Spring 4-30-2021

Going Green: A comparative analysis of green urbanism in Paris and Shanghai

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GOING GREEN:

A COMPARATIVE ANALYSIS OF GREEN URBANISM IN PARIS AND SHANGHAI

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2021

This thesis is presented in partial fulfillment of the requirements for the Degree of Bachelor of Arts in International Studies at the Croft Institute of International Studies and the Sally McDonnell Barksdale Honors College at the University of Mississippi.

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Abstract

As climate change becomes more pressing with each day and as we scramble to slow down the challenges it poses, adapting the means of operation within our cities will become an invaluable tool for reducing humanity's carbon footprint. This paper seeks to study the ways in which green infrastructure in global cities can be used to do just that—adapting to and mitigating the effects of challenges resulting from climate change. In order to provide a broad overview of the effectiveness of such green infrastructure systems across the globe, this research will focus on two cities that vary greatly in their geographic, political, and social conditions: Paris, France and Shanghai, China.

In order to counter the threats climate change is posing on their communities, cities are looking toward the things they can control, with one of the most wide-reaching of these solutions being a reimagination of their infrastructural systems to include more green, eco-friendly design. Eco-friendly city design and infrastructure can take several forms, with some of the most prominent approaches being new means of supplying green and renewable energy, sustainably built structures and communities which aim to make use of existing and natural resources, and a reimagination of public transportation systems. Paris, France and Shanghai, China are only two among several global cities that are beginning to work in the direction of city development with green technologies in mind, attempting to change their current, polluting methods while converging on similar policy and urban techniques.

Introduction:

Climate Change and Green Infrastructure in Global Cities

As climate change becomes more pressing with each day and as we scramble to slow down the challenges it poses, adapting the means of operation within our cities will become an invaluable tool for reducing humanity's carbon footprint. This paper seeks to study the ways in which green infrastructure in global cities can be used to do just that—adapting to and mitigating the effects of challenges resulting from climate change. In order to provide a broad overview of the effectiveness of such green infrastructure systems across the globe, this research will focus on two cities that vary greatly in their geographic, political, and social conditions: Paris, France and Shanghai, China.

Today, large, global cities like Shanghai and Paris "are home to over half of the world's population and generate 70% of greenhouse gas emissions," making them an indispensable location of and means for responding to climate challenges (Mairie de Paris 2015, 5). Cities are feeling the effects of climate change just as much as they are contributing to their perpetuation, however, and the problems they are facing are becoming more similar, regardless of their geographic location.

In order to counter the threats climate change is posing on their communities, cities are looking toward the things they *can* control, with one of the most wide-reaching of these solutions being a reimagination of their infrastructural systems to include more green, eco-friendly design. Eco-friendly city design and infrastructure can take several forms, with some of the most prominent approaches being new means of supplying green and renewable energy, sustainably built structures and communities which aim to make use of existing and natural resources, and a

reimagination of public transportation systems. Paris, France and Shanghai, China are only two among several global cities that are beginning to work in the direction of city development with green technologies in mind, attempting to change their current, polluting methods while converging on similar policy and urban techniques.

As will be explored in the first chapter of this research, Shanghai and Paris are two historically different places, with very different developmental histories. However, these developmental patterns which have lasted into the present day are slowly converging, as the two cities look toward similar techniques to respond to climate change, showing us how different corners of the globe might make strides in saving their communities in the years to come.

Why Paris and Shanghai?

Paris, France

In recent years, issues of global warming have become ever-present topics in French and Parisian politics and social functionings. This has become especially true as the European Union as a whole sees an increase in concern regarding climate change, a concern that is becoming more noticeably reflected in the political platforms and preferences of most EU countries. Election results from the latter half of 2020 confirmed this political trend, as Green Party popularity surged throughout the EU region.

France is no exception, as the Europe Écologie-Les Verts (EELV) party of France climbs the ladder of success and popularity among many major cities around the country. The increase in support for Les Verts may come as a response to the unprecedented heat waves that struck the country during the summer of 2019, a very clear and very tangible sign of the changing climate. The unbearable heat was especially felt in Paris, with the *New York Times* describing “the

scorching summer [which] blasted Parisians off the streets and turned the city into an eerie dystopia of what may lie ahead" (Nossiter 2019). Paris's mayor, Spanish-born Anne Hidalgo has taken up the climate fight as her own, making her intentions and ambitions for combating climate change in Paris quite clear as she states, "It is [her] responsibility as a politician to give concrete answers. Individual action will not be enough unless policymakers create the conditions for collective change" (Hidalgo 2019). Hidalgo has and continues to emphasize the importance of recognizing climate change and attempting to play an active role in its mitigation, a key platform element that has only strengthened as Paris fights worsening climate challenges of its own.

Among the most notable challenges the city faces are hotter summers, more frequent heat waves, heavy rains and storms, and droughts (Mairie de Paris 2015, 7–8). As a result of these challenges, the city has and will continue to experience stresses on the availability of vital resources like water, as well as a significant rise in threats to other areas such as health among the aging and immunocompromised populations. In the coming years, these climate challenges are only projected to become worse, with more extreme manifestations of current problems and longer-lasting impacts. These outcomes are what Mayor Hidalgo seeks to avoid—one way being through the implementation of a variety of eco-friendly public works and infrastructure projects intended to sustainably serve the city's ever-growing population, while also reducing its overall contribution to the climate challenges threatening its citizens.

Though the current Parisian mayor has made it clear that her sights are set on combating the climate crisis, the constitutional republic governmental structure of France may hinder Hidalgo's efforts of seeing quick, drastic change implemented in her city. Like many other countries who observe the same, democratic-governmental structure, metropolitan changes of magnitude may be more difficult to see through in a timely manner, as many public projects must

pass through layers of bureaucracy before coming to fruition. This may prove to be a challenge in moving forward with time-sensitive attempts at combating climate change on the urban stage, presenting the threat of a city's green agenda being met with the "red tape" of bureaucratic sectors, effectively delaying their implementation.

Shanghai, China

Being a southern coastal city, Shanghai has felt the effects of climate change in a much different way than Paris. China's financial hub is not only plagued by the ever-present threat of sea-level rise, flooding, and typhoons, but rising temperatures due to global warming also work to exacerbate the extreme levels of air pollution in the city and often result in urban heat islands. These challenges are made all the more threatening when taken into consideration with the already large and steadily increasing population of Shanghai. The city currently stands in the top three most populous cities in the world with over 27 million residents, an incredible population size that is proportional to that of China as a whole (World Population Review, "World City Populations 2021").

China is one of the greatest contributors to global warming, especially now that the national population currently makes up nearly 20 percent of the total global population (Worldometer 2021). As the country's population and production levels continue to rise, the Chinese government is now turning its sights toward making climate change concerns a national priority in attempts to address China's contributions to the global climate problem thus far. In preparation for tackling this undertaking, the current president of China, Xi Jinping, has pledged "to clean up three decades of environmental degradation, protect the country's ecosystems, stringently enforce environmental laws and regulations, and create a 'green economy,'" with hopes of changing China's current trajectory (Standaert 2017).

However, as much of the nation's power and decisions stem from the central government and its administration, cities throughout China will be held to those standards before their specific, individual interests when responding to climate challenges. This hurdle may prove to be an interesting influencer in cities like Shanghai as they proceed to alter their city structures to favor more green, non-polluting methods. The future for Shanghai's battle with climate change is especially unclear, as the city has just recently appointed a new mayor, Gong Zheng, who officially began his term in July 2020.

China's governmental structure of a single-party state allows for a swift resolution of national and regional concerns when necessary. As will be highlighted throughout this thesis, Shanghai is no stranger to the Chinese government's ability to affect change of monumental scale and speed, both in the realms of physical urbanization and in terms of positive climate action. This swiftness may very well be a key factor in China's abilities to significantly reverse its negative impact on the global climate problem in coming years, through greening actions such as those implemented in Shanghai.

Literature Review

My thesis will contribute to the existing work on urban planning and development through the lens of sustainability. The existing literature in the field discusses, among other things, the ways in which to sustain, maintain, and continue to develop the urban sphere without producing negative impacts on the environment. In areas of environmental scholarly research, it is generally held that green infrastructure and other green-city initiatives can have quite a large impact on the overall improvement of a region's "environmental friendliness." Cities have the ability to influence how millions of people function on a daily basis and if they become more green, so

will their citizens. However, issues such as maintaining accountability in sectors that have the ability to affect change often leads to questionable results in the long term.

Among the influential literature making up the field of green urbanism are *The Death and Life of Great American Cities* by Jane Jacobs, *Happy City: Transforming Our Lives Through Urban Design* by Charles Montgomery and *Walkable City* by Jeff Speck. All three of these works were instrumental in sparking my interest in studies of urban design and each covers a slightly different aspect of the field. Published in 1961, Jacobs's book is one of the very first of its kind. In it, she describes the basic elements of a city, why each of them is necessary to function cohesively and describes reasons for why certain, common urban projects typically fail, paired with ways to remedy the failures. This book stood and continues to stand as one of the primary sources on urban studies for the past century.

Montgomery's and Speck's studies of urban design vary slightly from Jacobs's. Montgomery focuses more heavily on the effect of urbanization on the human psyche and the environment. Cited several times throughout this thesis, Montgomery is a strong advocate for green spaces in urban areas and for the utilization of physical movement as a means of personal transportation. As his title suggests (*Walkable City*), Speck's approach to city design is similar to that of Montgomery's. Both authors reference walkability as being one of the saving graces of any city: If your city is walkable, you have created a successful design.

Methodology

By conducting a comparative analysis of green urbanism within Paris and Shanghai, this thesis analyzes how urban planning projects have been used to combat both historical and present-day urban issues, showing how urban planning and development have been and are still being used to accomplish large-scale levels of change.

I first chose one major historical urban project from both Paris and Shanghai and evaluated a number of factors to determine each project's impact on the overall cohesiveness and wellbeing of each city in the present. The aim of this historical analysis is to provide a lens through which to appreciate the ability of infrastructure to completely alter a city and its communities, resulting in adaptations that can last for centuries. In showing the long-lasting and successful grand-scale impacts that previous urban development projects have had on the two cities, one can then see how the same level of impact can be had on cities' attempts at adapting to climate change through green infrastructure developments.

I then conduct an analysis of the ways in which Shanghai and Paris are using city-infrastructure to respond to present-day climate challenges and in order to further narrow the scope of the research, three types of infrastructure—renewable energy sources, sustainable urban communities and public transportation—are examined within each city. To analyze the environmental-adaptation techniques of each city, each infrastructural system is evaluated and rated with a self-designed scale which will make note of the environmentally-friendly factors the system possesses and the overall effectiveness or ineffectiveness of the system in question. The rating each city's infrastructural project receives can then be compared to the equivalent project in the other city to determine where one system may have performed better or worse and why. This portion of the research has indeed shown how climate change is beginning to connect corners of the globe that, on first consideration, have few elements in common.

With information collected from a variety of primary sources within each country, this research will show how Paris and Shanghai have converged in their methods of development over time, becoming more and more alike as they face similar climate-related challenges and consequently transition to similar green technologies. Among the primary sources used for this research are the websites of the environmental branches of the municipal and national governments of each city and country, which shed light on current environmental policies and potential political implications of environmental advocacy in continued development. For Europe and Paris, I have looked at articles and reports found on the *Climate-ADAPT* website, which provide information on how various locations around Europe are responding and adapting to various climate issues, providing other locations, governments and researchers around the continent with examples and techniques. Among my sources for China is the website for *China Environmental News,* which focuses on reporting current objectives for and implementations of climate responses across China. I use the sites for the Ministry of Ecology and Environment of the People's Republic of China and the Shanghai Municipal Government as well, which detail the national and municipal governments' approaches to climate issues through various policy initiatives and future plans.

Structure

My thesis is divided into three primary chapters. Chapter one, "Historical Analysis and Overview of General Green Infrastructure Techniques," summarizes major turning points in both Paris and Shanghai's developmental past that led them to take on their present-day form. As will be seen in the chapter, Paris's development was more oriented toward solving social and structural problems that the city was facing at the time, whereas Shanghai's development was

oriented toward image creation and global perception. While one may think Paris's problem-oriented approach to urban design would better prepare them to use developmental techniques as a solution to climate challenges, the speed and efficiency with which Shanghai became a global metropolis has assisted it into present day as it pursues its green-development goals. The historical analysis functions as a foundation to show how urban planning has been used to modernize cities and solve major political, economic and social issues in the past, and how their implementations have had lasting impacts on the structure and function of the cities today. This serves to show how urban planning can be used as a means of adaptation in the light of climate change, which is reinforced by the following discussion of general green infrastructure movements.

Chapter two, "Sustainable Urban Communities," focuses on green infrastructure solutions that are being enacted within various construction sectors of Paris and Shanghai, specifically regarding low-emission sources of energy and the construction of sustainable communities. The third chapter, "Transforming Transportation," focuses on a handful of current green infrastructure solutions within the transportation sectors of Paris and Shanghai. These two chapters will cover the primary analysis of the thesis, and will utilize the aforementioned self-designed scale to rate the implementation of the infrastructural climate solutions within each city.

With the information displayed in these chapters, this thesis shows how city building and urban planning can be used in the hopes of achieving a range of societal, political and even global results. While Shanghai and Paris are fairly close in the amount of progress each has had in the transition of their infrastructure to more environmentally-friendly models, the analysis in

this paper displays that elements such as political and social influencers can have just as much of an impact on the implementation stages of these systems as on their success after completion.

Chapter 1: Historical Analysis and Overview of Green Infrastructure Techniques

Finding solutions to problems is an exercise of trial and error, with decisions made based on the existing knowledge of the matter at hand. If the settled-upon solution proves to be successful and solves the problem, we will know to use the same method in the future when the situation arises again. If the solution is not successful, on the other hand, we will know to pursue another avenue. This game of trial and error is an integral part of human development and progress, and can be seen taking place throughout the course of human history. We make decisions when determining how to best find or grow food, how to create new and useful tools, what materials are most effective for building a house, how to best build a thriving community, etc. Once we became successful in perpetuating those activities, we could then focus on the more intricate matters of how to avoid disease, how to increase productivity and connectivity, how to spark innovation, and how to ultimately see the prosperous continuation of human life.

One of the solutions we have found to be successful for solving these more intricate problems happens to be found within the very space that surrounds us—namely, the design of the urban sphere. We have returned to redesigning our urban spaces as a response to a wide range of problems we have faced in past centuries. In order to show how urban design has been successful in tackling problems such as revolution, economic development, control of disease, and (moving into present day) climate change, this chapter will present the urban histories of Shanghai, China and Paris, France, both of which have used urban planning as a solution to solve these very challenges. By showing important instances of urban transformation within each of these cities, we will see how the intentions behind these urbanization projects influenced how the cities operate today. By doing so, this chapter will set the stage for a different kind of urbanization,

which serves as the focal point of this thesis: urbanization as a response to climate change. If past urban projects impacted the goals of Paris and Shanghai in such a way that their influence has lasted into the image and functionings of the two cities today, the same can be said for current urban efforts regarding climate change.

The Rise of Modern-Day Paris

Paris's urban transformation is perhaps one of the most dramatic city reimaginings in modern history, undertaken by Napoléon III and French bureaucrat, Baron Georges-Eugène Haussmann. In hopes of restructuring the city of Paris to his vision, Napoléon III commissioned Baron Haussmann as his "prefect of the Seine" in 1853. Involving the relocation of thousands of residents and the destruction of large portions of the existing city, Napoléon's redesign project was a greatly debated topic at the time and is still surrounded by both very negative and positive reception.

The bearer of this reception, both positive and negative, was Baron Haussmann, as the mastermind executer behind Napoléon's requests for the project. As David P. Jordan describes him in his historical biography, Haussmann was "made by the Revolution of 1789...the product of Napoleonic schooling," and was therefore quick to pursue a career in government (Jordan 1995, 55). Though the subject of much animosity during the prime years of his career, Jordan continues to posit that Haussmann achieved a "unique and remarkable success" in what was "the most important appointment in the bureaucratic state" (Jordan 1995, 56).

He began his reimagination of Paris just when the city seemed to be needing it most. One of the most important governmental and economic locations in Europe at the time and the most important location in France, Paris was not quite up to reaching the potential its role required

when Haussmann stepped in. The city had been in a questionable state for quite some time. Jordan cites Voltaire as having commented on the things he believed could be changed in the urban fabric of Paris in order to make it a "wonder of the world." Paris was stuffy and immoble, and Voltaire harped on the need for elements that would create connectivity, describing a new Paris filled with wider streets, markets, public spaces, and more. In order for this vision to become reality, Voltaire knew, in 1749, that "some man zealous enough to undertake such projects, possessed of a soul firm enough...a mind enlightened enough…" was the only answer to the city's problems (Jordan 1995, 15).

Haussmann became this man, of course, a little over a century later. And he, together with Napoléon III, shared Voltaire's vision for the city that would become the wonder of the world. Anthony Sutcliffe, in his book highlighting the architectural transformation of Paris over the centuries, describes Haussmann's redesign as focusing on streets, "which were laid out in the periphery, or driven through the centre at the cost of thousands of demolitions" (Sutcliffe 1993, 83). It is true that wide, long streets became a primary element of the renewal project, as Sutcliffe says, "for reasons of public order, public health and traffic engineering" (Sutcliffe 1993, 86). It stands to reason that the classic Parisian boulevards were the priority in beginning to restructure the city, as they provided an answer to most of Napoléon's concerns: Wider streets reduced the filth and congestion that clogged the streets of the old Paris, they provided a connectivity between the city's districts that previously had not existed, as Jordan says, they "fumigated and aerated" the city, discouraged public unrest, and promoted a general sense of cohesiveness that Haussmann and Napoléon desired (Sutcliffe 1993).

All of these results were the necessary solutions to problems that plagued the functionings of the old Paris, prompting Voltaire's wishes for change. In a report for the BBC,

Jonathan Glancey writes that the openness of Haussmann's Paris "restored the city to health after long decades of cholera and typhus," "allowed government troops free movement to maintain public order at times of barricades, riots and other disturbances," and "gave Paris a sense of unity together with an air of bourgeois prosperity" (Glancey 2016). Glancey describes how these objectives were achieved through three phases of construction that would result in the new and improved city. In total, Glancey noted that "the plan involved the demolition of 19,730 historic buildings and the construction of 34,000 new ones," along with the previously mentioned infamous boulevards, impressive public squares and parks, technical innovations including a functioning sewage system and aqueduct system throughout the city, pipes for supplying gas in order to light streets and public areas, railway stations to connect the city to the rest of France and Europe, and more (Glancey 2016).

However, as touched on previously, the process and methods taken to see the fruition of Haussmann's innovations for the City of Light were not celebrated among most residents of Paris at the time. As Glancey writes, the project required an immense amount of destruction within a city that had been established centuries before and the relocation of residents whose families had been there just as long. In order to see Napoléon's vision of this world-class city come to life, he made the executive decision to sacrifice quite a bit of old to make way for the new—a decision that was a source of resentment for many.

Despite the fair amount of public backlash that it inspired, the fact that this new urban vision could solve all the critical concerns Paris had been facing, all while creating a city that would come to be emulated and recognized around the world, was monumental. And what was more monumental was that it worked—Haussmann's urban redesign of the new Paris, the Paris

that became one of the first models of a successful, functioning global city that is recognized and celebrated around the world, was effective.

Shanghai: Becoming the Head of the Chinese Dragon

The image of Shanghai over time has been far from cohesive or consistent. Unlike Paris, it has not always been known as what it is today: An international financial hub and one of the largest cities in the world. In fact, Shanghai has only reached the status of "city" fairly recently, considering its current size and global standing. Within the span of just a few short decades, Shanghai sprung from the eastern coast of China, coming into its global role of economic powerhouse with the help of the implementation of international urban planning techniques.

When Shanghai was first on its rise to global-city status, it was surrounded by a connotation of decadence and corruption throughout the world. As Stella Dong writes in her account of Shanghai's history as one of the world's metropolises, "At the peak of its spectacular career the swamp-ridden metropolis surely ranked as the most pleasure-mad, rapacious, corrupt, strife-ridden, licentious, squalid, and decadent city in the world" (Dong 2000, 1). Shanghai was almost like a nation-state of its own, separated from the established, successful and poised nation that was China. Though within China, Shanghai was truly very different from the rest of the country at the onset of its rise as a city, and for good reason.

Shanghai began its journey toward its position of global financial powerhouse in the early-/mid-1800s, as the city was occupied by foreign (namely, European) powers. At the time, the French and the British had the most notable presence in Shanghai. The British pushed strongly for the quick transition of Shanghai from a small, marshy fishing village to a city, with the intention of housing a foreign treaty port on its banks. With this objective, the British sought

to push their own economic agenda in the business of trading opium. China, and Shanghai specifically, were Britain's key to prosperous opium trade and their efforts to use Shanghai to their advantage came to fruition in 1842, following the first Opium War (Rattini 2006).

With its new function of treaty port, Shanghai brought many British, French, American, and other foreign business people into its borders, most of whom would live in the concessions which each of the foreign nations maintained and governed within the city. In her article on the history of foreign presence and concessions in Shanghai, Kristin Baird Rattini describes how the prosperity of the opium trade, along with the rising presence of foreign residents in the city greatly contributed to Shanghai's cultural and economic diversity and development. Though primarily enjoyed only by the rich, the city's prosperity lasted into the present day, interrupted only by World War II and the Japanese occupation (Rattini 2006).

This cultural and economic diversity within the city and its residents quickly translated into the urban form of Shanghai itself. In developing their concessions, the British, French, Americans and others made their marks on the physical makeup of the city, resulting in a wide range of architectural styles and urban organization from region to region, neighborhood to neighborhood. Shanghai has therefore had an international element ingrained in its form—so much so that many native Chinese residents do not quite consider the city to be truly Chinese, especially now that present-day globalization has made its mark.

Following the arrival of foreign business, the city continued to form around the Huangpu River, a branch of the larger Yangtze River. On the western bank of the Huangpu, in Puxi (literally, "west bank"), one found the strange mix of culture and architecture arising within and along the borders of the foreign concessions. On the eastern bank of the Huangpu, however, one found an entirely different kind of development in what would become known as Pudong

(literally, “east bank”). This region came to stand as representative of Shanghai’s true function and financial prowess, appearing out of the surrounding marsh in a matter of years.

Architect and urban planner at the Harvard-Yenching Institute, Dr. Non Arkaraprasertkul writes in his analysis of the development of the Pudong region, “Prior to the development of Pudong in the early 1990s, [it] was basically an undeveloped territory with scattered permanent settlements” (Arkaraprasertkul 2008, 48). Within just a matter of decades, this undeveloped stretch of land would become Pudong, housing the concentrated financial district of Lujiazui and its numerous, iconic skyscrapers. But what are the implications of such rapid development?

Arkaraprasertkul goes on to write that the extreme construction taking place on the Huangpu’s eastern bank was proving to be largely a result of Shanghai’s desire to assert its position within China and on the global stage. Happening on the heels of Deng Xiaopeng’s radical economic transformation of China known as “Reform and Opening Up,” Shanghai’s bold construction echoed the intentions of Deng’s efforts, reflecting that China was no longer “backwards,” as it had been perceived by some of the Western powers. In fact, Deng was an incredibly influential figure in the development of Shanghai, instructing “Shanghai’s authorities to fast-track the development of Pudong,” and “christen[ing] the city, the ‘Head of the Dragon,’” that was China (Brook). Along with Deng, President Jiang Zemin and Premier Zhu Rongji were influential figures in the impressive development of Pudong. After being chosen by Deng Xiaopeng for the job, Zhu replaced Jiang as mayor of Shanghai in 1988. Zhu was especially focused on the development of the Pudong region during his time in office, greatly increasing the region’s economic prowess (Schell & Delury 2013).

Similar to the melange of cultures and city-styles seen to the east, in Puxi, Pudong drew a substantial amount of its city inspiration from abroad. For example, Lujiazui’s most impressive

avenue coincidentally takes its form from that of the famous Champs Élysées in Paris. Arkaraprasertkul speaks to this similarity, writing, “The false premise of [Century Avenue] begins with the determination of its width to be exactly ‘one meter wider than the Champs Élysées,’” (Arkaraprasertkul 2008, 44). Arkaraprasertkul also notes how the city has taken and tried to incorporate elements of the design of Manhattan in New York City, but that the layout of Lujiazui ultimately misses the mark (Arkaraprasertkul 2008, 47). Lujiazui falls short in the element of connectivity. As the city spread out and raced to complete its impressive skyline and world-class business district, much of the elements that create a walkable, cohesive space were forgotten in the planning stages.

Shanghai, then, is a melting pot of urban planning technique. When designing the east bank, the plans were primarily intended to build Pudong quickly and to build it impressively. This resulted in having the globally recognized skyline that the city so coveted, among which are several towers that have held the title of “tallest building in the world” (namely, the Shanghai Tower, the Jin Mao Tower, the World Financial Centre, and the Oriental Pearl TV Tower). On the western bank, while the basis of the region was designed more thoroughly and over a longer period of time, Puxi still rose out of several foreign concessions, thus greatly diversifying the architectural and urban structure of the area. With time and modernization, Puxi followed in the footsteps of Pudong in building faster and building bigger, at the cost of several historic buildings and communities. Therefore, in light of Shanghai’s continued development and expanding population, it will be interesting to see what the future holds for the city that is really several cities in one.

Contemporary Urban Planning

Shanghai and Paris have shown the ways in which urban planning can be used in a myriad of ways, all with largely varying results. Paris's urban regeneration was primarily intended to solve many social and structural problems that were present in the city, while Shanghai's urbanization was both a result of foreign influence as well as an urbanization boom that was ultimately used as a tool for facilitating image production on the global stage. Both cities were successful in their aims, with Paris largely solving the societal and structural issues it wished to fix and Shanghai catapulting itself to the forefront of the global economy, with the rest of China at its back. These successes beg the question, What else can urban planning do? What are the other ways in which the structure of our cities can change our local or global functionings?

One of the primary ways in which city design and planning can be intentionally used to make change on a local and global scale is through climate change mitigation, a movement that has been gaining popularity throughout the world. With support from international organizations such as the UN, green planning has become one of the primary ways in which climate scientists and policy-makers believe we can affect the most change in terms of responding to our changing climate. Many cities are well on their way to taking the advice of international organizations such as these, and are experimenting with new city designs that allow for citizens to live less-polluting lives in a place (cities in general) that functions as one of the world's largest polluters. Whether this be through the design of transportation systems, the materials used in building new structures, the introduction of more green space, the repurposing of disused structures and places, or the transition to renewable, public energy systems, many areas of change have been tested and many have proven to be successful.

The hope moving forward is that green urban planning will be able to function in the same way that the image-grabbing planning of Shanghai, or the society-oriented planning of Paris were able to in the past. The current incentive for making these cities into green spaces of positive change is taking hold. Speaking about transforming Paris through green urbanism, Paris mayor Anne Hidalgo states, “My vision for Paris is as a green city where we can all breathe fresh air, share open space and enjoy our lives. That is why we are adapting our city...” (Hidalgo 2019). Likewise, the Planning Board of Shanghai Municipal Government has been working toward the green development of Shanghai for several years and has created a map of the areas within the city that they plan to transform with eco-friendly technologies over future years (Xiongfei He). Will green planning techniques be able to last into the future for such an extended period of time as those planning techniques used in historic Paris and Shanghai? If they succeed in achieving this long lifespan, the trajectory of our world in the face of global warming could be very different. Ultimately, only time will tell.

Conclusion

The next chapter will discuss the ways in which urban planning methods such as those mentioned above have been utilized as a tool in both Shanghai and Paris today. The way in which the urbanization tool will be used, however, is fairly different in present day compared to the way it was used in the past examples mentioned above. Namely, the next two chapters of this thesis will discuss how Paris and Shanghai are using urbanization as a means of “greening” their city systems in hopes of reducing their city’s global climate impact. In a way, the urbanization efforts we will see in the next few chapters could not have been carried out without the impacts that transformed each of the cities as a result of the projects discussed in this

chapter—large-scale, grandiose project implementation would not have been possible in Shanghai without their rise to urban power and much of the public transportation we see in Paris today would not have been possible without the introduction of Haussman's famous boulevards.

These are only two of the many elements of current, green urbanism that will be covered in the next chapters, each of which will be analyzed and scored to determine its relative effectiveness in relation to its intended purpose. This analysis will help to determine whether the momentum that green planning has gained is, in fact, warranted.

Chapter 2: Sustainable Urban Communities

Sustainability-built housing developments in urban areas will prove to be a vital tool as cities adapt to climate change and attempt to mitigate their resulting climate impact. As our global population continues to grow, and as more and more of that population becomes centered in our urban areas, cities will face the challenge of providing their current and new citizens with adequate space and living options. This challenge must be dealt with in a sustainable manner, however, as the physical area of many cities will most likely be smaller in the years to come as well, due to various factors such as sea level rise and others. Keeping this in mind, cities will be forced to either expand outside of their current city limits to find new space for housing, or, ideally, they will resort to renovations and refurbishments of old structures, reusing what is already available to them. This chapter will display some of the ways that can be done.

Renewable Energy and Rating System

The use of renewable energy sources in our efforts to create a sustainable city are integral. In order to evaluate the effectiveness of various renewable energy sources implemented in both Paris and Shanghai, a 3-point scale was devised to rate each system in question. The scale comprises 3 categories, each with one factor, whose presence in the system can win 0.5–1 point. The scale will look at the following factors: 1. Sustainable structure (renewable energy/power source), 2. Emissions (low or lower than previous model, if applicable), 3. Community impact (ability for community/stakeholder involvement).

The projects were also sorted into categories based on their sponsorship (public/government, private, or mixed), completion status (not yet started, in progress, or

complete), and innovation (greening of previous model or creation of a new model). These three categories provide a different view of the influencers behind the current and future success of the projects. For example, one could assume that, with government sponsorship, a project will have more funding and higher chances of success in the long run than a project that may be privately sponsored and receive less funding. Furthermore, the category of " innovation" gives us an idea of how creative cities are getting in terms of their commitment to establishing green infrastructure in their urban environments.

Solar Energy in Paris

Though making progress in its introduction of renewable energy sources, France as a whole still has much work to do in the implementation of green methods in order to transition to a more fully-renewable energy platform. Progress in France is hindered largely due to "excessively complicated regulation," which ultimately results in incredibly slow or even halted introductions of ideal forms of energy production (OECD 2016, 8). This, along with the pure age of the city and its buildings, presents a challenge in more large-scale greening projects. Unfortunately, introducing renewable energy (such as solar) to the old, existing buildings of Paris is a much more difficult task than trying to perform the same job on new developments, which consequently discourages and slows the "greening" of existing structures within the city.

However, Paris is forging ahead in attempts to introduce forms of green energy to its city streets. Among the methods being introduced to Paris are solar panels on the roofs of public and private buildings throughout the city. Among the groups trying to introduce solar panels to the city is an organization by the name of EnerCit'IF. This group was founded in 2018, and France's Climate Chance Association claims it is "the first ever citizen-led and local cooperative of

renewable energy production in Paris," (Climate Chance). Through the cooperation of the citizens of Paris and creators of the EnerCit'IF project, solar panels can be introduced into the city in a select handful of initial locations before becoming a more widespread development.

Solar Energy in Shanghai

China is one of the world's leading producers of solar power, and Shanghai is one of the many cities in the nation that takes advantage of its country's position. Though China still has a long way to go in order to shift the majority of its energy reliance away from coal and other fossil fuels, solar power is just one of the multiple ways that China (and Shanghai, more specifically) is attempting to create an economy and culture that is more solidly based on renewable energy. The renewables that will support energy in Shanghai will take the form of wind-, solar- and biomass-powered systems, among others (Reuters 2014).

Shanghai is indeed making strides in introducing solar energy. One of the most impressive ways in which Shanghai has been introducing solar energy is through a project which converted an unused metro depot into a fully functioning solar power station (C40 Cities 2017). This project is an interesting example of the construction of renewable energy sources, as it not only utilizes a fairly untapped power resource but it was also constructed in an already existing structure and its surrounding space. In their case study on the project, C40 Cities writes that the station has proven to be a success, as it is "fully connected to the grid in Shanghai," and greatly reduces expenses while increasing the amount of power supplied to the city (C40 Cities 2017).

Solar Energy Scores

On the 3-point scale, the Parisian solar energy initiative, EnerCit'IF received 3/3 points and the solar energy used in Shanghai received 2.5/3 points.

For "Sustainable structure," the EnerCit'IF project in Paris received one point, as renewable energy is its primary objective. For similar reasons, Shanghai's solar energy systems also received one point for their sustainable structure and use of renewable energy sources.

For "Emissions," the Parisian project received one point, as EnerCit'IF plans to create multiple solar farms (12 of which are planned) that "will be able to produce between 1,400 and 1,900 MWh per year—the equivalent of the electricity consumption of 500 to 600 homes" (Veolia 2019). In Shanghai, one point was given for the emissions produced by the solar units. One of the several solar power stations in Shanghai, the Shanghai Chengyang New Energy Co. Power Station "has produced 4.85 million kWh of power after a year-long operation, producing power 5% higher than expected, saving standard coal 1600t per year and reducing CO2 by 4100t" (C40 Cities 2017).

Lastly, in light of its "Community Impact," EnerCit'IF received one point, as it offers the ability for community members to become stakeholders by sponsoring a solar farm or having partial ownership over solar panels of their own. Shanghai's solar energy, on the other hand, received 0.5 points for its "Community Impact," as it is possible to request solar power at one's personal home, but the solar energy of the city is largely a government project.

Of the solar energy projects in France, the EnerCit'IF project was labeled as having mixed sponsorship, as it is a private organization partnered with public entities such as the City of Paris, Énergie Partagée and Ile-de-France. The city also sponsors solar energy elsewhere, specifically at RATP transportation sites and warehouses. The status of projects such as these,

through RATP and the City, are considered to be complete, as there are currently several operational solar panels on a variety of RATP sites around Paris. The EnerCit'IF project, on the other hand, is considered to be in progress, as it has planned and confirmed locations for its panels but they are not yet complete. Finally, the use of solar panels (through RATP and EnerCit'IF) is considered to be an approach that involves the greening of a previous model as pollutant-emitting or unsustainable energy systems have been converted to natural, renewable sources of energy.

Being a government undertaking, the solar energy of Shanghai is almost completely public/government sponsored, save for those solar panels that one can add to their home, if they so choose. The project of solar energy within the city is considered to be in progress, as the metro station turned solar farm and the Shanghai Chengyang Power Station are complete, but there are still several units that are in the process of being built and added to homes. Finally, as solar energy is the replacement of previous, unsustainable modes of energy production, the approach of transitioning to solar is considered to be innovation through greening a previous model.

Property	**Paris**	**Shanghai**
Sustainable structure	1	1
Low emissions	1	1
Community impact	1	0.5
TOTAL SCORE	**3**	**2.5**

Table 1: Paris and Shanghai Solar Energy Scores

Renewable Lighting in Paris

One of the most popular nicknames for Paris (of which there are many) is "The City of Light." The City of Light has earned its name well, with C40 Cities claiming Paris had a total of

"345,000 public light sources, including signage, street, and park lighting" in 2015 (C40 Cities 2015). Powering this amount of public lighting clearly comes at a high price and was a total $17.9 million in 2012, a number that has only increased in recent years (C40 Cities 2015). In order to further pursue their mission to introduce more forms of low-emission energy throughout the city and to reduce the costs of lighting the city's streets, Paris is looking toward transitioning to new sources of public lighting.

Paris hopes to see total reimagination of their current lighting system, with plans to run completely on renewable energy. According to C40 Cities, "Paris entered into a 10-year energy performance contract in 2011 for public lighting and luminous signage installations," which will monitor its progress as it makes this complete transition to new sources of light (C40 Cities 2015). While it is unclear when the project will be officially complete, Paris has indeed made progress on the transition thus far, and saw a 12% decrease in electric consumption in just the first year of the contract.

Renewable Lighting in Shanghai

China and Shanghai are slightly further along in their adoption of renewable lighting when compared to France and Paris. However, the state of China's energy consumption in the lighting sector has warranted this earlier jump to action, as already in 2012, the National Development and Reform Commission (NDRC) noted that 12 percent of China's annual power was consumed by its lighting systems (Dong 2012).

As the Shanghai government began to transition its city to renewable energy and energy-saving models in their lighting sector, the public was heavily involved in the process. Shanghai not only sold more energy-efficient bulbs directly to the public, but the news source,

China.org.cn claims that the government also planned to give "540,000 units to 270,000 low-income families" (*Shanghai Daily* 2009). *China.org.cn* also highlighted China's efforts to increase production of new units in order to further their progress in the lighting transition, writing "The government will distribute 600 million yuan (US$88 million) to subsidize the production of 120 million units of energy-saving lighting products...the National Development and Reform Commission and the Ministry of Finance announced" (*Shanghai Daily* 2009). The government also banned certain dated models when the efficient-lighting transition began, hoping to further stimulate the use of more environmentally-friendly models.

Lighting Scores

The renewable public lighting system in Paris received a final score of 2/3 on the rating scale. Shanghai's renewable lighting sources did slightly better than Paris on the rating scale, receiving a final 3/3 points.

For "Sustainable structure," the Parisian renewable lighting system received one point. Similarly, being a renewable source of energy, the lighting scheme in Shanghai received one point for "Sustainable structure" as well.

For its "Emissions," the renewable lighting of Paris received one point, as C40 Cities notes that the city expects to see "3,900 tons of CO2 saved annually from the 30% reduction in public lighting electricity usage by 2020," after the implementation of their renewable lighting plan (C40 Cities 2015). Shanghai's lighting system received one point for "Emissions" as well, with the *Shanghai Daily* stating that "The program...is expected to save 6.2 billion kilowatt-hours of power annually, or about 3.1 million yuan in electricity bills. It would also

mean carbon dioxide emissions would be cut by 6.2 million tons, and sulfur dioxide by 62,000 tons," (*Shanghai Daily* 2009).

Lastly, the project in Paris received 0 points for its "Community impact," as it is a purely city-based project and does not allow for outside stakeholder opportunities. Shanghai's project, however, was awarded one point for "Community impact." The phasing out of polluting bulbs had a significant impact on the city's residents, and the *Global Times* noted that, "having distributed some 23 million bulbs by June 2011, Shanghai [planned] to sell another 5 million to its residents [in 2012]" (Dong 2012).

Being a city-based project, the renewable lighting initiative in Paris is completely public/government sponsored, with the city being "committed to purchasing 100% renewable energy for municipal lighting from 2016, while simultaneously reducing energy consumption of Paris' public lighting," as noted in the Global Opportunity Explorer blog on sustainable solutions (Global Opportunity Explorer 2018). The Parisian project is currently still in progress, as some locations around the city have already transitioned to the more efficient bulbs, but the city as a whole is not yet 100% transitioned. The project is also considered to be a greening of a previous energy model, as it hopes to replace current bulbs with a more efficient and environmentally-friendly bulb.

The Shanghai project was also completely government funded, as government organizations supplied the new, efficient bulbs to locations around the city and public areas as well as to residents within Shanghai. The project was begun and completed several years ago, with the bulk of the transition taking place between 2008–2012. Lastly, as with the solar energy transition, the use of efficient and renewable lighting is considered to be a fairly innovative approach, by greening a previous model and shifting away from the old, polluting model.

Property	Paris	Shanghai
Sustainable Structure	1	1
Emissions	1	1
Community impact	0	1
TOTAL SCORE	**2**	**3**

Table 2: Paris and Shanghai Renewable Lighting Scores

Sustainably-Built Urban Communities and Rating System

Two urban community projects, Clichy-Batignolles in Paris and Sunqiao in Shanghai, have been chosen to determine how these two cities are attempting to respond to problems of increasing population and decreasing space. The rating of these communities will be based on a 6-point scale, with one point or half-points being given for each of the following factors encompassed by three primary categories: 1–4. Energy sources (1. Solar panels, 2. Water source, 3. Efficient heating and cooling systems, 4. Rooftop gardens and/or natural food sources), 5. Accessibility (easy access to a wide range of services within/near the community), 6. Materials (local building materials used). Additionally, the projects will be categorized by their sponsorship (public/government, private, or mixed), the type of project and consequential innovation (renovated structure/facility or newly built project), and its completion status (not yet started, in progress, or complete).

Paris: Clichy-Batignolles

Situated in the 17th arrondissement in the north-west region of Paris is the district of Clichy-Batignolles. One of Paris's current urban projects, this community would allow citizens to still live within the city but to live more sustainably than their neighbors in the surrounding arrondissements. As described in the *GreenBiz* blog, author Susannah Shmurak writes, "What

used to be a train yard is being turned into an urban park surrounded by energy-efficient buildings that will house 7,500 residents and provide places of employment for more than 12,000 people," and it will all fall within Paris city limits (Shmurak 2018).

Projected for completion by 2020, Clichy-Batignolles will serve as a feat for the environmental movement in cities around the world. Not only is the development a result of the refurbishment of unused transportation infrastructure, but the resulting product "must follow extremely strict guidelines for building energy consumption" as well, according to Shmurak (Shmurak 2018). The buildings within the community will be built in such a way as to operate by fairly passive means, including optimal positioning for use of natural heat and lighting, materials to help with absorption for various heating and cooling purposes, solar panel energy, green roofs for insulation and garden space, and more.

Shanghai: Sunqiao

Shanghai's approach to a sustainable community is slightly different than that of Paris. New development in Shanghai is a slightly controversial process, as many recent projects have been forged of collaboration between real estate groups and local party officials and have been constructed at the cost of the displacement of many low-income communities (harking back to the development processes of Shanghai as discussed in chapter one).

Fortunately, this does not seem to be the case with Sunqiao, Shanghai's sustainable urban development. As the primary design firm of the project, Sasaki states, Sunqiao will be located outside the main city, "between Shanghai's main international airport and the city center," and will function as the agricultural district of the booming Chinese metropolis (Grove). Though still in the conceptual and very early stages of building, this development will be a beneficial addition

to the ever-growing population of Shanghai, which is already home to more than 27 million people. The Sunqiao community will not only provide further space to accommodate the city's influx of residents, but it will also provide a new, more sustainable and local means of food production for those residents.

The development itself will consist of passive buildings and greenhouses that will utilize natural means of energy, such as solar power for natural sunlight and natural heating and cooling systems, as well as rainwater harvesting systems to collect and use rainwater for crops and residential structures (Walsh 2017). In addition to its primary function as an agricultural community, *Business Insider* claims that Sunqiao will also "function as a space to work, live, shop...it will include new public plazas, parks, housing, stores, restaurants, greenhouses, and a science museum" (Garfield 2017).

Sustainable Urban Communities Scores

On the 6-point rating scale, Clichy-Batignolles received a final score of 5/6, as did the Sunqiao development in Shanghai.

The energy sources utilized in Clichy-Batignolles received several points: one point for the presence of "Solar panels," one for the use of a sustainable "Water source," one for "Efficient heating and cooling systems," and 0.5 for the usage of "Rooftop gardens." While the community will have various buildings that incorporate rooftop gardens, they will be largely used for insulation and biodiversity, not necessarily for food production. The Sunqiao project received 0.5 points for the presence of "Solar panels," one point for using a sustainable "Water source," one point for "Efficient heating and cooling systems," and one point for the presence of "Rooftop gardens and natural food sources" on site.

Clichy-Batignolles was awarded one point for its "Accessibility" and the ease of access to other services, as *GreenBiz* author, Shmurak claims "the district [will encompass] a wide range of housing and services, including four schools, medical services, daycare facilities, gyms," and more (Shmurak 2018). The Sunquiao project received one point for its "Accessibility" as well, as the development plans to include public spaces, shopping, restaurants, and more for resident use.

Finally, 0.5 points were given to Clichy-Batignolles for its "Materials," as it will be built in an unused train yard but the planned buildings will be using new, foreign-sourced materials in their production. Sunqiao was awarded 0.5 points for its "Materials" as well, as it will not be the result of a renovation or refurbishment project, but as the buildings and the final function of the community will produce a sustainable system.

Categorically, Clichy-Batignolles was deemed to be a project sponsored by the government, as it will be "overseen by a public company owned by the city of Paris," and will be drawing its resources from sources such as "Eau de Paris, the public company responsible for producing and distributing water in the French capital," among others, according to Shmurak and OECD reporter, Nicolas Rougé (Shmurak 2018; Rougé 2015, 54). The community was created by renovating a structure/facility, since it will be developed on the site of an obsolete train yard. Lastly, the project is considered to still be in progress, as it was begun in 2002 and is projected to be complete in 2020 (though it is very probable that this date will be pushed back due to coronavirus).

On the other hand, Shanghai's Sunqiao project will receive a mix of public and private sponsorship, as it will be designed by the US-based firm, Sasaki Associates, whose client is the Pudong Agricultural Development Group. Additionally, *Business Insider* notes that "the district

will be developed and maintained by Shanghai Sunqiao Modern Agriculture United Development Co. Ltd, which is working with local planning officials" throughout the timeline of the project (Garfield 2017). As stated before, the project has been deemed newly built and not involving renovation or refurbishment of old structures. Lastly, it is still considered to be in progress, as the project is still in the conceptual and very basic construction phase, with reports of ground breaking in 2017/2018 and an expected completion date in 2020, as previously stated.

Property	**Paris**	**Shanghai**
Solar panels	1	0.5
Water source	1	1
Efficient heating and cooling system	1	1
Rooftop gardens and/or natural food sources	0.5	1
Accessibility	1	1
Materials	0.5	0.5
TOTAL SCORE	**5**	**5**

Table 3: Clichy-Batignolles and Sunqiao Scores

Conclusion

This chapter has examined the different areas of a city in which green urban development can be implemented and looks at elements of the city that are often more personally influential on our daily lives: elements of housing developments and communities. Of the sectors of sustainably built housing developments and community structures that were examined in this chapter, a total of 12 points were available. The final scores were very close, yet Shanghai finished with the highest scores: Paris received a total of 10 points and Shanghai received a total of 10.5 points overall.

The research of the next chapter follows a structure almost identical to the structure utilized in this chapter. Moving on from energy and community systems, the next chapter will analyze various elements of sustainability within transportation infrastructure. Among the infrastructure analyzed will be subway systems, bus fleets and rideshare programs.

Chapter 3: Transforming Transportation

Cities provide several amenities for their citizens to take advantage of, with one of the most integral and successful being that of public transportation. Provided at low- to little-cost, public transportation in cities is a viable alternative to each resident owning a vehicle of their own. This in and of itself is already a step in the right direction toward combating transportation pollution in the climate fight—intuitively (at least now while we are still largely centered around the fuel-burning car), the less individual vehicles there are on the road, the less pollution there will be. However, city governments and nonprofits can still make improvements in addition to the inherent contribution of public transportation in reducing emissions. As citizens use public amenities such as this, cities have the opportunity to make them even more influential instruments in the fight against climate change by making these systems even "greener" and more environmentally friendly than they already are.

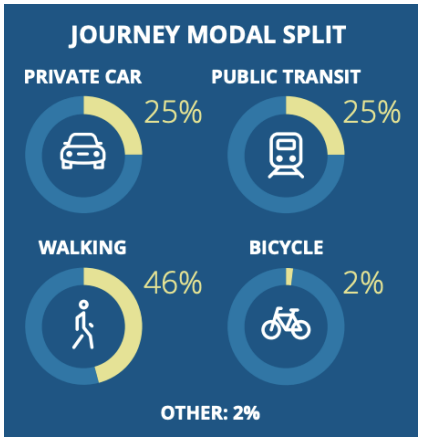
Although their development strategies vary, Paris and Shanghai have both seen a decreasing percentage of private vehicle use in the past several years. While previously very dependent on the individual car, Paris has seen a significant decrease in personal vehicle usage, dropping 45 percent from 1990 to 2018 (Bliss 2018). This is largely due to the current and previous administration within the city, as both the previous mayor, Bertrand Delanoe and current mayor, Anne Hidalgo, have introduced multiple policies intended to decrease private car usage within the city. However, from 2014 to 2020, the city of Paris planned to allocate only 11 percent of its 10 billion euro budget toward "public transportation and soft mobility," which is a fairly small amount, considering the mayor's large goals for the transformation of Parisian mobility (Mairie de Paris 2016).

Shanghai's individual car usage has seen a different trend over the past few decades, with continuing growth among the number of individual cars within the city. From 2015 to 2016, the number of cars in Shanghai increased by 13 percent, to a total of nearly 2.5 million registered vehicles, which was consequently supported by a large increase in total miles of public roads and highways (Ningning 2016). However, the percent of total transportation breakdown that private cars account for within Shanghai is decreasing, and public transportation now slightly outweighs the private car in Shanghai, at 33 percent usage and 27 percent usage, respectively, in 2020 (Deloitte 2020). This rise in usage of public transportation may be a result of the increased municipal budget allocation toward the transport sector in recent years, as municipal investment in the transportation infrastructure sector rose drastically between 2014 to 2017, from 42.248 billion yuan to 90.362 billion yuan (Shanghai Municipal People's Government 2020).

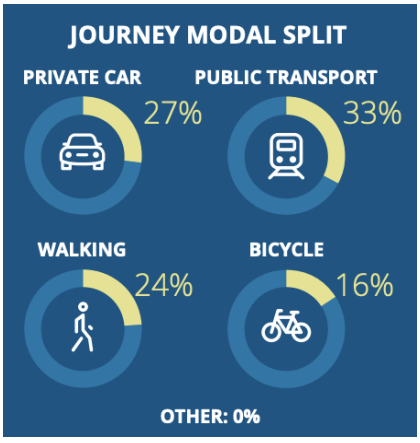
As we will see in this chapter, these alternate modes of transportation are becoming more popular in both cities, assisting in a transition away from the more polluting option of the individual car.

Figure 1: Paris and Shanghai, Journey Modal Split

Paris, 2019



Shanghai, 2020



Source: Deloitte City Mobility Index

Scale Description

In order to evaluate the effectiveness of green-ventures in the realm of public transportation and to determine the sustainability level of each of the techniques, I have devised a scale with which to rate the techniques. The scale comprises a variety of factors, each related to the way in which the technique in question functions and how it is more efficient, sustainable, or produces fewer emissions than its previous equivalent, among other things. The scale's properties are as follows: 1. Renewable energy or power source (not included in "Rideshare Programs" section), 2. Low or zero pollution rates, 3. Incentives, 4. Affordability, 5. Accessibility, 6. Ridership. Each project can receive one point for possessing one of the outlined factors, with half points being awarded based on partial fulfillment or completion of a category, for a total of 6 points.

In addition to the scale, I have also sorted each of the examined public transportation systems into categories. The categories mirror those used in chapter two, specifically focusing on the source of sponsorship for the transportation system, its completion status, and the innovative techniques used to create the "greener" version of the transportation method in question.

Subway Systems

Paris Metro

Paris is a city that is dependent upon and connected by its public transportation systems. With subway trains, tramways and buses sponsored by the state-owned Régie Autonome des Transports Parisiens (RAPT), public transportation in the city is relatively low-priced and easily accessible to the city's citizens and visitors. Over half of the population of Greater Paris uses the system, with approximately 7 million of its total population of 12 million people using it every day. Paris's metro is the seventh busiest in the world and the busiest in the European Union, and

comprises 214 kilometers of tracks with a total of 303 stations (Railway Technology). While having such a large ridership of the public subway system is successful in and of itself in terms of reducing transportation emissions, Paris is still pushing for ways to make the system even more sustainable as it seeks to transition its metro to run on a lower-emission power source.

Shanghai Metro

Shanghai's first metro line was introduced in 1993, when the city's population hovered around 9 million residents, a mere fraction of what it is today (GIZ Sustainable Mobility in China 2018). It has seen incredible rates of expansion since the development of its first line, with the fastest period of development occurring between 2005 and 2010, when the kilometer length of the total subway system catapulted from just under 100 km to over 400 km (GIZ Sustainable Mobility in China 2018).

Like Paris, Shanghai is another city for which public transportation systems are completely invaluable. With its incredible population and high volume of tourists, the Shanghai subway system is essential to daily functionings, accounting for 53 percent of public transportation trips in the city (Aldama 2017). The number of passengers that use the subway in Shanghai surpasses that of Paris at more than 10 million passengers a day (Wen et al. 2020). The system's expansive train routes reflect its impressive number of daily riders: With over 830 km of subway lines, Shanghai's metro system claims the title of "world's longest mass-transit rail system," a title it is likely to keep for some time, as the system plans for further expansions in future years (Aldama 2017). These future expansions, as well as what exists now, are great steps in the right direction for reducing emissions due to Shanghai transportation. Providing such a

large amount of public transportation will ensure that the large population has enticing alternative options to taking individual, polluting trips around the city.

Property	Paris	Shanghai
Total metro rail, km	220 km	531 km
Total urban area, km^2	2,723 km^2	6,340.5 km^2
Total Population	11.078 million people	27.79 million people
Ridership (daily average)	4.16 million people	10.63 million people

Table 4: Length of subway lines, Urban area, Population, Metro ridership of Paris and Shanghai

Paris and Shanghai: Comparison of Subway System Scores

When rating the subway systems, I settled on a final score of 5/6 points for that of Paris and 6/6 points for that of Shanghai.

In the category of "Renewable energy or power source," the Parisian system got 0.5 points, as there are diesel- and electric-powered technologies currently in use, but several "emissions-free regional trains [are set to] replace polluting diesel models" in the near future, as France's English news source, *The Local* describes (The Local 2019). *The Local* further notes that these models will be "equipped with fuel cells that produce electricity through a combination of hydrogen and oxygen," and will get France's public transportation provider, Société Nationale Des Chemins De Fer Français (SNCF) closer to its objective "'to have not a single diesel [train] left on French railroads in 15 years'" (The Local 2019). As Paris is still attempting to see a full transition of the energy on which their trains run, Shanghai surpasses Paris in the category of "Renewable energy or power source" with one point. The trains currently in use in Shanghai's underground railway system received one point for being nearly completely powered by the "third rail," which is a purely electricity-powered technology, rather than fuel-based.

One point was given for Paris in the "Low or zero pollution rates" category, as the rate of emissions produced during one metro trip in 2017 was 3.4 grams of CO_2 per kilometer, which will be improved even further with the introduction of the hydrogen models (SNCF). Shanghai's trains were awarded one point as well, as the entirety of the city's subway system produced just 3.5% of the transportation system's CO^2 emissions in 2014 (Yuan et al 2019).

Paris proceeded to earn one point for "Incentives," one point for "Affordability," and 0.5 points for "Accessibility." *Reuters Environment* writer, Geert De Clercq writes that "The mayor of Paris wants to make all public transportation free in an effort to reduce air pollution," attempting to sway those that still prefer to drive their own vehicles into the city toward the cleaner and cheaper option (De Clercq 2018). De Clercq describes how this incentive functions in addition to other techniques intended to decrease the number of cars in the city, such as "license plate-based driving restrictions" and "a vignette system requiring all cars to have a color-coded sticker indicating their age and pollution level so [the city] can impose more selective driving bans" (De Clercq 2018). In Shanghai, one point was given for "Incentives" due to its ease, one point awarded for its "Affordability" at no more than 11 yuan a trip, and one point given for the "Accessibility" of the system, as the stations are handicap accessible and have a total of over 360 locations throughout the city.

Finally, the Parisian metro received one point for the "Ridership" its metros support. With the total population of Paris being 11.078 million people, the metro supports 4.16 million riders every day, which is around 37 percent of the city's total population (World Population Review, "Paris Population 2021"). Likewise, the metro system of Shanghai received one point for "Ridership," as the *South China Morning Post* claims that the "average weekday traffic on the Shanghai Metro [stood] at 10.65 million individual trips, which [made] it second only to Tokyo"

in 2017 (Aldama 2017). Similarly to Paris, this average daily number of riders represents 38 percent of Shanghai's total population of 27.79 million people (World Population Review, "Shanghai Population 2021").

The Parisian system is sponsored by the government, which is involved in system upkeep and has significant platform incentives under the Hidalgo administration to see continued use of the public transportation systems in the city. In terms of project completion, the project was categorized as being in progress, as there are, of course, metros and trams running in Paris every day but the transition to and addition of the hydrogen trains to the subway system is still underway. Finally, the addition of these new hydrogen models was described as a greening of the previous model of diesel trains.

Similarly, it was determined that the Shanghai subway system is a project sponsored by the city government, which maintains upkeep and new construction of the stations and trains. Shanghai's project is complete, as the subways are in use daily, with the exception of various additions to the lines every few years. Lastly, this project has not seen any change from recent models, as it has been and continues to be operated largely by electricity rather than fuel.

Property	**Paris**	**Shanghai**
Renewable energy or power source	0.5	1
Low or zero pollution rates	1	1
Incentives	1	1
Affordability	1	1
Accessibility	0.5	1
Ridership	1	1
TOTAL SCORE	**5**	**6**

Table 5: Paris and Shanghai Metro Score

Bus Fleets

Paris Bus Fleet

Similarly to the Parisian subway and tramway systems, the bus fleet is another popular public transportation option in the city among its residents and tourists. The bus fleet has been put front and center in the fight against Paris's transportation emissions, as the city gears up to introduce several eco-friendly adaptations to their current units.

The largest such plan is the Bus2025 plan, undertaken by RATP. This project intends to introduce several electric buses to the current fleet by 2025, which "will replace the current diesel buses in a bid to improve air quality in the French capital as part of a wider plan to clean up air pollution before the 2024 Olympics," according to *Intelligent Transport* writer, Eve De Clerk (De Clerk 2019). The project will result in 4,700 clean buses by 2025, in addition to several eco-friendly adaptations planned for the existing bus depots as well (RATP 2019).

Shanghai Bus Fleet

Among Shanghai's city transport, one of the clearest and most impressive strides toward greener mobility has been accomplished through the public bus fleet. The city has been undergoing a major transformation of its buses, transitioning several of their available passenger units from typical combustion engines to fully electric vehicles in recent years. According to the *South China Morning Post*, hundreds of the "9,368 [buses] owned by Shanghai operators, 55 per cent of the entire city fleet," are electric, a number that is only expected to rise in coming years (Aldama 2019).

These buses make up the units that run on more than 1,100 bus lines throughout the city (Shanghai Highlights). As several of these new, electric buses have been added to the expansive

transportation network, the city has already seen a dramatic drop in cost of operation and emissions. The electric units are able to operate on a similar annual schedule as their diesel predecessors at a fraction of the cost—in 2019, where Shanghai's diesel buses cost 130,000 yuan to fuel for a year (about 50,000 kilometers), the electricity used to power the new electric models had a yearly cost of only 35,000 yuan. In addition, according to the Shanghai Municipal Transportation Commission, the 240 electric buses that had been added to the city's fleet were quickly deemed successful in making a dent in Shanghai's emissions, saving "the city's 24 million inhabitants 356 tonnes of carbon dioxide, 28kg of nitrogen oxide and 26kg of particulate matter every year," (Aldama 2019).

Property	**Paris**	**Shanghai**
Size of bus fleet (# of buses)	4,700 buses	9,368 buses
Ridership (daily average)	Unavailable	Unavailable

Table 6: Size of bus fleet and daily ridership in Paris and Shanghai
(Data unavailable for daily bus ridership comparison, likely due to the fact that many trips are taken and not recorded).

Paris and Shanghai: Comparison of Bus Fleet Scores

The final score of the Parisian public bus fleet was 5/6, while the bus fleet in Shanghai scored a total of 5.5/6 points.

To begin, the Parisian fleet was given 0.5 points for "Renewable energy or power source." As observed by the Urban Mobility Observatory, Eltis, "There are currently 4,700 buses in operation in RATP's fleet which includes 1,000 hybrid, 250 biogas, 3,300 diesel and 150 electric buses," with more than 100 new electric buses on their way to join the fleet (Martin 2021). When considering the sustainability of the Shanghai fleet's structure and the amount to which they use a renewable energy source for power, the fleet was awarded 0.5 points. This is because there is an extremely large number of electric buses currently being used in the city's

fleet, but it is not yet completely composed of electric buses. As stated before, only 55 percent of the city's total 9,368 buses were electric in 2019 (Aldama 2019).

For "Low or zero pollution rates," 0.5 points were awarded to the Parisian buses, as the rate of emissions from one bus trip in 2017 was 96.6 grams of CO_2 per kilometer, which will be improved with the introduction of hydrogen and electric buses (SNCF). The Shanghai fleet proceeded to earn one point for their emissions, as the bus system accounted for around 15–20% percent of Shanghai's total transportation emissions in 2014, which has since been lowered as a result of the introduction of the electric buses (Yuan et al 2019).

The Paris fleet received one point for "Incentives," one for "Affordability," and one for "Accessibility." For the Shanghai fleet, one point was awarded for its "Incentives," one for its "Affordability," as bus trips are even cheaper than trips through the Shanghai metro, and one for the fleet's "Accessibility," as the buses are handicap accessible and have over one thousand lines that operate throughout the city.

Finally, one point was awarded to Pairs for the bus fleet's total "Ridership," as a full 60% of the Parisian population used the public bus system in 2016 (De Clercq 2018). The Shanghai fleet also received one point, with 7.48 million of the 12.25 million passenger population using the bus in 2010.

When sorted into categories, the Parisian public bus fleet was considered to be government sponsored for much the same reasons as the metro—the government is involved with the upkeep of the fleet and has incentives for its continued use under the Hidalgo administration. The status of the bus project was considered to be "in progress," as the buses (both diesel and electric) are available for everyday use, but it is still in the process of transitioning to a fully electric fleet by 2025.

Likewise, it was determined that the Shanghai bus fleet is a government owned and operated system. The project is considered to be in progress, as there are buses running daily for passenger use in the city, but the fleet is still in the process of a full transition to electric buses within coming years. Lastly, the electric transition of the Shanghai bus fleet was considered to be a greening of the previous model as the old, fuel burning units are phased out.

Property	**Paris**	**Shanghai**
Renewable energy or power source	0.5	0.5
Low or zero pollution rates	0.5	1
Incentives	1	1
Affordability	1	1
Accessibility	1	1
Ridership	1	1
TOTAL SCORE	**5**	**5.5**

Table 7: Paris and Shanghai Bus Fleet Score

Rideshare Programs

Paris Rideshare Programs

In addition to the task of greening existing, polluting models of transport, cities are pushing for a restructuring of current transportation norms toward methods of mobility that would result in none of the negative emissions given off by the transportation methods they are otherwise attempting to change. With bike share programs and other, similar services, cities like Paris are pointing its citizens towards what has been at their fingertips all along.

Vélib' is one such bike program that has taken off in Paris, with over 1,300 bike stations located throughout the city for more than 20,000 bikes, resulting in more than 100,000 trips a day in 2019 (Wisniewski 2019). Not only do these widely available bikes greatly reduce

individual trips and subsequent emissions produced by riders on polluting public transport, they typically result in positive mental and physical health benefits among their usership. Urban researcher Charles Montgomery studied the effects of such bike share programs, specifically focusing on the results of Vélib' and its Parisian clientele. In his book, *Happy City*, Montgomery posits that the increasing success of such bike programs in our global cities is largely due to the simple fact that we are mobile, social beings—"Immobility is to the human body what rust is to the classic car," Montgomery says, and switching to the active transport that a bike provides is an ideal solution to that problem (Montgomery 2013, 183).

Shanghai Rideshare Programs

As with other transportation methods available in Shanghai, the size of the method must reflect the magnitude of the city's population, allowing it to have a reach wide enough to accommodate the citizens. As researchers Yongping Zhang and Zhifu Mi note, Shanghai's bike rental programs do not fall short of this requirement, and "as of July 2017, Shanghai had 1.5 million dockless bikes, making it the largest bike sharking market in the world," (Zhang & Mi 2018, 5). The usership of these bike-sharing programs have proven to be equally impressive in number—in evaluating the utilization of bike-share programs in the city in 2018, researchers found that with only 348,037 of Shanghai's more than one million bikes, citizens completed a total of 19.4 million trips in just two weeks (Li et al 2020).

However, though the bike-sharing programs as a whole are used at an incredible daily rate, many of the companies' individual bikes are often left untouched. Of the millions of trips taken on bikes each day, it is often the same several bikes that are located in the most populous areas of Shanghai that are used, while ones in less populated areas of the city remain on the rack

(Li et al 2020). This lack of equal adequate usership of all units across the city is proving to be a major problem: Though the bikes reduce the amount of emissions that would have resulted from other forms of transportation, the hundreds of unused bikes are proving to be a source of major congestion and disorder within the city, only resulting in physical waste once retired from use.

Property	Paris	Shanghai
Number of available bikes	20,000	1.5 million
Ridership (daily trips)	100,000	1 million

Table 8: Number of bikes and daily ridership among rideshare programs in Paris and Shanghai

Paris and Shanghai: Comparison of Rideshare programs Scores

On a slightly different, 5-point rating scale, the rideshare programs in Paris, specifically the bicycle ride sharing program, Vélib', received a total of 4.5/5 points. The Shanghai rideshare programs, specifically focusing on the bicycle rental companies of Mobike and Ofo, received a score of 4.5/5 on the project rating scale as well.

For the category of "Low or zero pollution rates," Vélib' received 0.5 points, as the bikes eventually become pollution items themselves, once they are retired from use (whether for having been damaged, out-of-date, etc.). Regarding the pollution produced by the Shanghai companies, 0.5 points were awarded, as, according to Zhang and Mi, "in 2016, bike sharing in Shanghai saved 8,358 tonnes of petrol and decreased CO_2 and NOX emissions by 25,240 and 64 tonnes, respectively," however, the number of bikes and the materials used in their production do become pollutants when the bikes are retired from service (Zhang & Mi 2018, 1). Bikes are, of course, offer a means of transportation that do not produce emissions. However, it is then a question of personal trade-off costs, as riders will then be sacrificing their own, physical effort in place of producing pollutants by using other means of transportation.

Vélib' was then awarded one point for "Incentives," as the bike share option provides a very convenient transportation option for citizens. One point was awarded for "Affordability," as Vélib' rides and memberships are priced at the cheap rate of 0–2 € per 30 minute ride. One point was also awarded for "Accessibility," as the company's more than 1,300 docking stations are located at a wide range of locations around the city. Similarly, the Shanghai companies received one point for "Incentives" as an easy transportation option, one point for "Affordability" of the services, which are about the same price as metro cards, and one point for the "Accessibility" of the services, considering the 1.5 million dockless bikes the city supplied in 2017 (Zhang & Mi 2018, 5).

Finally, Vélib' received one point for "Ridership," as the bikes result in more than 100,000 rides a day among the citizens and tourists of Paris. Shanghai's bike share systems received one point for "Ridership" as well—researchers Zheng et al state that in China alone, "more than 23 million shared bicycles have been introduced and attracted 400 million users as of January 2018," (Zheng et al 2019). Likewise, Shanghai is one of the most popular shared-bike cities in China, with its over 1.5 million dockless bikes resulting in over a million rides each day (Li et al 2020).

The Vélib' bike share program was deemed to be operating on a mixed sponsorship basis. The company is sponsored by the city of Paris, but also receives sponsorship from JCDecaux and Somupi. The project is considered to be complete, as Vélib' has been in operation since 2007, and has already introduced several electric bikes to its available inventory. Finally, the project was considered to be a creation of a new model of green transportation, as bikes themselves have not been "greened" with the creation of rideshare programs such as Vélib', but because of the new emphasis on shared bikes and the public incentives and subscription services involved.

It was determined that the Mobike and Ofo companies of Shanghai were operated through private sponsorship rather than through the government. Both systems are considered to be complete, as Mobike was founded in 2015, Ofo was founded in 2014, and both services have been operational since. Finally, both programs are considered to be sustainable transportation systems created through a new model, rather than the greening of a previously existing concept. Bikes themselves have not been "greened" as the Shanghai bus fleet has been, but there is a new emphasis placed on bike riding as a sustainable means of transportation through the creation of rideshare systems such as these.

Property	**Paris**	**Shanghai**
Low or zero pollution rates	0.5	0.5
Incentives	1	1
Affordability	1	1
Accessibility	1	1
Ridership	1	1
TOTAL SCORE	**4.5**	**4.5**

Table 9: Paris and Shanghai Rideshare Program Score

Conclusion

This chapter has displayed the ways in which Shanghai and Paris have implemented or have begun to implement changes to their existing transportation systems in order to make them more sustainable, ultimately with the hopes of reducing the cities' carbon emissions as a result of transportation. Shanghai had higher ratings overall, when considering all three of the forms of transportation that were examined—subway systems, bus fleets, and rideshare programs. Of the 17 total points available in this evaluation of transportation, Shanghai received 16 points and Paris received 14.5.

In examining the effectiveness of the urban systems that have been highlighted in this chapter and the last, we are able to see how green development is impacting the functionings of the city and the lives of its residents in a wide variety of ways. With Shanghai being the city that had the highest overall scores in both system analyses, we can now draw conclusions on what elements they may have incorporated into their system designs that Paris didn't, and why.

Conclusion of Research

This thesis researched a select few infrastructural techniques within the cities of Paris and Shanghai, determining their effectiveness in terms of their ability to function as a technique of mitigation and/or adaptation in the face of climate change. In contributing to the overall field of green urbanism and sustainable city development, this thesis is unique in its direct comparison of the "greening" of two very different cities, showing the ways in which challenges of climate change are causing a global convergence in our known methods of development.

Data Collection

In conducting this research, I hoped to discover which infrastructural systems within Paris and Shanghai were introducing new, green technologies, and of those systems, which were most successful between the two cities in terms of their implementation. In order to do this, I used a self-designed scale to rate each of the chosen infrastructural projects, based on various sustainable factors each could have possessed, as well as a variety of factors that related to public utilization and completion status. The information included in this section was obtained from a variety of primary sources, including local newspaper articles which highlighted aspects of new technology as well as official documentation from local governments and international organizations who monitor global environmental progress.

After collecting data from these primary sources, I compiled tables to display my findings and their corresponding scores on the self-designed scale. These tables were designed in such a way that the factors and scores of the systems in question for both Shanghai and Paris were displayed side by side. The presentation of the findings then provides a quick and concise

summary of which city's system performed higher in each of the specific sustainability- or community-related categories.

After compiling the data and tables for each of the infrastructural systems in question, my findings, which are highlighted in chapters two and three, show that Shanghai's progress in green urbanization obtained an overall higher score than Paris. Of the six total infrastructural areas that were examined, Shanghai scored highest in three categories (lighting, subway systems and bus fleets), Paris scored the highest in one (solar energy) and the two cities were tied in the remaining two (sustainable urban communities and rideshare programs).

Primary Findings

The results from the table scores show that, though the cities are not far from each other in terms of the effectiveness of their implementation of new, green infrastructure, Shanghai is typically one step ahead of Paris. Why might this be?

In order to determine the cause of Shanghai's relative success over Paris, I looked to trends between the two cities' historical and present day development processes, as well as more obvious characteristics such as age and population density. As we saw in chapter one, both cities were able to completely alter their cityscapes in the matter of a few decades (17 years for Haussmann's Paris redesign, 20–30 years for Shanghai's Pudong, which is still developing). This swift development shows that each city has the capacity to undergo such rapid and extensive changes within the systems they have in place, hence their ability to have similar and relatively high success rates in their implementation of green infrastructure technologies.

However, when discerning the reason for Paris's general lag behind Shanghai or Shanghai's tied scores with Paris, we must look for another explanation. This is where the

culprits of age and population density come in. Most of Paris's lag can be attributed to the simple fact that the present-day city dates back to Haussmann's Paris, which is more than a century older than present-day Shanghai. Though Shanghai is several centuries old itself, we saw in chapter one that most of the city we see today was developed over the past 3–4 decades. Therefore, the Shanghai of today was built on fairly modern technology, which would allow for easy implementation of the green infrastructure analyzed in this research.

However, Shanghai's performance can also perhaps be attributed to the incredible population density that is present in the city. This can be a blessing and a curse, as it can prompt the city to take quicker and more efficient action in terms of bettering their existing infrastructure, which accounts for some of Shanghai's success over Paris in terms of implementation. Population density can also be a hindrance, however, when it comes to the effectiveness of systems such as rideshare programs. As we saw in chapter three, Shanghai's population allows for rideshare programs to do fairly well, but the city then faces problems with regulation and organization of the large number of bikes that circulate around the city, which eventually become a form of pollutant themselves.

Lastly, elements of government involvement must be taken into account as well. If a city has a municipal or national government that is committed to finding ways in which to combat the climate problem, introducing green infrastructural technologies into the city in question will most likely be much easier. As we have seen, both Paris, with Mayor Anne Hidalgo, and Shanghai, with President Xi Jinping, have governmental figures that are committed to combating the climate problem within their regions.

Limitations

Among the primary limitations faced while conducting this research were those of language barriers and incomplete data for a select few case study infrastructural projects. In the area of language barriers, this was primarily an issue when trying to find reliable, comprehensive sources for information regarding Shanghai. As I do not speak Chinese, I was somewhat limited in the sources I could use to go toward my research. This luckily did not pose an insurmountable problem, however, as I was able to gather an adequate amount of information from English sources to support my argument. As I am studying French, I was able to fairly easily access and use both French and English sources to support the Paris portions of my research.

In terms of incomplete data for a select few case studies, this applies primarily to the cases within chapter two, "Sustainable Urban Communities." Though I believe all the projects in this chapter to be valuable additions to the research and thesis as a whole, their stages of completion made it somewhat difficult to obtain an adequate amount of information with which to analyze them. For example, both sustainable communities, Clichy-Batignolles and Sunqiao, are still largely in the planning stages of production, and could therefore not be evaluated in terms of their efficiency while fully functioning. The same problem arose with the solar panel projects of Paris and Shanghai, EnerCit'IF and the Shanghai metro depot, which are largely still in the early stages of execution. Conversely, the Shanghai renewable lighting project was completed several years ago, and not much information and/or coverage of the project was available online.

If given the opportunity to restart or to continue with this project, these limitations could potentially be addressed simply through the accumulation of more sources. If given more time,

the research could also be improved through the incorporation of more infrastructural projects and perhaps the development of a more comprehensive, detailed scale with which to rate them.

Potential Areas of Future Research

The field of sustainable development within our global cities and their architecture and urban planning sectors is wide-reaching and varied. Therefore, there are several areas in which potential future research could be performed. Namely, when continuing to compare a select few global cities, it might be interesting to delve into a different area of sustainable development. After having looked at the efficiency of the green infrastructural systems within the cities, as done in this thesis, one could then research the impact of the new infrastructural developments on the lives of the citizens. This would entail a different form of study than what was conducted here, and would most likely involve a substantial amount of interviews and personal accounts, in addition to scholarly research, to support the overall research. However, it has been seen that a change in our built environments to incorporate more green, eco-friendly elements can have a substantial impact on our human psyche and social environment.

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