Bicycling for Sustainable Urban Mobility: Comparing Urban Transformations in Paris and Bogotá

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BICYCLING FOR SUSTAINABLE URBAN MOBILITY: COMPARING URBAN TRANSFORMATIONS IN PARIS AND BOGOTÁ

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In partial fulfillment of a Bachelor of Arts Degree in Environmental Analysis: Sustainability in the Built Environment

Pomona College, Claremont, California

Fall 2023

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December 2023
Acknowledgements

I would like to thank Pomona College for admitting me against all odds and providing a stellar education that I will carry with me wherever I go, and especially for funding my study abroad in Copenhagen, where I rode bicycles a lot. My readers Marc Los Huertos and Heather Williams provided encouragement and support through this difficult semester.

Majoring in the Sustainability and the Built Environment track within the Environmental Analysis major allowed me to become a truly interdisciplinary scholar and encounter manifold perspectives on the world. I extend a special warm thank you to my thesis cohort, particularly my side-kick and colleague Marcello Ursic. Tusind tak!

I would like to thank my friends, both offline and online, for always being there for me and providing camaraderie and humor.

Lastly, I would like to thank my family: mom, dad, brother, and big red cat Hacker. Your belief in my abilities, even in moments of doubt, has been a guiding light.
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Abstract

Promoting cycling is one of the low-hanging fruits to decarbonizing transportation, with further extensive benefits to quality of life. The main deterrent to the adoption of cycling for transportation is the lack of safe and connected infrastructure. This thesis explores and compares the case studies of Paris and Bogotá, where cycling modal shares grew significantly within the last decade. Plans outlining ambitious goals around sustainable transportation were put in place, and total bicycle network lengths increased rapidly in both cities. My work focuses on examining policy and infrastructure developments that lead to increased adoption of cycling over time in Paris and Bogotá, exploring similarities and challenges and synthesizing recommendations for cities who wish to undergo a cycling transformation.
Introduction

Ironically, I have never been much of a serious cyclist. Before I moved to the USA to study at Pomona College, cycling at home in Moscow was something I did rarely, during the short snow-free season, taking my mountain bike to dirt trails in the park; I relied on metro trains and buses for transportation. Until only recently, I did not pay enough attention to bicycles, discounting them as a fringe mode of transportation or just a way to exercise. Everything changed when I found myself without a car in suburban Claremont, California. Unable to go anywhere on foot and relying on friends, Ubers, and Foothill Transit buses, I felt like a second-class person, excluded from the natural beauty of California, new connections and in-person shopping just because I chose not to spend thousands of dollars on a car. It did not take me long to get a bicycle, and I acquired sweet personal freedom in a 15-mile radius. This triggered an intellectual inquiry into the bicycle, one of humanity’s most ingenious inventions that is yet to realize its full potential.

The bicycle is the most energy-efficient means of human transport. One taco, standing at approximately 300 calories, can power a cyclist at a relaxed pace for an hour (UCSD, 2011). If you convert this taco into a measure of energy per unit distance that is familiar to every American, bicycles would have a fuel efficiency of 290 MPG (miles per gallon) in the city (UCSD, 2011), compared to 28 MPG on a 2024 Honda CR-V (Honda, 2024). Of course, bicycles also use no fossil fuels and produce no CO₂ emissions, except for negligible amounts during production.

If bicycles are so great, why does everyone not ride them? During the 20th century, development patterns all over the world have been designed specifically and exclusively for travel by automobile. This applies not only to road design, which excluded pedestrians and
cyclists, but also to land use, resulting in distances that are impossible to traverse by anything other than a motor vehicle, and population densities that cannot financially support public transportation like trains and buses. Even though personal vehicles are not the predominant mode of transportation in either Paris or Bogotá, cycling stands in opposition to driving due to the conflict over road space. Thinking about encouraging sustainable mobility is impossible without also thinking about reducing car dependency, and anyone who says otherwise is a populist or simply misinformed.

Towards the turn of the 21st century, it has become apparent that cities have become attractive places to live again, allowing for unparalleled access to opportunities and amenities. Cities have an inherent space constraint - there is simply not enough space to accommodate the traffic and parking needs of every resident were they to use a car to get around. This thesis focuses on sustainable urban mobility, implying that it is dense city environments that benefit the most from cycling activity with its broad benefits for health, congestion, pollution, aesthetics, and livability.

In my work, I chose to focus on cycling in two global cities: Paris and Bogotá, as they have been both generating lots of positive discussion in the online urban planning community. I purposefully picked two very different contexts: it was important to me to show that positive urban change can occur in the “Global South”, with its weak institutions, spotty funding and a legacy of corruption and violence, just as well as it can in an opulent former capital of a colonial metropole. Creating cycling infrastructure is generally a low-cost and low-tech endeavor compared to virtually every other mode of transportation (compare a bike lane to a highway overpass or a train station!), so there is no fundamental financial barrier for lower-income places to do well at accommodating bicycles. My deep dive into the policy
suggests that political will, defined as lasting support by a range of key decision-makers, is the key to a successful cycling transformation - after all, urban planning is inherently political.

My research questions:

- How have the policies and infrastructure developments for bicycle transportation in Paris and Bogotá increased the adoption of cycling for transportation?
- What are the best practices and challenges encountered?
- What lessons can be drawn from these cities' approaches to inform future sustainable urban transportation planning?

The work is structured as follows: firstly, I provide a comprehensive description and definition of sustainable urban mobility, focusing on the history and present of cycling and describing factors that determine how cycle-friendly a place is. Then, I describe the comparative research methodology and the value of using case studies in urban planning, along with exploring the term “best practice” in the context of cycling-focused policy and infrastructure. In the next two sections, I provide an analysis of policy and infrastructure developments in Paris and Bogotá respectively. A reflection section compares the case studies, discussing similar accomplishments and challenges, and a conclusion synthesizes the most salient results into a set of recommendations for urban policymakers.

To ease the reading experience for my non-expert audience, I provide a glossary.
● **Sustainable mobility**: pertains to transportation systems that fulfill the current transport and mobility needs of society while also preserving the ability of future generations to meet their own needs.

● **Active transportation**: modes of travel that involve physical activity, such as walking and cycling. These modes are often recognized for their health benefits as well as their positive impact on the environment.

● **Cycling infrastructure**: facilities and networks specifically designed for cyclists in urban areas. This includes features such as bike lanes, cycle tracks, bike sharing systems and parking facilities.

● **Carbon footprint**: a measure used to assess the environmental impact of different transportation methods. It quantifies the amount of greenhouse gasses emitted throughout an entity’s entire life cycle, typically measured in units of carbon dioxide.

● **Modal shift**: describes the transition of transportation usage from one mode (like private cars) to another more sustainable mode (such as bicycles).

● **Modal share**: indicates the percentage breakdown of various transportation modes within a given area or population.

● **Multimodality**: involves utilizing multiple modes of transportation for individual journeys or different trips. It emphasizes integrating and connecting various options like public transit, cycling and walking to enhance overall travel efficiency.

● **Density**: refers to the concentration of people, buildings, or activities in a specific area. Most often used to refer to population density (people per square mile) or built-up space density, measured in FAR (floor area ratio), which is the ratio of a building's total floor area to the size of the piece of land upon which it is built.

● **Best practices**: variety of procedures, techniques and methods that have been identified as highly effective in achieving desired outcomes
Theoretical framework

Sustainable transportation is good for people and the planet

Transportation is a crucial aspect of modern life. It shapes our daily life, economic systems, communities and environment. It is also resource-intensive, accounting for about 64% of global oil consumption, 27% of all energy use, and 23% of the world’s energy-related carbon dioxide emissions (IISD, 2021). As one of the main drivers of man-made climate change, making transportation more sustainable can significantly delay global warming through reducing GHG (greenhouse gas) and CO₂ (carbon dioxide) emissions.

What does sustainability mean? Even though it is a popular and widely accepted term, its precise definition is hard to determine. Sustainability first emerged as an ideal in the late 1970s, with the publishing of “A Blueprint for Survival”, a text signed by a group of scientists highlighting the severity of environmental problems. In 1987, the UN Brundtland Commission defined sustainable development as ‘development which meets the needs of the present, without compromising the ability of future generations to meet their own needs’ (Caradonna, 2022). According to this definition, four different objectives have to be accomplished: safeguarding long-term ecological sustainability, satisfying basic human needs and promoting inter- and intragenerational equity. Broadly speaking, sustainability is a desire to create a society that is ecologically minded, stable, safe and prosperous.

The term is generally linked to climate change, and carries a notion of correction, or counterbalance, an attempt to undo or slow down the negative effects of human development on the Earth (Caradonna, 2022). These effects include not only global warming, but also
pollution, deforestation and ecosystem destruction, overharvesting of resources, and agricultural impacts.

Sustainability can be interpreted in several ways, but its principal element is the approach to development that looks to balance different, and often competing, needs against an awareness of the environmental, social and economic limitations we face as a society. As transportation is a key driver of development, it requires a multi-faceted approach that promotes social and economic goals while keeping down environmental impacts. As a balanced strategy is difficult to achieve, economic objectives are often given preference (research agenda). According to Kehagia (2017), a sustainable transportation system must 1) optimally manage resources for construction and operation; 2) improve life quality by conserving energy, reducing pollution and promoting health; 3) ensure an affordable, accessible, time-reliable, secure and flexible movement for all members of society.

A helpful measure of climate change-producing activity is the carbon footprint: the total greenhouse gas emissions caused directly and indirectly by an individual, organization, event or product. It is calculated by summing the emissions resulting from every stage of a product or service’s lifetime material production, manufacturing, use, and end-of-life (UMich, 2022). Greenhouse gas emissions from the transportation sector primarily involve fossil fuels burned for road, rail, air, and marine transit. Almost all (95%) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel. (EPA, 2016). Thus, a transition to fossil fuel-free transportation is configured as one of the main strategies to minimize the impact of climate change on the environment and critical infrastructure.
Sustainable urban mobility

This thesis focuses on sustainable intra-urban mobility. Cities are home to the vast majority of the human population, providing better economic opportunity, education, culture, trade, and mobility options. The appeal of cities is predicated on face-to-face contact, networking and social interactions - location plays a key role, and efficiently carrying out trips is important. Urban mobility involves a wide range of transportation modes, including walking, cycling, public transit (buses, trams, subways), private vehicles (cars, motorcycles), taxis, ridesharing services, and non-motorized options like scooters and skateboards. Transportation that combines several modes of transportation in one trip is called multimodal (Pedestrian and Bicycle Information Center), e.g. cycling and riding the train, or walking and taking a bus. A broad guideline to achieve sustainable mobility: efficiency, alteration, and reduction, or “travel more efficiently”, “travel differently” and “travel less” (Holden, 2007), also known as the Avoid, Shift, Improve framework (ADB, 2009). This framework was developed by the Asian Development Bank as part of the Sustainable Urban Transport paradigm, and is being widely adopted as a structure within which sustainable mobility options can be adopted. At the foundation of the ASI framework are the core ideas that firstly, demand-based approaches to transportation planning and there is a need to manage demand, and secondly, that there is a need for the city to provide affordable, adaptable and implementable mobility (Hickman & Banister, 2014).

However, the most significant change in travel patterns has been observed in the last 50 years: the phenomenon of mass motorization. Motorization refers to the increase in the level of vehicle ownership per capita. The global statistics display consistent growth in vehicle ownership and energy/carbon use (Berger, 2014). The motor car with the internal combustion engine has existed for 125 years and managed in that time to become central to society,
economy and the city (Saedizand, 2022). In addition to cars, many countries in Asia and Africa rely on two- and three-wheeled gasoline and diesel-powered vehicles, as well as vans, trucks, etc., for the same purposes.

**Car dependence**

Car-based mobility is an attractive mode choice due to its flexibility, convenience, and ability to quickly cover large distances, but there is a large amount of social, environmental and economic negative externalities to virtually all members of society (Chatziioannou, 2020). Advertised as free and joyful, the motorized experience is often that of congestion, poor safety record, destruction of urban fabric, consumption of finite resources and high social inequality. The negative externality has been quantified in the European Union, which estimates that a car has an average social cost of €0.11 per rider per km that is not covered by taxes, duties or fees by its owner. In countries with higher rates of subsidization of private vehicle mobility like the US, the number is significantly higher. On the other hand, active transportation provides social benefits in the form of less sick days and health insurance used: €0.18 per km cycled, and €0.37 per km walked (Gössling, 2019).

When car-based mobility is placed in a city context, the externalities worsen due to the lack of space inherent to city living, where the population density is higher than in suburban and rural areas (Saedizand, 2022). As the most space-intensive mode of transport, the car competes for space with other transport modes, and transportation mode change in cities is hampered by commuters using cars to move in urban areas (Gössling, 2019). Despite growing pressure on urban space, many cities continue to accommodate car growth, building road infrastructure and parking capacity (Saedizand, 2022). The phenomenon of excessively car-dominated daily travel patterns is called car dependency, and it is currently considered a serious problem. Some researchers argue that car dependency is associated with high rates of
car travel per capita, car-oriented land use patterns and a lack of alternative transport options (Litman, 2002). Others define it as relying on the car as the only transport mode. Mattioli (2016) describes car dependency as occurring at different levels: the level of the city, the individual and the trip, which all could be car-dependent even if the other levels are not.

The shift to sustainable mobility requires a switch away from personal car-based mobility, also known as the modal shift or modal split change. The conventional approach to transportation planning often emphasizes encouragement of the use of private vehicles and the construction of additional road infrastructure, while the sustainable transportation approach focuses on alternative modes (walking, cycling, transit) and better operation of existing networks. In addition to decarbonisation, there are potent co-benefits from reducing car use, especially in urban contexts: health gains from pollution reduction and active lifestyle, better urban design and livability, congestion, trip satisfaction, independence for non-drivers, reductions in accidents and deaths (Woodcock, 2007). In 2009, the phenomenon of declining car use in the world’s developed cities was first documented (Newman, 2011). The growth of vehicle miles per capita traveled has been declining in many European, North American and Australian big cities: “The Automobile City seems to have hit a wall”. However, this phenomenon is currently confined to urbanized locations with high population density and high socio-economic status populations, and vehicle miles traveled continue to rise globally (Reid, 2013).

A major obstacle to achieving sustainable mobility is urban form, referring to physical characteristics of the built environment: street layout, building distribution and density, land use patterns (Cervero, 2009). A body of research suggests built environments are significant predictors of non-motorized travel (Handy et al., 2002; Frumpkin, et al., 2004). Factors like
residential density, mixed land-use, and street intersection density correlate positively with promoting bicycle and walking travel. The built environment, once built to accommodate cars, as most 20th century housing developments are, is resistant to changes in transportation mode. Destinations in car-centric cities are on average much further away from each other than those planned with other transit modes in mind. A key term in urban planning research is density (Cervero, 2009) - the amount of people, buildings or activities per unit of space. Scattered residential single-family suburbs, shopping malls, office parks are interlinked with historic downtowns through wide roads and depend entirely on cars and fossil fuel use. Public transit often exists, but low-density development has a smaller potential to support effective transit operations due to low ridership and high costs (Cervero, 2011). The fragmentation between land uses and the lack of connectivity makes it ineffective to walk and cycle. There is a large amount of literature on the potential to influence travel behavior through changing the urban form (Stojanovski, 2019).

Low-carbon mobility remains an ambitious goal, as progress comes slowly. Significant progress towards sustainable lifestyles and travel behavior is difficult to achieve, as many options require substantial change. Most urban areas worldwide retain very high car mode shares (Hickman & Banister, 2014), with transport CO₂ emissions high and projected to grow. Especially significant growth is projected in Asian quickly developing, rapidly urbanizing countries such as China and India. Even if sustainable urban mobility is part of the political discourse, implementation often lacks far behind policy advancements: for instance, far-removed in the future goals for “net zero carbon” need to be backed by credible action to reduce emissions. Actions need to be more forward-looking in the policy realm and more successful in their implementation. One of the main obstacles is funding: investment in the restructuring of urban form is rarely a top priority for decision makers. Another issue is the
length of the political window, usually 4-5 years in democratic countries - many crucial sustainable infrastructure projects take longer than that to plan and realize (Hickman & Banister, 2014).

Much of the debate about sustainable mobility is focused on technological band-aids like electric cars, as opposed to tangibly reducing emissions (Cox and Cox, 2022). Even at the level of IPCC, electro-mobility in land-based vehicles - electric cars - is given the first place of priority, in front of fuel and material advancements, overall demand reductions and efficiency, and the creation of multimodal public transit networks. Electric mobility gained enormous prominence in the past decade, spurring large government incentives in many places, notably California, where $3.2 billion dollars were given to Tesla by the state of California since 2009 (GovTech, 2022). There are entrenched economic interests in the car and fossil fuel industry that promote “greenwashing” related to EVs, claiming that they are a sustainable mode choice. Much attention has also been given to the so-called “Smart City” which necessitates the implementation of technological innovations such as the Internet of Things, AI, sensors and other boondoggles (Kovačić, 2022). While these projects are important and necessary in many cases that do not relate to personal mobility, their costs do not correspond to the utility towards the issue of addressing climate change.

These solutions are not enough - we cannot drive our way out of the climate crisis. Firstly, the electric car is as sustainable as its energy source, which means that unless a “clean” electricity generation method is used, GHG gasses are emitted into the air at the moment of electricity production (ibid). Electrifying cars will only lower emissions if people drive less, as they still have a large carbon footprint, as do car-dependent built environments. Electric cars are also more dangerous to pedestrians due to their weight, and EV manufacturing,
operation and infrastructure still require a lot of resources and space (TransAlt, 2019). Worse yet, they are likely to worsen ecological degradation, geopolitical tensions, armed conflict and human rights abuses associated with the worldwide mining of critical minerals needed for electric batteries (Zeng, 2022). It is actually more sustainable in terms of carbon footprint to keep using an old internal combustion engine car than purchasing a new electric car, as manufacturing emissions offset additional emissions produced by existing gasoline cars (Kagawa, 2021).

There are, however, emergent sustainable transportation practices in rail, light rapid transit (LRT), walking and cycling, and urban planning, specifically land use policy. While rail and LRT facilitate trips over medium and long distances, walking and cycling cover short and medium distances. Well-designed sustainable multimodal transportation systems allow for fast and easy connections between different modes of transportation (Myrovali, 2023). On the mode shift side, automobiles per household and VMT (vehicle miles per capita traveled) are clear and quantitative measures of car dependency, and a reduction goal is easy to integrate into policy (Holtzclaw, 2004). The need to reduce distance between destinations culminated in the concept of a 15-minute city, which focuses on principles of human-scale urban design, density of residents, flexibility and connectivity (Khavian-Garmisir, 2022).

**Active transportation**

Active transportation is the most sustainable mode of transportation. It consists primarily of walking and cycling, but scooters, skateboards, and personal motorized devices are also included. Walking is the most environmentally-friendly active transportation behavior. Cycling also causes virtually no environmental damage, its emissions are negligible and have
to do with the need for infrastructure, manufacturing and maintenance (Fishman, 2016). Both of those transportation modes promote health through physical activity, take up little space, and are economical both in direct user costs and in public infrastructure costs (Pucher, 2021).

Active transportation has a lot of positive externalities. It has a positive effect on health, particularly as a source of moderate to vigorous activity (Buehler & Pucher, 2021). Cycling for transport enables people to incorporate physical activity into daily life. There is also a large body of research proving that physical activity is important for improving mental health, reducing anxiety and depression (Hensley et al., 2014). In study cases where social and public health benefits of active transportation have been monetized, resulting savings for the government healthcare system were considerable and led to increased investment in cycling facilities (Gössling, 2019). There exist secondary benefits from reduced motor vehicle use, when car trips are replaced. It has an excellent effect on quality of life as it manifests in better streetscape design and public spaces for people to meet and spend time together (Gehl, 2010). The Danish architect Jan Gehl, a long time pioneer of reorienting the city to the pedestrian and the cyclist, states that slow traffic means lively cities, and lengthy outdoor stays means lively residential areas and city spaces. The concepts of livability, urban vitality, street life and other spatial quality attributes, while somewhat fuzzy, aim to describe urban environments characterized by a high quality of life that encompasses both environmental and social amenities (Ahmed, 2019). Providing human-scale architecture, greenery, less cars, slow travel speeds and urban furniture are common interventions to make public spaces more attractive and livable (Hensley et al., 2014).
Cycling for transportation

Cycling is the most efficient form of urban transit - it requires few resources and generates few adverse environmental and social impacts. Central to cycling’s efficiency is its reliance on power produced by the human body, a sustainable and renewable energy source. Cycling is around 5 times more efficient than walking and 10 times more efficient than driving a car (UCSD, 2011). To illustrate, one hundred calories can power a cyclist for 3 miles (15,000 feet), but it would only power a car 280 feet. The spatial efficiency of cycling also stands out, as it eschews the space requirements associated with motorized modes of transportation. By doing so, it alleviates urban congestion - both on the roads and in parking areas - and facilitates seamless movement within densely populated urban areas (Rietveld & Daniel, 2004). Its operational attributes, characterized by minimal friction, rapid acceleration, and ease of navigation through city streets, make cycling particularly well-suited for short- to medium-distance commuting (Fishman et al., 2015).

The groundbreaking potential of cycling directly relates to its use as a short-distance transportation tool to replace motor car travel. This becomes especially pertinent in car-oriented environments. For example, in the United States. In 2021, 52% of all trips, including all modes of transportation, were less than three miles, with 28% of trips less than one mile and under (Energy.gov, 2022). These are distances that could easily be covered by a bicycle but are usually done by car due to an auto-dependent pattern of land use that places daily commuting destinations far away from residences (Saeidizand, 2022). While walking to destinations often takes an unfeasibly long time in suburban landscapes composed largely of single-family homes, cycling can become a leading sustainable transportation mode.
Cycling, although often hailed as a panacea for transportation, does have its limitations. Primarily, it's not universally accessible, requiring a level of physical fitness and skill. This makes cycling less feasible for individuals with disabilities, the elderly or those who don't feel like riding in traffic. Moreover, extreme weather conditions or long distances can make cycling impractical, limiting its usefulness in areas or for people with longer commuting routes. Additionally, cycling doesn't address the need for transporting goods, which is an important aspect of urban and intercity transportation. While cycling is an option for short to medium distances under favorable conditions, a comprehensive approach to sustainable transportation should encompass various methods like public transit, walkability, electric vehicles, paratransit and taxis to ensure accessibility and practicality for everyone.

**History of cycling**

The history of cycling as a mode of transportation goes back to the 19th century. In the 1810s, the "running machine" or hobby horse, a precursor to the modern bicycle, was invented. However, it was the 1880s when the safety bicycle, featuring equally-sized wheels and a chain drive mechanism, gained popularity and made cycling a practical and efficient means of transportation and recreation (Pucher & Buehler, 2008). After that, cycling gained explosive popularity, with cycling clubs, mass-produced manufacturing and dedicated infrastructure. In fact, as the author of the book Roads Were Not Built For Cars argues, it was early cycling advocates that influenced road improvements that would evolve into modern roadways, now primarily used by motor vehicles (Reid, 2015). First a toy and sport vehicle for the European and American elite, bicycle use expanded, and by the late 1920s, they were a staple transportation mode for the working class in many countries. National differences accounted for varying levels of popularity in different countries, and bicycling has historically seen sharp spikes of interest, or “booms”, followed by quick drops (Reid, 2017).
This haphazard nature of bicycling interest did not generate enough political support to adopt policy that would consider cyclists as road users who deserve their own right of way (Longhurst, 2015).

By the mid-1930s, cars became more financially accessible and started taking over the road space. Legal, political and infrastructural decisions have ended up privileging the automobile (Reid, 2013). After decades of prioritizing motor vehicles, cycling began enjoying a slow but steady renaissance. In the 1970s, the convergence of an oil crisis, growing environmental awareness, and the recognition of the pollution brought on by cars caused a “bike boom” worldwide. While short-lived in the USA at only 4 years, the numbers were striking: bicycle sales reached 15 million in 1973, the highest year on record (Reid, 2015). Since then, cycling has continued enjoying a slow return: the Economist reported in 2012 that total bike trips have tripled since 1970, and that bike commuting has doubled in a single decade (The Economist, 2012). In 2020, the COVID-19 pandemic triggered a new wave of interest in cycling, spurred by quarantine lockdowns and the ever-expanding reach of the internet.

Nowadays, the general consensus between urban planning and transportation experts is that cycling is a vital part of a city’s sustainable urban mobility plan (Pucher & Buehler, 2008). It cannot and should not completely cover the travel needs of every resident; moreover, cycling works best in tandem with a multimodal public transit system that provides opportunities to ride public transport to travel long distances easily, while relying on bicycles when they need extra flexibility, or to cover the first/last mile to and from transit stations (World Bank, 2022).

Electric bicycles, or e-bikes, are a promising recent technology that could make cycling for transportation easier, more comfortable and more accessible to all. They enhance the
experience of cycling by providing an electric motor, also known as an e-assist, which makes pedaling easier and increases the average speed to 25-40 km/h. This has manifold additional benefits, allowing users to cover longer distances faster without becoming physically tired and carry heavy loads like grocery shopping or children. Most importantly, e-bikes make cycling accessible to more people by reducing the base physical fitness needed to ride - this effect is especially pronounced in locales with hilly or mountainous terrain, where strenuous riding uphill can serve as a deterrent. Studies promote e-cycling for population groups like parents with children, seniors, and urban commuters who do not want to increase their heart rate, sweat, or need a change of clothes after reaching their destination. E-bikes are proven to be more effective in replacing car trips due to their larger storage and towing capacity compared to pedal bicycles (Bigazzi, 2020). In practice, many cities have provided tax breaks and subsidies to offset the high cost of e-bikes and incorporated e-bikes into their bikeshare systems, as they are a technological solution to many conventional cycling problems that keep people away from trying cycling.

The successful global case studies of widespread adoption of cycling for transportation are few and far between compared to the vast majority of built environments. They thus become incredibly important to study. While I would like to focus on emerging cycling cities that are slightly under-researched, there are countries that are universally recognized as cycling leaders: Netherlands, Denmark, Germany; and cities that stand out as leaders by high cycling mode share in their country: Amsterdam and Utrecht in the Netherlands, Davis and Portland in the USA, Bremen and Munster in Germany, Strasbourg and Bordeaux in France (Holden, 2007). Many sources in this thesis agree that the Netherlands and Denmark are two countries with the most cycling-friendly built environments (Kreutzarek, 2022).
The Netherlands as a model for cycling

Oil crisis and country-wide spurred campaigns in the Netherlands to ramp up funding for cycling infrastructure: 50 years down the line, Netherlands is the most bicycle-friendly country in the world and a source of inspiration for every city aspiring for sustainable mobility (Bruntlett, 2018). The bicycle mode share is 28% (de Haas & Kamersma, 2019), and the modal share has remained relatively stable (30% in 1999) even as active mobility declined in Western Europe and the USA (Buehler, 2012). There are more bicycles than cars in the Netherlands, and the average distance cycled per day per person is 3 km. Bicycles are particularly popular for short trips 500 meters to 5 kilometers in distance, with shorter distances covered by foot and longer ones by public transit or car. While bicycles do not play a major role for every trip purpose, they make up over half - 52% - of all-education related trips, owning to the fact that cycling infrastructure is safe enough to use for children for independent commuting to school, as cycling benefits the mobility of city residents who are not old enough to drive a car (de Haas & Kamersma, 2019).

How was this achieved in 50 years? Researchers and urban mobility authors argue that the combination of strategic investment in cycling infrastructure combined with disincentivizing car travel worked to create an environment where cycling was 1) safe; 2) fast; 3) convenient (Bruntlett, 2018). The Netherlands has a dense, fully separated from car traffic network that is 35,000 km long, equal to a quarter of the road network. Car travel is disincentivized by high fees and taxes, restricted parking and streets designed to slow down vehicles, with most streets having speed limits of 30 km/h, or 19 mph. (ibid) There are many other factors contributing to the popularity of cycling in the Netherlands, like flat terrain, densely populated cities due to the small size of the country, long-time prosperity and a democratic culture. One of the sociohistorical reasons that stands out. Attention to infrastructure is
ingrained into Dutch culture by geographical necessity: for centuries, the low-lying country has fought a battle with nature over keeping water away from land, drying land and reclaiming large territories. Carefully engineered water infrastructure like canal networks, dykes and water pumps require maintenance, provided by the Ministry of Transport and Infrastructure, which has existed since 1809 (government.nl, 2011). The successful case example of the Netherlands demonstrates the policies that promote urban cycling for transportation in action.

Finally, bicycles help create equitable cities. Existing class inequalities can be seen in the modes of transportation preferred, so it is important for those interested in issues of social justice to recognize the bicycle as a tool of liberation, connecting the most vulnerable populations with access to better-paying jobs as well as healthcare for a very low cost per trip.

**Determiners of cycling**

One of the largest determinants of cycling is the built environment and the infrastructure, previously referred to as urban form. Many researchers and activists have discussed the characteristics of the built environment in the city that lends itself well for urban cycling. Cycling activity is high in cities that 1) have a mixed, dense land-use pattern; 2) actively promote cycling; 3) have well-developed public transportation services; 4) have cycling infrastructure. (Meng et al., 2014). Cycling infrastructure encompasses features like bike lanes, cycle tracks, bike sharing systems and parking facilities. Bicycle infrastructure is considered to be of outsized importance as a determiner of how many people will cycle, providing more perceived safety by physically separating cycle ways from motor and pedestrian traffic, providing an unobstructed path. Previous research supports the broad conclusion that bicycle infrastructure induces more bicycle traffic (Fosgerau, 2017). “Build it
and they will come” has become a slogan for bicycle activists all over the world advocating in their cities. The theory is slightly contested, as not all places that build infrastructure spur immediate mode shifts (Reid, 2017).

Social, cultural and behavioral factors have a significant impact on the popularity of cycling in urban areas. One key factor is the perception that cycling is seen as less prestigious compared to driving. In many societies, driving has become the norm for transportation due to lobbying efforts, subsidies, marketing and societal preference (Semenescu, 2022). Moreover, there is a deep rooted cultural belief that cycling is more suited for leisure rather than being a legitimate mode of transport. This perception is reinforced by its association with sports and exercise, leading to the notion that only those in vehicles have a true purpose while commuting and disregarding the genuine transportation needs of cyclists (Hickman & Banister, 2014). Additionally, while challenging weather conditions like long winters or heavy rainfall can pose difficulties for cycling enthusiasts, many cities around the world successfully maintain vibrant cycling cultures despite such challenges: Amsterdam gets lots of rain, while Helsinki’s snowy winter lasts 5 months. These factors highlight the importance of not just addressing infrastructure barriers, but also changing societal attitudes and correcting misconceptions about cycling.

The implementation of bicycle infrastructure in cities comes with considerable challenges, mainly due to a disregard for cycling as a primary mode of transportation. Although the specific obstacles may vary depending on the location, there are consistent barriers that can be identified across the board. Brezina and Castro (2017) classify these barriers into three main categories; legal restrictions, planning limitations and deficiencies in infrastructure. The prevailing approach to transportation planning, known for its quantitative and "rationalist"
nature, further complicates matters (McLeod, 2020). This is particularly evident in the United States, where planning predominantly focuses on automobile traffic and prioritizes speed and traffic volume throughput above safety, ignoring the needs of cyclists, pedestrians and transit riders. Unfortunately, these harmful practices have spread worldwide, particularly in one of my case studies, Bogotá, where multi-lane high-speed *avenidas* with grade-separated crossings pose barriers to active transportation.

By examining Hamburg, Germany as a brief case study, we can uncover specific challenges faced by many cities with cycling. Hamburg grapples with issues such as limited physical space, a lack of political determination, financial constraints and an inadequate understanding of travel patterns and demands within the city. A significant point of contention arises when private stakeholders resist giving up on street parking spaces to create dedicated bicycle lanes. This often leads to prolonged and intricate negotiations between the city, residents and businesses (Wang, 2018). These issues highlight the broader conflict surrounding how urban space is allocated—a tug of war between different stakeholders competing for limited resources in the urban environment (Giuliani, 2015).

Psychological reasons exist behind people's resistance to changing their travel habits and incorporating more cycling. One reason is path dependence, which refers to ‘self-reinforcing mechanisms that exist in the logic of production to ensure that a type of product prevails on the market even though better alternatives exist’ (Hensley, 2014). Various forms of path dependence have contributed to the dominance of policies and designs that support car-based transportation, at the expense of public transport and active modes of transportation. This has resulted in suboptimal car-dependent development patterns becoming entrenched. A study highlights mental barriers as unquestioned assumptions that hinder considering all available...
options or disregarding certain potential actions. The study also argues that decision makers like politicians and planners often overlook the needs of cyclists due to deeply ingrained beliefs (Brezina, 2020).

Cycling as a form of sustainable transport is indeed beyond transport and should also cover institutional reform, governance, policy making, interactions between the transport sector and other sectors (Zhou, 2012).
Methodology

Learning from other places is a necessary, yet often overlooked concept in the field of urban planning. Each city and town is unique in some ways, yet places can be very similar in certain respects. Transportation, utilities, housing availability, and production are all vital urban functions that can be benchmarked against each other, especially when quantitative measures of performance exist. In this thesis, I will compare Paris, Bogotá and Denver not only with each other, but with so-called “best practices”, a collection of peer-reviewed research articles from various fields as well as less formalized data collected by pro-cycling groups, non-profits, journalists and simple cyclists.

The comparative method

Comparative urbanism is the study of similarity and difference among cities and urban processes (Nijman, 2017). It is believed that while cities have their own unique historical, cultural and socio economic contexts, they also face challenges that are intensified by globalization. However, comparisons are often difficult due to the different legal, economical and organizational systems, even as globalization makes places more alike. While there is value in describing commonalities in the spatial re-ordering of cities, robust comparative conceptual frameworks and methodologies must be clearly defined (ibid).

Embarking on a comparative urban politics research agenda requires a certain degree of reductionism to decenter the context that characterizes policy evaluation in a single-case study. In my thesis, I intend to bridge the difference in city contexts by using several qualitative factors, depending on which data the city collects: modal share percentage, number of riders and trips, kilometers of bicycle infrastructure, adherence of network to best practices, and other quantifiable measures.
One significant advantage of comparing cities is the opportunity to examine best practices and innovative solutions. As cities strive to address common challenges, which strategies prove to be more successful than others? Comparative analysis helps identify approaches that yield the most favorable results and understand the conditions underpinning their success, offering a balanced perspective on the objective strengths and weaknesses of different policy initiatives (McLeod et al., 2020).

Comparison also involves understanding why certain policies succeed in one context but may not perform well in another. This encourages urban researchers to critically dig deeper into the socio-cultural, economic and political dynamics that shape policy outcomes. By doing this, it ensures that we don't simply apply the lessons learned from one city to another without considering its unique characteristics (Söderberg, 2023).

Beyond academic research, comparing cities is crucial for fostering global collaboration in urban governance. In today's interconnected world, cities are nodes rather than isolated entities. By creating a platform for sharing knowledge and learning from each other, comparative studies can help cities adopt successful policies and avoid repeating the same challenges without taking advantage of collective wisdom (Söderberg, 2023). Comparative policy analysis offers more than just a list of effective and ineffective policies, providing deeper insights into urban governance, stakeholder conflicts, and the role of public engagement and activism in shaping urban environments.
Case study structure

In my thesis, I will be using a mixed-methods comparative approach consisting of document and media collection and analysis, followed by a comparative analysis. The document collection will feature academic articles and books, planning documents such as master plans, maps, transportation studies, strategic documents, etc. Media features will consist of journalistic articles, blog posts and even social media posts, as progress happens fast and is often documented in online, transient forms of communication. I verify the claims made in such online sources to the best of my ability by using triangulation: cross-referencing results with documentary evidence and site observations to ensure validity. I then identify commonalities and disparities, assessing the content of bicycle-related policy and the impact of different policy strategies in each city. I describe in detail the local context that led to the adoption of bicycle policy, focusing on political actors and activists, recognizing the influence of geographical, cultural and economic factors. Finally, I will draw conclusions and extract lessons and best practices for advancing sustainable transportation through bicycling.

When a city or country decides to solve a transportation problem, it will often seek to learn from somewhere else. According to transportation researcher Alon Levy of the blog Pedestrian Observations (2022), comparative learning in the transportation sector can be symmetrical or asymmetrical. Symmetrical learning occurs in macro regions, often geographically and culturally close: the Nordic countries, the German-speaking countries, within Southern European countries like Spain, Italy and Turkey. The members of these regions benchmark their national performance to that of others, and there are horizontal ties and an openness to learning. There exists also an asymmetrical core-periphery model within most locations: Levy takes Southern and Northern Europe as an example. Within Europe, the Nordics and large Western European countries like Germany and France are seen as the core,
while the South is the periphery. Nordic planners cite other Nordic planners as cases to learn from but not Southern ones, while Northern practices penetrate into the South with relative ease. This core-periphery model can be extrapolated to the whole world, where the Anglosphere is the global core and the rest of the world is the periphery. Pedestrian Observation argues that the United States, as a global leader in many aspects, is often reluctant to learn from other countries, choosing instead to focus on best practices within the country. These learning asymmetries impose false hierarchies of “good countries” and prevent effective knowledge transfer: thus, I attempt to avoid this practice by focusing on completely different geographical areas.

In this thesis, I wanted to bridge the knowledge gap by using two completely different cities in different contexts that rarely, if ever, are compared to one another. In my case selection, I am using two cities: Paris, France and Bogotá, Colombia. As a European capital, Paris has seen galloping advances in bicycle infrastructure and the modal shift, and its urban form and land use are benevolent to sustainable transportation modes like transit, cycling and walking. Bogotá is a Latin American capital that managed to become world-famous due to its pioneering transportation solutions like the bus rapid transit system TransMilenio and its high usage of bicycling for commuting.

The concept of “best practices” encompasses a variety of procedures, techniques and methods that have been identified as highly effective in achieving desired outcomes (Kreutzarek, 2022). These practices are determined through research, empirical evidence and the successful experiences of users worldwide. In this thesis, I rely on this concept to describe practices that stimulate the increase of modal share of cycling.
Policy best practices

All bicycle infrastructure starts with policy. Most cities who pursue cycling for transportation create plans as part of their long-range urban planning, outlining the existing and proposed network with the use of maps (McLeod et al., 2020). To compare and contrast different cities’ success with increasing the mode share of cycling, a framework is needed to compare the characteristics of a city’s plan to one of best practices. According to the literature, there are several characteristics of a successful bicycle plan in cities that have undergone a cycling transformation: vision, equity, infrastructure, cohesion, safety, implementation, funding, sustainability (Kreutzarek 2022). The methodology outlined below aims to provide a perspective on analyzing these policy documents encompassing various cities and spanning an extended timeframe.

Objectives and Vision

A crafted bicycle plan hinges on the fundamental principles of clear communication and goal setting (McLeod et al., 2020). To effectively guide city officials, stakeholders and the public, the plan's objectives to improve cycling must be unambiguous, while its overarching vision should vividly portray the desired future. Furthermore, these objectives can be made impactful by linking them to tangible and measurable outcomes. For example, establishing targets like "Achieve a 20% increase in cycling modal share by 2030" provides a benchmark against which progress can be periodically assessed. This allows for adjustments along the way (McLeod et al., 2020).

McLeod et al. (2020) emphasizes that inclusivity is not a virtue, but a necessity in urban planning, particularly within transportation frameworks. To ensure the effectiveness of a bicycle plan, it is crucial to consider the city’s underserved areas and populations. By taking
an equity approach to network design, we can promote equal access to cycling infrastructure for all demographics and regions, thereby fostering a cycling culture that encompasses the entire city.

The development of infrastructure plays a large role in implementing transportation policies. As highlighted by Canitez (2019), it is essential to have infrastructure such as protected bike lanes and bike sharing stations in order for a city’s commitment to promoting cycling not to be merely symbolic. Additionally, sustainable infrastructure should include maintenance protocols, potential upgrades and adaptability to changing urban landscapes, for instance, cleaning during adverse weather conditions.

In cities with complex transportation networks, it is crucial for cycling infrastructure to seamlessly integrate with other modes of transportation like buses and subways. This bike-transit can take the form of storage and bike shares at stations and train carriages for bicycles. This interconnected approach described by Bruntlett (2018) expands accessibility and attractiveness of cycling while also ensuring coexistence between cyclists and pedestrians in shared urban spaces.

The safety of cyclists holds outsized importance when aiming to increase ridership. Riders’ confidence in their safety is vital for any strategy aimed at encouraging people to cycle. Malgras (2023), studying Paris, emphasizes safe infrastructure for all users as a primary factor in attracting new riders, with broader initiatives such as public awareness campaigns, educational programs and strong enforcement mechanisms that can further reduce risks for both cyclists and drivers.
A successful policy is one that resonates with its intended beneficiaries. According to McLeod et al. (2020), continuously engaging with the public and ensuring voices shape the policy can significantly increase its acceptance and effectiveness. This practice is known as participatory planning. Beyond consultation, during the design phase, establishing a reliable feedback mechanism ensures that the policy remains adaptable, allowing officials to incorporate evolving public needs and preferences.

Every ambitious plan requires a financial strategy. As McLeod et al. (2020) argue, for a bicycle master plan to go from concept to reality, it must have dedicated allocations. Moreover, considering the long-term nature of plans, it is essential to identify and secure sustainable funding sources to ensure that fiscal constraints do not compromise the vision of the plan.

When it comes to implementation and following through, a plan can only be effective if it is rigorously put into action. Robartes et al. (2021) highlight the importance of having timelines and well-defined roles for different stakeholders involved, including city departments and community partners. This clear delineation of responsibilities ensures accountability and increases the chances of successful execution on the ground.

It's important to remember that a city's bicycle master plan should not exist in isolation, but rather align with city objectives related to the environment, socioeconomic factors and equity. As suggested by McLeod et al. (2020), when the plan is in sync with these overarching goals, it has a greater potential for making an impact. It is thus important in the sustainable transportation context to determine whether the city or broader governmental entity is
pursuing ambitious “progressive” legislation towards broadly sustainable goals like climate change adaptation and mitigation, environmental justice, and equity.

**What is good cycling infrastructure?**

While it is important to have multi-faceted policies to stimulate cycling, it is even more important to provide good street design that is successful in attracting riders. Literature review on the factors that encourage/dissuade cycle use suggests that the potential rider’s perceived safety is the main deciding factor, compared on a range of other determinants including the coherence, directness, attractiveness, safety and comfort of the network (Hull, 2014).

Good design can definitely encourage cycling. The planning documents that encompass guidance on design elements can be design handbooks, manuals and official guidelines on bicycle infrastructure, published by government entities, researchers or activists. Many of them are recommendations, while some have an element of enforcement, e.g. Complete Streets ordinances in the USA (infrastructural manuals) where the design policy requires pedestrians and cyclists to be considered as part of street reconstruction (Pedestrian and Bicycle Information Center).

To illustrate the principles of successful design, I will again turn to the example of the Netherlands, who produces an incredible amount of literature, data and cycling know-how for creating effective cycling infrastructure and appropriate cycle facilities (Bicycle Infrastructure Manuals, 2023). The “CROW Design Manual For Bicycle Traffic” (2016) provides 5 main principles of successful bicycle infrastructure, explained below.
| Cohesion          | Describes the level of interconnectedness between origins and destinations, the ability to cycle from anywhere to anywhere. Cycle-friendly infrastructure should “form a cohesive whole and link all origins and destinations that cyclists may have”. Examples of destinations are residences, education facilities, shopping, sports, recreation facilities, etc. |
| Directness       | Refers to creating short and fast routes, minimizing detours and turns. This reduces time commuting and physical effort, and enhances safety. Directness can be achieved by having a dense network, creating cycling- and pedestrian-exclusive routes, and correctly identifying major commuter flows. |
| Safety           | Refers to road safety as well as public health: reducing stress and minimizing exposure to pollution and noise. Infrastructure, including bicycle infrastructure, should guarantee the safety of all road users. This is to be achieved by avoiding differences in speed and mass, providing a separate physical space for drivers, cyclists and pedestrians. On the street design level, this means segregating different vehicle types by providing solitary cycle lanes or using physical separators. In intersections, where the majority of traffic accidents occur, best practice is to provide grade-separated crossings: aligning the junction of different traffic modes at different heights. Wherever that is impossible, maximum visibility and traffic calming is to be used. At the network level, links between routes should be planned to avoid exposure, accident risks, emissions, noise and stress are avoided. |
| Comfort          | Comfortable bicycle infrastructure should ensure that cyclists experience minimal stops or nuisance. Comfort encompasses many facets of cycling: avoiding physical effort by eliminating sharp inclines and unnecessary stops, and having suitable road paving. On the network level, cycling trips must have direct connections, avoid detours, and reduce bends. |
### Attractiveness

Even more subjective than comfort yet essential for inducing ridership, this measure should not be overlooked. Practice and evidence indicate that cyclists prefer areas that are green, open, by the water, lively and traffic-less, and dislike feeling unsafe, traffic, congestion, darkness and industrial/deserted areas.

The below graph from Kreutzarek (2022) identifies physical “infrastructural elements which improve the overall safety or the comfort of the cyclists, as well as enhance the directness and the interconnectivity of a bicycle network”. This graph demonstrates that there are solutions to nearly every problem a cyclist might encounter navigating the city.

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Case Study #1: Paris

In recent years, Paris has received a large amount of attention from sustainable transportation researchers and cycling advocates. What baffled them the most was not just the large size of the cycling network or the forward-looking policies: the main feature in Paris’ cycling transformation was the speed with which changes were undertaken. Under Mayor Anna Hidalgo’s transformative leadership starting in 2014, Parisian streetscapes changed quickly, adding cycling infrastructure and starkly increasing the modal share to 7%, with the fastest growth observed after COVID-19 lockdown (Possible, 2023). More importantly, cycling measures were enhanced with broader policies to create more sustainable and resident-focused neighborhoods.

Overview
Paris, the capital of France, has 2.1 million residents in the central district, while 12.2 million reside in the Île-de-France metropolitan area. This paper focuses on the central district, circled in red, as a separate commune (municipality), governed by a mayor and a municipal council. The area of this core district is 105 km² and therefore has a population density of around 20.000/km² (Wijnstekers, 2022).

Logically, Paris seems poised to adopt cycling for transportation. It is a city of short distances, compact street network and high population density, which are aforementioned factors that typically support short distance non-motorized travel. However, there were also obstacles to overcome in order for Paris to become a haven for cyclists. The city streets are often narrow and busy, with no space for bicycle lanes without taking space from cars or pedestrians (Wijnstekers, 2022). There was a need to overcome cultural inertia, as many Parisians had become accustomed to car-centric transportation. Additionally, creating a cycling infrastructure that included bike sharing programs and adequate parking required substantial investment and planning efforts. Despite these challenges, Paris' commitment to urban mobility and proactive policies gradually established its reputation as a leading cycling city on the global stage (Possible, 2023).

Paris expanded its cycling infrastructure significantly, growing its network from 737 km in 2014 to 1,442 km in 2022 (Ville de Paris, 2023). The mode share for cycling in the city, according to Najdowski, was between 3-5% prior to the implementation of Plan Vélo. Since then, and notably after the COVID-19 pandemic, cycling trips have risen to represent 7% of all trips (Ville de Paris, 2023). Additionally, the use of cycle paths surged by 71.6% from 2021 to 2023, reflecting the city's successful efforts in promoting bicycle use (Ville de Paris,
Anne Hidalgo has stated in a recent press cast that in 10 years, car traffic has decreased by 40%, and pollution by 45% (Hidalgo, 2023).

Use of the capital's cycling facilities jumped by +37.3% just in the first quarter of 2023, according to figures from the Parisian Mobility Observatory (Paris en Selle, 2023). This suggests that the rate of growth in cycling ridership does not correspond in a linear fashion with the length of the network, but rather that the network cohesion has reached a point where the connectivity of the network makes journeys by bicycle more attractive than other transport modes. In other words, a critical mass has been achieved.

**Policy analysis**

**Bicycle plan**

The transformation of Paris into a city that embraces cycling can be traced back to the 1970s, when the first attempts to take back urban spaces from cars were taken by the city’s mayoral team (Possible, 2023). These measures included reducing parking spaces, introducing paid parking. The first bicycle plan was introduced by Mayor Jean Tibéri and laid ground for the first 180 km of cycle lanes (many shared with buses) on main roads. Tibéri also adopted “ten concrete measures allowing to achieve a better shared public space” aimed at allocating more road space to cycles, including providing adequate cycle parking facilities. These developments paved the way for more substantial change under the administration of Mayor Bertrand Delanoë (2001-2014), who continued creating lanes for public transport and cycles, widening pavements, creating pedestrian areas and enlarging the programme of 30 KM/h zones (possible). In 2007, the public bike share system Vellib started. These examples suggest that mayors of French cities hold a lot of power within their communities to influence transportation decisions, and this is proven by Hancock (2015), who demonstrates that
decisions and investments in walking and cycling for Paris, and the different surrounding districts, are largely taken at the local level and guided by the local mayors. The relatively long mayoral term lengths of six years, renewable once, are conducive to implementing and seeing through transportation policy, where change often takes a long time.

The new era of cycling in Paris began in 2014, when Anne Hidalgo of the Socialist Party, a former deputy to the outgoing mayor, became the first female mayor of Paris. She was later re-elected for a second term mandate in 2021-2026. Upon election, Anne Hidalgo declared her strong commitment to implement measures to reduce car use and make Paris an exemplar of a cycling city (Xiao et al., 2021).

The first Plan Vélo (Plan Bike) (2015-2020) introduced under Hidalgo set an ambitious target for cycling improvements, aiming to triple the number of cycle journeys by 2020 (Ville de Paris, 2022). This resulted in having 1094 km of cycle lanes in 2021, doubling the network’s total length (Possible, 2023). It identified the potential for the development of cycling: planners estimated that 13% of total trips could be done by bicycle, as the average distance between destinations in Paris was 2.8 km. Over 2015-2020, the Council reported having achieved significant shifts in use of cycle lanes (+47% on average between 2019 and 2020 and +22% between 2020 and 2021). Despite success, only 56% of planned cycle lanes and 50% of street calming targets were reached (Paris en Selle, 2022).
The focus of the original Plan Vélo lay in the REV (Reseau Express Vélo) project, focused on providing north-south and west-east connectivity. Anne Hidalgo had mentioned in interviews that the era of being able to traverse Paris by car through the center was over, and these trips were seen as potential for cycling (Reid, 2023). The allocations of cycling infrastructure followed the logic of effective development based on the network as a whole. Cohesion, described as one of the five principles in the CROW manual of cycling infrastructure, was one of the guiding principles for cycling network development. This was also applied in the development of the cycling infrastructure of Plan Vélo (CROW, 2017; Najdovski, w. d.)

A large catalyst for positive resident perception was the Seine river right bank redevelopment project, which reduced lanes of traffic from two to zero and transformed the bank into a pedestrian space (Possible, 2023). Waterfront redevelopments have long been catalysts for
radical urban change in cities, with high-profile examples in Hamburg, Copenhagen, Seoul and San Francisco. By transforming riverfronts away from industrial uses or roads into public spaces, new attraction points appear by the water. Additionally, Paris transformed the high-end Rue de Rivoli into a bicycle-friendly street with only one car travel lane (Possible, 2023).

Aside from the network, key features of the Plan Vélo 1 include the emphasis on creating a cohesive network instead of isolated routes, increasing bicycle parking capacity, integrating locked storage boxes and train stop facilities, establishing cycle lanes that counter car flow, adjusting red light timings for cyclist convenience, providing subsidies, and nurturing a vibrant bike culture (Ville de Paris, 2022).

The tracking tool Plan Vélo Observatory by activist group Paris en Selle provides a useful graphic quantifying the implementation of the 2015-2020 plan (Paris en Selle, 2022). This citizen oversight in addition to ambitious targets has allowed Paris to progress rapidly towards its goals.

The success over 2019-2020 spurred more change into action, and the current Plan Vélo 2 for 2021-2026 was brought into action by Mayor Anne Hidalgo after her re-election on a platform of turning Paris into a 15-minute city. This time, the goal was as unambiguous as it was ambitious: to make Paris a 100% cycling-friendly city (Ville de Paris, 2023).
The main network - or Vélopolitain - is the structuring cycle network, with a high level of service, and integrates the axes of the suburban network, the RER Vélo. It is also part of the Greater Paris Metropolis bicycle network. The main network's cycling infrastructure follows best practice recommendations: the paths are secure, separated from traffic, wide and comfortable. The secondary network completes the mesh of the structuring network more finely. The city of Paris has not yet committed to following qualitative specifications for safety and comfort on these smaller bicycle facilities, and they can be a little uncomfortable for riders (Paris en Selle, 2023).

In addition to central cycling facilities, the network expands more and more ambitiously into the suburbs. The regional network RER Vélo has been renamed to Vélo Ile-de-France in
2023, and 11 lines are planned to connect the center and suburbs. The figure below represents the planned network in 2023 through 2030 (Paris en Selle, 2023).

When analyzed through the CROW bicycle infrastructure design framework, out of 5 principles of good cycling design, cohesion and directness are practiced through the densification of the networks and the provision of direct routes, hubs and links. While these connected routes definitely provide for a more attractive commute, the design decisions will be discussed in the infrastructure section.

Paris en Selle, the cycling citizen association, tracks the rate of implementation of Plan Vélo 2 on its Observatory website (Paris en Selle, 2023).
Beyond the scope of the bicycle network, various other mobility policies have been implemented to reshape Paris’s landscape. One key focus is the vision outlined in the Plan Vélo 2: “To reduce as much as possible all individual motorized journeys that can be made in a way other than motorized and individual towards virtuous modes of transport” (Ville de Paris, 2023). This guiding principle drives the reconfiguration of urban space, shifting towards pedestrian-friendly streets and vibrant public spaces over car-centric areas. Realizing this vision demands the continuing use of strategies to deter car usage, notably the 30 km/h speed limit, restricted/paid entry into the city center, a progressive parking policy and car-free streets. Another key part of the 2021-2026 plan is incorporating gender equity considerations into the design of public spaces, making the outside safer for women and accommodating their needs (Ville de Paris, 2023). Vision Zero, a policy that aims for 0 deaths on the road, was put in place in 2015. Finally, Parisian policy stimulates the creation and operation of varied public transit options, emblematically illustrated by the country-wide revival of the tram that started in the city in 1992 (Possible, 2023). While these practices are not directly cycling-related, they adhere to the broader goals of sustainable transportation and encourage cycling indirectly.

Vélib, Paris' extensive public bicycle sharing system, was introduced in 2007. Vélib' represents the union of cycling and freedom, opening up cycling for spontaneous trips, people who do not own bicycles, and of course, the many Parisian tourists. The idea was conceived by Mayor Bertrand Delanoë, inspired by the Vélo'v system in Lyon (Hadiya, 2009). Initially
starting with 7,000 bikes at 750 stations it expanded to 16,000 bikes at 1,200 stations within a year. By its anniversary in 2013, Vélib' had become the third largest system of its kind worldwide (Hadiya, 2019). As of 2022, the system boasts a total of 19,000 bicycles with electric ones accounting for around 40% of them. With 390,000 subscribers in the same year and over 4.7 million trips made in October alone, it continues to enjoy enduring popularity, among residents and visitors alike (Ville de Paris, 2020). Undoubtedly, Vélib' stands as a component of Paris’ overall transportation infrastructure, making cycling accessible to a much wider audience.

Other relevant non-transport policies I have identified as promoting cycling in Paris are the following ways to improve the quality of life in the city: proximity and affordable housing. The most notable and progressive one is the 15-minute city supported by Mayor Anne Hidalgo in her campaign - the city of proximity, where hour-long commutes and car dependency are no longer needed, where dense and plentiful housing supports urban amenities (Gongadze, 2023). The 15-minute city is perhaps more important than any transportation policy, as land use decisions are much more permanent and relevant than our attempts to control the road space. Urban planning professionals have known for decades that density is sustainable, yet suburban sprawl continues. Therefore, examples like Paris are extremely important to promote worldwide as a city that achieves its climate goals and promotes health: carbon emissions have fallen by 20% in the period between 2004 and 2018 (UNFCCC, 2023). The 15-minute city is also housing policy, and as the capital of a large and generous welfare state, Paris has managed to double homebuilding, concentrate housing in low-carbon inner-ring suburbs (enabling sustainable mobility), and distribute more affordable social housing (Durning, 2021). In a place where destinations are close, cycling presents itself as a logical and accessible transportation mode.
Funding came in large amounts with Anne Hidalgo’s leadership: the initial Plan Vélo invested 150 million euro, and the second plan 250 million: 200 for cycling infrastructure and parking, 10 for traffic calming zones, 40 for other cycling-related policies (Ville de Paris, 2023). Separately, in 2023, the French government announced a €2 billion plan to expand cycling infrastructure through 2027 as part of a broader effort to discourage driving. If the spending of local and regional authorities is also taken into account, the total amount rises to 6 billion euros during the same time frame (Paris en Selle, 2023).

The achievement of urban progress in just two mayoral terms can be largely credited to strong political determination and the establishment of an ambitious vision outlined in the city's master plan. Having political resolve is crucial for driving and sustaining reforms that may face opposition otherwise (Possible, 2023). The expansion of institutions referred to as "the associations" plays a role in this process involving the creation or reinforcement of organizations capable of managing and perpetuating new initiatives. The most notable of them is Paris en Selle, a citizen association concerned with the promotion of cycling. It is notable for being not a grass-roots initiative originally: it was submitted by residents as a suggestion during the first participatory budget open to projects by Parisian citizens in 2015, shortly after Mayor Hidalgo came into term (Paris en Selle, 2023). Paris en Selle is a founding member of the Collectif Vélo Île-de-France, which brings together 35 cycling associations from the Ile-de-France region united around the Vélo Île-de-France project.

“Paris metropolitan area “Métropole du Grand Paris” is an administrative structure created in 2016, it is the inter-municipal authority and a public establishment of inter-municipal cooperation bringing together 131 municipalities including Paris with a surface of over 814
km², 8 times the area of Paris. It has a population of 7,057,905 inhabitants and a density of 8,668.121.” (Fenu, 2021)

The combined efforts of the city, administrative structures, and associations are vital for coordinating and implementing the initiatives outlined in the master plan, thus enabling transformative success within a relatively short span of two mayoral administrations. Plan Vélo is mainly managed by the Cycling Mission (formerly Cycling Development Mission), a section of the Roads and Travel Department, under the responsibility of David Belliard, Deputy Mayor of Paris in charge of space transformation public, transport, mobility, street and road codes. Created following pressing requests from Paris en Selle in 2018 and for a long time staffed by a small team, the Cycling Mission now has 17 people working full-time on the implementation of the City's Cycling Plan (Paris en Selle, 2023).

Not everyone is happy with the changes. Discontent came from people accustomed to driving, and opponents of Anne Hidalgo criticized her for being elitist and inconsiderate to suburban residents who commuted into Paris via automobile. Another key party opposing cycling in Paris is the police prefecture, which has a lot of power over the roads and sometimes blocks projects of reallocating road space from cars (Possible, 2023). Despite car trips being the minority in dense Paris, this opposition to reducing lanes and closing streets to motor traffic has generated a new tension between cyclists and pedestrians, who have always been the majority on Parisian streets (ibid).

**Infrastructure**

The challenges of integrating bicycle infrastructure into existing car-centric infrastructure in Paris often lead to confusing decisions regarding the infrastructure layout. However, it is commendable how quickly and intelligently efforts have been made to improve overall
network connectivity and incorporate supporting components. Clearly indicating cycling infrastructure, such as using specific colors, plays a crucial role in enhancing visibility for traffic policy and promoting cycling. It's important to note that intersections, which are known to be particularly hazardous for cyclists, have typically been designed with a focus on accommodating cars rather than ensuring cyclist safety. (Wijnstekers, 2022) As previously mentioned, the cycling potential of Paris is still not fully realized (7% mode share vs. potential 13%), and insufficiently high-quality infrastructure is one of the main reasons for the gap.

Technical recommendations for French engineers that accompany the Plan Vélo reveal the typology of bicycle paths (CEREMA, 2021).

- **Bikeway**
  
  The cycle path is a roadway exclusively reserved for two- or three-wheeled cycles and motorized personal transport vehicles. It is separated from the general roadway and the sidewalk by a physical element.

- **Greenway**
  
  A greenway is a road exclusively reserved for the circulation of non-motorized vehicles with the exception of electric personal transport vehicles, pedestrians and horse riders.

- **The cycle lane**
  
  The cycle lane is a traffic lane exclusively reserved for two- or three-wheeled cycles and electric personal transport vehicles. It may be suitable for situations where the desired motorized traffic and bicycle traffic is low to moderate. It should be noted that the cycle lane is perceived as less safe and attractive by riders.

- **The bike-bus corridor**
The bike-bus corridor is a space shared by cyclists and buses. In some cities it also admits taxis. It offers cyclists a significant width to circulate.

On this map from 2020 from Paris en Selle, 23% of the cycling network is considered unsatisfactory. Many of the segments provide short comments sourced from resident audits: “busy with pedestrians”, “two-way cycling without traffic calming”, “no space”, “steep ascent”, “bus conflict”. These provide an insight into some of the infrastructural problems - the growing pains of an emerging cycling metropolis.

During the Covid-19 pandemic, the lull in traffic provided an opportunity for fast action in filling out the bicycle network. The city of Paris launched an ambitious project to greatly increase cycling by introducing new bike lanes, known as coronapistes (Transport Gender Observatory, 2020). By the end of 2020, they had created 52 kilometers of these lanes in
close collaboration with the greater Ile de France region. These new lanes were strategically placed along major cycling routes in Paris as part of the Vélo Ile-de-France suburban network, aligning them with metro lines. Besides just adding more bike lanes, the end of lockdown likely influenced more people to use bicycles, offering a socially-distanced alternative to public transport. Many of the street redesigns carried elements of tactical urbanism (ibid), an urban design methodology that prioritizes fast, cheap, easy to put up and down, often bottom-up solutions for reallocating urban space. For example, instead of digging up a street and rebuilding it anew, the new paths were drawn using yellow paint, while plastic cones were put in place in order to physically separate bike paths from car traffic. In July 2021, deputy mayor David Belliard announced that all coronapistes would be made permanent before the Olympic and Paralympic Games in Paris 2024 (Belliard, 2021). If such temporary infrastructure gains users and popularity, it can be rebuilt in a more permanent way.

Some of the main infrastructural challenges include implementation, safety and street space conflict with pedestrians, all closely related to each other (Colville-Andersen, 2023). As few peer-reviewed sources exist evaluating the quality and safety of the network, we will turn to user-generated content, readily available online. Mikael Colville-Andersen, an influential bicycle planning researcher and author famous for popularizing Copenhagen cycling culture, reviews some Parisian bike lanes in video format on Youtube (ibid). While he lauds the speed and creativity as I do in this thesis, he examines some unsafe and uncomfortable designs. On some of the main streets, the bike lanes are extremely narrow - best practice in Copenhagen allows two people to ride abreast, accommodating large volumes, different speeds, electric and cargo bikes better and providing a more comfortable experience. Other examples do not pay enough attention to intersections, creating confusion and dangerous conflicts with other
road users. Mikael also states that he does not recommend bike-bus lanes for any city, as buses make frequent stops and the two modes get in the way of each other a lot. The heavy prioritization of cycling has also elicited negative reactions by pedestrians who felt further deprived of the already limited space assigned to them on public roads (Possible, 2023). Anne Hidalgo addressed this criticism in 2023 by stating that "absolute priority for pedestrians" will be adopted, and bicycle paths on the sidewalks will not be planned anymore (Streetsblog, 2023).

Spatial justice is crucial to consider as part of the cycling revolution in Paris. Notable disparities exist between Inner and Outer Paris, and low-income workers of color with long commutes live in communities with less access to public transit and active transportation (Possible, 2023). The centralized nature of public transit and a lack of connection between neighboring districts, as well as dispersed, sprawling land use patterns, can cause car dependence in Outer Paris. The new cycling infrastructure prevails in the historical center of Paris and serves tourists as much as residents, while working-class municipalities outside the city have budgetary constraints, leading to disparities (ibid). While this thesis focuses on cycling for transportation, it is important to define a subset of people for whom cycling is work. Composing a class of key workers and a sizable proportion of overall people cycling in cities, delivery cyclists are marginalized in cycling policy, planning and advocacy (Transport Gender Observatory, 2023). Paris has pledged to improve the working conditions and status of self-employed bicycle delivery drivers. Open since September 2021, the Maison des couriers (House of couriers) welcomes delivery men free of charge four days a week to a space where they can rest, have a coffee or warm up their meals, but also obtain administrative and legal support. Union wage negotiations have been enabled by the city to secure a fair minimum wage (Francetvinfo, 2023).
To summarize, the role of the Parisian Mayor, particularly Anne Hidalgo, has been crucial in shaping the city's approach to promoting active travel. Building upon the foundation laid by previous mayors, Hidalgo's administration made active travel a focal point of her leadership. The idea of creating a comprehensive network for cycling and walking gained significant support, marking a significant shift in the city's transportation policies, despite some challenges in implementation. The establishment of dedicated units and organizations focused on active travel within the city's governance structure has helped redirect institutional priorities away from motorized transportation. Engaged citizens have played a dual role by both supporting and critiquing these policies, with particular emphasis on addressing investment disparities. Notable projects like the transformation of the Seine riverbanks served as powerful examples that inspired further development and demonstrated the positive impact through data on infrastructure improvements and usage patterns. The international recognition and attention towards Paris’ efforts to promote active travel have minimized potential obstacles to policy implementation while also acknowledging the city's pro cycling initiatives on a global scale. Additionally, unforeseen events such as public transport strikes and reduced motor traffic due to pandemic related circumstances provided unique opportunities to test new ideas quickly and showcased public willingness to embrace changes in urban mobility.
Case Study #2: Bogotá

Bogotá is a well-studied global case in sustainable urban mobility adoption. The Colombian capital is renowned for its cycling culture as well as for its clever low-cost solution to public transportation - bus rapid transit (BRT). While there is a growing focus on sustainable transportation in wealthier countries like France, many developing nations have less resources to devote to this issue. These countries are witnessing an increase in car ownership without a corresponding expansion in road infrastructure to accommodate the rising demand. As a result, cities in these nations often experience severe traffic congestion during peak hours, including challenges with road based public transportation. In Latin American cities, successful examples of urban cycling promotion have often been undervalued and received little attention, with the vast majority of case studies focusing on European cities. Bogotá is one of many well-researched encouraging examples in South America of a city that has been able to achieve success and inspire local and global leaders to push for sustainable mobility. Ciclovía, an open streets event that closes roads to cars and gives full access to cyclists and pedestrians, appeared in Bogotá in 1974 and spread worldwide. Clear policies in mayors’ planning documents, a latent bicycle culture, advocacy groups, and continuity in effective local policies (Rosas-Satizábal, 2019) led to the success of cycling for transportation.
Bogotá has undergone an urban cycling transformation. Recent data on ridership and infrastructure developments clearly show this change: according to the Secretaría Distrital de Movilidad (2023), the city now has a network of 608 kilometers of cycling lanes, enabling around 900,000 trips every day. As mentioned by Rosas-Satizábal (2019), the modal share grew from 0.58% in 1996 to an impressive 9.10% in 2017. This upward trend continued in recent years, with the data from Bogotá Cómo Vamos indicating that it reached 11.7% in 2023.
Bogotá has favorable conditions for cycling (Mosquera et al., 2012). It has a predominantly flat terrain, the climate is cool and constant all year round (an average temperature throughout the day of 13.1 °C). No snow or extreme heat makes cycling pleasant anytime. Traveled distances in Bogotá are generally short, given the high population density. Despite that, as a city that exploded in size in the 20th century, Bogotá is also car-centric. Many streets resemble USA freeways with 3-4 lanes of traffic in each direction, with stoplight-free multi-level intersections that are decidedly unfriendly to pedestrians and cyclists. Transport in Bogotá is surprisingly car-dominated for a city where only 11.7% (Bogotá Cómo Vamos) of people use a personal car, 8.1% use a motorcycle and 5.2% take the taxi. Motorways run through the heart of the city, and pedestrians are forced onto bridges or into tunnels, which are often few and far between. Several Latin American cities have the same conditions and even sizable amounts of cycling infrastructure, but not the same level of ridership, indicating that there are more factors at play than just bike lanes.

Traffic congestion in Bogotá poses challenges, which is a common issue faced by many cities in Latin America. Bogotá was ranked as the most congested city in South America and the fifth most congested globally in 2017 (Valencia et al., 2022). Automobile commuters in Bogotá spend 80 hours per year stuck in traffic, which equates to losing two full working weeks due to their daily commute. While 65% of households don’t own a car, 85% of the city’s public space is currently used up by motorized vehicles, says Nicolás Estupiñán, Bogotá’s secretary of mobility (Planetizen, 2020). Efforts have been made to address this problem through the implementation of the Pico y Placa (“speed and plate”) system, which restricts road usage based on license plate numbers. Those that use public transit often suffer from high prices and crowding. Still acutely struggling with those challenges, Bogotá
nevertheless showcases a marked success with an almost 30-year old history of prioritizing sustainable mobility.

**Policy analysis**

As a city that stands out with its cycling success, Bogotá started planning early for the bicycle. In 1974, Ciclovía, the legendary open streets event, was first held, opening up roads to cyclists every Sunday and creating an occasion to get in the saddle. In 1995, the office of mayor Antanas Mockus declared the idea that all street users are equal. This led to street space reallocation processes, where parking was abolished to create sidewalks and bicycle paths (linear infrastructure known locally as ciclorrutas), and many exclusive bus lanes were provided (Cervero, 2009). In 1991, the Colombian political system gave mayors complete autonomy in terms of urban transportation planning and project investments. As such, mayors designed their 4-year term City Plan in which they set goals and allocated resources. During the first mayoralty of Enrique Peñalosa between 1998 and 2000, the construction of cycle routes in Bogotá began and expanded dramatically, delivering 300 km of stages, which even in 2015 made up the vast majority of the existing network in the city. Mayor Claudia López, elected in 2015, an avid cyclist herself, has shown a strong commitment to enhancing Bogotá's cycling infrastructure as a response to environmental and health challenges. The position of Bicycle Coordinator in Bogotá, known as the "Gerente de la Bici," was created in 2016 by Mayor Enrique Peñalosa. The role was established to support the development and implementation of Plan Bici, which ran through 2020 and had a goal of 10% modal share (Rosas-Satizábal, 2019).

There are several bicycle-related policy documents in Bogotá that overlap in scope. Improving active urban transportation is mostly legislated through the 2020-2024 Mayor’s Strategic Plan (Plan de Desarrollo Distrital, 2023) and the newly developed Sustainable and
Safe Mobility Plan (Plan de Movilidad Sostenible y Segura, 2023). The inclusion of the word "safe" in the plan’s title demonstrates a strong commitment to avoiding all road deaths and injuries, consistent with the 2016 Vision Zero framework, in which no death in traffic is acceptable or justifiable. By 2035, Bogotá aims to have 77% of all travel done using sustainable modes such as walking, cycling and public transportation (ibid). This goal aligns with the mayor’s agenda, which involves adding 280 kilometers of bike lanes over the 4-year term and is further supported by the longer-term Public Bicycle Plan (Política Pública de la Bicicleta), which also calls for expanding cycling infrastructure. The author of Ciclismo Urbano refers to this slightly confusing legal framework with lots of actors: “even for people in the public sector of Bogotá, it is not easy to understand which entity is in charge of the different functions, responsibilities and duties associated with cycling infrastructure” (Valencia et al., 2022).

The history of Ciclovía in Bogotá is a testament to the city's innovative approach to public space and mobility in the post-oil crisis era (ITDP, 2022). Initiated in 1974 by Jaime Ortiz and the advocacy group Pro-Cicla, this pioneering program closed streets to motor vehicles, opening them up for cycling, walking, and other recreational activities every Sunday for seven hours (Rosas-Satizábal, 2019). Officially enacted in 1976 by Mayor Luis Prieto Ocampo, who signed two decrees definitively approving the program, Ciclovía has since become an intrinsic part of Bogotá's cultural and urban identity. It is within this transformative space that the creators of the event observed, “the bicycle quite naturally became a symbol of revolution, highlighting its role in advocating for individuality, civil rights, women's rights, urban mobility, simplicity, new urbanism, and environmental consciousness” (Morales, 2018). Ciclovía habituated Bogotáns to use bicycles for recreation decades before cycling for transportation took hold, paving the way for infrastructure
demand. The event has been running non-stop since its conception and attracts on average 1.5 million riders every Sunday. Most importantly, it has spread globally. For city residents worldwide, seeing their streets free of polluting gridlock, used by people, is a potent catalyst to push for a green urban transformation.

Bogotá initially set up 35 kilometers of temporary bike lanes in 2020, later expanding to 84 kilometers (Fenu, 2021). The idea behind these temporary lanes was to promote bicycles as a hygienic way of traveling, helping people avoid close contact and crowded areas. These bike lanes were also added to six vehicular bridges exclusively for cyclists. This was also a strategy to reduce the number of people using public transport, like TransMilenio, thereby making it more efficient and sustainable. Additionally, these bike lanes were planned alongside the existing routes of TransMilenio, creating more connections within the city's cycle route network. (ibid) The lull in traffic during the five-month quarantine provided Bogotá the opportunity to start implementing bicycle paths by taking away a car lane on busy corridors, creating the first street-level paths in the city (ibid).

Funding for cycling infrastructure in Bogotá is sourced from the District Administration's budget, local government agencies like the Secretariat of Mobility and the Institute of Urban Development, and international grants, including the Bloomberg Initiative for Cycling Infrastructure (Valencia et al., 2022). While various broad transportation documents allocate funding for bicycling, 2.2 billion Colombian pesos were secured for the execution of projects associated with the use of bicycles in the city for the next 18 years until 2039 as part of the Bicycle Public Policy (Secretaria Distrital de Planeación, 2023).
There have been many other fundamental actions augmenting Bogotá’s positive result in stimulating urban cycling. These actions include political leadership, bicycle culture promotion, the participation of cycling citizen groups, the structuring of promotional campaigns, education in road behavior in school, the integration of the bicycle with other modes, enhanced signage (Valencia et al., 2022). The city adopted Vision Zero in 2016 to eliminate traffic fatalities, focusing on cyclist and pedestrian safety. In 2021, the "Política Pública de la Bicicleta" (Public Policy of the Bicycle) was introduced by the Secretariat of Mobility, providing long-term guidelines for cycling infrastructure and aiming to insulate cycling initiatives from the fluctuations of political cycles. Additionally, in 2022, Bogotá launched a bike-sharing program called Tembici, affirming its dedication to making cycling a safe, accessible, and sustainable transportation option (IDTP, 2022).

Cycling is just one of the three general strategies that the city has recently implemented, along with car use reduction and transit prioritization (ITDP, 2022). Bogotá is a city that has seen most of its growth in the 20th century, with an orientation towards the car. For decades it did not have a sound public transit system, and people relied on private mini-buses that regularly got stuck in traffic. In 2000, this changed to include another world-famous Colombian transportation solution, which cost the city a fraction of what a metro system would. Bogotá got a system of bus rapid transit: the TransMilenio, where frequent buses move on dedicated bus lanes unaffected by traffic, and bus stops resembled train platforms for fast boarding (ITDP, 2022). Unfortunately, the system suffers from extreme overcrowding, proving that large, dense cities are best served by mass rapid transit/metro/heavy rail, as only rail can accommodate frequencies needed to transport vast amounts of people. Consequently, new transit modes have been announced in the 2023
Sustainable Mobility plan: the city plans to create both light rail (RegioTrams) and a heavy metro railway network of 5 lines (Secretaría Distrital de Movilidad, 2023).

All of this success has been achieved in a relatively short time and without a current cycling-specific policy document or structuring plan around what needed to be done to promote cycling. The regulatory landscape for Bogotá’s cycling transportation is rather chaotic and depends on lucky political decisions. It has been described as “An imperfect regulatory framework for a perfect result” (Valencia et al., 2022). Overall, it could be said that what happened in Bogotá is a miracle. However, the inertia has been created, and more policies sprung into action. Thinking differently, in this context with low technical and institutional capacity, the variability with the planning, structuring, design and operation of bicycle systems could have contributed to the success. This finding emphasizes the fact that valuable governance lessons can be learnt not only from rich European cities with robust democracies and rigid planning systems.

**Infrastructure**

When designing the Bogotá cycling network, the morphology and topography of the city were taken into account (Beltran, 2022). From north to south, the city has a flat topography, while from east to west it has different degrees of slope. For the network plan, a mesh concept was used because it provides more versatility and adaptation, given that the road network was designed as a grid with streets running from south to north and east to west. The network was also integrated with the TransMilenio bus system, which is equipped with bicycle parking lots.
This version of the map was published in June 2023 by the Mobility Secretary of Bogotá. The map’s legend describes some of the elements in the network, as well as other relevant transportation facilities. From top to bottom, they are the main network, the auxiliary corridors (shared with motor vehicles), new cycle routes, and temporary routes (those in testing). Also depicted are names of principal corridors, sites of interest, cycling-focused public spaces with parking, restrooms, and commerce, parking at TransMilenio stops, and the stops themselves.

Bogotá’s planning proved that cycling is inherently connected to walking. In 1998, the year the cycling network began to be laid out, there were no sidewalks (Valencia et al., 2022). The space on the edges of the road was a place for people to leave their cars, while pedestrians had to find places to circulate between them. The first cycling paths were laid as sidewalks, dividers and canal banks, off-road with a shared space for cyclists and pedestrians. This careful approach was taken to minimize the effect on motorized transportation modes while
demand for walking space was high and cycling demand was still low. Later on, as demand for cycling grew, space for routes was found on the road. This smart approach allowed the planners to “sit on two chairs”: provide conditions for cycling to gain momentum while simultaneously avoiding the ire of motorists who would feel like their road space was being taken away for a fringe mode of transportation.

Ciclismo Urbano (2022) provides the following typologies of cycle routes in Bogotá, corresponding to colored lines on the map below:

- **Cycle route on sidewalk (blue)**
  Has a barrier between cyclists and motorized traffic and soft separation (usually a line or a very small gap) between cyclists and pedestrians.

- **Cycle route on road (red)**
  Barrier separation from both motorists and pedestrians, the most used type for new routes.

- **Cycle route on park or trail (green)**
  Usually in parks or along river banks, these routes do not have motor vehicles, but often share space with pedestrians.

- **Cycle route on divider (yellow)**
  These routes are located on the dividers between traffic directions on main and wide roads.

- **Adapted cycle pathways (black)**
  Minor interventions on local, calmed streets shared with other modes of traffic. Least common typology in Bogotá.
Cycling infrastructure goes beyond just routes in Bogotá. Elements such as parking, signage, traffic lights, demarcations, have been key in the strategy to promote and encourage bicycling. The uncertainty of not knowing where to leave the bicycle at the destination, or perceiving it as unsafe, is a large disincentive to making a trip. This is especially important to promote non-recurring, sporadic and spontaneous trips, like going to the doctor, rather than a commute to a familiar location. Bogotá has begun placing racks at entrances since the beginning of cycling provision, and there is even a bicycle parking mandate from 2017 that
mandates a bike parking minimum of 10% of car parking spaces, or a minimum of 12 spaces (ibid).

Bogotá is an enormous city within its bounds, but a truly sustainable system serves the metropolitan area too. While there are not yet bicycle routes out of the city, multimodal connections encompassing numerous modes of transit are crucial for comfortably making long trips. In public transportation, a hub is a place where passengers are exchanged between transport modes. In the Plan for Safe and Sustainable Mobility, six Modal Integration Complexes at the entrances to the city are planned, where the articulation and exchange with the regional and district public transportation system will occur (Secretaría Distrital de Movilidad, 2023). While the modes are not yet described, it will probably include TransMilenio, buses, bikes, and the proposed two RegioTram lines and five metro lines, all physically, operationally and fare-wise integrated with the Bogotá public transportation system.

While Bogotá is a success story, serious challenges exist. Despite the kilometers of infrastructure and many pro-bicycle plans and programs, the city has only begun to delve into designs focused on attracting more cyclists. Many other problems persist, such as personal safety, road safety and the connectivity and maintenance of the cycle infrastructure network, among others (Valencia et al., 2022). Safety is the largest problem: cyclists represent between 10 and 15% of those killed on the roads, figures that remain constant over time. This can be attributed to unsafe street design and to the fact that drivers of motor vehicles in Bogotá have a culture of aggressive driving that affects the most vulnerable road actors: cyclists and pedestrians. In addition to that, personal safety - fear of being robbed or killed - is a deterrent from cycling, especially affecting night-time riding and women. Feeling unsafe on the bike in
the street stems from the patchwork nature of the network, as sudden lapses in protected routes force riders to share the road with faster vehicles much larger in size, compromising the separation safety principle in the CROW manual. Finally, property safety matters: while Bogotá consistently prioritizes bicycle parking infrastructure, secure parking can not yet be expected everywhere, and bicycle theft is a common deterrent to commuting (ITDP, 2022).

Class and gender are issues of utmost importance when it comes to cycling for transportation. Gender biases undermine every aspect of cycling, whether for sport or for transportation, and the activity has traditionally carried masculine connotations. In many of the cities with emerging cycling cultures, these regular cyclists are mostly men, many of them young, who primarily commute to work (Avila-Palencia, 2023). Western European mobility experts have remarked that a city is truly cycling-friendly if women feel comfortable to cycle, the “indicator species”, as those with the most barriers to mobility (8-80 Cities, 2017). In Bogotá, of total bike trips, only 24% were made by women (Bogotá Cómo Vamos, 2020). “Women who want to ride bikes encounter fears such as not knowing basic mechanics, not having enough skills to maneuver in a city where traffic is violent, street harassment, among many other reasons,” says Ángela Sánchez, founder of Curvas en Bici, a non-profit that seeks to empower female cyclists (Higuera-Mendieta et al., 2021). Studies carried out in Bogotá (Montoya-Robledo et al., 2020) and in Canada (Sersli et al., 2020) have shown that mothers commonly identify cycling as a risky activity, a mode of transportation less convenient than a motorized one for childcare mobility activities. To alleviate this, the city has adopted a gender-informed approach in the new 2023 Safe and Sustainable Mobility plan, prioritizing women as having far less access to the opportunities and mobility services in the city than men, higher exposure to risks and burdened with unpaid caretaking duties (Secretaría Distrital de Movilidad, 2023).
Bogotá is a city with a high level of spatial and income inequality, whose urban development has been characterized by the ebb and flow of large amounts of people. Colombia is the second country in the world by the amount of internally displaced people (UNHCR, 2023). A lack of structured housing and an ever increasing influx of inhabitants has made it hard for the housing stock to keep up. Overall, Bogotá’s poorer populations are concentrated in the south and east, where a more informal settlement pattern is established. Research conducted by Higuera-Mendieta (2021) shows that a lower socio-economic status in Bogotá is positively associated with cycle commuting. Enhancing bicycle infrastructure for these residents is crucial. However, most informal settlements in Bogotá are built on steep sloping terrain, where cycling quickly becomes too physically demanding. Thus, improving transport accessibility for such areas requires investments beyond improving bicycle infrastructure (Higuera-Mendieta et al., 2021).

Cycling in Bogotá has been influenced by activist groups and advocates, who grew out of a tradition of organized group rides. Although they began as thematic or recreational cycling groups, these organizations, for example, the Ciclopaseo de los Miércoles, had the parallel objective of promoting and making cycling visible (Valencia et al., 2022). Other groups that emerged later began to act as defense groups, to exert pressure, tired of the indifference of the governments in power in the face of the numbers of road accidents and the deterioration of infrastructure. An example is an initiative group that formed to protect the cycling routes from encroachment from the TransMilenio construction. On the civil society side, local bicycle councils have been formed by the city in 2019 that act as advisory and consultative bodies of the District and local Administration for the construction of public bicycle policy. The Wednesday Cycle Rides were initiated and Bike Week started to be organized. However,
it wasn't until 2012 that public funds were allocated for these events. This led to the culmination of efforts in 2015 with the World Bicycle Forum and the emergence of Bicired Colombia—a robust network of urban and rural cycling advocates nationwide. "The establishment of Bicired Colombia truly revolutionized the national cycling movement" (Jesús Acero, Architect of Bogotá Pedalea Strategy) (Valencia et al., 2022).

The current high levels of bike ridership in Bogotá are the result of a complex and lengthy process spanning multiple decades. The surge in bike demand has only recently occurred in Bogotá despite infrastructure increasing at a linear pace, and this study examines the process and uncovers the key elements that contribute to a successful program. By looking at this specific case, we can see how effective transportation policies, coupled with support from citizens, have played a significant role.

To summarize, initial investments in infrastructure, strong political leadership, defined policies outlined in planning documents, a thriving bicycle culture, and active advocacy groups are the primary factors explaining why the city enjoys its current level of success signified by the high modal share. The case of Bogotá highlights the influential role of political will and continuous policy that strong mayoral support has ensured. Furthermore, it reveals that there is an underlying order to this process; establishing clear bicycle oriented policies as a priority (such as setting targets for constructing bike lanes or reducing cyclist accidents). This enables resource allocation for infrastructure development starting in 2000 and facilitates hiring staff members for bicycle-specific planning and technical matters later in 2014 (ITDP, 2022). Political leadership played a vital role as the driving force behind these policies. Continuity of policies over time is crucial as it ensures a steady flow of resources and consistent inputs throughout a process that spans more than 20 years. Even though the
initially constructed bike paths were not fully utilized for more than a decade, they played a vital role in the overall process and offered an effective approach to increasing the number of cycling trips in the city.
Reflection

The comparative study of Paris and Bogotá has yielded a comprehensive body of data that allows me to reflect on the policies and infrastructure developments for bicycle transportation and discuss the best practices and challenges encountered. Despite the large difference in context, culture, history, and funding, I have found a notable overlap in both policy and infrastructure solutions that also correspond with global best practices outlined in the beginning. These insights have the potential to inform global sustainable urban mobility strategies. The overarching themes observed in both cities include the role of strong mayoral leadership, the impact of COVID-19 policies on cycling infrastructure, the setting of ambitious targets, and the participatory elements in urban governance.

Both cities have mayors with a large political and administrative authority, with the power to appoint and dismiss department heads and create a budget. This facilitates the political process related to the consensus between key stakeholders; additionally, mayors are held accountable for the fulfillment of their promises as prominent and visible public figures.

It was due to their authority that COVID-19 policies related to temporary cycling lanes and road diets were implemented, another key driving factor uniting Paris and Bogotá. A temporary respite in car traffic provided an opportunity for a faster expansion of cycling facilities, spurred by the desire for social distancing and a respite from lockdowns. Even though not all of these pop-up lanes became permanent, coronapistes in Paris and ciclovías temporales in Bogotá allowed the population to try and become accustomed to bicycle use, laying down a behavioral pattern that led to further growth in use.
Paris and Bogotá are remarkable in their setting of ambitious goals in policy documents, quantified as the percentage of trips undertaken through bicycling, total length of network, etc. To reiterate, Paris’ current quantifiable sustainable transportation goal is to make the city “100% cycling-friendly” by 2026, and Bogotá’s is “77% trips made by sustainable transportation by 2035”. In my opinion, these goals have supported the fast implementation of policies, increased political popularity of city governments, provided positive inertia for further sustainable transportations and allowed the cities to become global positive examples.

Finally, public participation in urban governance has enhanced the adoption of cycling for transportation in Paris and Bogotá. Although both cities are situated in the context of democratic governments, with the population already determining decision-making, both capitals went further and incorporated interested members of the public into the city government, allowing them to advocate more effectively for cycling policy. In Paris, a large advocacy group was integrated into the mayoral government, in Bogotá, the position of a “bicycle ambassador” was established, with a result of more people responsible for the creation and maintenance of the bicycle system.

These results support one of my key premonitions going in: not only rich, white, privileged, old, European, educated cities deserve and can have thriving cycling cultures. Paris and Bogotá resemble each other with their capital status, high density, favorable weather conditions and strong mayors. On the other hand, they could not be more different: income levels, historical context, political processes, pace of urbanization, informality levels. Inspired decision-making by a group of actors who agreed that cycling makes cities better was the key driver of progress. Therefore, I synthesize my observations to conclude that political will is the main ingredient of a successful cycling transformation.
Undertaking a cycling transformation that goes against the grain of 100 years of car-centric development is no easy feat, and it was not carried out perfectly by any means. I identified three main challenges to pay particular attention to as the development goes on: safety, equity and car dependence.

Safety remains the key challenge and deterrent to cycling in both Paris and Bogotá. Unfortunately, very few of the cycling infrastructure facilities correspond in quality with the safety-related best practices outlined in the beginning of the work. Safety relates to accidents that arise from sharing the road space with motor vehicles, as the speed differential is highest and poses the most danger of death and injury. The next frontier of development for Paris is Bogotá will be to focus on intersection safety, where the majority of accidents occur. As dense cities with high pedestrian activity, the conflict of sharing sidewalk space poses risks as well, especially in Paris, where pedestrians dominate. Finally, more robust storage facilities are badly needed to eliminate bicycle theft as a worry.

Equity is a massive factor to keep mindful of, one that is too often forgotten in the broader definition of sustainability. Access to cycling, a healthy and affordable mode of transportation, should be fair and equal. Both Paris and Bogotá struggle with income disparities, spatial inequality, unequal distribution of resources, gender differences in the demographic group that cycles, and other problems. In encouraging recent developments, both cities have taken steps to protect one of the most vulnerable groups of society that uses cycling facilities more than anyone: delivery workers, often of low socio-economic status and precariously employed as gig workers. It is my hope that global societies continue to
popularize discourse related to the most cost-effective way of moving around without forgetting to include the needs of marginalized groups.

Car dependence is a challenge that continues to undermine cycling reform in sustainable urban mobility. Decades of policy focusing on the personal motor vehicle have created a path dependence pattern that is hard to break out of, and many political actors actively work to prevent the construction of bicycle lanes and traffic calming, not in the least by members of the general population. Car-centric attitudes in all levels of society in Paris and Bogotá continue to stifle funding for cycling infrastructure, 30 km/h zones, road diets, and other improvements. This finding comes as a surprise, as private cars are not the main form of transportation in either city, but confirms the findings from the literature that a successful transition to sustainable transportation not only variously incentivises carbon-light modes, but also necessitates the disincentivization of polluting modes through fees and parking reform. Addressing these challenges is the next step in future urban planning initiatives.

Overall, comparing two metropolises on opposite sides of the world has offered unique insights into adapting cycling policies and infrastructure in varied urban contexts. When we analyze these observations, it becomes clear that the key to establishing a cycling culture in cities like Paris and Bogotá lies in political determination. This powerful driving force goes beyond differences, cultural variations and historical contexts. Both cities, despite facing challenges related to safety, fairness and an overreliance on cars, prove that committed political leadership can bring about significant changes in urban transportation. The valuable lessons learned from Paris and Bogotá serve as a roadmap for cities aiming to transform their transportation systems. As cities around the world grapple with the need for sustainable and inclusive transportation, the experiences of Paris and Bogotá demonstrate the transformative
power of political dedication in overcoming long-standing obstacles and reshaping urban environments for the benefit of all residents. This study reinforces the idea that with leaders and active community involvement, even car-centric cities can become models of cycling-friendly and sustainable urban living.
Conclusion

To conclude, I strongly believe that every city, no matter the current circumstances, has the potential to be a sustainable, climate-resilient, walkable and cyclable city. Every place on Earth has a cycling culture if there is at least one person who cycles, and every place has a story of how cycling “got big”, even though it might be in its infancy stage. The stories I told of Paris and Bogotá are mature and successful, and it is my hope that other places can skip some of the growing pains by learning from best practice. My work adds to a body of research that examines interventions that positively influence transportation bicycling.

For every city that would like to complement their public transit with effective, safe and comfortable active transportation, I synthesized the following concise recommendations for cities that would like to undergo a cycling transformation:

1. Set ambitious targets
2. Incorporate participatory planning
3. Prioritize road safety

The examples of Paris and Bogotá have demonstrated that having a bold vision can lead to quick positive changes. A potential avenue for further research could analyze the determinants for following through on these promises, as there are countless examples of places with bold cycling vision, but little progress. Incorporating participatory planning is crucial for cities that want to accomplish a truly people-centric environment. Inviting residents to participate in the decision-making and design process can bring out values, sentiments and problems that are not evident within other means of influencing policy, like voting and advocacy. Finally, prioritizing road safety, particularly through safe design that
leaves no room for user mistake, is the most crucial recommendation. The vast majority of people who want to cycle, but do not, are scared of dying and being injured on the road. Adopting the Vision Zero paradigm striving for 0 deaths in traffic, with a laser-focus on cyclists and pedestrians, has worked for years in cities who put in the effort to improve their transportation systems.

These recommendations contribute to an understanding of urban sustainability, public policy, and transportation planning on a global scale, bypassing the differences in economic status, cultural norms, or urban infrastructure. Pursuing these recommendations will lead to a positive feedback loop, bringing out more bicyclists on the streets, and promoting growth centered around the bicycle.
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