dependent on sustained pressure from civil society organizations. Puebla has a Mobility Plan with quantitative indicators that need to be met by specific times. Guadalajara, which is developed in Chapter 4, is often considered a national example. Notably, Guadalajara now has a mechanism to ensure cycling infrastructure funding written into the state mobility law and metropolitan governance of cycling policy.

Overall, this project revealed that institutional development and organizational capacity are crucial to sustaining infrastructure implementation and ensuring its quality. The presence of organizations with clear mandates and technical capabilities and their ability to coordinate create standards and procedures that become institutionalized are determinant factors for the implementation of cycling infrastructure.

I think of [cycling infrastructure planning] as an iceberg where there are things you see and things you don't see. There is a tendency [for governments] to look after the part that sticks out, which is the part you can see. The visible part of cyclist mobility is what you see on bike paths and lanes, bikeshare systems, bike parking, and so forth. But for all of that to work, there are thousands of things that are not visible. We have to look after the visible and the invisible. Below all of the visible pieces is a framework that allows it all to stay afloat. That framework includes institutionalizing cycling legislation, financing mechanisms, oversight, and control. Not many are advocating for this because it is not visible, and results take time. Maybe our most significant challenge is that we need some visible actions and things, but we also need to create a framework that would mean that these actions become permanent. It's not only about how we create public policy but how do we follow up on it? And how do we make it a part of everyday life in the city? Evidently, if we only work on the visible parts, they become short-term measures or their impact becomes limited to specific areas. If you only work on the invisible parts, it

looks like nothing is happening. The challenge is to work above and below the surface. When you work on the visible parts, people notice it and see that it is more than just talk, it's a reality. (Public Official, Mérida, 02/12/2020).

3.6 APPENDIX 1. INTERVIEW PROTOCOL

The following protocol was used during interviews, while also allowing for interviewees to bring up topics they considered relevant to the topic of cycling infrastructure development. The protocol was also adapted to fit within shorter times when interviewees were time-constrained, and adopted to interviewee experience and role (for example, some activists were not able to answer process questions but could speak to quality of infrastructure).

Interviewee attributes

What is your primary role at your current organization?
How did you come to work here?
How did you come to work on cycling?

Organization attributes

What work does your organization do related to urban cycling?
Is there a department or unit here that focuses on cycling?

Cycling infrastructure history

What can you tell me about the development of cycling infrastructure in your city over the last decade? Why was this infrastructure built?
What are the main drivers for building cycling infrastructure in your city?

Cycling infrastructure: process

Have you or your organization ever been involved in any planning and building cycling infrastructure? What was that like?
What kinds of difficulties might be encountered during planning? During building?
How is cycling infrastructure funded here? How is funding secured?
Have you encountered barriers to accessing funds for the development of cycling infrastructure?
What do you consider successful infrastructure development? How do you know if developments have been successful?
Have there been any assessments of the success of cycling infrastructure in your city? (ask for documents) how did they assess success?

Walk me through the most recent infrastructure development project
What was the impetus for developing this project?
Who decides to build new cycling infrastructure? Who decides how much to spend on it?
Who decides where to put it? Does anyone else participate in making those decisions?
To your knowledge, who are the main organizations/actors who are involved in the process of planning cycling infrastructure?
To your knowledge, who are the main organizations/actors who are involved in the process of building cycling infrastructure?
How does the planning speak to the building?
Do the actors involved in the process have shared goals?

Non-governmental actors

Do you work with any non-governmental organizations on cycling infrastructure? How do you work together?
Do you work with any international organizations on cycling infrastructure? Who are they?
How do you work together?
Do you collaborate or interact with organizations in other metropolitan areas?
Which ones? Can you tell me more about how you work with them?

Is there anyone in particular who has been a key player in getting cycling infrastructure built in your city?
Do you know of any groups who oppose cycling infrastructure development [locally]?
If yes, who are they?
What do they oppose?
How do they oppose it?
What have they achieved?

Legal framework

Some states have recently passed cycling/mobility policies. Do you know if your state has passed one? What difference do they make? If not, should there be one? What difference would it make?
To your knowledge, are there any laws that structure your organization's work around cycling policy?
If yes, what laws?
How do [those laws] influence your work on cycling?
Are there any other government policies that currently guide your work? Please explain.
What is lacking in the current legal framework?

Cycling infrastructure: current conditions

What characteristics of your city facilitate using a bike for transportation?
What characteristics make it hard?
What is the most important aspect that needs to improve?
What do you think of the quality of the infrastructure that you have in this city?
What is good about it? What could be improved?

What does the typical infrastructure look like? What is an example of a successful bikeway? What about a failed one? Has infrastructure improved over time?
Who cycles in this city? Who has access to infrastructure? Who doesn't have access? Has this changed over time?

Other

Is there anything else you think is important to know about cycling policy or cycling infrastructure in your city?

3.7 APPENDIX 2 CODING SCHEME

Table 21. Variables affecting implementation derived from literature.

Concept	Definition and subcodes	Source
Culture	Existing norms and values among agencies, citizens and society.	(Aldred, 2013; Aldred & Jungnickel, 2014; Bardal et al., 2020)
Legal framework	Presence or absence of laws that shape or constrain action. *Legal barriers* manifest themselves when the measures lack or have weak support in existing laws and regulations, and legal mandates overlap or are outside the realm of action of city governments. Legal framework includes (but is not limited to) *legal mandates to build infrastructure*, *legal recognition of cycling as transportation, legal recognition of cycling infrastructure, regulations for infrastructure design, regulations for infrastructure use*	(Bai, 2007; Bardal et al., 2020; Bulkeley, 2010; Martins & Ferreira, 2011; Ryan, 2015)
Organizational resources	Variables that fall within the organizational realm include *organizational mandates (new and existing), funding, human resources, data and information management, organizational knowledge, and the collaboration within and between organizations* designing and implementing the policies.	(Bardal et al., 2020; Larson, 2002; Ryan, 2015)
Political support	Political support refers to the backing of policies by democratic institutions at the national, regional or local governmental levels, or from organized interest groups. *Includes advocate organizations, political parties, political entrepreneurs, political parties and opposition groups, political will.*	(Aldred, 2013; Bulkeley, 2010; Lankao, 2007; Sosa López & Montero, 2018).

Table 22. Infrastructure quality attributes

Concept	Definition	Source
Spatial integration	infrastructure is integrated into various spatial contexts – urban, suburban, downtown	(Hull & O'Holleran, 2014; McLeod et al., 2020)
Coherence	Continuity of the network and connection to destinations	
Directness	Infrastructure provides cyclists with short and fast routes	
Attractiveness	Infrastructure is furnished, illuminated, and provided with signage	
Traffic safety	Design ensures safety of all users	
Other	Other properties (shade in warm climates, public safety)	(Adam et al., 2020; McLeod et al., 2020)

Table 23. Infrastructure planning process

Concept	Definition and subcodes	Source
Process opportunity	Leveraging existing process to implement infrastructure (includes public works opportunities and private development opportunities).	(Assunçao-Denis and Tomalty, 2019).
Spatial opportunity	Opportunistic development of infrastructure on specific routes or topographic opportunities	(Assunçao-Denis and Tomalty, 2019).
Political opportunity	Development of infrastructure occurs through organized advocacy of political actors (for example formalizing citizen bike lanes).	From interviews
Strategic planning	Development follows a strategic mapping and planning process, often included in a bike master plan.	(Assunçao-Denis and Tomalty, 2019).
Coordination across agencies	Creation of coordination mechanisms across agencies. Creation of capacity for joint action.	From interviews
Implementation process	Executive project development, funding, socialization, oversight	From interviews
Process barriers	Barriers or issues that arise during implementation	From interviews
Maintenance	Maintenance of cycling infrastructure	From interviews
Socialization	Socialization of infrastructure projects	From interviews

Table 24. Other variables that affect cycling

Concept	Definition and subcodes	Source
Natural and built environment	Context-specific characteristics such as topography, weather, climate and urban form.	(Handy, van Wee, and Kroesen 2014; Heinen, van Wee, and Maat 2010; Rérat 2019).
Socio-economic	Socio-economic characteristics of people who cycle age, gender, class.	(S. Handy et al., 2014; Heinen et al., 2010; Rérat, 2019).
Automobility	Mentions of car dominant culture. Scholarship shows that contexts indicating growth in utility cycling do so in part because they implement measures against automobility	(Pucher et al., 2010)
Attitudes towards cycling	Perceptions of attitudes towards cycling	From interviews
Generational divide	Generational differences between dececionmakers, planners, implementation agencies	From interviews
Other	*Other factors* perceived as affecting cycling in the city (crime for example)	From interviews

3.8 REFERENCES

1. Adam, L., Jones, T., & te Brömmelstroet, M. (2020). Planning for cycling in the dispersed city: Establishing a hierarchy of effectiveness of municipal cycling policies. *Transportation*, *47*(2), 503–527. https://doi.org/10.1007/s11116-018-9878-3
2. Adorno, G., Fields, N., Cronley, C., Parekh, R., & Magruder, K. (2018). Ageing in a low-density urban city: Transportation mobility as a social equity issue. *Ageing & Society*, *38*(2), 296-320.
3. Akar, G., Fischer, N., & Namgung, M. (2013). Bicycling Choice and Gender Case Study: The Ohio State University. *International Journal of Sustainable Transportation*, *7*(5), 347–365. https://doi.org/10.1080/15568318.2012.673694
4. Aldred, R. (2012). Chapter 4 The Role of Advocacy and Activism. In J. Parkin (Ed.), *Transport and Sustainability* (pp. 83–108). Emerald Group Publishing Limited. https://doi.org/10.1108/S2044-9941(2012)0000001006
5. Aldred, R. (2013). Who are Londoners on Bikes and what do they want? Negotiating identity and issue definition in a 'pop-up' cycle campaign. *Journal of Transport Geography*, *30*, 194–201. https://doi.org/10.1016/j.jtrangeo.2013.01.005
6. Aldred, R., & Jungnickel, K. (2014). Why culture matters for transport policy: The case of cycling in the UK. *Journal of Transport Geography*, *34*, 78–87. https://doi.org/10.1016/j.jtrangeo.2013.11.004
7. Amin, A. (2014). Lively Infrastructure. *Theory, Culture & Society*, *31*(7–8), 137–161. https://doi.org/10.1177/0263276414548490
8. Anaya-Boig, E. (2021a). Cycling Policies. In *International Encyclopedia of Transportation* (pp. 241–245). Elsevier. https://doi.org/10.1016/B978-0-08-102671-7.10689-X
9. Anaya-Boig, E., (2021b). Integrated Cycling Policy. A framework proposal for a research-based cycling policy innovation, In: Zuev, D., Psarikidou, K., Popan, C., (Eds.), Cycling Societies: Innovations, Inequalities and Governance. Routledge.
10. Anguelovski, I., & Carmin, J. (2011). Something borrowed, everything new: Innovation and institutionalization in urban climate governance. *Current Opinion in Environmental Sustainability*, *3*(3), 169–175. https://doi.org/10.1016/j.cosust.2010.12.017

11. Assunçao-Denis, M. È., & Tomalty, R. (2019). Increasing cycling for transportation in Canadian communities: understanding what works. Transportation research part A: policy and practice, 123, 288-304.
12. Bai, X. (2007). Integrating Global Environmental Concerns into Urban Management: The Scale and Readiness Arguments. *Journal of Industrial Ecology*, *11*(2), 15–29. https://doi.org/10.1162/jie.2007.1202
13. Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, *15*(2), 73–80. https://doi.org/10.1016/j.tranpol.2007.10.005
14. Bardal, K. G., Gjertsen, A., & Reinar, M. B. (2020). Sustainable mobility: Policy design and implementation in three Norwegian cities. *Transportation Research Part D: Transport and Environment*, *82*, 102330. https://doi.org/10.1016/j.trd.2020.102330
15. Bean, C. E., Kearns, R., & Collins, D. (2008). Exploring social mobilities: Narratives of walking and driving in Auckland, New Zealand. *Urban studies*, *45*(13), 2829-2848
16. Braun, L. M., Rodriguez, D. A., & Gordon-Larsen, P. (2019). Social (in)equity in access to cycling infrastructure: Cross-sectional associations between bike lanes and area-level sociodemographic characteristics in 22 large U.S. cities. *Journal of Transport Geography*, *80*, 102544. https://doi.org/10.1016/j.jtrangeo.2019.102544
17. Buehler, R., & Dill, J. (2016). Bikeway Networks: A Review of Effects on Cycling. *Transport Reviews*, *36*(1), 9–27. https://doi.org/10.1080/01441647.2015.1069908
18. Buehler, R., & Pucher, J. (2012). Cycling to work in 90 large American cities: New evidence on the role of bike paths and lanes. *Transportation*, *39*(2), 409–432. https://doi.org/10.1007/s11116-011-9355-8
19. Buehler, T., & Handy, S. (2008). Fifty Years of Bicycle Policy in Davis, California. *Transportation Research Record: Journal of the Transportation Research Board*, *2074*(1), 52–57. https://doi.org/10.3141/2074-07
20. Bulkeley, H. (2010). Cities and the Governing of Climate Change. *Annual Review of Environment and Resources*, *35*(1), 229–253. https://doi.org/10.1146/annurev-environ-072809-101747
21. Carstensen, T. A., Olafsson, A. S., Bech, N. M., Poulsen, T. S., & Zhao, C. (2015). The spatio-temporal development of Copenhagen's bicycle infrastructure 1912–2013.

Geografisk Tidsskrift-Danish Journal of Geography, *115*(2), 142–156. https://doi.org/10.1080/00167223.2015.1034151

22. Carter, N. (2006). Party Politicization Of The Environment In Britain. *Party Politics*, *12*(6), 747–767. https://doi.org/10.1177/1354068806068599
23. Casa de la Ciudad (2017) Plan maestro de movilidad ciclovías de la Zona Metropolitana de Oaxaca URL: https://casadelaciudad.org/plan-maestro-de-movilidad-ciclovias-de-la-zona-metropolitana-de-oaxaca/
24. Castañeda, P. (2021). Cycling case closed? A situated response to Samuel Nello-Deakin's "Environmental determinants of cycling: Not seeing the forest for the trees?" *Journal of Transport Geography*, *90*, 102947. https://doi.org/10.1016/j.jtrangeo.2020.102947
25. Censo de Población y Vivienda 2020 (CPV). 2020. Instituto Nacional de Estadística y Geografía. https://www.inegi.org.mx/programas/ccpv/2020/
26. Censo General de Población y Vivienda 1990 (CGPV). 1990. Instituto Nacional de Estadística, Geografía e Informática. https://www.inegi.org.mx/programas/ccpv/1990/
27. Centro de Estudios de las Finanzas Públicas (CEFP). 2019. *Series históricas de indicadores macroeconómicos de México a 2018*. *Technical Note CEFP/020/2019*. https://www.cefp.gob.mx/publicaciones/documento/2019/cefp0202019.pdf
28. Cepeda Zorrilla, M., Hodgson, F., & Jopson, A. (2019). Exploring the influence of attitudes, social comparison and image and prestige among non-cyclists to predict intention to cycle in Mexico City. *Transportation Research Part F: Traffic Psychology and Behaviour*, *60*, 327–342. https://doi.org/10.1016/j.trf.2018.10.009
29. Cervero, R., Caldwell, B., & Cuellar, J. (2013). Bike-and-Ride: Build It and They Will Come. *Journal of Public Transportation*, *16*(4), 83–105. https://doi.org/10.5038/2375-0901.16.4.5
30. Cervero, R., Denman, S., & Jin, Y. (2019). Network design, built and natural environments, and bicycle commuting: Evidence from British cities and towns. *Transport Policy*, *74*, 153–164. https://doi.org/10.1016/j.tranpol.2018.09.007
31. Cox, P., & Koglin, T. (2021). *Theorising infrastructure:* 21.
32. Denzin, N. K., & Lincoln, Y. S. (Eds.). (2011). *The Sage handbook of qualitative research*. sage.

33. Dill, J. (2009). Bicycling for Transportation and Health: The Role of Infrastructure. *Journal of Public Health Policy*, *30*(S1), S95–S110. https://doi.org/10.1057/jphp.2008.56
34. Dill, J., & Carr, T. (2003). Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them. *Transportation Research Record: Journal of the Transportation Research Board*, *1828*(1), 116–123. https://doi.org/10.3141/1828-14
35. Dill, J., & McNeil, N. (2013). Four Types of Cyclists?: Examination of Typology for Better Understanding of Bicycling Behavior and Potential. *Transportation Research Record*, *2387*(1), 129–138. https://doi.org/10.3141/2387-15
36. El-Assi, W., Salah Mahmoud, M., & Nurul Habib, K. (2017). Effects of built environment and weather on bike sharing demand: A station level analysis of commercial bike sharing in Toronto. *Transportation*, *44*(3), 589–613. https://doi.org/10.1007/s11116-015-9669-z
37. Forsyth, A., & Krizek, K. J. (2010). Promoting Walking and Bicycling: Assessing the Evidence to Assist Planners. *Built Environment*, *36*(4), 429–446. https://doi.org/10.2148/benv.36.4.429
38. Furness, Z. (2010). Critical mass rides against car culture. FA (., et al. Cycling Philosophy for Everyone. A Philosophical Tour de Force, 134-145.
39. Gamble, J., Snizek, B., & Nielsen, T. S. (2017). From people to cycling indicators: Documenting and understanding the urban context of cyclists' experiences in Quito, Ecuador. *Journal of Transport Geography*, *60*, 167–177. https://doi.org/10.1016/j.jtrangeo.2017.03.004
40. Gartner, C. (2016). The science and politics of infrastructure research: asserting power, place, and agency in infrastructure knowledge. Journal of Human Development and Capabilities, 17(3), 377-396.
41. Gebhart, K., & Noland, R. B. (2014). The impact of weather conditions on bikeshare trips in Washington, DC. *Transportation*, *41*(6), 1205–1225. https://doi.org/10.1007/s11116-014-9540-7
42. Gobierno de Aguascalientes (2018) Ley de Fomento a la Bicicleta del Estado de Aguascalientes. Decreto no. 394 Primera Sección del Periódico Oficial del Estado de Aguascalientes, el lunes 10 de septiembre de 2018

https://eservicios2.aguascalientes.gob.mx/NormatecaAdministrador/archivos/EDO-18-153.pdf

43. Gobierno de Aguascalientes (2018) Ley de Movilidad del Estado de Aguascalientes. Decreto no. 288. Primera Sección del Periódico Oficial del Estado de Aguascalientes, el lunes 30 de abril de 2018. https://eservicios2.aguascalientes.gob.mx/NormatecaAdministrador/archivos/EDO-18-141.pdf
44. Gobierno de Guanajuato (2016) Ley no. 187. Ley de Movilidad del Estado de Guanajuato y sus Municipios (2016) Periódico Oficial del Gobierno del Estado de Guanajuato, 22 de noviembre del 2016 https://www.León.gob.mx/León/modulos/img/adjuntos/adjuntos-121.pdf
45. Gobierno de Jalisco (2010a). Plan de Movilidad No Motorizada del Area Metropolitana de Guadalajara Retrieved 08/01/21 https://issuu.com/el_informador/docs/movilidad_no_motorizada
46. Gobierno de Jalisco (2010b). Manual de Lineamientos y estándares Para Vias Peatonales y Ciclistas del Plan Maestro de Movilidad Urbana no Motorizada de la Zona Metropolitana de Guadalajara Retrieved 08/01/21 https://docplayer.es/23897570-Plan-maestro-de-movilidad-urbana-no-motorizada-del-area-metroplitana-de-guadalajara.html
47. Gobierno de Jalisco (2013) Ley de Movilidad y Transporte del Estado de Jalisco. NÚMERO 24451/LX/13. https://transparencia.info.jalisco.gob.mx/sites/default/files/Ley%20de%20Movilidad%20y%20Transporte%20del%20Estado%20de%20Jalisco_2.pdf
48. Gobierno de Michoacan (2016) Ley de Fomento al uso de la Bicicleta y Protección al Ciclista del Estado de Michoacán de Ocampo No. 358. Periódico Oficial del Estado, el 16 de Diciembre de 2016, Tomo: CLXVI, no. 22, Décima Primera Sección. http://congresomich.gob.mx/file/LEY-DE-FOMENTO-AL-USO-DE-LA-BICICLETA-Y-PROTECCION-AL-CICLISTA-REF-16-DE-DIC-DE-2016.pdf
49. Gobierno de Oaxaca (2013) Ley De Fomento y Promoción del uso de la Bicicleta en las Zonas Metropolitanas del Estado de Oaxaca. Congreso del Estado Libre y Soberano de Oaxaca, Decreto no. 2096 http://docs64.congresooaxaca.gob.mx/documents/legislacion_estatals/Ley_de_Fomento_

y_Promoción_del_Uso_de_la_Bicicleta_en_las_Zonas_Metropolitanas_del_Estado_de_Oaxaca..pdf

50. Gobierno de Querétaro (2011). Ley que Regula el Sistema Estatal de Promoción de Uso de la Bicicleta; http://legislaturaqueretaro.gob.mx/app/uploads/2016/01/LEY005.pdf
51. Gobierno de Yucatán (2013) Ley De Fomento al Uso de la Bicicleta en El Estado de Yucatán Decreto Número 83.
52. https://normas.cndh.org.mx/Documentos/Yucatán/Ley_FUBE_Yuc.pdf
53. Gobierno del Estado de Mexico (2015) Ley de Movilidad del Estado de México. Decreto no. 446. Periódico Oficial "Gaceta del Gobierno" el 12 de Agosto de 2015.
54. Gössling, S. (2013). Urban transport transitions: Copenhagen, City of Cyclists. *Journal of Transport Geography*, *33*, 196–206. https://doi.org/10.1016/j.jtrangeo.2013.10.013
55. Handy, S. L., & Xing, Y. (2011). Factors Correlated with Bicycle Commuting: A Study in Six Small U.S. Cities. *International Journal of Sustainable Transportation*, *5*(2), 91–110. https://doi.org/10.1080/15568310903514789
56. Handy, S., & McCann, B. (2010). The Regional Response to Federal Funding for Bicycle and Pedestrian Projects: An Exploratory Study. *Journal of the American Planning Association*, *77*(1), 23–38. https://doi.org/10.1080/01944363.2011.526537
57. Handy, S., van Wee, B., & Kroesen, M. (2014). Promoting Cycling for Transport: Research Needs and Challenges. *Transport Reviews*, *34*(1), 4–24. https://doi.org/10.1080/01441647.2013.860204
58. Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by Bicycle: An Overview of the Literature. *Transport Reviews*, *30*(1), 59–96. https://doi.org/10.1080/01441640903187001
59. Holgate, C. (2007). Factors and Actors in Climate Change Mitigation: A Tale of Two South African Cities. *Local Environment*, *12*(5), 471–484. https://doi.org/10.1080/13549830701656994
60. Hull, A., & O'Holleran, C. (2014). Bicycle infrastructure: Can good design encourage cycling? *Urban, Planning and Transport Research*, *2*(1), 369–406. https://doi.org/10.1080/21650020.2014.955210
61. IMPLAN León (2016). Actualización del plan maestro de ciclovías, León Guanajuato https://implan.gob.mx/pdf/estudios/movilidad/plan-maestro-de-ciclovias-2016.pdf

62. IMPLAN Morelia (2017) Mapeo Colaborativo Ciclista. URL: https://implanmorelia.org/site/wp-content/uploads/2020/03/MAPEO_COLABORATIVO_CICLISTA.pdf

63. IMPLAN Puebla (2013) Plan de Movilidad Urbana Sustentable para el Municipio de Puebla

64. Institute for Tansportation & Development Policy- México, e Interface for Cycling Expertise, ITDP/I-CE (2011). Ciclociudades. Manual integral de movilidad ciclista para ciudades mexicanas. IV. La movilidad en bicicleta como política pública URL: http://ciclociudades.mx/manual-tomo-iv/

65. Instituto Nacional de Estadística y Geografía (INEGI) (2020b, 31 de julio). *Accidentes de tránsito terrestre en zonas urbanas y suburbanas*. inegi. https://www.inegi.org.mx/programas/accidentes/#Tabulados

66. Instituto Nacional de Estadística y Geografía (INEGI). (2020, December 9). *Producto Interno Bruto por Entidad Federativa 2019* [Press Release No. 632/20] https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2020/OtrTemEcon/PIBEntFed2019.pdf

67. Instituto Nacional de Estadística y Geografía (INEGI). (2020a). *Banco de Indiadores*. inegi. https://www.inegi.org.mx/app/indicadores/default.aspx?tm=6#divFV6207048973

68. ITDP (2016) Invertir para Movernos. Diagnóstico de Inversión en Movilidad en las Zonas Metropolitanas 2011-2015. http://mexico.itdp.org/wp-content/uploads/Invertir_para_Movernos_2015.pdf

69. Koglin, T. (2015). Organisation does matter – planning for cycling in Stockholm and Copenhagen. *Transport Policy*, *39*, 55–62. https://doi.org/10.1016/j.tranpol.2015.02.003

70. Koohsari, M. J., Cole, R., Oka, K., Shibata, A., Yasunaga, A., Hanibuchi, T., Owen, N., & Sugiyama, T. (2020). Associations of built environment attributes with bicycle use for transport. *Environment and Planning B: Urban Analytics and City Science*, *47*(9), 1745–1757. https://doi.org/10.1177/2399808319845006

71. Lankao, P. R. (2007). How do Local Governments in Mexico City Manage Global Warming? *Local Environment*, *12*(5), 519–535. https://doi.org/10.1080/13549830701656887

72. Larson, A. M. (2002). Natural Resources and Decentralization in Nicaragua: Are Local Governments Up to the Job? *World Development*, *30*(1), 17–31. https://doi.org/10.1016/S0305-750X(01)00098-5
73. Luker, K. (2009). *Salsa dancing into the social sciences*. Harvard University Press.
74. Marqués, R., Hernández-Herrador, V., Calvo-Salazar, M., & García-Cebrián, J. A. (2015). How infrastructure can promote cycling in cities: Lessons from Seville. *Research in Transportation Economics*, *53*, 31–44. https://doi.org/10.1016/j.retrec.2015.10.017
75. Martins, R. D., & Ferreira, L. D. C. (2011). Opportunities and constraints for local and subnational climate change policy in urban areas: Insights from diverse contexts. *International Journal of Global Environmental Issues*, *11*(1), 37–53. https://doi.org/10.1504/IJGENVI.2011.04025
76. McLeod, S., Babb, C., & Barlow, S. (2020). How to 'do' a bike plan: Collating best practices to synthesise a Maturity Model of planning for cycling. *Transportation Research Interdisciplinary Perspectives*, *5*, 100130. https://doi.org/10.1016/j.trip.2020.100130
77. Mertens, L., Compernolle, S., Deforche, B., Mackenbach, J. D., Lakerveld, J., Brug, J., Roda, C., Feuillet, T., Oppert, J.-M., Glonti, K., Rutter, H., Bardos, H., De Bourdeaudhuij, I., & Van Dyck, D. (2017). Built environmental correlates of cycling for transport across Europe. *Health & Place*, *44*, 35–42. https://doi.org/10.1016/j.healthplace.2017.01.007
78. Mexico Instituto Municipal de Planeación, Aguascalientes, (2015). Programa de Desarrollo Urbano de la Ciudad de Aguascalientes 2040.
79. Mexico. (1961). *Constitution of the United Mexican States, 1917 (as amended)*. Washington: Pan American Union.
80. MOMOV (2016) Plan De Movilidad Urbana No Motorizada Para La Zona Metropolitana De Mérida https://m50.com.mx/wp-content/uploads/2018/07/Plan-de-Movilidad-No-Motorizada.pdf
81. Monseral, Eduardo (2018) Circuito Sur. Creando Ciudad desde un render. Observatorio de Mobilidad Sostenible de Mérida. Accessed 7/14/21 URL: https://movilidadMérida.org/circuito-sur-creando-ciudad-desde-un-render/

82. Monsreal, Eduardo and Mendoza, Freddy (2021) Infraestructura Ciclista de la Zona Metropolitana de Mérida 2021. *Observatorio de Movilidad Sostenible de Mérida* https://movilidadMérida.org/infraestructura-ciclista-de-la-zona-metropolitana-de-Mérida-2021/

83. Mora, R., Truffello, R., & Oyarzún, G. (2021). Equity and accessibility of cycling infrastructure: An analysis of Santiago de Chile. *Journal of Transport Geography*, *91*, 102964. https://doi.org/10.1016/j.jtrangeo.2021.102964

84. Mrkajić, V., & Anguelovski, I. (2016). Planning for sustainable mobility in transition cities: Cycling losses and hopes of revival in Novi Sad, Serbia. *Cities*, *52*, 66–78. https://doi.org/10.1016/j.cities.2015.11.029

85. Municipio de Puebla (2017) Norma Técnica de Diseño e Imagen Urbana para el Municipio de Puebla. https://ojp.puebla.gob.mx/index.php/otros/item/norma-tecnica-de-diseno-e-imagen-urbana-para-el-municipio-de-puebla

86. Municipio de Querétaro (2015). 200 Kilómetros Ciqrovías y Bicis Compartidas. https://municipiodeQuerétaro.gob.mx/wp-content/uploads/2019/08/03_lb-ciclovias-comprimido_compressed.pdf

87. Nello-Deakin, S. (2020). Environmental determinants of cycling: Not seeing the forest for the trees?. Journal of transport geography, 85, 102704.

88. Parkin, J., & Koorey, G. (2012). Chapter 6 Network Planning and Infrastructure Design. In J. Parkin (Ed.), *Transport and Sustainability* (pp. 131–160). Emerald Group Publishing Limited. https://doi.org/10.1108/S2044-9941(2012)0000001008

89. Parkin, J., Wardman, M., & Page, M. (2007). Models of perceived cycling risk and route acceptability. Accident Analysis & Prevention, 39(2), 364-371.

90. Parra, D. C., Gomez, L. F., Pinzon, J. D., Brownson, R. C., & Millett, C. (2018). Equity in cycle lane networks: Examination of the distribution of the cycle lane network by socioeconomic index in Bogotá, Colombia. *Cities & Health*, *2*(1), 60–68. https://doi.org/10.1080/23748834.2018.1507068

91. Picon, A. (2018). Urban Infrastructure, Imagination and Politics: From the Networked Metropolis to the Smart City: URBAN INFRASTRUCTURE, IMAGINATION AND

POLITICS. *International Journal of Urban and Regional Research*, *42*(2), 263–275. https://doi.org/10.1111/1468-2427.12527

92. Pucher, J., & Buehler, R. (2017). Cycling towards a more sustainable transport future. *Transport Reviews*, *37*(6), 689–694. https://doi.org/10.1080/01441647.2017.1340234
93. Pucher, J., Dill, J., & Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: An international review. *Preventive Medicine*, *50*, S106–S125. https://doi.org/10.1016/j.ypmed.2009.07.028
94. Rérat, P. (2019). Cycling to work: Meanings and experiences of a sustainable practice. *Transportation Research Part A: Policy and Practice*, *123*, 91–104. https://doi.org/10.1016/j.tra.2018.10.017
95. Rodríguez, M., Pinto, A. M., Páez, D., Ortiz, M. Á., Buis, J., & Márquez, J. C. (2017). *Cómo impulsar el ciclismo urbano: Recomendaciones para las instituciones de América Latina y el Caribe*. Inter-American Development Bank. https://doi.org/10.18235/0000660
96. Rosas-Satizábal, D., & Rodriguez-Valencia, A. (2019). Factors and policies explaining the emergence of the bicycle commuter in Bogotá. *Case Studies on Transport Policy*, *7*(1), 138–149. https://doi.org/10.1016/j.cstp.2018.12.007
97. Ryan, D. (2015). From commitment to action: A literature review on climate policy implementation at city level. *Climatic Change*, *131*(4), 519–529. https://doi.org/10.1007/s10584-015-1402-6
98. Sagaris, L. (2010). From sustainable transport development to active citizenship and participatory democracy: The experience of Living City in Chile: From sustainable transport development to active citizenship and participatory democracy. *Natural Resources Forum*, *34*(4), 275–288. https://doi.org/10.1111/j.1477-8947.2010.01312.x
99. Sagaris, L. (2014). Citizen participation for sustainable transport: The case of "Living City" in Santiago, Chile (1997–2012). *Journal of Transport Geography*, *41*, 74–83. https://doi.org/10.1016/j.jtrangeo.2014.08.011
100. Sagaris, L. (2015). Lessons from 40 years of planning for cycle-inclusion: Reflections from Santiago, Chile. *Natural Resources Forum*, *39*(1), 64–81. https://doi.org/10.1111/1477-8947.12062
101. Secretaría de Desarrollo Agrario, Territorial y Urbano, Consejo Nacional de Población & Instituto Nacional de Estadística y Geografía (SEDATU/CONAPO/INEGI). (2018).

Delimitación de las Zonas Metropolitanas de México 2015. https://www.inegi.org.mx/contenido/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825006792.pdf

102. Secretaria de Movilidad y Espacio Publico (SEMOVEP) Morelia (2019). Norma Técnica de Diseño de Calles para el Municipio de Morelia. URL: https://semovep.morelia.gob.mx/pdf/normaTecnica.pdf
103. Seher, R. (2011). I Want to Ride My Bicycle': Why and How Cities Plan for Bicycle Infrastructure. *BUFFALO LAW REVIEW*, *59*, 37.
104. Smith, Kieran (05/22/2018) The guerrilla cyclists solving urban transport problems. The Guardian. Retrieved (07/01/2021) URL: https://www.theguardian.com/environment/bike-blog/2018/may/11/the-guerilla-cyclists-solving-urban-transport-problems
105. Sosa López, O., & Montero, S. (2018). Expert-citizens: Producing and contesting sustainable mobility policy in Mexican cities. *Journal of Transport Geography*, *67*, 137–144. https://doi.org/10.1016/j.jtrangeo.2017.08.018
106. Titze, S., Stronegger, W. J., Janschitz, S., & Oja, P. (2008). Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. *Preventive Medicine*, *47*(3), 252–259. https://doi.org/10.1016/j.ypmed.2008.02.019
107. Tucker, B., & Manaugh, K. (2018). Bicycle equity in Brazil: Access to safe cycling routes across neighborhoods in Rio de Janeiro and Curitiba. *International Journal of Sustainable Transportation*, *12*(1), 29–38. https://doi.org/10.1080/15568318.2017.1324585
108. Urry, J. (2004). The 'System' of Automobility. *Theory, Culture & Society*, *21*(4–5), 25–39. https://doi.org/10.1177/0263276404046059
109. Weatherspark. (2021). *The Typical Weather Anywhere on Earth*. weatherspark. https://weatherspark.com/
110. Wilson, A., & Mitra, R. (2020). Implementing cycling infrastructure in a politicized space: Lessons from Toronto, Canada. *Journal of Transport Geography*, *86*, 102760.

111. Xylia, M., & Silveira, S. (2018). The role of charging technologies in upscaling the use of electric buses in public transport: Experiences from demonstration projects. *Transportation Research Part A: Policy and Practice*, *118*, 399-415.
112. Zhao, P. (2014). The Impact of the Built Environment on Bicycle Commuting: Evidence from Beijing. *Urban Studies*, *51*(5), 1019–1037. https://doi.org/10.1177/0042098013494423
113. Zubicaray, G., M. Brito, M. L. Ramírez, N. García & J. Macías. (2021). *Las ciudades mexicanas: tendencias de expansión y sus impactos*. Coalition for Urban Transitions. https://urbantransitions.global/wp-content/uploads/2021/02/Las_ciudades_mexicanas_digital.pdf

Chapter 4. FROM EXPRESSWAYS TO BIKEWAYS: HOW GUADALAJARA INSTITUTIONALIZED CYCLING AS PUBLIC POLICY

4.1 INTRODUCTION

Over the past 20 years, Guadalajara Jalisco has gone from being a city with few cyclists and no public policy or funding to support cycling as a transportation mode to a nationally and internationally recognized city for its work in advancing cycling mobility. Guadalajara recently became the no. 1 city on the Institute for Transportation and Development Policy Mexico's annual cycling city ranking *Ciclociudades*, and it has been in the top 4 since the ranking started in 2013 (ITDP 2013, 2014, 2015, 2018, 2019, 2020). The Interamerican Bank developed an evaluation of cycling-friendly cities in Latin America, where Guadalajara was ranked as no.1 in the region (Seijas, 2016).

Guadalajara has become a national leader in the promotion of cycling. Guadalajara's weekly *Ciclovía RecreActiva*, where 70 km of arterial streets are closed throughout the city every Sunday morning, attracts up to 350,000 people each week and is the largest in the country. The MiBici bikeshare system, active since 2014, has over 100,000 registered users and has accumulated over 16,000,000 trips over the last six years and is the second-largest in the country, next only to ecobici in Mexico City (which is four times the size of Guadalajara) (MiBici, 2021). In this period, the city has also built 187 km of cycling infrastructure at the metropolitan level. Most importantly, Guadalajara has developed institutions dedicated to planning and implementing cycling policy at the municipal and metropolitan level, which sustain and oversee

cycling mobility, and has a growing number of legal frameworks and norms supporting these activities. Aside from the capital of the country, Guadalajara is the only city in Mexico with a metropolitan system of governance for urban mobility.

The research questions guiding this case study are: *what were the main factors and events that have led Guadalajara to adopt and implement policies to promote cycling mobility? What is the story behind Guadalajara's adoption and implementation of cycling policy? What evidence exists about the success of these policies?* The present case critically analyzes the process through which cycling became institutionalized into a consistent component of metropolitan transportation policy.

In 2000, there were no specific policies, agencies, or institutional structures to promote or fund cycling for mobility. Cyclists were not legally recognized as formal users of the roads; bicycles were not recognized as vehicles. There was virtually no designated infrastructure facilitating cycling mobility in the Metropolitan area. In 2021, Guadalajara has municipal, metropolitan, and state-level institutions and funding mechanisms that govern, sustain, and promote increasingly ambitious cycling plans. Cyclists now have legal standing, rights, and responsibilities as recognized users of the streets.

In this paper, I analyze the process that led to this urban and institutional transformation of Guadalajara. This analysis identifies the actors and events that have made Guadalajara a reference as a cycling city and presents salient evidence on the impact of these programs. I demonstrate how local actors built a strong, diverse, and highly media driven movement to mobilize sustainable transportation as a new policy issue and successfully pushed for its gradual institutionalization as a core part of Guadalajara's metropolitan urban planning agenda.

On the one hand, this case study identifies and analyzes many of Guadalajara's particularities that make their experience unique and perhaps difficult to replicate elsewhere since it is rooted in many local and contextual factors explored here. However, this case study also provides a blueprint and example for a Latin American City that has progressively and successfully incorporated cycling into its urban mobility system. This work identifies the mechanisms that made the transformation possible within this context as a valuable case for other cities seeking to make such a transition, benefiting from Guadalajara's example of success.

Based on the widely accepted premise that a variety of CSOs shape mobility policy on the ground and on the assumption that one of the central policies for which CSOs advocate is cycling infrastructure[20], the first hypothesis in Chapter 3 was stated as *Cycling infrastructure is more likely to occur in places where at least one CSO is actively working in favor of cycling infrastructure*. In Chapter 3, I explored broadly how CSOs seek to affect infrastructure provision in cities across Mexico. This chapter focuses closely on one of those cities to describe a sizeable citizen-led mobilization that led cycling specifically and sustainable mobility policy more broadly to become a part of the permanent policy agenda in Guadalajara. I show how this movement built political support for their ideas, pushed for the creation of institutions and governmental structures that would support their goals, and gradually adopted their preferred policies.

This paper is organized in seven sections. In the first section, I provide a literature factors known to affect cycling policy uptake, with an emphasis on the role of political support which is the focus of this analysis. This chapter builds on the work presented in Chapter 3 by showing

[20] Infrastructure is central to advocate demands, but not always the exclusive focus of their advocacy. Different organizations have different views on the need for infrastructure. The focus here is narrow but the advocacy and views of actors are on a spectrum.

how cycling was institutionalized through an extensive social mobilization of civilian organizations. Then, I describe the methods and data used to develop this research and the local context of the Guadalajara Metropolitan Area. Next, I develop a timeline identifying and interpreting key events and potential mechanisms that have led to Guadalajara's transformation. Finally, I present the results and conclusion where I distill and highlight the most important catalysts and drivers of change. Because the activists in the movements described here kept an archive of videos of many of the events covered in this research, this complimentary material is located in Appendix 1.

4.2 THE ROLE OF CIVIL SOCIETY ORGANIZATIONS IN THE INSTITUTIONALIZATION OF CYCLING POLICY

Sustainable mobility has emerged as a new paradigm in transport policy (Banister, 2008). This paradigm introduces an emphasis on non-motorized modes of transport cycling and walking), and mass public transportation systems (transit), and on questions of trip quality, equity, and citizen representation in planning (Montero, 2017). However, citizen participation in transportation is not new. Since the 1960s, people in cities across the world have sought to influence thinking about transportation systems and the role of automobiles in cities, often through opposition against urban highway projects and pro-cycling advocacy, especially in the global north (Toronto, Vancouver, New York, Portland, The Netherlands) (Sagaris, 2014).

The literature recognizes that civil society organizations, including informal grassroots organizations and more established non-governmental organizations, have played a crucial role in bringing urban and cycling mobility to the forefront of public policy in Mexico and Latin America (Sagaris, 2010, 2014; Sosa López & Montero, 2018). This case study contributes to

understanding how civil society can influence sustainable mobility policy in the region by examining a social movement that emerged in the 2000s in opposition to the car-centric urban planning paradigm in Guadalajara, Mexico.

The literature surrounding the participation of CSOs in the definition of sustainable mobility policy in Latin America also points to the variety of factors contributing to policymaking in this arena. CSOs in urban mobility represent a wide variety of activist organizations. These range from grassroots bicycle activist groups (Gamble et al., 2017) and movements challenging urban planning paradigms (Sagaris, 2014) to more professionalized NGOs, like the Institute for Transportation and Development Policy (ITDP) and World Resources Institute (WRI), with international ties and high levels of legitimacy as experts in the field, which Sosa Lopez and Montero call "expert-citizens" (Sosa López & Montero, 2018).

Political support refers to the backing of policies by democratic institutions at the national, regional, or local government levels or organized interest groups. (Bulkeley, 2010; Lankao, 2007; Martins & Ferreira, 2011). Additionally, research focuses on the influence of interest groups from business and civil society to explain policy development. This influence can be positive due to CSO presence, a professionalized and organized environmental movement advocating for policy, or businesses that can benefit from their implementation. Research has shown that cycling advocacy groups can convince local governments to invest in infrastructure and allocate more space for bicycles (Aldred & Jungnickel, 2014; T. Buehler & Handy, 2008; Sosa López & Montero, 2018).

Organized interest can also block policy implementation. In cycling infrastructure, organized neighborhood groups, business owners, or other lobby organizations can organize and block projects. For example, Ryan et al. in Buenos Aires found that bicycle manufacturers and

retailers supported cycling policies, while associations of taxi owners and employees tried to block them (Ryan, 2015). Ryan (2015) also notes that the role of political parties in developing urban climate policy is under-researched, which could include cycling policy (Carter, 2006; Ryan, 2015).

4.3 METHODS

In this case study, I relied on semi-structured interviews and secondary data to reconstruct and explain the process through which cycling policy took off in Guadalajara and the current state of affairs. Because this process took place over 20 years, I purposefully recruited people who were active throughout this process and in key roles and sectors (government, civil society, and business sector) to gain a balanced perspective to interpret what happened at pivotal points in time. I identified actors through targeted internet searches of Guadalajara's leading advocacy organizations and relevant government websites. Additionally, I employed snowball sampling. During interviews, I asked participants to provide the names of and referrals for colleagues and contacts who made significant contributions during the process. Referrals were essential to successfully obtain interviews, including in cases where individuals had been contacted vía email previously with no response. In all, twelve interviews were conducted in Guadalajara, which is a subset of a larger effort involving 99 interviews in ten locations. Ten of these interviews were about the process described, and two were about available data on infrastructure, its evolution, the bikeshare system, and best available data on bike trips. At least eight of the interviewees were regular bike commuters, which supported robust discussion of the changes in the city from a user perspective.

I used secondary sources such as policy documents, activist webpages, newspaper articles, and public data on cycling provided the information base to validate dates and events reported

during interviews and to fill information gaps. One of the interviewees has developed extensive research on the early history of cycling in Guadalajara, and the context presented for 1971 – 2003 is based on his research and interpretations conveyed during our interview (Salcedo - Torres, 2016). Table 25 summarizes the list of interviewees and people consulted for data acquisition, their roles, and their participation in the process.

I carried out and recorded the first ten interviews in Guadalajara during January of 2020, and two over Zoom in 2021. I transcribed the Spanish audio and developed the analysis using the Spanish language transcripts and translating only the excerpts included in this analysis as examples of themes that emerged. The transcripts were used to reconstruct a timeline of key events and milestones in Guadalajara's adoption and implementation of policies to support urban cycling. The milestones, factors, and events highlighted are not exhaustive but are focused on the elements that multiple interviewees cited as transformative for progress and change. In addition, interviewee perspectives on what factors were essential for policy change were recorded and are the focus of my analysis and interpretation of the timeline and the mechanisms that were determinant for change over the 20 years during which cycling policy became an institutionalized agenda.

There is a limited amount of data on the change in the number of cycling trips over time in Guadalajara. The only data point for cycling trips in the entire metropolitan area is from 2007, which indicates that the total share of cycling trips in the Guadalajara Metropolitan area was 2.2%. However, the information base is consistent with a finding that increases in cycling occurred in locations where the vast majority of the pro-cycling policies have been implemented, mainly Zapopan and Guadalajara (see section 4.5.5). Because of this limitation in the availability of quantitative metrics related to cycling increases, while a case could be made for the success of

current policies to promote cycling, this analysis focuses on the policy process, and specifically on the institutionalization and implementation of cycling policy that have made Guadalajara a national reference.

Table 25. List of interviewees and data contacts and their roles

Contact	Occupation	Sector	Cycling related activities and achievements	Date interviewed
1	Director of Mobility of the Zapopan Municipality.	Public official	Leading figure in Cycling social movement between 2008 and 2015. Former *Ciudad para Todos* Activist. Director of Mobility for Zapopan since 2015	January, 22, 2020
2	Director of Mobility of the Guadalajara Municipality	Public official	Former director of *Cuadra Urbanismo*. Led the socialization of the MiBici System (Guadalajara Bikeshare). Director of Mobility in Guadalajara since 2018.	January 23, 2020
3	Cycling consultant	Private	Former director of non-motorized mobility for the *Instituto de Movilidad y Transporte de Jalisco* and Ciudad para Todos activist	January 21, 2020
4	Activist and researcher	Civil Society	Founder of the activist organization GDL en Bici. Researcher on cycling and cycling history in Guadalajara	January 21, 2020
5	Activist and Researcher	Civil Society	Former activist for the organization CITA and Director of the Zapopan Strategic projects office.	January 20, 2020
6	Researcher	Civil Society	Former activist for the organization Ciudad para todos and staff of the Zapopan Strategic projects office. Co-author of Guadalajara's non-motorized mobility office	January 24, 2020
7	Director of non-motorized Mobility	Public Official	Director of non-motorized Mobility for the Guadalajara Mobility Office. Manages cycling infrastructure database, provided historical cycling infrastructure data for Guadalajara.	April 8, 2021 (phone and email exchanges)
8	Business person	Private	Founding members of Guadalajara 2020. This group (8, 9, 10) Organized and funded learning exchanges with Bogotá public officials and brought the *Ciclovía to* Guadalajara.	January, 22 and 23, 2020
9	Business person	Private		
10	Business person	Private		
11	Director of data	Public Official	Director of data for the Agencia Metropolitana de Servicios de Infraestructura para la *Movilidad* provided historical cycling infrastructure data for Metropolitan area.	July 04, 2021 (phone)
12	Director of research	Public Official	Director of research *Instituto Metropolitano de Planeacion* (IMEPLAN). Former analyst for the Jalisco Congress (during the passage of the Mobility Law Reform)	January 19, 2020 (phone)/ August 26, 2020 (Zoom)

4.4 LOCAL SETTING

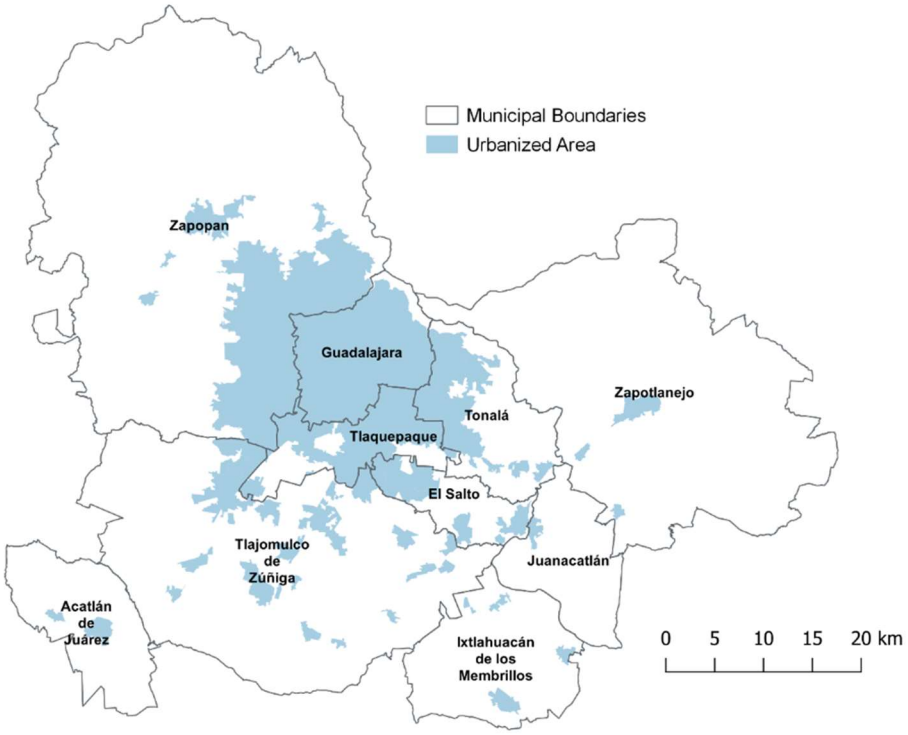
The Guadalajara Metropolitan Area (GMA), located in the state of Jalisco (Figure 43), comprises 10 municipalities: Guadalajara, San Pedro Tlaquepaque, Tonalá, Zapopan, Tlajomulco de Zúñiga, El Salto, Juanacatlán, Ixtlahuacán de los Membrillos, Acatlán de Juárez, Zapotlanejo. The urban core of Guadalajara is centered in the Capital Municipality (Guadalajara), Zapopan, and to a smaller extent Tlaquepaque and Tonalá. Zapopan and Guadalajara concentrate most of the cycling infrastructure built to date (Figure 51), and are home to the bikeshare system MiBici (Balderas Torres et al., 2021).

The GMA is the second-largest city in Mexico and is an important economic hub. In 2019, the State of Jalisco contributed 7.1% of national GDP, which places it in fourth place nationally (INEGI, 2020), while its GDP per capita was MXN $146,333.40 in 2017 (CEFP, 2019). Within the State, 62% of the population and 67% of the economic activity are concentrated in the capital city (Guadalajara) and its surrounding metropolitan area. Guadalajara is also home to the Jesuit institution ITESO, one of the leading universities and one of the first to offer degrees in urbanism in the country.

Figure 43. Location of Guadalajara, Jalisco

The municipalities that make up the GMA (Figure 44) cover an area of 3,560.6 km^2, and the urban core of the city spreads across 490 km^2 (SEDATU/CONAPO/INEGI, 2018). Between 1990 and 2015, 97% of the growth in the GMA occurred outside the boundaries of the municipality of Guadalajara itself, either on the periphery or as discontinuous urban areas. The population of the GMA has grown 75.40% over the last 30 years (with a current total population of 5,268,642) (CGPV, 1990; CPV, 2020). While the population of the entire GMA has grown, the population of the capital municipality has decreased 16.03% in the past 30 years (currently having 1,385,629 inhabitants). This emptying of the urban core and growth in the peripheries is a classic sign of urban sprawl.

Figure 44. Guadalajara Metropolitan Area and urban core



In 50 years, the GMA has faced an accelerated and inadequately planned urban expansion process, which has exceeded the territorial limits of the urban area and has reached rural communities, incorporating them into the expanded urban area. This expansion has been fostered mainly by two situations. First, the local authorities intended to make Guadalajara competitive to attract direct foreign investment with tax incentives and by modifying the urban development law that allowed business capital to satisfy its urban land needs, limiting municipal governments in the regulation of urban land. Second, the proliferation of shopping malls, office towers (business centers), gated communities, and mixed commercial centers has contributed to the configuration of socioeconomic segregation and fragmentation in the GMA (González and Venegas, 2018). Guadalajara's rapid and fragmented urban growth makes it increasingly challenging to provide quality services and infrastructure. This expansion and fragmentation

increased the cost of providing urban services and negatively impacted the area's economic and social networks.

Guadalajara has also experienced significant growth in the rate of motorization. There are currently 2,514,649 vehicles registered in the GMA, representing 244.31% growth over 20 years (INEGI, 2020a). The GMA has one of the highest motorization levels in the country, with 62 private vehicles per 100 inhabitants in 2018, over twice the national average of 26.9 private vehicles per 100 inhabitants (Balderas Torres et al., 2021). In Guadalajara, only 27% of trips were done by car in 2007. Investment in public transport for many years did not meet the investment made in private vehicles, and the investment in cycling infrastructure was nearly zero (Herrera, 2015).

The GMA offers different types of public transportation. There are the buses that, under a concessionary scheme, run 277 routes with a fleet of approximately 5,200 vehicles. The Urban Electric Train System began running in 1989. It has three lines, and the most recent one was inaugurated in September 2020. This line crosses the municipalities of Zapopan, Guadalajara, and Tlaquepaque along 21.5 km and 18 stations. The two previous lines run 33.5 km and have 29 stations (SITEUR, 2021). The Metropolitan Public Transport System, called SITREN, was inaugurated in 2007. It links the trunk and feeder routes of the other systems through four lines (one of them is operated with electric buses, and the other three lines operate with conventional buses) (SITEUR, 2021). Finally, the city has a Bus Rapid Transit, called "Macrobús," which began operations in March 2009. Along 16.6 km, it crosses the entire city from north to south, Guadalajara to Tlaquepaque, and 27 stations. The second line of the Macrobús is currently under construction. It will run along 41.5 km of the Periférico (central city's freeway) and have 42 stations with universal accessibility (SITEUR, 2021).

The perception of crime and insecurity among the GMA adult population in 2020 was 77.30%, while the prevalence of crime per 100,000 inhabitants was 33,202. Robbery or assault on the street or public transport accounted for 17.2% of the total number of most frequently committed crimes (ENVIPE, 2020). However, it is essential to consider that most crimes are not reported in Mexico, so these figures could be even higher. In 2019, the State of Jalisco reported 212 collisions involving cyclists, of which 123 occurred in the GMA (INEGI, 2020b).

Guadalajara is relatively flat and has a moderate climate that is ideal for cycling. In Guadalajara, the wet season is overcast, the dry season is partly cloudy, and it is warm year-round. The minimum temperature in the city of Guadalajara is 33ºF, and the maximum is 93ºF. The hot season lasts for two months, from mid-April to mid-June, with an average daily high temperature above 86°F. The cool season lasts for two and a half months, from late November to early February, with an average daily high temperature below 77°F. The wetter season lasts almost four months, from early June to late September, with a greater than 40% chance of a given day being a wet day. The chance of a wet day peaks at 80% in mid-July. The drier season lasts more than eight months, from late September to early June. The smallest chance of a wet day is 1% in early April. The topography within two miles of Guadalajara contains only modest variations in elevation, with a maximum elevation change of 269 feet and an average elevation above sea level of 5,240 feet (Weatherspark, 2021).

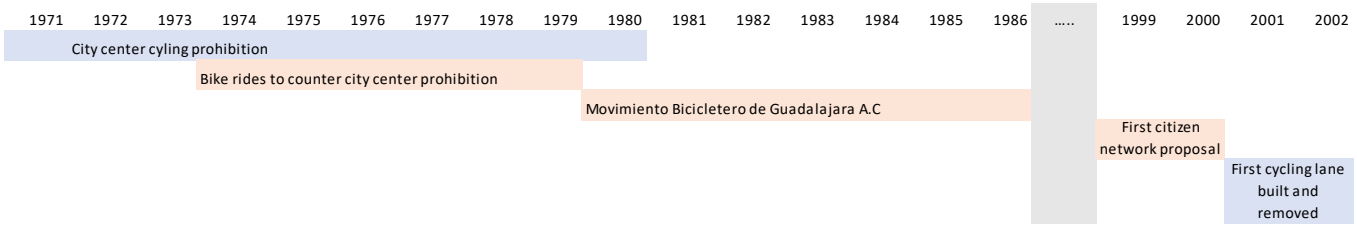
4.5 RESULTS AND DISCUSSION

4.5.1 *Cycling precedents: Cycling in Guadalajara before 2004*

The first documented records of cycling-related policy in Guadalajara date back to the 1970s when bicycles were a common sight in the city, and cars were also beginning to become

more prevalent. With the increased presence of cars on the road, cyclist fatalities were also growing (Salcedo-Torres, 2016)

Figure 45. Early precedents timeline (1970-2003)



The timeline for the early stages here is shown in (Figure 45). In 1971, responding to these trends, the Jalisco State Transit Department (*Departamento de Transito del Estado de Jalisco*) posted a notice in the local newspaper *El Informador* prohibiting bicycles from being used in the city center between 9 am and 9 pm because these times were "unsafe for cyclists" (Salcedo-Torres, 2016) (Figure 46). In a follow-up interview published in the same newspaper with the director of transit, he reiterated the prohibition stating that Guadalajara had outgrown its status as a cycling town,

> *Guadalajara is no longer a small town, and as such, we must move on to [transportation policies] that have worked for larger cities. (Salvador Villaseñor, Director of Transit for the Jalisco State Transportation Department, March 28, 1971, retrieved by Salcedo-Torres, 2016)*

This prohibition was maintained through the '70s but gradually stopped being enforced. While it was in place, cyclist groups, including bicycle shop owners, countered some of these measures by organizing weekend cycling events which passed through the prohibited area (Figure 46). Partially due to this policy, during this period, bikes became less common as a mode of transportation in the urban core and were constructed into a mode for leisure and weekends, perceived as "too dangerous" to use during peak traffic times. However, even though bikes were constrained and their use declined, they continued to be used as a mode of transportation for low-

income laborers and workers out of necessity. Because bikes continued to be a primary mode of transportation for some people, cyclists found their way back into the city center (Salcedo-Torres, 2016).

Figure 46. Bikes prohibited from the City Center and Family cycling events from the 1970s

BOLETIN DE TRANSITO

NUMERO 2

Con fecha 15 del próximo mes de abril, entrará en vigor la ampliación a la restricción de circulación de bicicletas en las calles de Guadalajara, en los siguientes términos.

Se prohibe la circulación de bicicletas en la longitud total de las Avenidas 16 de Septiembre, Alcalde, Juárez y Vallarta al igual que en la Calzada Independencia, desde la Calzada del Campesino hasta Circunvalación División del Norte. Circunvalación Santa Eduwigis, Circunvalación Providencia, América, Unión y La Paz, en toda su extensión, de las 9 a las 21 horas.

ATENTAMENTE

SUFRAGIO EFECTIVO. NO REELECCION.

Guadalajara, Jal., 25 de Marzo de 1971.

EL JEFE DEL DEPARTAMENTO.

Lic. Salvador Villaseñor Morales.

Notice from the department of transit:
"As of April 15, Bikes are prohibited in all streets of the Guadalajara t downtown [perimeter marked by main streets] between 9 am and 9pm."

"Grand Family Bike Ride, Sunday at 9 am"

Retrieved by Salcedo-Torres (2016)

In the 1980s, the first cycling advocacy group formed in Guadalajara, *Movimiento Bicicletero de Guadalajara A.C*. This group organized monthly bike rides and started to promote cycling as a mode of transportation through flyers and appearances on radio and interviews in newspapers, but eventually stopped organizing in 1988, having given up after years of organizing without making any progress. During the 1990s, a Professor from the Jesuit College IESO, Gabriel Michel, developed the first documented proposal for a network of cycling lanes in

Guadalajara and presented it to Mayor Fernando Garza. In 2002, following the presentation of this plan, there was a first attempt to build a cycling lane on *Avenida La Paz*. This cycling lane was built in Guadalajara, but the nearby upper-class Arcos Vallarta Neighborhood residents protested and had it removed before it was a year old. The removal of the *La Paz* cycling lane set a complicated precedent for building cycling infrastructure since it was perceived as politically unpopular based on this early experience.

In the early 2000s, Guadalajara's urbanization model included widespread urban sprawl and uncontrolled vehicle fleet expansion. Many people interviewed here stated that their engagement with urban issues stemmed from the detrimental effect of traffic, noise, pollution, and congestion on their daily lives and considered that continuing this path was damaging to the quality of life of Guadalajara's citizens[21]. Also, more people were becoming aware that other models of urban development were possible through travel, study abroad, and sharing of information on internet-based platforms[22] and eventually social media. The shared concern over the city's future led many citizen groups to organize in the following and create a social movement demanding a change in the urban planning model for Guadalajara. For example, one of the leading advocates in the sustainable urban mobility movement that emerged stated:

> *One day I was in my car with my daughter who was in kindergarten and we were stuck under the Minerva bridge with so many cars that just weren't moving. I was so frustrated about the lack of mobility in Guadalajara that I started to do research to understand the situation and to learn more about urban mobility. That's when I started to become more aware and to become an advocate for topics in urban mobility. I started by researching on the Internet*

[21] This realization was mentioned by 7 of the key informants interviewed as a precedent for their involvement in the movements and activities that followed.

[22] The fact that urban mobility and problems related to urban transportation were becoming more pressing given the increase in this problem's severity and its palpable consequences is cited by interviewees as a reason that the movement that formed was successful: promoting a change for this paradigm and the discourse surrounding the desired changes were "easy to digest" and therefore became very popular

and writing a blog with the resources I had available. (Former Ciudad para Todos Leader and Public Official, 01/22/2020)

The series of events that are described in the following sections do not necessarily represent linear independent progression. Many were part of ongoing parallel processes that built on each other to create momentum and build political capital. Many key informants claimed that the single achievement that contributed most to making Guadalajara's transformation possible was the creation of political capital for non-motorized Mobility. During this time, there was also increased media attention to the topic of urban Mobility and cycling (Montero, 2017).

4.5.2 *2004-2007 Guadalajara's Vía RecreActiva and Bogotá Learning Tours*

In 2003, Enrique Peñalosa, the mayor of Bogotá between 1998–2000, visited Guadalajara, Mexico, to give a talk. He was invited by a group of businesspeople who later started the advocacy organization called *Guadalajara 2020*[23]. This group of prominent people from the business community included the (at the time) current and previous director of Guadalajara's largest industrial chamber (*Consejo de Cámaras Industriales*). Their business ties and positions of leadership gave them both significant convening capacity and access to influential people.

In an unrelated effort to raise money for a joint business venture, the members of *Guadalajara 2020* invited Enrique Peñalosa to give a presentation so they could charge money at the entrance and raise funds. During his visit, Peñalosa delivered seven widely attended talks where he revealed what he considered were pressing issues for Guadalajara: moving away from a car-centric and sprawling model of growth towards a more equitable and sustainable city. A diverse audience of students, public officials from the local and state governments, the media,

[23] The name Guadalajara 2020 refers to a 2020 vision (perfect vision) for the city.

and environmental and social advocacy organizations attended these talks. From the start, *Guadalajara 2020*'s members ensured that their events were as apolitical as possible. They invited elected and public officials from all political parties and purposefully avoided affiliation or association with specific political parties.

Enrique Peñalosa's talks were *"transformational"* for the members of *Guadalajara 2020.* The ideas brought forth by Peñalosa made them realize that Guadalajara did not have a long-term vision for their city and that the current patterns of development were based on short term planning horizons that were detrimental to the quality of life of all its citizens, and especially low-income people who were the least likely to own cars (Personal interview, Guadalajara 2020 Member, Guadalajara 01/22/2020).

In his talks, Peñalosa also spoke about the policies recently implemented in Bogotá and that he claimed led to the city's transformation. Many of these policies focused on improving public transportation, bicycle infrastructure, and interventions to improve public space. Following Peñalosa's presentation, *Guadalajara 2020* became interested in studying Bogotá to see what policies they could bring back to Guadalajara, a city that they considered to be socially and economically similar to Bogotá.

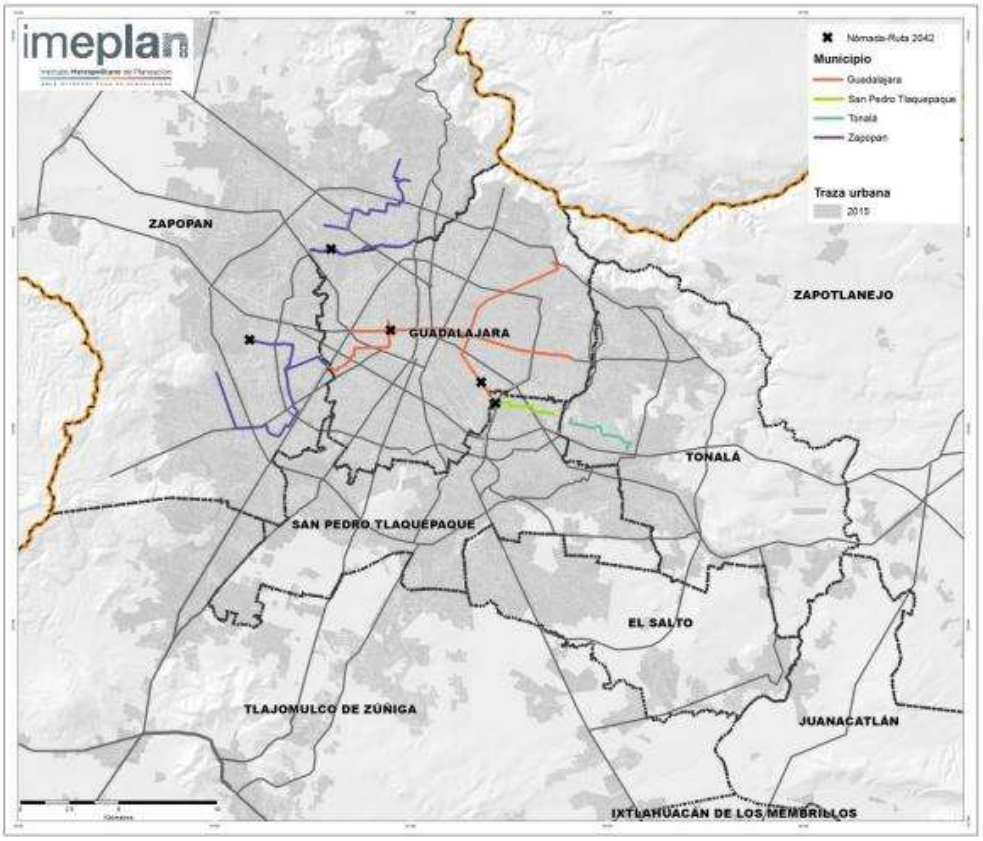
After the visit from Peñalosa, *Guadalajara 2020* members did two tours of Bogotá during which they visited the famous *Ciclovía,* a weekly street-closure program to promote urban biking, leisure activities, and exercise. During the *Ciclovía*, which started in the 1970s, 100 km of Bogotá closed to car traffic from 7 am until 2 pm and were reserved for cyclists and pedestrians. Inspired by this program, *Guadalajara 2020* members decided to bring a similar program to Guadalajara.

Given their personal and business ties in Guadalajara, when the members of *Guadalajara 2020* returned from Bogotá, they convinced the mayor of Guadalajara, Emilio González, to implement a *Ciclovía* in Guadalajara. The program was locally renamed *Vía RecreActiva*[24] the previous director of the Bogotá *Ciclovía*, Lucy Barriga, was hired to help launch the program and eventually direct it. *Guadalajara 2020* paid for Emilio González to visit Bogotá and learn about their urban policies. In September 2004 Emilio González, inaugurated *Vía RecreActiva*, an 11- kilometer weekly car-free program inspired by Bogotá's *Ciclovía*, and 30,000 people showed up on the first day. The route has been extended over time and in 2020 was 70 km (Figure 47) and had weekly assistance of 350,000 people in 2020 before it was paused due to the COVID-19 pandemic.

> *Our visión with the Via RecreActiva was to unite the city and allow the population of Guadalajara to feel the right to appropriate the streets. This was our key objective. Because once people started coming and they discovered the city as a giant linear park, they saw a completely different city. People started to realize that it was possible to cross the city by bicycle, and that was the beginning of the euphoria that sparked everything that happened for cycling in Guadalajara over the next few years (Guadalajara 2020 Member, Guadalajara 01/22/2020)* .

[24] RecreActiva is a word play between recreational (*recreativa*) and Active (*activa*)

Figure 47. Via RecreActiva accross Guadalajara Metropolitan Area Municipalities



Source: IMEPLAN 2021

Aside from being the event that eventually led to Guadalajara's *Vía RecreActiva*, a policy that Montero (2017) describes as "an embryonic, even if rather experimental, policy shift in the local government agenda towards promoting non-car forms of urban transport", Enrique Peñalosa's talk and the following visits to Bogotá by members of *Guadalajara 2020* was the activating incident that resulted in fourteen study tours. In these visits, local business leaders, politicians, bus company owners, NGOs, and journalists from Guadalajara traveled to learn from Bogotá, mostly paid and enabled by members of *Guadalajara 2020* (Montero, 2017).

In the following years, prominent politicians including Diego Monraz, the Jalisco State Transportation Secretary, and Enrique Alfaro, a legislator who became mayor of Guadalajara and eventually was elected Governor of Jalisco in 2018. These study tours have been analyzed by Montero (2017) as a learning mechanism through which Guadalajara public figures and decision-makers were able to build coalitions, promote sustainable transportation policies, and mobilize public opinion to enable the policy changes that followed in the next few years in Guadalajara.

Continuing with their determination to work with all political parties, *Guadalajara 2020* sent people from the whole political spectrum to participate in these tours. The Bogotá learning tours helped public officials in decision-making roles see that promoting non-motorized mobility alternatives was possible and even popular in a context similar to Guadalajara (and were no longer able to use the classic "*this isn't Amsterdam*" excuse). They also gained technical knowledge on how this transition could occur and the possibility of promoting active mobility policies in a context similar to their own.

> *We focused on sending people from all political parties. We took them [to Bogotá] to see what they had achieved. Colombia is a country that was also a Spanish Colony, with similar drug cartels and crime problems. Bogotá is a much poorer city, and they have achieved a lot; they had some fascinating public policies. It wasn't the typical European reference like Amsterdam (Guadalajara 2020 Member, Guadalajara 01/22/2020)* .

The *Vía RecreActiva* and the Bogotá learning tours are a key precedent to what happened over the next decade. First, the immense success of the *Vía RecreActiva* meant that tens of thousands of citizens of the Guadalajara Metropolitan Area were experiencing the "*joy*" of cycling regularly. Many people were first exposed to bikes and became comfortable with cycling by participating in the *Vía RecreActiva* and then venturing to other forms of cycling (Sarmiento

et al, 2019). Through this massive weekly event, bikes became more popular and visible to politicians and citizens.

In addition to their access to prominent politicians and the Jalisco business community, *Guadalajara 2020* was connected with key allies in the press who started to cover the *Via RecreActiva* and many of the urban policies they were promoting. Starting around this time, urban mobility in the city became an issue that received regular attention in the media (Montero, 2017).

> *Another factor that was very important in this process was the support of the media. This was key at the beginning and has been vital throughout the entire process. They were our allies from the very beginning because they were our friends. In Guadalajara, at the time there were 57 written, radio, and TV media outlets. 54 of those belong to a Foundation called Extra, and the president of that foundation is a friend of ours. He is the owner of El Informador [Jalisco's largest newspaper]. So when we started [with the Via RecreActiva], the government wanted to pay for the program's coverage and we said "No, don't pay them, they will see this is a citizen-led initiative." So the media was never paid, and the information was always transparent. From then on, they took on the topic [of Mobility] and have been strategic allies. (Guadalajara 2020 Member, Guadalajara 01/22/2020) .*

4.5.3 *2007 - 2012 Grassroots organizations and mobilization: Ciudad para todos, CITA, GDL en Bici, Colectivo Ecologista de Jalisco*

In the years that followed the successful launch of the *CicloVía RecreActiva* more citizen groups started to organize for sustainable mobility policies, including cycling in a parallel movement to Guadalajara 2020, which eventually joined efforts. Figure 49 shows a timeline of key events and milestones. Organizations like *Ciudad para todos*, CITA, and *GDL en Bici* were formed at this time. They were joined by the previously established *Colectivo Ecologista de*

Jalisco[25]*,* an environmental advocacy organization founded in 1986 and that had started to gain interest in urban environmental issues related to mobility and cycling, primarily driven by their knowledge of movements and policy changes in Europe and select cities in the United States, Canada, and South America.

A coalition of pro- sustainable mobility organizations consolidated in 2007 after the government of Jalisco decided to build an overpass in Guadalajara to increase traffic flow and speeds on the *Avenida Lopez Mateos*, the main Avenue that crosses the city. These pro-sustainable mobility groups had recently started to organize massive bike rides (*rodadas*), and invited people to protest the *Lopez Mateos* project at the *Plaza del Sol*, a popular commercial area. The citizens protesting viewed the investment in this project as incongruent with some of the recent policies that the Government of Guadalajara had started to implement, like the *Vía RecreActiva*.

The citizen groups were not able to stop the *Lopez Mateos* overpass project. However, this was a pivotal moment in the city because after this event, the most active grassroots organizations that promote sustainable urban mobility policy and cycling consolidated and started to organize beyond public bike rides. The people who formed these organizations, including academics, practitioners, students, artists, and others, got to know each other, built personal and professional ties and became a coalition of activists. The organizations highlighted in this study were grassroots organizations but were formed by highly educated, upper-class, and professional individuals.

> *Most of the people who started this movement were [private] university students, and we came from socioeconomic backgrounds that were not exactly*

[25] Between 2007 and 2016 there were dozens of citizen organizations mobilizing against these topics, up to 65 at the peak. The organizations that are named here are the ones that stood out most during my interviews and in my desk research but there are many more that were active over the years.

the most humble in the city. (Former Ciudad para Todos Leader and Public Official, 01/22/2020)

One of the core issues they advocated for was improving cycling conditions in the city, including building cycling infrastructure and limiting car use divesting from car infrastructure, which they viewed as regressive and detrimental to most people's quality of life since most people did not own cars.

During these years, this coalition of activists staged protests against large car infrastructure projects in Guadalajara, and through these protests, they created visibility for the lack of investment in more sustainable forms of mobility like mass transit and cycling. They developed policy proposals and found ways to engage and challenge public officials, eventually getting them to implement their favored policies. The organizations that emerged and were active during this time were also successful at building relationships with the media and leveraging the growing popularity of social media, where they shared press-releases and videos, and organized events.

This social phenomenon that began in 2007 led to a wave of people, students, and university professors that started to generate public opinion that began to permeate everyday conversations. The way of thinking about the city [of the general public] started to change. We started to position the need for a more sustainable and more livable city with a dignified future. We positioned the idea of a more sustainable, more equitable, healthier city and centered these ideas around public space and mobility (Former Ciudad para Todos Leader and Public Official, 01/22/2020).

Starting with the overpass protests in 2007 and into the next few years, widespread mobilization around urban issues led by the coalition formed during this time. The activist movement held many events, festivals, and conferences to promote sustainable mobility for a livable city.

In 2007 this coalition formed the Citizen Council for non-motorized mobility as a mechanism for activists and subject matter experts to advise local governments on matters of

urban mobility. The organizations sought to influence and demand transparency in the decision-making process of the local government. This council was organized by citizens and integrated into the formal structure of the Guadalajara municipality in 2009. During the following years, this council was very active in promoting non-motorized mobility and public transportation.

There are a few milestones during these years of intensive activism that interviewees signal as especially consequential to the grassroots movement. In 2007 the city of Guadalajara announced that it would host the 2011 Pan American Games. Activists viewed this as a window of opportunity that organized citizens saw to reach out to authorities to talk about urban development in the city. At this point, the grassroots citizen groups that had started to form around topics related to urban mobility (*Ciudad para Todos, CITA, GDL en Bici, Colectivo Ecologista*) urged the government to avoid previous mistakes that other cities had made when hosting these types of games (citing examples like Atlanta). They preferred to follow of Barcelona's example where authorities used the Olympics to reimagine and rebuild many of their emblematic urban spaces.

> *The announcement of the Panamerican Games was a pivotal moment because it gave us an excuse to seek out authorities and talk about the city's future (CITA Activist, Guadalajara, 01/20/2020).*

Following the Pan American games announcement, the organization *CITA* started a yearly event between 2007 and 2011 called *Com:plot* where they invited citizens to be "accomplices" in the vision of their city. During these events, they brought international experts and developed proposals for improving the conditions and governance of urban issues in Guadalajara. At the end of each yearly event, the organizations involved would hand over policy proposals to the local governments in the metropolitan area, although none of these proposals were implemented.

During this time, as the citizen movement gained traction and sought ways to advocate for urban policies in Guadalajara, activists realized that there were no agencies in the city in charge of urban mobility that had a long-term vision or planning horizon for the city, and the agencies that were charged with urban development were fragmented, weak and disconnected from transportation planning.

During the first *Com:plot* in 2007, there was an event called Guadalajara Cycling Lane (*Carril de bici en Guadalajara*) where cyclists painted the streets with their bike tires to show how cyclists use the streets and "paint a cycling lane with their bikes". That day, 40 people were arrested and charged for damaging the street, although they were shortly released, and their charges dropped. These arrests are an interesting precedent because a few years later, in 2011, activists painted the streets to make a *Ciclovía Ciudana,* a citizen cycling lane to protest the lack of investment in infrastructure by authorities (see below). By then, the government "celebrated" their actions and came up with funds to make those cycling lanes permanent, whereas, in 2007, activists were arrested after painting the streets. This change suggests that these groups and their ideas had gained more traction and acceptability with government officials during the next few years.

After the overpass protests, Alfonso Petersen, the mayor of Guadalajara, was the first to implement cycling infrastructure in the Guadalajara Municipality since the failed attempt on Avenida de la Paz. During his tenure (2007 – 2008), he signed an agreement with the Institute for Transportation and Development (ITDP) Mexico for technical assistance for developing cycling infrastructure, with a mayoral promise to build 10 km and invest 20 million pesos over his 3-year administration. That same year, with ITDP's assistance, Guadalajara built its first bike track on *Avenida Federalismo.* The project had relatively high acceptance and signaled a change

in public opinion since the *Avenida La Paz* cycling lane. This lane was an important milestone because it was the first time a mayor in Guadalajara made cycling a part of their commitments for their administration and promised to invest public funds to develop cycling infrastructure. He also made the Citizen Council for non-motorized mobility an institution of the municipality in 2009.

> *We are emphasizing solutions that will favor a more generalized adoption for cycling, and that will disincentivize the use of private vehicles (Alfonso Petersen, El Informador, 02/04/2008).*

Alfonso Petersen commissioned a Plan for non-motorized mobility in 2009, which had been a long-standing request of citizen groups in the Non-motorized Mobility Council (Fonseca, 2009b). Previously, in 2008, a group of activists from *Ciudad Para Todos* and *Colectivo Ecologista de Jalisco* went to the Car Free Conference in Portland, Oregon. Diego Monraz, a coordinator for mobility policy, who later became the State Transportation Secretary,[26] was also in Portland and scheduled a meeting with the firm Alta Planning to negotiate their advisory services for the Non-Motorized Mobility plan Guadalajara.

The activists found out about the meeting and infiltrated to demand that local experts and citizens, who had long requested this plan, be involved in its development rather than solely developed by a foreign firm and handed over to the state government. As a result of that meeting, the Non-motorized Mobility Plan was developed the following year with Alta Planning and Gil Peñalosa's technical input and a local Guadalajara firm, AU Consulting. The local firm provided local knowhow, involved activists in the development of the plan, led the socialization of the plan, and held numerous public consultations. The non-motorized mobility plan was developed throughout 2009 and presented to the State Government in 2010 (rather than to the municipality

[26] Diego Monraz went to Bogotá 9 times as art of Guadalajara 2020's learning tours (Montero, 2017)

because the scale of the plan was at the Metropolitan Level). A 1,500 km cycling network was designed for the metropolitan area where 380 km of cycling lanes were defined as priorities in this plan (Gobierno de Jalisco, 2010a).

The plan also included actions for improving pedestrian infrastructure and creating quality public spaces. The plan was extensively socialized, and its elaboration had broad participation from civil society organizations, academia, and local experts. This strategy is a significant milestone because it marks the beginning of incorporating civil society demands into official public policy and includes a metropolitan-level vision of non-motorized mobility for Guadalajara.

> *The Non-motorized Mobility Plan had a strong focus on citizen participation. We created a technical oversight council with public officials and a city council with representatives from citizen organizations. We would session every two weeks to discuss the progress made on the plan, which allowed input from everyone…. We held multiple participatory workshops at universities with students during the National Cycling Conference that Guadalajara hosted in 2009. We developed consultations on the Via RecreActiva. We invited many different people to help us draw the network and include their cycling trajectories (Former activist and researcher, Guadalajara 01/24/20).*

Even though it was not implemented for a few years this document has been the basis of the cycling infrastructure planning and construction in the city. The process also included the development of the first technical guidelines for building cycling infrastructure in Guadalajara, which set standards for the quality of infrastructure early on (Gobierno de Jalisco, 2010b). It also led to another critical milestone where citizens worked with legislators to develop a figure for metropolitan governance for the city.

> *When we first handed the plan to the State Government in 2010, they told us that "this is great, but there is no metropolitan-level governance figure so thanks for participating." However, [developing the plan] was such an intense process that involved so many people that we were all excited, and we started*

to talk, "Ok, where do we begin? How do we get this done?" (Former activist and researcher, Guadalajara 01/24/20).

In 2011, the Jalisco Congress passed the Metropolitan Coordination Law (*Ley de Coordinacion Metropolitana*), which legally established the Guadalajara Metropolitan Area, and, among other things, mandated the creation of the Metropolitan Planning Institute, (Instituto Metropolitano de Planeación, IMEPLAN).

We worked together to recover a law that had been previously drafted and proposed called the Metropolitan Coordination Law. We sought to activate these coordination spaces, where our logic for pursuing this was completely technical. Ideally, the coordination and governance of the metropolitan area would be separate from political cycles and decentralized from the state government…. From this process, the Metropolitan Planning Agency was created. This entire structure resulted from citizen-led efforts to create metropolitan governance and ensure its independence (Cita Activist, Guadalajara, 01/20/2020).

At the same time that the Non-Motorized mobility strategy was being developed, the Guadalajara Government announced that they would start building the *Puente Atirantado* (a cable-stayed bridge), which would take two years and require an investment of 450 million pesos. The construction of this bridge would involve removing green spaces, and *Ciudad para Todos, GDL en Bici, Colectivo Ecologista de Jalisco,* and other organizations in the mobility coalition led a series of protests to stop this project and demanded that the cities invest in a sustainable urban mobility plan (Fonseca, 2009a). Activists camped at the construction site and held activities to garner public attention. While they were not successful at stopping the construction (and interviewees suggest they knew that they would not be able to), the protests received a lot of press coverage and were key to positioning and marketing their message and ideas about mobility in the broader population .

We staged a protest where we camped at the site where the bridge was going to be built. We mainly did this to make our ideas visible. We had signs that

said, "we want bridges for dialogue, not bridges for cars." It was a very playful event. We had a library on the street; we projected movies… We camped there to convey the message, "this is not the way." We had a great reaction from the press, who covered our events and conveyed our message [to the broader public]. Following our protests, there were opportunities to engage with authorities, but the bridge was eventually built. Our spirits were pretty broken, and soon after, [the government] announced an even bigger project to build an expressway (Former activist and researcher, Guadalajara 01/24/20).

Once again, in 2010, the Jalisco Government announced that it would build a large car infrastructure expressway project for Guadalajara called the *Via Express*. This project was opposed by the citizen groups actively working to get the government to divest from car infrastructure and staging protests against large infrastructure projects over the last three years (Carlsson, 2010). The Government of Jalisco released a promotional video about the *Vía Express*. Around the same time, activists traveled to York, UK to the 2010 Car Free Conference, including Jesus Carlos Soto from Ciudad Para todos and Mario Silva from Colectivo Ecologista de Jalisco, two prominent activists who eventually transitioned into government leadership roles. At that Conference, they asked international experts to react to the *Vía Express* promotional video and videotaped them as they watched it and gave feedback.

By this time, we had started to learn how to use videos as a tool for protesting… we had learned how to make videos and quickly edit them. When we were in York, we asked all international experts to watch the promotional video for the Via Express and give their opinion. We filmed them reacting and giving their testimony and made a video called "No to the Via Express." This video is interesting because we used cutting-edge technology that is nothing new these days, but at the time, we were innovating (Former activist and public official, Guadalajara 01/22/20).

While they were still in York, they sent the video to a state legislator who had been vocal about not agreeing with the *Via Express*. He agreed to project the video in the state congress,

where sessions were being held to discuss the proposal. Other activists who had not gone to York attended this session to see the projection of the video.

> *We went to the Congress, and suddenly they announced, "We have just received a video from international experts in York talking about this proposal that we would like to show you" The video was projected to a room full of legislators and technical staff. Furthermore, the video was very clear and borderline mocking the project because it made no sense in 2011. It was a video of international experts saying, " this is the worst thing you can do when cities are shifting to a new paradigm. This is a XX century project for the XXI century" (Former activist and researcher, Guadalajara 01/24/20).*

The neighborhoods surrounding the location where the *Vía Express* saw the video (which accumulated over 40,000 views in the next week) took quotes from the videos and made large signs that they hung from their buildings to oppose the *Vía Express*. The activists and the neighborhood organizations formed a coalition and together staged protests. Pablo Lemus, a prominent business person who was the president of the Coparmex Jalisco (one of the larger chambers of Commerce) and a supporter of the *Vía Express* Project, saw the video and had a change of heart about the project. He changed his mind and stopped supporting the project; he also helped get the activist's message across to other prominent people in the business sector, and eventually, the coalition that opposed the *Vía Express* was big enough that the governor canceled it.

This was considered a huge victory for grassroots organizations because it was the first time, after a few attempts, that they were able to stop a big car infrastructure project, and the biggest one of all the projects that they had protested. Pablo Lemus, who later become Mayor of the Zapopan municipality, became an ally of the grassroots movement. As mayor of Zapopan he created the Mobility Office and appointed Jesus Carlos Soto, the spokesperson *for Ciudad para Todos* and co-Author of the "*No a la Via Express"* video to lead this new area.

In March of 2011, noting that the Non-motorized Mobility Plan for Guadalajara had been published for almost two years while nothing in the plan had been implemented, *Bicitec* (a student cycling organization from the Tecnologico de Monterrey, Guadalajara Campus) *Ciudad Para Todos and GDL en Bici* convened citizens to paint a cycling lane Avenida Santa Margarita in the Zapopan municipality (. This portion of cycling infrastructure was established as a priority in the Non-motorized Mobility Plan because of its large volume of cyclists. Two more citizen cycling lanes were painted after that, the second one on *Avenida Inglaterra*. Shortly after citizens painted these cycling lanes, the government made them permanent and invested resources in improving them or re-making them (Maguey, 2011).

> *There was an organization called Bicitec that wanted cycling infrastructure to go to the Tec [campus] by bike. They asked one of their professors, a Ciudad para Todos activist, for support, and he involved other organizations in the movement. We decided to build a citizen cycling lane. We knew how to design them since we had developed the design guide for the non-motorized mobility project. We knew how to make videos. So we improvised stencils from wood to make the signaling [based on the design guide], and we met at 8am to paint the street. We measured and designed the cycling lane and we painted it ourselves. By noon the press was there, and later the mayor of Zapopan Hector Vielma came and said, "let's make this cycling lane official; you have my support. (Former activist and researcher, Guadalajara 01/24/20).*

After participating in the previous World Car-Free Cities Conference, Guadalajara activists proposed that their city host this event in 2011 and organized the event. This conference was a pivotal moment both locally and nationally since it attracted mobility activists and practitioners from around the country. The conference took place September 5-9, 2011. During this week, there were expert panels, master classes, recreational activities around the concept of "car free cities" and seminars. After the Conference, and taking advantage of the momentum it created, the activist movement produced a citizen declaration for urban mobility, which was launched on September 22, international Car Free Day, and which included a set of proposals

that were in line with the ideas discussed at the Car Free conference. The demands included that 30% of the mobility budget be invested in non-motorized mobility, a ban on building large car infrastructure projects (like bridges and tunnels), adopt policies to disincentivize car use, and to make urban mobility planning a participatory process (Britton, 2011).

Urban Mobility was a prominent topic during the 2012 elections in Jalisco, and most candidates included non-motorized mobility as part of their policy agendas, which was a notable change from past election cycles. Candidates to the governorship of Jalisco met with activists and business sector representatives to present ideas on urban mobility and governance of urban development topics at the metropolitan level. The candidates used language discourse that activists had been positioning for many years and that candidates in previous elections had never used before (Table 26).

In 2012 activists built a Citizen Platform for Sustainable Urban Mobility (*Plataforma ciudadana para la movilidad sustentable)*. This group of citizen organizations presented a Citizen Urban Mobility Agenda (*Agenda Ciudadana para la Movilidad Sustentable)* to newly elected mayors of the municipalities in the Guadalajara Metropolitan Area following the 2012 elections. The agenda was a detailed plan with priority actions and indicators for the municipal and state government along six lines of action (Promoting accessibility, metropolization, sustainable mobility, disincentivizing car use, mechanisms for citizen participation, integration with land use). This document also included a legislative agenda and proposals that should be integrated into upcoming state and municipal development plans. This agenda was made possible by grants from the Hewlett Foundation to the *Colectivo Ecologista de Jalisco (*Plataforma Metropolitana para la Sustentabilidad, 2012).

Table 26. Governernatorial candidate proposals for non-motorized mobility

Candidate	What is your proposal for improving non-motorized mobility?
Fernando Guzmán (PAN)	*To strengthen traffic culture and increase pedestrian and cycling infrastructure. To create cyclist and pedestrian corredors and improve accessibility and special transportation accomodations for people with disabilities. To privilage bikes and make bike mobility safer, to rationalize car use and to incentivize less polluting forms of transportation"*
Aristóteles Sandoval (PRI)	*I will work with interested municipalities to promote pedestrain and cycling mobility to make these modes more viable. I will promote multimodal transportation and I will work to rehanilitate pedestrian infrastructure. I will work with local authorities to calm traffic and I will prioritize pedestrians, cyclists and public transportation."*
Fernando Garza (PRD)	*"I will primarily promote bike mobility"*
Enrique Alfaro (MC)	*"We will promote a genuine program for improving non-motorized mobility that contemplates the construction of useful cycling infrastructure that also connect to other modes of transportation and we will develop non-motorized mobility plans for medium sized cities in Jalisco"*

Source: Salcedo-Torres (2016)

This agenda is also an excellent example of the level of professionalization of the activists in the Guadalajara movement. They had the technical know-how needed to put forward transportation policy proposals, and they also knew how to propose policy and who the proposals should be directed to in order to enter the legislative process. They understood that on-the-ground policy needed to be backed by legislation and other formal institutions. They also were able to get some of their advocacy Funded through a grant from the Hewlett Foundation to the *Colectivo Ecologista de Jalisco.*

> *When we presented our agenda to the Governor he promised to follow the points laid out in the agenda. And then, the citizen Agenda was incorporated into the State Development Plan for his administration without changing anything, not even a comma. Suddenly these ideas that we had been working*

on for many years were officially incorporated into the government agenda (Former Ciudad para Todos Leader and Public Official, 01/22/2020).

4.5.4 *2013 – 2020 Institutions for non-motorized mobility planning, cycling policy consolidated*

Following an intense period of activism where the organizations promoting sustainable mobility gained visibility, and traction with policymakers between 2007 and 2013, the topic of urban mobility and cycling started to permeate into government institutions starting with the adoption of the policy proposals presented by the Citizen platform for Sustainable Mobility. In 2013 the newly elected Governor, Aristoteles Sandoval, presented a Mobility Law proposal to the Jalisco Congress. The law would override the Transport and Roads Law (*Ley de Vialidad y Transporte*), a long-standing request from civil society organizations, who wanted a deep reform that would give cyclists and pedestrians rights and priority way on roads.

Before the governor presented this proposal, activists had testified multiple times before Congress to ask for the Transport Law to be reformed. Once the law proposal was put forward, civil society organizations presented requests for what they considered to be essential for the law to include prioritize non-motorized mobility. This included giving legal standing to bikes as vehicles and cyclists as users of the road and integrating cycling in road design and prioritization of planning. The requests from civil society also included stable funding for non-motorized mobility and a commitment to implementing a bikeshare system.

Civil society organizations were critical of the new law when it was passed because it did not contemplate most of their proposals, deeming the change from a Transport Law to a Mobility Law a symbolic name change rather than a substantive one. The only citizen proposals included relative to cycling mobility were prohibiting driving and parking in cycling lanes. However, the

mobility law also mandated the creation of the Jalisco Mobility and Transport Institute (*Instituto de Movilidad y Transporte de Jalisco*), a state-level body charged with planning, research, technical guidance for municipalities on all issues related to urban mobility and technical assistance for the Ministry of Mobility and Transport.

Once the agency was created and its bylaws developed, for the first time, a state-level agency included an office for non-motorized mobility and the responsibility to create an "integrated system for non-motorized mobility". At the municipal level, the mayor Zapopan municipality, at the request of local organizations, created a new strategic projects office to work on projects that contemplate urban issues in the long term, like non-motorized mobility and public space improvements. This period also marked the beginning of a wave of activists that joined the public administration in the agencies that they advocated to create. The new non-motorized mobility office of the IMTJ and the Zapopan Strategic Projects Office recruited *CITA* and *Ciudad para todos* activists Felipe Reyes and Alfredo Hidalgo for their leadership.

In 2013 the Jalisco Governor Aristoteles Sandoval announced 162 million pesos for a public bikeshare system for Guadalajara, starting in the Guadalajara and Zapopan municipalities, which was a policy proposal from the Citizen Platform. The system started with 860 bikes and 84 stations in 2014, and by 2018 expanded to 2,500 bikes and 446 stations. This project was significant because it was an emblematic cycling project put forward by the Governor, with a significant investment in the infrastructure, socialization, and deployment process, which another civil society organization of urbanists carried out called *Cuadra Urbanismo*. Currently, MiBici is considered a very successful system, the second largest in the country after Mexico City's *ecobici*, and one of the key drivers of the increase in cycling mobility in the city. The process for

planning, deploying, and socializing MiBici was participatory, developed neighborhood by neighborhood, and considered a crucial part of its current success.

In 2015, following mayoral elections in the Guadalajara Metropolitan area where non-motorized mobility once again was a core part of municipal and state candidate policy platforms, Guadalajara and Zapopan (and a couple of years later Tlajomulco, and Tlaquepaque) reformed their municipal governance structures to include an urban mobility office charged with, among other things, developing and implementing non-motorized mobility policy. Activists from Ciudad para Todos (Jesus Carlos Soto) and Colectivo Ecologista de Jalisco (Mario Silva, Patricia Martinez) were invited to the Guadalajara and Zapopan offices, the two largest municipalities, to develop and lead these institutions. This was the first time municipalities in the Guadalajara metropolitan area had legal mandates to implement cycling policy and the corresponding administrative infrastructure. Eventually, in 2018 Libertad Zavala, the director of *Cuadra Urbanismo*, took over the leadership of the Guadalajara Municipality, and Mario Silva went to direct the Metropolitan Planning Agency.

Mobility offices in the Guadalajara Metropolitan area reformed existing offices in the municipality, mainly in charge of monitoring street parking serve multiple purposes. They are the offices that develop and oversee the implementation of cycling and pedestrian policy and infrastructure. They host educational programs like cycling schools for citizens and traffic education workshops for people who violate traffic rules. They have created a new figure called a mobility agent that supervises the streets and ensures that cycling infrastructure and sidewalks remain free of cars (but separate from transit police). They also work with real estate development agencies to regulate their street interventions. The Guadalajara mobility office also implements a yearly cyclist perception survey and recently developed a cycling map of

Guadalajara, mapping all of the bike-friendly businesses, repair shops, bike shops, and other points of interest in the city. Advocates have directed the Guadalajara and Zapopan Mobility Offices since they started in 2015.

In 2017 the Mobility Law was reformed to include the rights and protections for cycling and cyclists that had been requested for the first version of the law. The law also included specific sanctions and actions against motorists who violate the rights of cyclists. This new version of the law also mandates local governments to build cycling infrastructure such as secluded cycling lanes and bike parking facilities.

While in 2002, the first cycling lane on Avenida de la Paz was removed only after one year of its creation, in 2017 the city overwhelming voted in favor of building new cycling infrastructure. A sign of the shift in public opinion surrounding cycling and its designated infrastructure came in 2017, when a cycling lane was built on the Avenida Marcelino Barragán, and which faced opposition from the neighbors whose street parking would be reduced. The neighbors managed to get enough signatures to have a city-wide referendum to vote on whether the new cycling lane should be maintained. The popular vote resulted in massive support for the cycling lane (over 80% of voters in favor) (Rivas, 2017). Interviewees considered this result to be an indicator of a massive shift in public perception towards cycling and cycling infrastructure, a result of many years of work and activism, and policy shifts.

Figure 48. Should the bikeway on Marcelino Barragan stay?

Yes it should, arguments in favor:

1. *We should demand that the government provide conditions for everyone's most optimal mobility*
2. *This cycling lane is the success of many years of citizen engagement*
3. *We are trying to change the course of mobility in the city*
4. *The infrastructure will benefit more than 30,000 students*
5. *It offers safe conditions that favor cycling mobility*
6. *It covers an area that is strategic for promoting bike mobility*
7. *It is a strategic area to promote combined transportation*
8. *It is a vaccine against diseases caused by cars*
9. *It is a spearhead for sustainable mobility*
10. *It is a transformation of public space that will benefit all citizens*

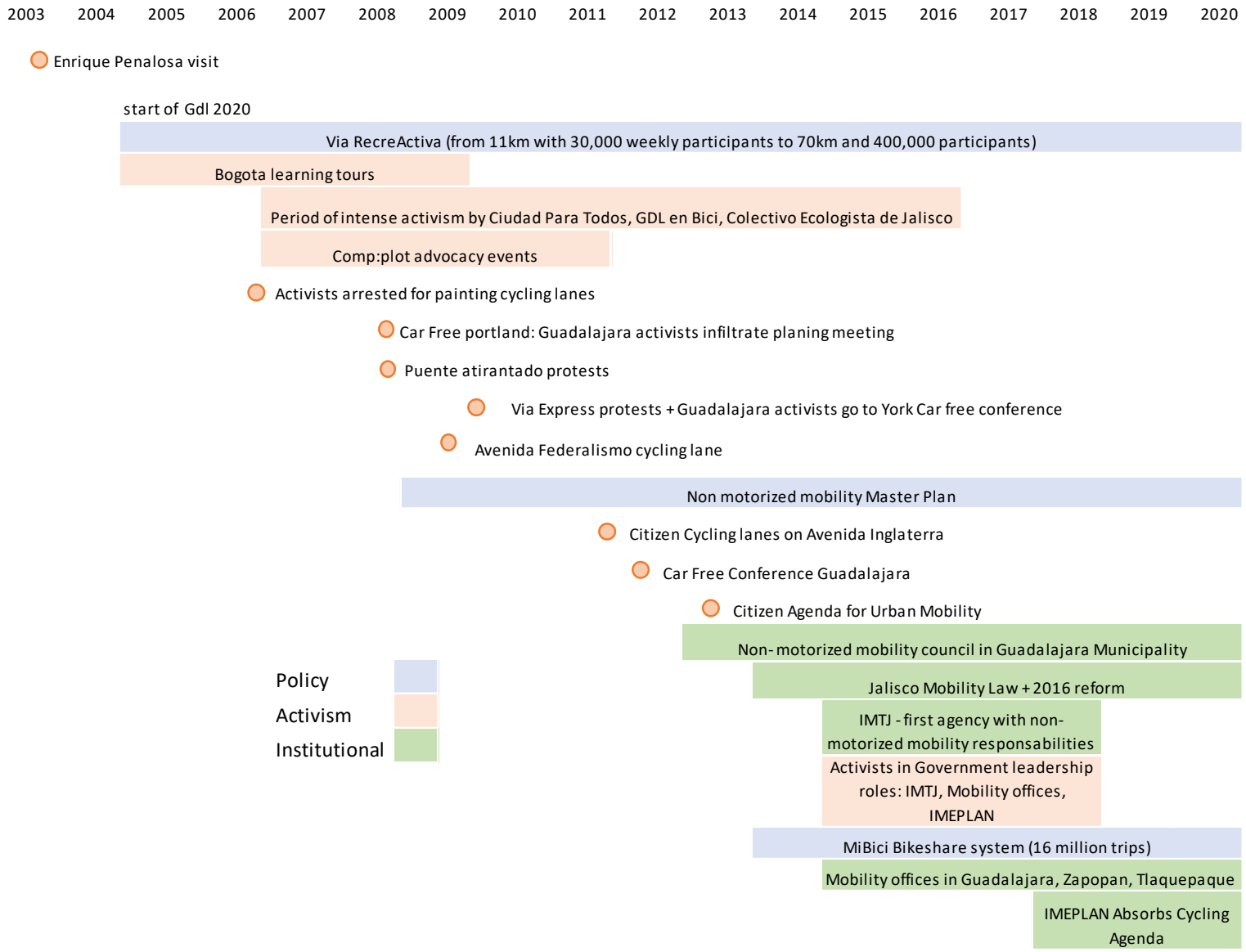
No it shouldn't, opposing arguments:

1. *It violates Guadalajara's Urban Image Code and free transit, guaranteed by the constitution, implies that exclusive right of way is not allowed.*
2. *The neighbors in surrounding areas were not consulted about construction of the cycling lane, nor was it socialized, and now they are the most affected by this project.*
3. *The poor planning of the cycling lane puts users, people with disabilities, senior citizens and pedestrians in danger, especially around bus stops.*
4. *The cycling lane will negatively impact quality of life, business revenue, trip times, and it will also cause pollution and stress.*
5. *The cycling lane has caused an increase in robberies and traffic collisions for pedestrians, cyclists and motorists with zero presence of the Mobility Office.*
6. *Public wellbeing should be more important than any public works project.*
7. *The cycling lane is in the way of emergency vehicle access*
8. *The cycling lane does not have continuity nor does it meet the objectives of the Mobility Office.*
9. *It blocks access to public transportation and makes it difficult to get on and off the bus.*
10. *Cyclists have rights but they don't have any economic or administrative obligations*

Source: Instituto Electoral y de Participacion Ciudadana (2017)

In 2018, the Metropolitan Planning Agency, IMEPLAN absorbed the state agency IMTJ and became responsible for coordinating the long-term planning of mobility the Metropolis. By taking on this responsibility, urban mobility planning became integrated with areas such as urban development, public safety, and environmental management. When the IMTJ was absorbed by the IMEPLAN in 2018, and after a change in political party, the IMEPLAN hired Colectivo Ecologista de Jalisco leader and former director of the Guadalajara Municipality to lead it (Mario Silva). Finally, in 2019 a new agency called Metropolitan Agency for Mobility Infrastrucure (*Agencia Metropolitana de Infraestructura para la Movilidad,* AMIM) was responsible for overseeing the maintenance of, among other things, cycling infrastructure and a yearly budget to plan and implement these repairs.

Figure 49. Key activism, policy and institutional milestones and events during the study period



4.5.5 *Current state of cycling in Guadalajara*

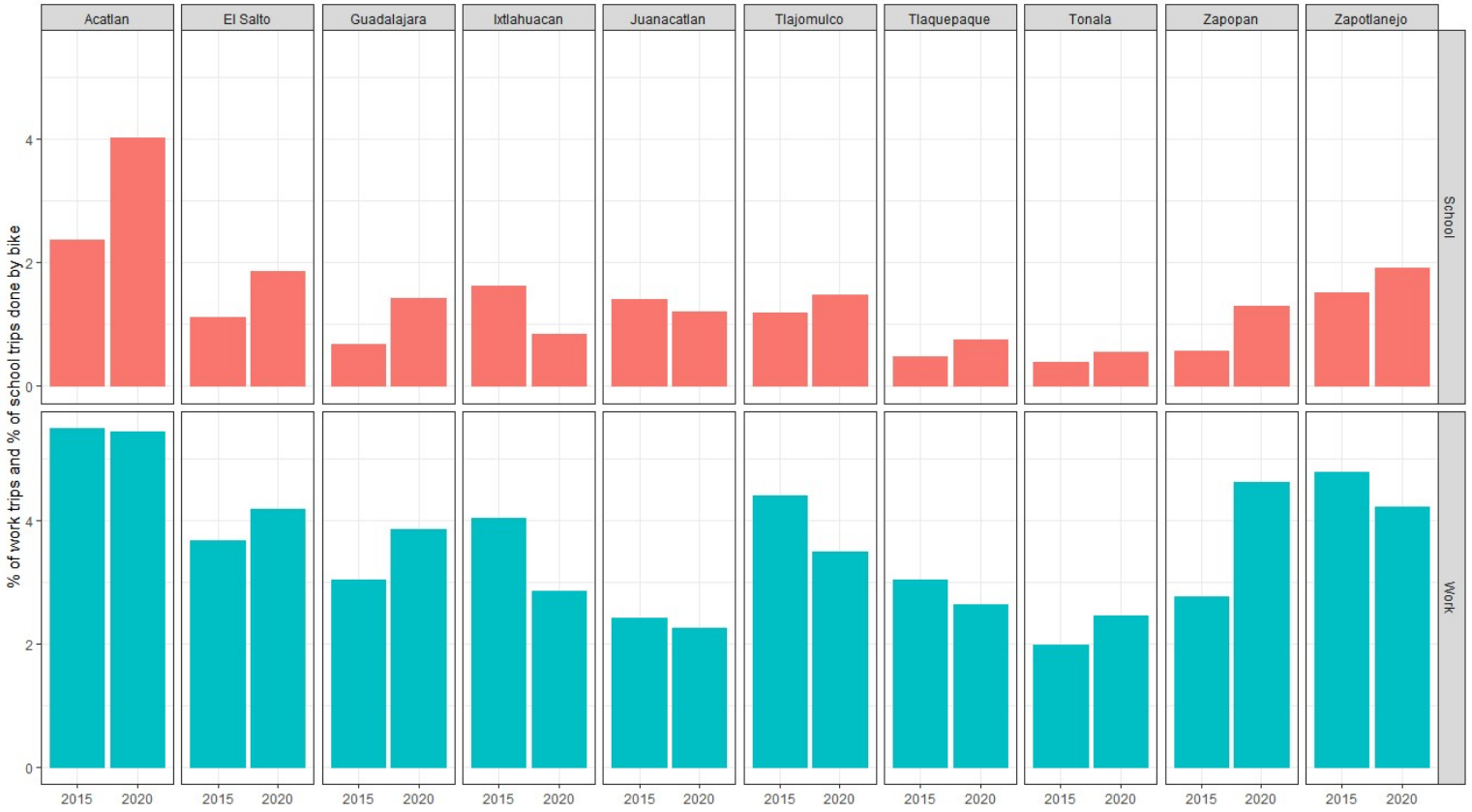
The last comprehensive origin and destination survey for the City of Guadalajara developed in 2007 showed that only 2.2% of the trips in the Metropolitan area were done by bike (Herrera, 2015). While a lot of progress has been made to develop infrastructure (Figure 51) and implement a very successful bikeshare system (Figure 52), there has been no metropolitan-level measurement of the change in the mode share of bike trips or causal evaluations of these policies. As interviewees point out, while many conditions have improved, Guadalajara has some distance still to go to improve cycling conditions in the broader metropolitan area.

> *I still do not think it's easy [to ride a bike in Guadalajara]. What we have achieved in the last few years is to consolidate a core area with a lot of infrastructure and signalling that create certain conditions that are more favorable. But that does not mean that it's easy to pedal everywhere. Guadalajara is a complicated metrópolis like any other, and it is a low-density city that has expanded with long distances planned for cars following the "gringo" model of urban expansion (Former activist and public official, Guadalajara 01/22/20).*

The only available data points that compare bike usage over time come from the Extended National Survey from the National Census Bureau, conducted in 2015 and 2020 (INEGI 2016, 2021). This survey asks individuals what their preferred mode of transportation is to work for employed people and school for students. Based on the modal shares of trips to work and trips to school in the municipalities comprising the metropolitan area of Guadalajara are presented in Figure 50, which shows an increase in Zapopan and Guadalajara, where most of the infrastructure is located and also where the operational area of the bikeshare system MiBici is centered. The Mibici bikeshare system has been highly successful. The system has accumulated

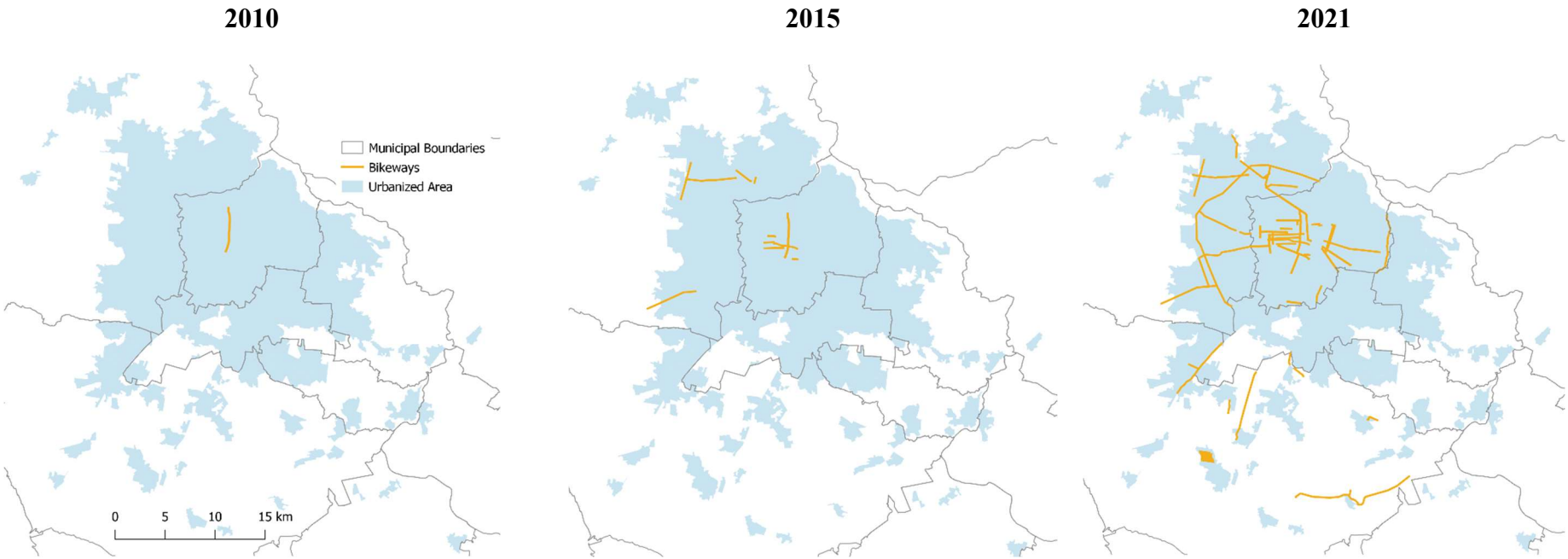
over 16 million trips since December 2014. In a survey developed by WRI Mexico to MiBici bikeshare users in 2019, 59 % of users did not bike before they became members of MiBici (WRI, 2019).

Figure 50. % of School trips and work trips done by bike in each municipality of the GMA



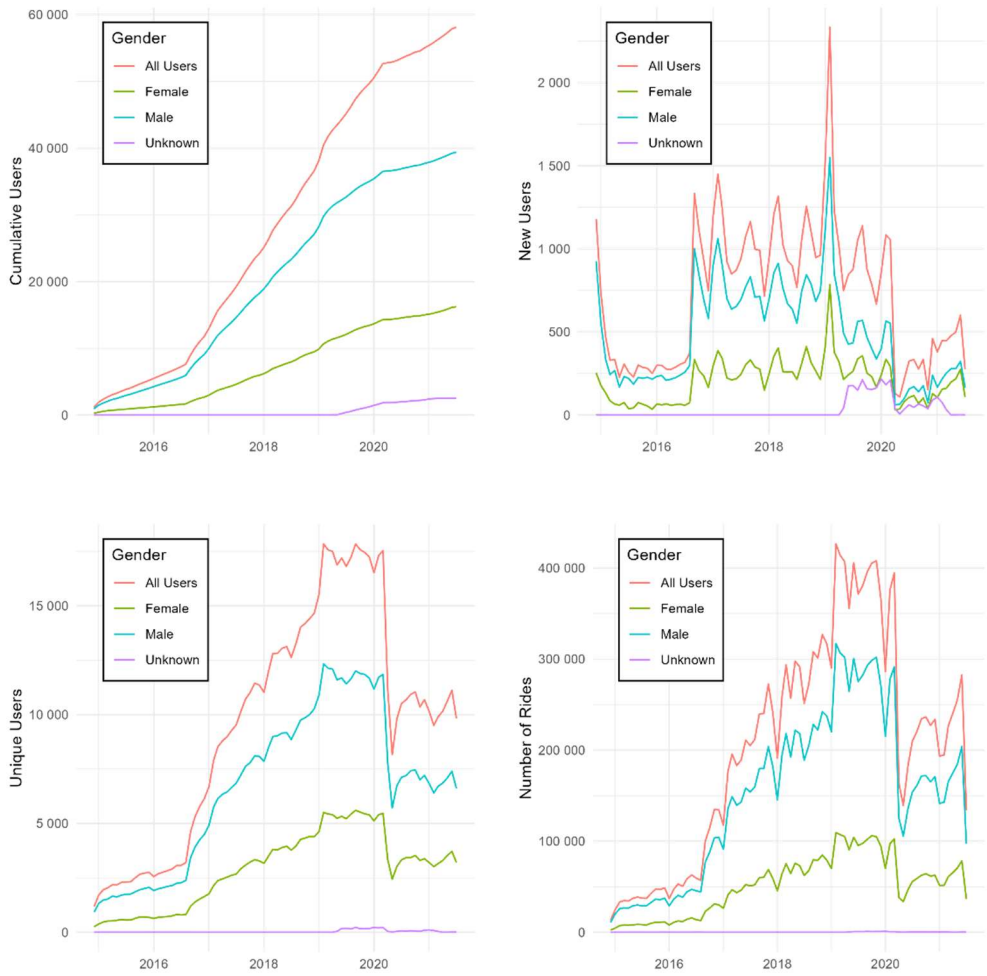
Source: INEGI 2016, 2021

Figure 51. Evolution of cycling infrastructure in the Guadalajara Metropolitan area



Source: AMIM (2021)

Figure 52. Growth of the MiBici Bikeshare system



Note: Cycling infrastructure and the MiBici system is concentrated in Guadalajara and Zapopan; Source: Mibici (2021)

4.6 Conclusions

In this paper, I reconstructed and analyzed the events that led Guadalajara to transform its institutions and streets to promote cycling. I demonstrated how local actors built a strong, diverse, and highly media-oriented movement to mobilize sustainable transportation generally and cycling mobility specifically as a new policy area. This movement, comprised of civil society organizations, academics, and prominent business figures, pushed for the gradual creation and reform of institutions, laws, and agencies, including creating a metropolitan-level structure for urban planning and governance. Individual actors working as activists in this movement gradually transitioned into government roles to implement this agenda from the inside.

At the beginning of this case study, in 2000, no institutions were responsible for creating and implementing non-motorized mobility policies. By 2021 there is a governance structure that spans the state, metropolitan and municipal levels. Cyclists are acknowledged in the law, and so is the infrastructure to support cycling mobility. There is a weekly event that has successfully allowed Guadalajara to reclaim their streets on their bikes for over 20 years, a bikeshare system in Guadalajara and Zapopan that has accumulated over 16 million trips in 5 years, and a growing network of cycling infrastructure spanning four municipalities (with most of it concentrated in Guadalajara and Zapopan). Cycling advocates have occupied leadership positions at the state, metropolitan and municipal levels since 2013. Finally, an important achievement of the anti-highway and pro-sustainability movement is that since the *Via Express* was canceled, no more large car infrastructure like overpasses, bridges, and freeways have been built in the city.

> *Something that has also happened is that for the last 6 years, no bridges, overpasses or large public works for cars have been proposed or developed. I*

think it has become clear now that these projects are just not politically viable anymore (Director of the Guadalajara Mobility office, Guadalajara, 01/23/2020).

Many important factors led to these changes and their persistence. The first is the local context of Guadalajara, a city immersed in a pattern of uncontrolled urban sprawl, increasing traffic, and loss of quality of life. For many of the actors involved, the desire to change urban development led them to organize and engage with urban issues. The civil society organizations involved in Guadalajara's gradual adoption of non-motorized mobility policies were politically savvy and able to capitalize on their status as concerned citizens to build social legitimacy.

The movement was completely citizen-led and legitimate, and it is very hard for a mayor anywhere else in Mexico to say "I want to be like Guadalajara". Because you don't have this social process that developed in Guadalajara, and you can't replicate that. I am completely convinced that none of [the cycling policy] we have today would have been possible without the organizations that got involved and built a citizen movement (Former Ciudad para Todos Leader and Public Official, 01/22/2020).

The first organization to actively seek policy change during the study period, *Guadalajara 2020*, was a group of prominent business sector representatives with connections in business, high levels of government, and the media. Their influence planted two seeds that started Guadalajara's transformation. The first was their labor to lobby for and launch the *Ciclovia RecreActiva*, a program that has allowed hundreds and thousands of Guadalajara residents to take over the streets and experience cycling each week for almost 20 years. The second was the visits they organized to Bogotá for people in positions of leadership, where they were able to show them how policies to improve non-motorized mobility were possible in a similar Latin American context. Many of the actors they sent to Bogotá became mayors and even the Governor of the State of Jalisco.

The second wave of citizen advocacy came a few years later and started to consolidate in 2007. This new surge included a coalition of civil society organizations that were highly educated and, over time, learned strategies to make themselves and their policy ideas visible to both the general public and decision-makers. Their movement was comprised of upper-class citizens who created an aspirational image of cycling in a city where most traditional cyclists were working class.

> *Traditional cyclists in Guadalajara are low-wage workers. Since it was a middle- and upper-class movement, we created an aspirational image of cycling. Since 2007 we have started to create the image of a cyclist by choice who is environmentally aware, hipster, and cool. That helped, even if it's superficial to admit. Nevertheless, it made many people want to ride a bike. (Former Ciudad para Todos Leader and Public Official, 01/22/2020).*

Their movement involved staging protests, communicating with the press, engaging with international experts, elaborating detailed and sophisticated policy proposals, and seeking out politicians to publicly commit to implementing their agenda which they gradually achieved. This group of CSOs had a deep understanding of the laws and governance structures they needed to change to implement their policy proposals. They used technologies and platforms that were innovative at the time, like social media and digital videos. The movement also presented a unified message, both amongst themselves and eventually towards their peers that left activism to join the government and lead some of the offices and agencies they had advocated to create.

> *It seems like people outside of our movement believe that we are extraordinarily united, and honestly, this makes me laugh because it's really not true. However, we have an unspoken pact of not being aggressive towards each other. We do not always agree on everything…. We don't always agree with everything [other organizations or activists that are public officials] do, but we don't make this public, and we especially don't do things that could bring others down. That has made a difference because then nobody can take*

advantage of the cracks within our movement (GDL en bici activist, Guadalajara 01/22/2020).

Another core ally was the academic sector, which supported the movement by joining the coalition of pro- sustainable mobility organizations, developing research on related topics and creating training opportunities for people interested in these issues.

Universities have also been crucial actors, they have helped us position all of our ideas with research and general support. They have also created training programs and degrees that with time have helped form people who work on these issues. I think their role is very relevant … in 2007 there were no graduate degrees even tangential to urban mobility. Now we have a masters degree in sustainable mobility and public space in the University Of Guadalajara. [The Jesuit University] ITESO has a masters degree in public space and mobility, the TEC offers many options and so on. So these changes have made universities key actors that helped position our agenda (GDL en Bici activist, Guadalajara 01/22/2020).

Finally, activists' incursion into government allowed both advocates to implement the agenda they built from the inside and to further the institutionalization of non-motorized mobility.

Some government agencies started to incorporate activists who had been promoting [non-motorized mobility] for many years. This facilitated internal dialogues, and projects started to be implemented. These are projects that are now official government projects which originated from citizen proposals. This started a period of more permeability and dialogue [between government and civil society]. Since then, there is more involvement [of the government] and openness and a very explicit commitment to these topics. Over time, more and more activists who had worked on these topics for many years have joined the ranks of government (Former Cita activist and public official, Guadalajara 01/20/20).

4.7 APPENDIX: LIVE ARCHIVE OF GUADALAJARA'S SOCIAL MOVEMENT "CITIES FOR ALL"

1) Guadalajara's Vía RecreActiva - The World's Most Transformative *Ciclovía* https://vimeo.com/34649520
2) Experts react to the Vía Express promotional video (2010): *Vía Express en el mundo* https://www.youtube.com/watch?v=9u3e9f0q7QY&feature=emb_logo
3) *Puente Atirantado* Protests (2009)
    a. Acción contra el Puente Atirantado 1.0 https://www.youtube.com/watch?v=z1t1-l7Uv-w&feature=emb_title
    b. Denuncia ciudadana al puente atirantado https://www.youtube.com/watch?v=obtCrx6YxJ0&feature=emb_logo
    c. Acampan vs Puente Atirantado - Grupo Reforma https://www.youtube.com/watch?v=p42ntjMW-tg&feature=emb_logo
4) Car-free Guadalajara (2011)
    a. Promotional video 1: https://www.youtube.com/watch?v=EEbkDEs41mQ
    b. Promotional video 2: https://www.youtube.com/watch?v=mFVn1owH1Xo&feature=emb_logo
5) Over the wheel (Subtitled documentary, 2012): https://www.youtube.com/watch?v=No5mbRZTaqA&feature=youtu.be

4.8 REFERENCES

1. Agencia Metropolitana de Infraestructura para la Movilidad (2021). Personal communication 07/14/2021

2. Aldred, R., & Jungnickel, K. (2014). Why culture matters for transport policy: The case of cycling in the UK. *Journal of Transport Geography*, *34*, 78–87. https://doi.org/10.1016/j.jtrangeo.2013.11.004

3. Balderas Torres, A., et al. "Sustainable mobility for sustainable cities: Lessons from cycling schemes in Mexico City and Guadalajara, Mexico. Coalition for Urban Transitions. London and Washington, DC." (2021): 3.
4. Banister, D. (2008). The sustainable mobility paradigm. Transport policy, 15(2), 73-80.
5. Britton, Eric (2011) Towards Carfree Cities X: What happened in Guadalajara from 3 to 10 September 2011? Retrieved 08/01/21 https://worldstreets.wordpress.com/2011/09/28/towards-carfree-cities-x-what-happened-in-guadalajara-from-3-to-10-september-2011/
6. Buehler, T., & Handy, S. (2008). Fifty Years of Bicycle Policy in Davis, California. *Transportation Research Record: Journal of the Transportation Research Board*, *2074*(1), 52–57. https://doi.org/10.3141/2074-07
7. Bulkeley, H. (2010). Cities and the Governing of Climate Change. *Annual Review of Environment and Resources*, *35*(1), 229–253. https://doi.org/10.1146/annurev-environ-072809-101747
8. Carlsson Chris (2010) New Freeway Revolt Grips Guadalajara Streetsblog Retrieved 08/01/21 https://sf.streetsblog.org/2010/12/06/new-freeway-revolt-grips-guadalajara/
9. Carter, N. (2006). Party Politicization Of The Environment In Britain. Party Politics, 12(6), 747–767. https://doi.org/10.1177/1354068806068599
10. Censo de Población y Vivienda 2020 (CPV). 2020. Instituto Nacional de Estadística y Geografía. Retrieved 08/01/21 https://www.inegi.org.mx/programas/ccpv/2020/
11. Censo General de Población y Vivienda 1990 (CGPV). 1990. Instituto Nacional de Estadística, Geografía e Informática. Retrieved 08/01/21 https://www.inegi.org.mx/programas/ccpv/1990/
12. Centro de Estudios de las Finanzas Públicas, CEFP (2019). Series históricas de indicadores macroeconómicos de México a 2018. Technical Note CEFP/020/2019. Retrieved 08/01/21 https://www.cefp.gob.mx/publicaciones/documento/2019/cefp0202019.pdf
13. El Informador (2009) Organismos ciudadanos rechazan puente atirantado. Retrieved 08/01/21 https://www.informador.mx/Jalisco/Organismos-ciudadanos-rechazan-puente-atirantado-20090712-0235.html

14. El Informador (2010) Presentan el Plan Maestro de Movilidad Urbana no Motorizada Retrieved 08/01/21 https://www.informador.mx/Jalisco/Presentan-el-Plan-Maestro-de-Movilidad-Urbana-no-Motorizada-20100519-0221.html
15. Encuesta Nacional de Victimización y Percepción sobre Seguridad Pública (ENVIPE). 2020. Instituto Nacional de Estadística y Geografía. https://www.inegi.org.mx/programas/envipe/2020/
16. Fonseca Leticia (2009a) Nueva manifestación contra puente atirantado Solicitan Plan Integral de Movilidad El Informador Retrieved 08/01/21 https://www.informador.mx/Jalisco/Nueva-manifestacion-contra-puente-atirantado-20090717-0053.html
17. Fonseca, Leticia (2009b) Inicia elaboración del Plan Maestro de Movilidad no Motorizada. El Informador Retrieved 08/01/21 https://www.informador.mx/Jalisco/Inicia-elaboracion-del-Plan-Maestro-de-Movilidad-no-Motorizada-20090122-0082.html
18. Gamble, J., Snizek, B., & Nielsen, T. S. (2017). From people to cycling indicators: Documenting and understanding the urban context of cyclists' experiences in Quito, Ecuador. Journal of Transport Geography, 60, 167–177. https://doi.org/10.1016/j.jtrangeo.2017.03.004
19. GDL en Bici (2011) "Declaración de Guadalajara por la Movilidad Sustentable" Retrieved 08/01/21 https://gdlenbici.org/2011/09/22/declaracion-de-guadalajara-por-una-movilidad-sustentable/
20. Gobierno de Guadalajara (2009) Reglamento del Consejo Ciudadano de Movilidad no motorizado Retrieved 08/01/21 https://transparencia.guadalajara.gob.mx/sites/default/files/reglamentos/Reg.MovilidadNoMotorizada.pdf
21. Gobierno de Jalisco (2010a). Plan de Movilidad No Motorizada del Area Metropolitana de Guadalajara Retrieved 08/01/21 https://issuu.com/el_informador/docs/movilidad_no_motorizada
22. Gobierno de Jalisco (2010b). Manual de Lineamientos y estándares Para Vias Peatonales y Ciclistas del Plan Maestro de Movilidad Urbana no Motorizada de la Zona

Metropolitana de Guadalajara Retrieved 08/01/21 https://docplayer.es/23897570-Plan-maestro-de-movilidad-urbana-no-motorizada-del-area-metroplitana-de-guadalajara.html

23. Gobierno del Estado de Jalisco. (2019, August 19). Esto es lo que debes conocer sobre la nueva etapa de Mi Transporte. jalisco. Retrieved 08/01/21 https://www.jalisco.gob.mx/es/gobierno/comunicados/esto-es-lo-que-debes-conocer-sobre-la-nueva-etapa-de-mi-transporte
24. Gobierno del Estado de Jalisco. (2020, May 26). Mi transporte avanza para brindar un servicio ordenado, eficiente y de calidad. jalisco. Retrieved 08/01/21 https://www.jalisco.gob.mx/es/gobierno/comunicados/mi-transporte-avanza-para-brindar-un-servicio-ordenado-eficiente-y-de-calidad
25. Gobierno del Estado de Jalisco. (2021, May 12). Retrieved 08/01/21 Alistan nuevas unidades de Mi Transporte. jalisco. https://www.jalisco.gob.mx/es/gobierno/comunicados/alistan-nuevas-unidades-de-mi-transporte
26. González, S. M. & M. A. Venegas. (2018). Procesos de expansión urbana y artefactos de la globalización en la zona conurbada de Guadalajara, 1960-2015. In G. Hoyos, O. Serrano, E. Serena & M. P. Mora (Coords.), Ciudad, género, cultura y educación en las regiones (82-106). Universidad Nacional Autónoma de México & Asociación Mexicana de Ciencias para el Desarrollo Regional A. C.
27. Herrera, Salvador (2015) Oportunidades de desarrollo orientado al transporte y bajo en emisiones en Guadalaja Retrieved 08/01/21 http://itdp.mx/dotmx/descargas/estrategias/Guadalajara.pdf
28. IMEPLAN (2021) Análisis Vía Recreativa. Promotor de la movilidad urbana metropolitana Retrieved 08/01/21 https://www.imeplan.mx/en/entrevistas/analisis-recreativa
29. Instituto Electoral y de Participacion Ciudadana (2017) Mecanismos de Participación Social Consulta popular: Ciclovía MGB. Resultado del Ejercicio 2017. Retrieved 08/01/21 http://www.iepcjalisco.org.mx/participacion-ciudadana/consulta-popular-ciclovía/
30. Instituto Nacional de Estadística y Geografía (INEGI). (2020, December 9). Producto Interno Bruto por Entidad Federativa 2019 [Press Release No. 632/20] Retrieved

08/01/21
https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2020/OtrTemEcon/PIBEntFed2019.pdf

31. Instituto Nacional de Estadística y Geografía (INEGI) (2020b, 31 de julio). Accidentes de tránsito terrestre en zonas urbanas y suburbanas. inegi. Retrieved 08/01/21 https://www.inegi.org.mx/programas/accidentes/#Tabulados
32. Instituto Nacional de Estadística y Geografía (INEGI). (2020a). Banco de Indiadores. inegi. Retrieved 08/01/21 https://www.inegi.org.mx/app/indicadores/default.aspx?tm=6#divFV6207048973
33. ITDP. Institute for Transportation & Development Policy (2013). Ranking. Índice de Ciclociudades 2013. Resumen ejecutivo. Retrieved 08/01/21 : http://ciclociudades.mx/ranking-ciclociudades-2013/
34. ITDP. Institute for Transportation & Development Policy (2014). Ranking. Índice de Ciclociudades 2014. Resumen ejecutivo. Retrieved 08/01/21 : http://ciclociudades.mx/ranking-ciclociudades-2014/
35. ITDP. Institute for Transportation & Development Policy (2015). Ranking. Índice de Ciclociudades 2015. Resumen ejecutivo. Retrieved 08/01/21 : http://ciclociudades.mx/ranking-ciclociudades-2015/
36. ITDP. Institute for Transportation & Development Policy (2018). Ranking. Índice de Ciclociudades 2018. Resumen ejecutivo. Retrieved 08/01/21 http://ciclociudades.mx/presentacion-de-ranking-ciclociudades-y-perfil-ciclista-2018/
37. ITDP. Institute for Transportation & Development Policy (2019). Ranking. Índice de Ciclociudades 2019. Resumen ejecutivo. Retrieved 08/01/21 http://ciclociudades.mx/ranking-ciclociudades-2019/
38. ITDP. Institute for Transportation & Development Policy (2020). Ranking. Índice de Ciclociudades 2020. Resumen ejecutivo. Retrieved 08/01/21 https://mexico.itdp.org/noticias/descarga-el-ranking-ciclociudades-2020/
39. Lankao, P. R. (2007). How do Local Governments in Mexico City Manage Global Warming? *Local Environment*, *12*(5), 519–535. https://doi.org/10.1080/13549830701656887

40. Maguey, Carlos (2011) Crean segunda ciclovía ciudadana. Animal Politico. Retrieved 08/01/21 https://www.animalpolitico.com/2011/03/crean-segunda-ciclovía-ciudadana/
41. Martins, R. D., & Ferreira, L. D. C. (2011). Opportunities and constraints for local and subnational climate change policy in urban areas: Insights from diverse contexts. *International Journal of Global Environmental Issues*, *11*(1), 37–53. https://doi.org/10.1504/IJGENVI.2011.04025
42. MiBici (2021) Open Data https://www.mibici.net/en/open-data/
43. Montero, Sergio. "Study tours and inter-city policy learning: Mobilizing Bogotá's transportation policies in Guadalajara." Environment and Planning A: Economy and Space 49.2 (2017): 332-350.
44. Plataforma Metropolitana para la Sustentabilidad (2012). Agenda Ciudadana para la Movilidad Sustentable: Prioridades para municipios del Área Metropolitana de Guadalajara. Retrieved 08/01/21 http://www.cej.org.mx/descargas/estudiosypublicaciones/movilidadytransporte/agendaciudadanaparamovilidadsustentablemunicipios.pdf
45. Rivas, Rodrigo (2017) Consulta a tapatíos resulta a favor de la ciclovía. El informador. https://www.informador.mx/Jalisco/Consulta-a-tapatios-resulta-a-favor-de-la-ciclovía-20170709-0025.html
46. Ryan, D. (2015). From commitment to action: A literature review on climate policy implementation at city level. Climatic Change, 131(4), 519–529. https://doi.org/10.1007/s10584-015-1402-6
47. Sagaris, L. (2010). From sustainable transport development to active citizenship and participatory democracy: The experience of Living City in Chile: From sustainable transport development to active citizenship and participatory democracy. Natural Resources Forum, 34(4), 275–288. https://doi.org/10.1111/j.1477-8947.2010.01312.x
48. Sagaris, L. (2014). Citizen participation for sustainable transport: The case of "Living City" in Santiago, Chile (1997–2012). Journal of Transport Geography, 41, 74–83. https://doi.org/10.1016/j.jtrangeo.2014.08.011
49. Salcedo-Torres, Yeriel. "Pedaleando hacia una ciudad cicloincluyente." (2016). Retrieved 08/01/21 https://rei.iteso.mx/handle/11117/3791

50. Sarmiento, C. S., S. Alveano, and R. King. (2019). " Guadalajara: Revisiting Public Space Interventions through the Via RecreActiva." World Resources Report Case Study. Washington, DC: World Resources Institute. Available online at www. citiesforall.org Retrieved 08/01/21 https://wrirosscities.org/sites/default/files/WRR_Case-Study_Guadalajara_Final.pdf
51. Secretaría de Desarrollo Agrario, Territorial y Urbano, Consejo Nacional de Población & Instituto Nacional de Estadística y Geografía (SEDATU/CONAPO/INEGI). (2018). *Delimitación de las Zonas Metropolitanas de México 2015*.
52. Seijas, Adriana (2016) 3 de las ciudades más ciclo-inclusivas de la región. IDB. Retrieved 08/01/21 https://blogs.iadb.org/ciudades-sostenibles/es/ciudades-ciclo-inclusivas-2/
53. Sistema de Transporte Eléctrico Urbano (SITEUR). (2021). *Sistema de Transporte Eléctrico Urbano*. siteur. http://siteur.gob.mx/sistemas-de-transporte/tren-el%C3%A9ctrico.html
54. Sosa López, O., & Montero, S. (2018). Expert-citizens: Producing and contesting sustainable mobility policy in Mexican cities. Journal of Transport Geography, 67, 137–144. https://doi.org/10.1016/j.jtrangeo.2017.08.018
55. Weatherspark. (2021). *The Typical Weather Anywhere on Earth*. weatherspark. https://weatherspark.com/
56. WRI (2019) Reporte de Resultados. Analisis, Impactos y Beneficis del sistema de Bicicletas compartidas MiBici.
57. Zubicaray, G., M. Brito, M. L. Ramírez, N. García & J. Macías. (2021). Las ciudades mexicanas: tendencias de expansión y sus impactos. Coalition for Urban Transitions. Retrieved 08/01/21 https://urbantransitions.global/wp-content/uploads/2021/02/Las_ciudades_mexicanas_digital.pdf

Chapter 5. CONCLUSION

The research presented in this dissertation examines the impact of driving restrictions and pollution warnings on the use of the Mexico City bikeshare system and how cycling policy and the implementation of cycling infrastructure have become institutionalized in Mexican cities. This research focused largely on the operational level to gain insight into the barriers and possible solutions during the implementation of cycling infrastructure. Together, they contribute to the growing scholarship on cycling mobility and policy, focusing on Latin America, a currently understudied region.

Chapter 2 investigates the effect of driving restrictions on bikeshare ridership in Mexico City. The results show that bikeshare usage increases during peak commuting hours when transportation is more inelastic and decreases when travel is less essential. Further analysis suggests that bikeshare users are more perceptive to air pollution following health warnings, supporting the idea that the effect of driving restrictions on bikeshare use is hampered by the poor air quality. This study contributes to the literature examining the impact of events that constrain driving on public bike share use and the literature examining the health impacts of bikeshare use. It provides further evidence that when transportation is constrained, large-scale adoption of cycling can occur. While this study fills an important gap in the literature, future research should go even further in examining individual mode shifts to assess whether observed changes at the system level are attributable to people who usually drive and also follow individual users to see if their bikeshare use reverts to its previous state after the driving

restrictions days. Further research could also examine the effect of different shocks to assess the impact of air pollution as a mitigating factor of bikeshare uptake.

Chapter 3 developed the case for the pivotal role CSOs have played in developing cycling infrastructure in Mexican Cities. While the presence or activity of civil society organizations did not guarantee the implementation of cycling infrastructure, this research demonstrated that in most settings, CSOs are not only actively involved in every aspect of infrastructure provision and its institutionalization as a governmental activity but represent an essential presence in ensuring progress and the professionalization of infrastructure design.

In the second part of chapter 3, I studied how infrastructure is implemented in each city included in this study: Cuernavaca, Toluca. Oaxaca, Mérida, Aguascalientes, Querétaro, Morelia, León, Puebla, and Guadalajara. I studied the primary laws, organizations, and planning instruments and norms that cities have used to implement cycling infrastructure and policy successfully. I found that high-level mandates in state laws on their own make very little difference in terms of making progress on the ground both in terms of kilometers of infrastructure implemented and its quality. Lack of laws can be a barrier, for example, for garnering funds to build infrastructure, limiting or slowing down the ability to implement projects, but this is not always the case. Specialized agencies (municipal Mobility Offices and state Mobility Agencies) containing non-motorized mobility departments have proven to be one of the most important variables promoting the implementation of cycling infrastructure. The agencies responsible for designing and implementing projects are critical for sustaining cycling infrastructure planning and implementation.

Beyond the presence or absence of these agencies, the internal capacity they build and the level of oversight they can have over projects is also determinant for their ability to implement

cycling infrastructure projects and ensure their quality. This research analyzes implementation processes at the city level to understand the emergence and role of various institutions. Future research focused specifically at the project level could more granularly distill the importance of the presence or absence of specific arrangements.

Finally, in Chapter 4, I reconstructed and analyzed the events that led Guadalajara to transform its institutions and its streets to promote cycling. I demonstrated how local actors built a strong, diverse, and highly mediatic movement to mobilize sustainable transportation generally and cycling mobility specifically as a new policy area. This movement, comprised of civil society organizations, academics, and prominent business figures, pushed for the steady and persistent creation and reform of institutions, laws, and agencies, including creating a metropolitan-level structure for urban planning and governance. Individual actors working as activists in this movement transitioned over time into government roles to implement this agenda from the inside. Given that many cities are early in a journey to promote cycling mobility, the experience in Guadalajara and Mexico more generally can be valuable and serve as an example of success for practitioners and scholars.

This dissertation contributes to the growing body of literature on cycling policy and cycling infrastructure. Chapter 2 is the first research studying driving restrictions and bikeshare use together and provides further evidence that restricting driving can lead to widespread adoption of bikeshare. Chapter 3 provides a detailed analysis of cycling infrastructure implementation processes and common challenges in ten cities. Given that medium-sized Mexican cities have similar challenges to other cities in Latin America and beyond, these experiences can inform implementation in other cities, especially considering that most of the literature to date mainly reflects the North American and European experience. Chapter 3 also

highlights that implementing infrastructure is not just about technology but institutions, governance structures and organizations, an important point which is often lacking in the discussions about infrastructure implementation. Finally, Chapter 4 offers an example of a city that successfully institutionalized cycling as public policy and the local processes that led to this outcome, providing both an example of success and a cautionary tale, because the success of cycling policy in Guadalajara follows an extensive social process that cannot be easily replicated.