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URBAN SUSTAINABILITY; THE ISSUE OF TRANSPORTATION AND MOBILITY. A BENCHMARKING ANALYSIS BETWEEN AMSTERDAM AND ZÜRICH

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ABSTRACT

One of the most significant changes over the centuries has been the phenomenon of urbanization or the shift from rural areas to large cities. It has had important consequences for many aspects of social, political, and economic life, not common only to a particular country or region, but currently visiting each nation in the world. On another side, global surface temperatures have risen faster since 1970 than in any other 50-year period in the last 2000 years. Temperatures could rise by as much as 4.4°C by the end of the century if carbon dioxide emissions continue at their current rate. The quantities of greenhouse gases reached new highs in 2019.

Concerning these phenomena that our era is confronted with, to deal with the situation, a quick and effective response is essential. One of the key options on the table is to build sustainable cities and communities.

This master dissertation covers some recurring and significant themes in urban form. The purpose is to create a reference to an idea of making sustainability work in urban areas. This research looks at seven design principles that go into creating a sustainable city or urban area. Mobility, compactness and density, climate change, energy efficiency, sustainable water supply, greening, and mixed land use are among the design concepts.

Furthermore, sustainable mobility and transportation play a critical role in reducing greenhouse gas emissions. This research looks at the requirements for adopting Sustainable Transportation Policies in a city or urban area, with a focus on the new paradigm of "E-Mobility".

Keywords: Urban Sustainability, Sustainable Mobility, M-a-a-S and Multimodal Transportation Systems, Electrification of Transportation Fleet

SINTESI

Uno dei cambiamenti più significativi nel corso dei secoli è stato il fenomeno dell'urbanizzazione o del passaggio dalle aree rurali alle grandi città. Ha avuto importanti conseguenze per molti aspetti della vita sociale, politica ed economica, non comuni solo a un particolare paese o regione, ma che attualmente visitano ogni nazione del mondo. D'altro canto, le temperature superficiali globali sono aumentate più velocemente dal 1970 che in qualsiasi altro periodo di 50 anni negli ultimi 2000 anni. Le temperature potrebbero aumentare fino a 4,4°C entro la fine del secolo se le emissioni di anidride carbonica continueranno al ritmo attuale. Le quantità di gas serra hanno raggiunto nuovi massimi nel 2019.

Di fronte a questi fenomeni con cui si confronta la nostra epoca, per far fronte alla situazione è indispensabile una risposta rapida ed efficace. Una delle opzioni chiave sul tavolo è costruire città e comunità sostenibili.

Questa tesi copre sette temi ricorrenti e significativi in forma urbana. Lo scopo è creare un riferimento a un'idea di far funzionare la sostenibilità nelle aree urbane. Questa ricerca esamina sette principi di progettazione che contribuiscono alla creazione di una città o di un'area urbana sostenibile. Mobilità, compattezza e densità, cambiamento climatico, efficienza energetica, approvvigionamento idrico sostenibile, inverdimento e uso misto del suolo sono tra i concetti di design.

Inoltre, la mobilità e i trasporti sostenibili svolgono un ruolo fondamentale nella riduzione delle emissioni di gas serra. Questa ricerca esamina i requisiti per l'adozione di politiche di trasporto sostenibile in una città o in un'area urbana, con un focus sul nuovo paradigma di "E-Mobility".

Parole chiave: Sostenibilità Urbana, Mobilità Sostenibile, M-a-a-S e Sistemi di Trasporto Multimodali, Elettrificazione della Flotta di Trasporto

“We all shape our Built Environment and in return, it shapes us”

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INTRODUCTION

The world is currently confronted with a new demographic trend that is reshaping the landscapes of our countries throughout time. To control this situation, a prompt and efficient response is required, especially given the rapid population growth.

To gain a quick overview of urbanization, consider that approximately 2% of the world's population resided in cities at the turn of the 19th century. According to the most recent U.N. urbanization forecasts, 55% of the world's population lives in cities in 2018, and this number is predicted to rise to 66% by 2050. Climate change, on the other hand, is currently one of the most pressing global crises. Climate change is a broad topic, especially in urban sustainability. Therefore, achieving the reduction in global emissions of carbon dioxide (CO_2) and other greenhouse gases is the common goal of countries that joined the UNFCCC.

The United Nations took a significant step forward in this regard when it proposed the 17 Sustainable Development Goals in 2015, including SDG 11 Sustainable Cities and Communities, which aims to provide main targets for cities to follow to achieve sustainable development. In this backdrop, urban mobility is gaining popularity as a potential solution for improving citizens living conditions in cities. Local public transportation services play a critical role here, as SDG 11.2 recognizes. The issue of sustainable transport is on the agenda 2030 for Sustainable Development.

"UN SDG 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons." Public Transport should not discriminate among different categories of people and all the users' needs must be considered equally.

Throughout the 20th century, transportation systems were regarded as driving engines of economic and social progress (Gudmundsson et al., 2015).

The negative effects of transportation activities, such as traffic congestion, fatalities and injuries, pollution, and energy consumption, are becoming more widely recognized (Moradi and Vagnoni, 2018). Urban transportation activities are a substantial contributor to those negative

effects, particularly in cities where significant levels of motorization exist, and individual mobility is dominated by automobiles. Urban transportation is predicted to be responsible for 25% of CO_2 transport emissions, with passenger transit accounting for 58% (European Environment Agency, 2013).

By 2030, there will be 43 megacities with populations of more than 10 million, the majority of which will be in developing regions. This raises concerns about how developing megacities can achieve long-term urbanization, growth, and development. Urban transportation is critical to accomplishing the goals of sustainable urban development (Banister, 2005). As a result, in terms of urban mobility, the transition to sustainable urban mobility futures in developing megacities is a major issue involving sustainability, transitions, and urban mobility, and effective conceptual tools to better understand the dynamics of change and stability associated with transition processes are required (Canitez, 2019).

In other words, Transportation has been regarded as a link to all elements of life around the world for decades. In this situation, transportation is at the center of many economic, environmental, and social development issues. Safe, clean, sustainable, and egalitarian transportation networks, in most circumstances, assist countries in thriving, particularly in cities and metropolitan centers. However, a slew of studies demonstrates that most cities' and urban areas' transportation systems are unsustainable. Some of these transportation networks are seen as a threat to future generations' environmental, social, and economic well-being. Changing such tendencies in transportation, then, necessitates coordination across numerous stakeholders at the regional, national, and international levels.

In reality, most industrialized countries continue to spend on physical infrastructure and mobility, which are regarded to be key drivers for sustainable transportation. In smart cities, more than ever before, ensuring sustainable growth necessitates the integration of dependable transportation systems. The main goal of smart cities is to combine human capital, infrastructure, and social capital to generate more sustainable economic development and a higher quality of life for city residents. In other words, when it comes to creating smart cities, sustainable transportation is one of the most important factors to consider (Bamwesigye and Hlavackova, 2019).

As a result, national and local governments with the help of private parties must find innovative ways to provide more efficient and sustainable public transportation services.

The first chapter of this dissertation provides an overview of the general literature on the topic of urban sustainability. It includes a definition of the three pillars of sustainable urban development, an introduction to the key principles of sustainable urban forms, public program initiatives in the field, and financing sustainability.

According to the literature, various cities and urban areas have established innovative policies to reach this goal. Mobility as a Service (M-a-a-S) and Multimodal Transportation Systems will be discussed, as an interesting example of the potential benefits of new solutions and, at the same time, of the conditions for making such models function in a paper-based method to get the expected results and be better transferred in different territorial areas. The second chapter of this research is to assess the current situation of these policies in Europe.

In the third chapter, a specialized framework (HERE - Urban Mobility Index) was employed to determine which elements would be more attractive for the context of sustainable mobility and transport. Connectivity, affordability, sustainability, and innovation are the four primary topics examined. Each analysis issue is built on some interconnected elements and measurements. This platform evaluates 38 cities from around the world.

According to the results of the HERE analysis in the issue of innovation and IEA reports, Amsterdam is a benchmarking city (e.g., the first city in terms of the quantity of charging stations) in terms of transitioning the fleet to electric vehicles, and Zürich is a city that is working on this issue with some shortages in terms of implementing the main principles for this transition to EVs. This study, with a review of the strengths and weaknesses in these two case studies, will result in an E-Mobility Consolidated Plan that will assist public authorities in improving the electrification of the entire fleet in the future. Therefore, the final chapter will examine the "Electrification of Entire Fleet", a new solution in Mobility and Transportation systems, looking at the applications made in two European case studies: Amsterdam and Zürich.

CHAPTER 1: LITERATURE REVIEW

1.1. THE NECESSITY OF SUSTAINABILITY IN URBANIZATION

Urbanization dynamics that characterize contemporary urban environments all over the world require more infrastructures, more use of natural resources, creating more air pollution and noise that leads to an increased impact on the environment; the ecological footprint of cities is spreading.

Today, our world demands a human development that states changes in people's lifestyles, and in another hand, this development should be sustainable at the same time, it means lowering the effects on the natural environment. One solution to achieve this goal is shifting the traditional model of planning from very largescale planning to think about the experiment of individuals, households, and neighborhoods for comparing the challenges and opportunities. Some authors argue that planning for sustainable development should be "process-based" – rather than "fixed-goal" – oriented. Unlike the traditional approaches of strategy making to set fixed goals related to either supply-side and/or demand-side management, it is argued that triggering a social learning process with full involvement of all stakeholders and planners in the process would be the most suitable strategy for sustainable development (Bagheri and Hjorth, 2007). Here, the first stage is gathering data; collecting local data then aggregate them and create knowledge and solutions.

The adequate knowledge of the characteristics and dynamics of urban and territorial systems becomes therefore a crucial element to support and address public and private action on territories. Practical question: The nature of a city is working through which processes? Using the dynamics of these processes to create policies and planning that work better for people.

Urban Sustainability is an important conceptual framework for analyzing the processes linking urbanization to development. Sustainable Urban Development implies a process by which sustainability can be attained, emphasizing improvement, progress, and positive change, incorporating both environmental and social dimensions. Sustainable urban development highlights the need for reform of market mechanisms to achieve environmental goals and the achievement of a balance with social and economic considerations.

Some keywords related to Sustainability are *Transformation, New Thinking or Innovation, and Local Expert Role*.

The relationship between innovation and growth in the long term directly impacts economic growth (Solow, 1956). Some researchers assert that innovation is the main key to the sustainable development of all societies in our era (Matos and Silvestre, 2013; Boons et al., 2013). This research talks about Innovation in Urban Sustainability, some items relating to this issue are energy benchmarking, bike share, community solar, green stormwater infrastructure, and cool roofs.

When we talk about urban sustainability, spontaneously the subject of the growth of cities worldwide comes into mind. More than half the world's people are living in cities. Cities generate 60 percent of the gross national product. A growing number of cities, however, are showing symptoms of the global environment and development crisis. Cities should be healthy, providing housing and employment opportunities, meet environmental standards and be sustainable. Sustainability needs to be addressed on a global scale, reforms need to concentrate on the interaction of the urban environment with the global economy and environment. Cities more sustainable are more competitive and attractive to people and investments, and they are more able to lift citizens out of poverty, provide places to live, work and play. Cities as collective systems of resources with their specific dynamics create networking facts.

People come to a city for its attractiveness, in this case, their knowledge and work skills get to multiply and interact with the working knowledge of a lot of other people. The cities that are shaping their ambitious plan for their sustainable future are taking actions on climate change mitigation, green economic development, disaster and climate change resilience, livability and social inclusion, and smart technologies.

As a summary of this discussion, “The urbanization of society is part of the development process. We should look at urban and territorial systems as an integrated and complex system of resources, activities, actors, and physical structures that interact and continuously transform themselves in territorial frameworks made by continuously changing economic, social, and natural environments.”

1.2. DEFINITION OF SUSTAINABLE DEVELOPMENT AND ITS MULTIPLE DIMENSIONS

The term Sustainability is derived from the Latin word “Sustinere” with the meaning to hold and sustain, meaning to maintain, endure, carry on, or support. It states that something endures and keeps going well into the future instead of being only about today. The term "sustainability" was not coined until the late 1980s, more than 20 years after the modern environmental movement began.

The World Council of Churches used the term "sustainability" in a modern sense for the first time in 1974. It was suggested by western environmentalists in reaction to developing world goals to be concerned about the environment when people in a lot of parts of the world suffer from poverty.

In 1980, the term Sustainable Development emerged in the World Conversation Strategy, published by the International Union for Conservation of Nature and Natural Resources.

In 1987, one of the earliest definitions of sustainability as defined in the United Nations World Commission on Environment and Development, chaired by Harlem Brundtland. The UN published its report *“Our Common Future”* as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. They said that sustainable development was about both equities between generations and equity within generations (Dresner, 2002). The Brundtland Commission was followed by the UN Rio Conference on Environment and Development "*Earth Summit"* in 1992, which resulted in Agenda 21, a set of principles for both developed and developing countries to achieve growth while minimizing their environmental impact.

In 1994, Business writer John Elkington coined the term *triple bottom line* (often abbreviated to TBL). Guru coined the phrase "triple bottom line" as his way of measuring performance in corporate America. The idea was that a company can be managed in a way that not only makes money, but also improves people's lives and the planet. In other words, TBL theory posits that instead of one bottom line, there should be three: profit, people, and the planet.

The 3-overlapping-circles model, this concept has been presented in a related form in business through the concept of the "triple bottom line."

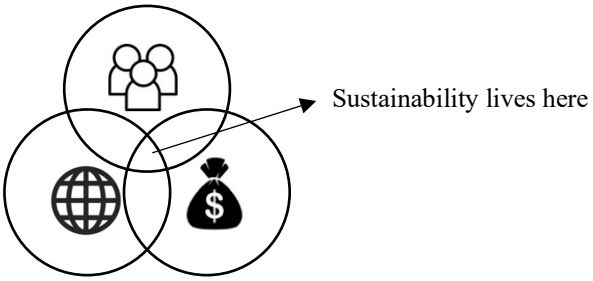


Figure 1. Graphic describing the three types of bottom lines (Willard, 2010).

The overlapping-circles model of sustainability acknowledges the intersection of economic, environmental, and social factors. Depending on our mindset, we resize the circles to show that one factor is more dominant than the other two.

The 3-nested-dependencies reflect the co-dependent reality model (Doppelt, 2008). It shows that human society is a wholly-owned subsidiary of the environment—that without food, clean water, fresh air, fertile soil, and other natural resources, we're cooked. It's the people in societies who decide how they will exchange goods and services. That is, they decide what economic model they will use. Because they create their economies, they can change them if they find their current economic models are not working to improve their quality of life. To add another metaphor: the economy is the tail and society is the dog—not vice versa (Willard, 2010).

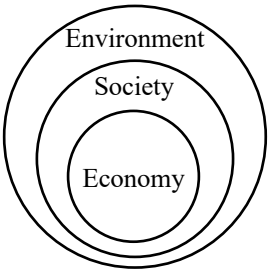


Figure 2. 3-nested-dependencies model
Based on Bob Doppelt, the Power of Sustainable Thinking; Peter Senge et al., The Necessary Revolution.

In 2005, Jérôme Pelenc talked about the strong and weak concepts of sustainability as the fundamental debate in sustainable development major: weak sustainability assumes that natural capital and manufactured capital are essentially substitutable and considers that there are no essential differences between the kinds of well-being they generate (Ekins et al., 2003; Neumayer, 2003; Neumayer, 2012). The only thing that matters is the total value of the aggregate stock of capital, which should be at least maintained or ideally increased for the sake of future generations (Solow, 1993).

The strong conception demonstrates that this substitutability should be severely seriously limited due to the existence of critical elements that natural capital provides for human existence and well-being. Briefly, we can say that because all human activities are a subset of the biosphere and thus finite, natural capital should be passed on to the next generation in its entirety. According to some other authors, the notion of sustainable development serves as a political compromise because it tries to reconcile the otherwise incompatible concepts of neoliberal economic development and environmental preservation (McManus, 1996; Gunder, 2006).

Within the space of just a few decades, the term sustainability has made an extraordinary rise to fame, going from the fringes to the mainstream as it has become one of the defining features of 21st-century reality.

Today, the term sustainability encompasses a whole paradigm shift to our understanding of the world and our place within it. This new paradigm of sustainability is set to a fundamental and pervasive effect on how we can manage and design systems in the 21st century as it will affect all aspects of our economy.

Nowadays, Sustainability in any part of human life is getting a crucial role, therefore, the importance of environmental and social issues is increasing day by day, meanwhile, we know that economic development was the only priority decades ago.

1.3. URBANIZATION AND SUSTAINABILITY

Urbanization is the process by which rural communities grow to form cities or urban centers, and, by extension, the growth, and expansion of those cities (Mark, 2014). One of the most significant changes over the centuries has been urbanization or the shift from rural areas to large cities. Urbanization has had important consequences for many aspects of social, political, and economic life (Kleniewski and Thomas, 2011). It has been closely linked to modernization, industrialization, and the sociological process of rationalization (Gries and Grundmann, 2018). The capacity to use resources more efficiently, promote more sustainable land use, and maintain the biodiversity of natural ecosystems is one of the benefits of urbanization, which creates huge social, economic, and environmental changes (UNFPA).

Now, in the UN Sustainable Development Goal 11 "Sustainable cities and communities", developing urban resilience and sustainability in the face of rising urbanization is at the forefront of international policy.

Urbanization is the steady increase in the number of people living in cities or urban centers. As it's mentioned before, these occurrences result from the continuous mass movement of people from villages or rural settlements to cities or urban areas. But it can also result from a natural increase (the excess of births over deaths), especially where this population increase takes place in areas where advanced technology and development projects are present. The definition of what qualifies a town as an urban center differs from one country to another depending on the population criteria used (Tombari, 2019). Each nation uses its criteria for defining urban centers depending on how the population is distributed (Satterthwaite, 2005). For the first time in history, the majority of the people live now in urban areas and the urban population is growing rapidly (United Nations, 2007).

Urbanization is not common only to a particular country or region of the world, as it is a phenomenon that is currently visiting every nation of the world. In 1960, the global urban population was 34% of the world's total and only 43% as of 1990, however, by 2014 the urban population accounted for 54% of the world's total and continues to grow. By 2050 the proportion of living in urban areas is expected to reach 66% (UNDESA, 2014; UN-Habitat, 2016; UNDESA, 2019).

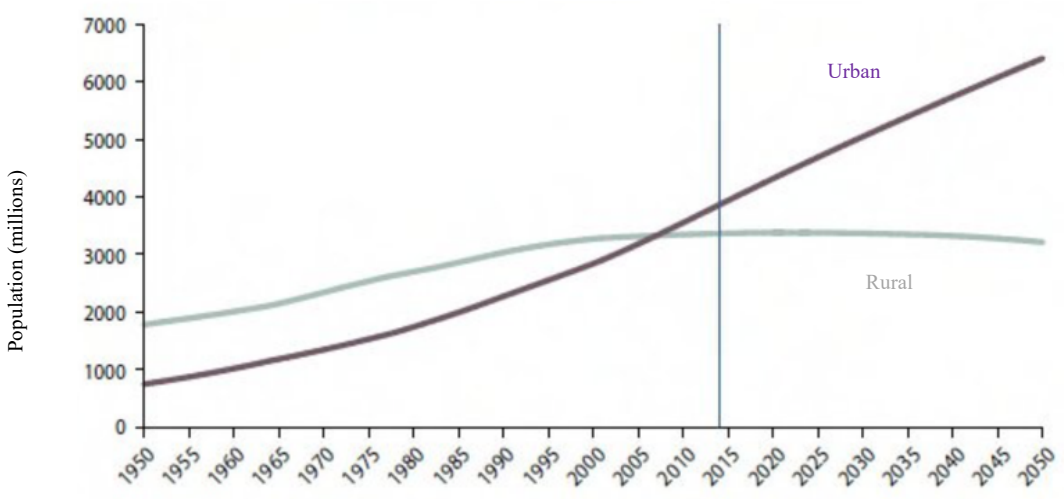


Figure 3. Urban and Rural Population of the World, 1950-2050
(Source; UN Department of Economic and Social Affairs, 2014)

Now, we can mention some main causes of urbanization such as industrialization, commercialization, employment opportunities, social benefits and related services, and modernization.

1.4. THE POSSIBILITIES TO IMPLEMENT SUSTAINABLE DEVELOPMENT IN AN URBAN AREA

Sustainability plans provide a wide range of visions as to how urban areas and cities can incorporate sustainability targets into their development.

All politicians, local authorities, planning agencies, developers, and in a broad vision private business entities and public companies plus every single citizen have a crucial role to determine how to interpret and implement it if a city wants to start this development should understand the importance of the function of this group members as a union in which are implementing this goal altogether.

As an abstract of studies in the field, this research suggests some practical solutions which can help to implement Sustainable Urban Policies in an urban area.

I. Encouraging private investment to enter this field.

II. Some public auctions such as raising the taxes to avoid driving businesses elsewhere.

III. Use of sponsorship or partnership for funding sustainability.

IV. Performing general medium and long-term plans in medium-scale (cites) and large scale (regions or national one).

V. Use of potentiality of individuals to implement the sustainable development items.

VI. Working on the innovative actions.

VII. Using the availability of local knowledge.

VIII. Motivating the students and researchers into a city to act effectively.

IX. Educating, fostering general awareness, and advertising to encourage people to respect the sustainability.

1.5. ECOLOGICAL PLANNING AND SUSTAINABILITY

To effectively apply sustainable principles to planning and management, new tools are required. At different scales and over time, the spatial dimension of sustainability involves processes and relationships between different land uses, ecosystems, and biotopes. As a result, ecological knowledge is required when planning for long-term sustainability.

The malleable definition of the term "sustainable development" makes its use in urban planning challenging, if not impossible. Ecological Planning in the western world, according to Jan Scheurer (2000), has at least three dimensions. The first is Technical, which focuses on bettering urban resource management through technological advances such as more efficient energy and water usage, waste separation, architectural adaptations, and enhanced transportation quality, to name a few. The second dimension is Urban Design, which looks at how cities can "minimize mobility impacts while increasing self-sufficiency and independence from energy-intensive and long-distance resource inputs". These two dimensions are inextricably linked to *spatial planning*, which is characterized as the use of land and the construction of buildings and infrastructure (Naess, 2001). The third dimension is Social Capital, which is needed to incorporate and complement technological and formal choices - knowledge, education, and lifestyle choices - as well as to supplement them (Scheurer, 2000).

1.6. SUSTAINABLE URBAN FORM: DESIGN CONCEPTS

Generally, Form is not easy to define. Kevin Lynch (1981) defines urban form as the spatial pattern of the inert, large, permanent physical objects in a city. Handy (2006) defines it as a set of characteristics relating to the transportation systems, land use patterns, and urban design. The form is the product of the aggregation of more or less repeated elements.

The urban pattern, then, is the product of several elements-concepts being brought together. The majority of urban patterns are composed of a small number of relatively undifferentiated types of elements that replicate and combine. Hence, Lozano says (1990) these concepts are remarkably similar and can be conceptually grouped into concepts. In particular, elements of concepts are likely street design, street patterns, block size and form, the layout of parks and public spaces, typical lot configuration, etc. This research assumes that there are recurring ideas that combine to form distinct urban sustainable forms. Here, qualitative methods are used to identify these forms and their design concepts. To write this part, I was inspired by the Sustainable Urban Forms Article (Jabareen, 2006). The investigation in this part is focused on information gathered from advertising materials, scientific assessments, news accounts, and site visits, among other sources. This research focuses on seven recurring and significant themes in urban form.

The goal of this part is to create a reference to an idea of making sustainability work in the urban areas. There is a complex of main elements and their characteristics to constitute urban environments.

Here, we need to introduce the list of Urban Sectors to be considered and then the related lists of possible intervention elements. Obviously, for every single city or urban area worldwide, the list of organizations and their interactions is different – but a lot of them are in common. The improvement of the functionality of related organizations or sectors involved in this major has a crucial role in the management and implement sustainability principles into the cities.

Hence, this stage clarifies the issue of the Local Administrative Organization of Sustainability, then it goes over the subject of Design Concepts.

The administrative structure can influence bureaucratic procedure, efficiency, and responsiveness, and it's especially important to consider when establishing new bureaucratic functions and programs. The factors that influence the assignment of these functions to specific government agencies or departments, especially at the local level, are, however, understudied.

The lack of empirical evidence on bureaucratic assignment in local government makes it difficult to understand institutional design and the organizational options available, particularly when it comes to specific policy areas. The goal of sustainability is becoming more and more common. Local policymakers have a variety of institutional units to which they may delegate primary responsibility for sustainability due to its newness and cross-cutting existence.

Cities play a crucial role in achieving sustainability. Around two-thirds of the 2,509 measures listed in Agenda 21 for achieving greater sustainability require the active participation of local government (Sauvage, Keen, and Mahanty, 2006).

Two-thirds of the world's population is projected to live in cities by 2030 (United Nations, 2006). According to Laws et al. (2004) and Wang et al. (2012), Implementation and management should be the subject of more sustainability research. They argue that sustainability research should move away from the specifics of sustainability practices *"what is sustainability?",* and the motivations of *"why is sustainability important?"* and toward strategies for change implementation. They argue that more research is required to better understand the conditions that lead to successful and productive local initiative administration.

Administrative structures vary widely, but there are specific distinctions: some cities choose to place responsibility for sustainability within the executive branch, while others choose a line department as the focal point. On the surface, the decision may appear to be insignificant as long as environmental, economic, and social sustainability goals are met. However, there are important trade-offs to consider when choosing an administrative structure that can have a significant impact on the bureaucratic process, results, and responsiveness. Explaining the administrative choices made in how sustainability activities are structured is a vital first step in untangling the consequences of these decisions.

The first step explains the related elements or sub-issues of each design concept. the frame of this part is based on "*the subject explanation, main goals to catch, and some possible tools used for achieving the results"*. Then for clarifying some policies, there is one of the best available examples that are implemented in a city or urban area.

Configuration of Design Concepts and Sub-issues

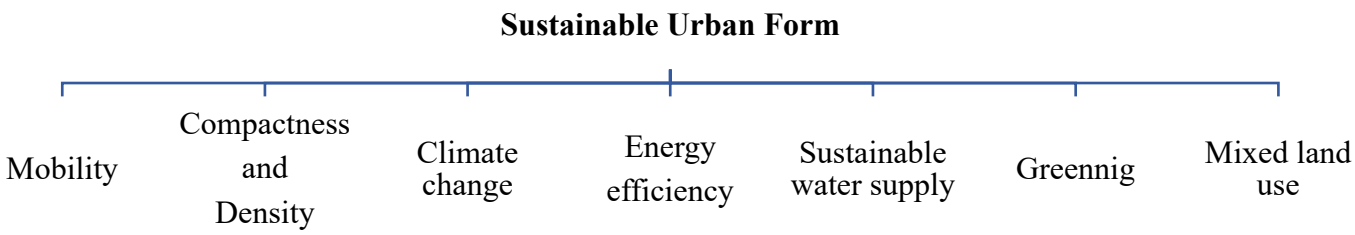


Figure 4. Design Concepts of Sustainable Urban Form (elaboration by the author).

Mobility:

1. Passive solar system implementation
2. Street canyon design
3. Building design
4. Built form
5. Design the vegetation and bodies of water for buildings
6. Traffic reduction
7. Use of compatible urban materials
8. Desert technology

Energy Efficient:

1. Pedestrian-friendly
2. Cycling
3. Developing the public transportation system and encouraging non-motorized trips
4. Diminishing the physical separation of activities
5. Motivate the individuals to use hybrid and electric technology

Greening:

1. Forestry
2. Agriculture
3. Parks & green zone improvement

1.6.1. Concept 1: Mobility

Here, the policies are implemented to reduce the use of non-renewable and dirty energies like oil and natural gas as motorized vehicles fuel, the achievements are reduction in the traffic, air & noise pollution, reducing the daily travel costs of individuals, having more efficient transportation

system, creating new job opportunities- green ones, and help to increase the health care level of individuals.

Some possible tools to achieve these targets:

i. Pedestrian-friendly

To reduce emissions, noise, and street congestion through a range of measures that promote more sustainable forms of mobility. The emphasis is on improving conditions for pedestrians to make cities more livable, safer, and healthier places.

Constructing a network-efficient of sidewalks in-side and outside of the city, especially in the principal and width streets of the city for creating the connectivity between the most popular and working areas, connecting the alleys to the work and commercial centers, as much as possible connected street layouts. also preparing the alleys as a pleasant site to individuals thanks to planting some greeneries there and designing the surfaces.

In most cities the alleys are one of the most underutilized places, they like lighting infrastructure, stormwater, or any paving infrastructure, and offer to serve as a perfect feeding ground for crime and environmental degradation that does not make anybody happy.

As an EU regional and urban development policy, "*the City Walk project"* is helping to unlock the positive effects of walking in urban areas and so create more livable cities. The project brings together 17 partners from nine countries. Municipalities, development agencies, research organizations, and chambers of commerce from across the Danube region are sharing common practices and methodologies to help cities develop efficient, people-friendly urban transport systems that prioritize walking over motorized transport.

Total investment for the project "City Walk - Towards energy responsible places: establishing walkable cities in the Danube Region" is 2,229,590 Euros, with the EU's European Regional Development Fund and Instrument for Pre-Accession Assistance contributing 1,895,151 Euros through the "Danube Transnational" Operational Program for the 2014-2020 programming period (official website of the European Union).

In the United States, "*Noteworthy Local Policies"* That Support Safe and Complete Pedestrian and Bicycle Networks provide local and state agencies with the tools to create a solid policy platform to support the creation of multimodal transportation networks for users of all ages and

abilities. The local and state governmental agencies make a crucial role in developing and applying policies and provide evidence to support policy adoption. Effective policy shapes long-term planning efforts, as well as more immediate decision-making. It informs infrastructure planning, design, construction, and maintenance and shapes decision-making related to investments in infrastructure and capital improvements. The policy informs and shapes an agency's work in engineering, education, enforcement, emergency response, encouragement, and evaluation efforts.

This multidisciplinary approach, embodied in both required Federal safety planning and best practices in bicycle and pedestrian planning and design, is important in establishing a safe and complete pedestrian and bicycle network. The terms bicycling, walking, bicyclist, and pedestrian are used throughout this document and are intended to be inclusive of people of all ages and ability levels, including people with disabilities.

Six policy elements for creating complete networks, identifying six areas for transportation agencies and stakeholders to develop effective policies to help create safe and complete bicycle and pedestrian networks: define success, protect non-motorized, promote supportive development, design the network, make it last, and pay for it (U.S. Department of Transportation).

Example (a benchmarking city in the field): Los Angeles, U.S.

Many North American Cities are taking steps to strengthen their green infrastructure, or the networks of wildlands, woodlands, waterways, and wetlands that, when combined with green roofs, permeable paving, vegetative swales, parks, and green streets, support ecological processes and contribute to human health and quality of life (Benedict and McMahon, 2002). The city of Los Angeles (in the U.S.) has an estimated 12,309 alley segments, a network of more than 900 linear miles, or approximately 1998 acres (Cassidy, Newell, and Wolch, 2008). Alleys are thus significant, though typically overlooked, urban public infrastructure resources (J.P. Newell et al., 2012). The potential benefits of alley greening projects are numerous. Alleys may facilitate urban runoff management through infiltration, groundwater recharge, heat island reduction, and expanded wildlife habitat (Wolch et al., 2010).

City of Los Angles (LA) is looking at 250 acres of alley space available in south LA to re-envision the alleys address a multitude of city problems and create a positive impact in communities from the very beginning "*The Green Alley Master Plan Program"* was understood

that it is community input that has to be driving the success of the program. Design to respond to social, cultural, and environmental needs of a particular neighborhood.

Some design solutions include adding permeable spaces as pavement in alleys to help with stormwater management and creating community connectivity closing some of the alleys completely to car traffic, creating pedestrian-friendly zones, therefore, creating play areas for kids, and adding plants to add more nature which helps with the well-being and also in addressing some of our climate change challenges. The whole project covers 80 square miles and 350,000 residents. The network works with bike lanes, sidewalks, and streets to create efficient connectivity (Paulina Lis, 2018).

ii. Cycling

Cycling is the most energy-efficient urban transport mode with a high potential to reduce energy consumption and enhance the livability of cities. However, most of this potential still has to be activated. Cycling is already a "serious" transport mode in some countries (e.g. Netherlands and Denmark). But it can also become a high-impact measure to foster energy-efficient transport patterns in countries without a real "cycling culture". reduce CO_2 emissions and air pollution by increasing the modal share of cycling. increasing traffic safety and improving public health by promoting physical activity.

In 2010, the project of the EU's Intelligent Energy as *PRESTO* "Promoting Cycling for Everyone as a Daily Transport Mode" is implemented. Dirk Dufour, Ligtermoet, and Partners, authors of this project, talk about Cycling Infrastructure, Promotion of Cycling, and Legislation on Pedelecs.

This research mentions some of the critical points of this project which are related to my research below.

Cycling policy is on the agenda in developed countries, especially in European cities. In recent years and decades, many local authorities have been undertaking a range of activities to stimulate cycling as a daily transport mode, because they are increasingly convinced that cycling is good for cities. If we want to develop cycling as a daily urban transport mode, then our cities need to be fit for cycling.

Champion Cycle Cities have modal shares of upwards of 30%. Tapping this potential will only work if riding a bicycle is physically possible, safe, and attractive. Only then will cycling be able to compete against the car in cities.

- For this, an integrated cycling infrastructure policy is needed.
- Infrastructure and street and road design must be adapted to cyclist's needs.
- A well-organized cycle network must allow cyclists to reach any destination easily, safely, and conveniently.
- Careful design choices need to be made in each specific situation.
- Consider cycling parking policy and the intermodal linkage between cycling and public transport.

Cycle friendly infrastructure: Basic Requirements

When investing in cycling infrastructure, we need to make the right choices. What is needed to improve cycling conditions, to make cycling safe, and to attract as many cyclists as possible? Starting from cyclists' needs some key requirements can be defined.

1. Cyclists' needs: First we need to be aware of the essential user needs of cyclists and the characteristics of bicycles. It is vital to keep in mind that the bicycle is mainly used for short distances. More than 80% of all bicycle trips are less than 5 km long. Cycling is essentially a local transport mode. Looking at the travel purpose, the bicycle is useful for all kinds of trips and all ages. Apart from daily utility trips, the bicycle also plays a major role in recreational trips. In the last decade, recreational cycling has increased systematically in all European countries. Besides the qualities of the surrounding landscape, attractive cycle facilities are a key element in promoting recreational cycle trips. When these cycle facilities are also run through more urban areas, they also have the potential for supporting daily functional cycle trips at the same time. While the needs of functional and recreational cyclists differ, facilities should be closely integrated into urban environments so that double use is promoted.

2. Cycle infrastructure works: There are large differences in cycle use among the various countries and cities especially in Europe. Some specific research projects have shown that good cycle infrastructure indeed leads to a higher cycling share. The benchmarking "Fietsbalans"

project, conducted by the Fietsersbond (Dutch cycling association), has revealed a clear link between levels of cycling in a municipality and the quality of the cycling infrastructure. The quality of the infrastructure was recorded objectively using measuring equipment and is expressed in the so-called "bicycle Balance Score". In Dutch municipalities with a high bicycle Balance Score, bicycle use is on average 14% higher than in municipalities with a low bicycle Balance Score.

Quality requirements for cycling infrastructure: What is it that makes cyclists want to get on their bikes? Starting from user needs, it is possible to define five main requirements for cycle-friendly infrastructure: *safe, direct, cohesive, attractive, and comfortable*.

These were developed in the Netherlands but have been internationally recognized as valid policy guidelines. It will not always or everywhere be possible to fulfill each requirement, not even in Champion Cycling Cities. But the point is that the more of them are fulfilled, the more people will be attracted to get on their bikes. These requirements must always be kept in mind as objectives to strive for. And they can also be used as criteria to assess the quality and shortcomings of existing infrastructure.

3. Design requirements: stability, zigzagging, and section of free space: The physical cycling infrastructure needs to take into account the physical space needs of cycling. This includes the dimensions of the cyclist and the bicycle, but also the physical characteristics of the activity of riding a bicycle.

Fear distances from obstacles, designers also have to take the fear of obstacles into account: cyclists will want to keep their distance from curbs, edges, and walls. The Dutch Design Manual indicates the following obstacle distances: for green verges and low curbstones, the obstacle distance is 0.25 m; for higher curbstones 0.50 m, for closed walls 0.625 m.

Section of free space, now we can calculate the pavement width required for one cyclist: take the width required by the bicycle and its rider (0.75 m) and add to that the zigzagging margin and fear distances from obstacles (these margins may overlap). The most common situation is that of a cyclist riding along a high curb on one side: an absolute minimum pavement width of 0.9 m is required.

Whenever possible, we should provide room for side-by-side riding: this makes cycling a more enjoyable social activity, allows adults to drive next to children, and allows faster cyclists to overtake slower ones. This means we should go for a recommended minimum width of 1.5 m. For comfortable driving in tunnels, provide a minimum of 0.75 m headroom.

In the European Union, PRESTO (Promoting Cycling for Everyone as a Daily Transport Mode) is a project of the EU's Intelligent Energy – Europe Program granted by the Executive Agency for Competitiveness and Innovation (EACI). Five cities and a range of experts unite in developing strategies to tap the potential of cycling in cities. The cities represent a range of diverse sizes, locations, cultures, and cycling traditions. All will deploy actions in three fields: cycling infrastructure, cycling promotion, and pedelecs (PRESTO Project of EU, 2010).

Example (a benchmarking city in the field): Copenhagen, Denmark

Bicycling is one of the most primary means of transportation in Denmark, there are five times more bicycles than cars in Copenhagen, it's more than 12,000 kilometers or about 7,500 miles of cycle tracks. The city's current bicycle infrastructure consists of segregated cycle tracks, on-street bike lanes, off-street routes, cycle bridges, and even a bicycle highway where commuters are given the highest priority. With its flat terrain, this city offers favorable cycling conditions. The first bicycle path was built as early as 1892. Cycling became very popular among residents. Their interest in it continued to grow in the 1920s and 1930s. however, after the second world war car traffic dramatically increased. This led to the energy crisis in 1973, the government had to implement car-free Sundays to conserve oil reserves. The city also built more bike lanes on the roads. Copenhagen created dedicated bike lanes on main roads instead of putting them on indirect routes. The city uses a five-centimeter or about two-inch high curb that separates bike lanes from roads. There are even special traffic lights that give cyclists a five-second head start over cars.

Copenhagen's "snake" is an iconic cycle bridge that crosses over the harbor (a sky bridge of 230 meters in length). Copenhagen is also well known for its cycle super-highways. A series of bike routes that connect Copenhagen to nearby suburbs. They have food rests on the side of the road, service stations with air pumps, traffic lights dedicated to cyclists, and access to public transportation. More than 60 percent of Copenhageners chose to cycle to work and school (websites of Freethink, 2019).

iii. Developing the Public Transportation System; *"efficient, clean and convenient "*

The role of sustainable transport was first recognized at the 1992 United Nation's Earth Summit and reinforced in its outcome document – Agenda 21. In undertaking the five-year review of the implementation of Agenda 21 during its nineteenth Special Session in 1997, the UN General Assembly further noted that, over the next twenty years, transportation would be expected to be the major driving force behind a growing world demand for energy (Indeed, it is now the largest end-use of energy in developed countries and the fastest growing one in most developing countries). Further, at the 2002 World Summit on Sustainable Development, the role of transport was once again captured in the outcome document - the Johannesburg Plan of Implementation (JPOI). JPOI provided multiple anchor points for sustainable transport, in the context of infrastructure, public transport systems, goods delivery networks, affordability, efficiency, and convenience of transportation, as well as improving urban air quality and health, and reduce greenhouse gas emissions.

The global attention to transport has continued in recent years. World leaders recognized unanimously at the 2012 United Nations Conference on Sustainable Development (Rio +20) that transportation and mobility are central to sustainable development. Sustainable transportation can enhance economic growth and improve accessibility. Sustainable transport achieves better integration of the economy while respecting the environment. improving social equity, health, the resilience of cities, urban-rural linkages, and productivity of rural areas. Subsequently, the UN Secretary-General, as part of his Five-Year Action Agenda, identified transport as a major component of sustainable development. To this and Secretary-General established and launched in August 2014 a High-Level Advisory Group on Sustainable Transport (HLAG-ST), representing all modes of transport including road, rail, aviation, marine, ferry, and urban public transport providers. The policy recommendations of the Advisory Group were submitted to the Secretary-General in a global sustainable transport outlook report, entitled "Mobilizing Sustainable Transport for Development", released at the first Global Sustainable Transport Conference in November 2016.

The importance of sustainable transport for countries in special situations is also recognized by the international community, through the Istanbul Program of Action for the LDCs, the Vienna Program of Action for the LLDCs, the SAMOA Pathway for SIDS, the Sendai Framework for Disaster Risk Reduction, and the New Urban Agenda.

In the 2030 Agenda for Sustainable Development, sustainable transport is mainstreamed across several SDGs and targets, especially those related to food security, health, energy, economic growth, infrastructure, and cities and human settlements. The importance of transport for climate action is further recognized under the UNFCCC - the transport sector will be playing a particularly important role in the achievement of the Paris Agreement, given the fact close to a quarter of energy-related global greenhouse gas emissions come from transport and that these emissions are projected to grow substantially in the years to come (official website of the United Nations).

Invest in the renovation of means of transportation and adding electronic and hybrid vehicles in the public transportation system reduces the traffic congestion, diminishing the oil fuel usage and saving the time of commuters.

Example (a benchmarking city in the field): Hong Kong Island

The United States with 800 cars for every 1000 people has a car culture, Hong Kong with only 92 cars for 1000 people has a culture of public transit. On Hong Kong Island the iconic and only double-decker tram system in the world costs just 2.3 Hong Kong dollars or 30 US cents. The peak tram takes you to the most spectacular view of the city in just 7 minutes – a steep 370-meter that would otherwise take a full hour. There are busses, able-cars, helicopters, and the longest outdoor covered escalator in the world. Finally, the 12-line, 93-station mass transit railway or M-T-R is responsible for moving most of the city's seven and a half million people. Note, unlike nearly every other place in the world, Hong Kong's public transit pays for itself. It is so profitable that it subsidizes the government. Its unique business model is an unexpected window into the city's ongoing protests (Website of PolyMatter, 2019).

iv. Encouraging non-motorized trips with implementing high taxes on the motorized vehicle.
v. Diminishing the physical separation of activities that decreases the travel needs of individuals.
vi. Motivate the individuals to buy and use hybrid and electric technology vehicles by promoting some incentives like exemption or decrease the tax, long-term or low-interest loans, etc.

1.6.2. Concept 2: Energy-efficient Consumption

The policies are implemented to reduce the use of non-renewable and dirty energies by substituting the renewable ones that bring a huge reduction in emissions of carbon dioxide (CO_2) and other greenhouse gases. The achievements are pollution reduction, creating electricity thanks to solar energy and wind instead of constructing and using power plants, balancing the energy costs, and making a lot of new job opportunities for individuals - green jobs.

The tools to achieve the targets (Jabareen, 2006):

i. Implementing the Passive Solar System; decreases the use of energy.

- Using solar cells, implementing on the roof of the building, installing cells in the balconies, creating a network of solar cells in the parking area, etc. Like that is happening in the Dimond Sustainable City of Dubai, UAE.
- The green roof design: to stop heat from escaping, like that is happening in Copenhagen, Denmark.
- Wind power usage, offshore wind turbine to create the required energy of a city, an example is Copenhagen.

ii. Street canyon design: Width-to-height to influence the warming-cooling process.

iii. Building design; to influence the capacity of external surfaces and use of transitional spaces, control building heat gains & losses.

iv. Built form; high enough density of residential areas and their types to influence airflow, view of the sky/sun, and exposed surface area.

v. Design and implement the vegetation and bodies of water for the building and closed spaces; to influence evaporation cooling processes on building surfaces and open spaces.

vi. Traffic reduction policies: to reduce air & noise pollution and also heat discharging.

vii. Using the compatible and efficient urban materials and surfaces finish; to influence absorption, heat storage, and emissivity.

viii. Desert technology: it is used in the areas that are closed to deserts or dry areas; as a low-tech solution (solar farm); the fans and pods system functioning: some fans with simple motors are working for blowing air out and create a negative pressure inside the closed space then the air goes to come to the wing trees “a gold path” afterward we can

wet or moist them with gray water created by the buildings around. the systems are using for planting vegetables, flowers, and fruits (website of the sustainability city, 2017).

Note, ***Carbon-neutral status***; in one hand, cities are using dirty *Energy* such as "coal, fossil fuels, natural gas …" for implementing their activities, and on other hand, they can create some possibilities to use *Renewable Energy* "wind, solar, biomass, hydropower, …". If a city can implement some conditions in which the use amount of renewable energy can compensate the amount of dirty used energy, the result is called "*Net Zero"* status that means this city can control the carbon emissions well, like that is happening in Copenhagen, Denmark.

1.6.3. Concept 3: Greening

Green urbanism, or the greening of cities, tends to be an essential design principle for a sustainable urban form. Greenspace has the potential to positively impact several important urban priorities, including sustainability (Swanwick, Dunnett, and Woolley, 2003).
Designing the cities according to the greening urbanism approach will become them more pleasant (Van der Ryn and Cowan, 1995; Nassauer, 1997), and more sustainable spaces (Dumreicher et al., 2000). Finding an effective method to integrate nature into the city itself and the city dwellers will bring the diversity of urban landscapes for that area. Two main conditions for having green urbanism are, first, try to live within ecological limits and second, emphasizing a high quality of neighborhood and community life. The achievements of implementing this policy are contributions to biodiversity preservation through the protection and enhancement of a diverse range of urban ecosystems (Gilbert, 1991; Kendle and Forbes, 1997; Niemela, 1999), improvement of the physical urban environment by lowering emissions, mitigating urban climate extremes, and assisting in the creation of cost-effective, long-term urban drainage systems (Von Stulpnagel, Horbert, and Sukopp, 1990; Plummer and Shewan, 1992; Hough, 1995), enhancement of the city's appearance and quality of life (DoE, 1996), growing a city's economic attractiveness (Beer et al., 2003), it has health benefits (Ulrich, 1999), and Greening also seeks to conserve and improve the ecological diversity of urban environments.

How can we translate this vision into reality? “Related tools”

i. Forestry, while planting more trees is essential for sustainable development, providing critical services. these ecosystems store carbon, support biodiversity, regulate water flows and reduce soil erosion. We need to take an action by protecting the forests; stop illegal logging & forest clearance, restore degraded forests, and promoting sustainable management.

ii. Agriculture, green growth is fundamental for long-term food security and poverty reduction. Some environmental alternatives can help farmers avoid catastrophic losses and improve their income. Investing in and promoting organic products and eco-tourism can create green jobs and maintaining ecosystem services such as crop pollination and water purification.

iii. In cities, Improving the park's greenery and creating green zones in unutilized spaces like alleys. And the Green coverage of buildings and roof gardens design can be helpful in this regard (website of Asia LEDs, 2014).

Example (a benchmarking city in the field): Singapore, the Republic of Singapore

Singapore has been closed to the greenest city in Asia. This city has some remarkable architecture including the most recognizable building the Marina Bay Sands, while these mega structures may seem bad for the environment. Singapore is insured they have interwoven nature into the design. Singapore receives over 19 million tourists each year, which is more than what some of the large European capital cities receive. The major tourist attractions in Singapore have an eco-driven concept for example Cloud Forest in the gardens by the bay takes you on a journey through nature. Having environmental education means that Singapore can have wide-reaching effects with its sustainable efforts. Nowadays, from tourist attractions, Singapore may be classed as one the most socially sustainable countries in the world due to its remarkable housing schemes.

80% of the population lives in public housing, this public housing helps families avoid homelessness other kinds of housing instability. This has had great success in stimulating Singapore’s economy as one of the most economically successful countries in the world. Having a stable economy allows Singapore to divert its attention toward pressing environmental issues than worrying about financial problems. Given the lung constraints and the high population density

they have done exceptionally well to provide adequate green spaces, there is over 47% of green coverage in Singapore.

This greenery extends up the buildings and forms new gardens in the sky.

1.6.4. Concept 4: Density and Compactness

Yet much of the debate over the sustainability of cities and urban forms have centered on increasing growth density, ensuring a mix of uses, containing urban "sprawl," and achieving social and economic diversity and vitality–a notion known as the "compact city" (Jenks et al., 1996; Jenks and Dempsey, 2005). The European Commission was an early and powerful proponent of urban containment and compact forms of development (Conference of European Churches, 1990). Compact urban forms, it was hypothesized, would decrease urban sprawl, protect agricultural and amenity land, and allow for more effective use of previously developed urban land (Jenks and Jones, 2010).

Compactness refers to urban contiguity and connectivity, which suggests that future urban development should take place adjacent to existing urban structures (Wheeler, 2002). When the concept is applied to existing rather than new urban fabric, it refers to the containment of further sprawl, rather than the reduction of the present sprawl (Hagan, 2000). The compactness of urban space can minimize the transport of energy, water, materials, products, and people (Elkin, McLaren, and Hillman, 1991). Compactness also encourages social interactions.

Density is the ratio of people or dwelling units to land area. Higher densities are strongly advocated, and there are examples of schemes designed and proposed at densities exceeding those recommended in CABE's 2005 guidance, with over 100 dwellings per hectare (Owers and Oliver, 2001; Dawson, 2004). High density and integrated land use conserve resources. As density increases and Compactness is implemented, car ownership declines, and car travel-gasoline consumption also decreases.

1.6.5. Concept 5: Mixed Land Use

Mixed-use or wide-range zoning allows compatible land uses to locate close to one another and as a result that, decrease the travel distances between activities (Parker, 1994) Mixed land use states the diversity of functionality such as residential, commercial, industrial, transportation uses,

institutional, etc. thereby reducing the need for travel. This policy states that many services are within a reasonable distance, therefore, motivates individuals for walking and cycling, decreases traffic, thereby reducing air and noise pollution. Also, this method can increase the safety of public spaces by renewing life in many parts of the city (Elkin, McLaren, and Hillman, 1991), increase the attractiveness of local streets and increases the health care level, and makes walkers and cyclers fresh and happy.

The tools for obtaining this policy are explained in the previous parts such as constructing pedestrian-friendly zones and improving the network of bike lanes.

Furthermore, we can consider some other Methods and Policies such as (CABE, 2008; English Partnerships, 2007) Reduction of Waste Products (reduced domestic and construction waste) and Reuse of Them, Intelligent lighting and integrated security, heating & IT systems, Eco-rating (BREEM[1] excellent), and Environmental Justice; creating social equity through a fair distribution of environmental burdens.

These are primarily the physical and environmental aspects of sustainability, and they are the ones that are most likely to be incorporated into developments. While not all of them are related to urban form, the ones that are highlighted in this research. afterward, we should consider the social sustainability arguments that underpin the physical aspects, such as high densities and good public transportation, which are related to the social benefits of ease of access to facilities.

This world is facing a lot of other initiatives to obtain sustainable cities in different areas of earth that may be are mentioned in other studies.

The next part focuses on some new concepts in urban sustainability such as Climate Change Mitigation and Adaption, and the Sustainability of Water Supply in Urban Areas.

[1] BREEAM Communities consists of forty individual assessment issues spanning five core technical categories, governance; land use and ecology; resources and energy; social and economic wellbeing; and transport and movement plus a sixth category called “Innovation”.

1.6.6. Concept 6: Climate Change Mitigation and Adaption

What is climate change? *"Climate change is called the crisis of our time"*

According to the levels of carbon dioxide in our atmosphere over hundreds of thousands of years, we started breaking CO_2 records in 1950 and we haven't stopped since. Scientists say there is a 95% chance that human activity is the cause.

We have been burning more and more fossil fuels like oil and coal, which release CO_2, to power our homes, factories, airplanes, and cars. The global population has tripled in the past 70 years, and we are consuming more products from animals that released another pollutant called methane, so all those gases are in the air and when the sunlight gets into the earth's atmosphere, some of the heat gets trapped and the planet gets warmer, that is called the Greenhouse Effect. But the concern is not the earth getting warmer, it is that happening far quickly. We are facing the warmest temperature on earth since the Last Ice Age 10 thousand years ago.

The UN says that right now, our world is about one degree hotter than pre-industrial times, that is around the year 1800. The UN says if we warm by 1.5° C before the end of the century, we should be fine, the UN says even two degrees would probably be alright. But the problem is speed because right now we are on track to hit 1.5° C in only 10 years (till 2030), and we do not slow the warming down, it could mean catastrophe within our lifetime and the future generation.

Sea levels are rising about three millimeters a year because seawater expands as the temperature gets warmer. Melting ice sheets and glaciers add trillions of tones of freshwater into our oceans. Entire coastal cities could be underwater within 80 years like Miami in the U.S. and entire island nations in the pacific could completely disappear.

Now, there is a plan to slow all this down. Back in 2016, World Leaders signed the so-called "Paris Agreement", and big pledge is to cap the temperature rising by 1.5° C or max of 2° C (36° F), before the year 2100, then countries own their targets on how much CO_2 they emit. But here is the thing four years after the agreement global CO_2 levels are still going up.

Climate Change is a broad topic especially in urban sustainability, a lot of nations, organizations, scholars, researchers, and politicians have talked about their concerns in this regard. on top of all these organizations and individuals, United Nations and European Union established several plans and programs to control this crisis, some of them were implemented well, some of them are in progress, but the concern is that a lot of these policies especially on the national level have not been done.

Achieving the reduction in global emissions of carbon dioxide (CO_2) and other greenhouse gases is the common goal of countries that joined the UNFCCC. As a result, the number of environmentally friendly innovations has increased at a remarkable rate in recent decades (Su and Moaniba, 2017).

All these goals can transfer into the real world by reducing the use of cars, use trains more, eat less meat, shifting to renewable energy, cycle more, consume a bit more carefully, and implementing some other policies that are mentioned in the next parts.

Parties to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and its Paris Agreement recognize that adaptation to climate change and resilience is a global challenge faced by all with local, subnational, national, regional, and international dimensions. It is a key component of the long-term global response to climate change to protect people, livelihoods, and ecosystems. Parties acknowledge that adaptation action should follow a country-driven, gender-responsive, participatory, and fully transparent approach, considering vulnerable groups, communities, and ecosystems, and should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous people and local knowledge systems, to integrate adaptation into relevant socioeconomic and environmental policies and actions (official website of the United Nations).

1.6.7. Concept 7: Sustainability of Water Supply in Urban Areas

First public water supply systems were developed thousands of years ago. Providing an adequate supply of safe water is a tip-top goal of all water providers in urban areas.

These systems have developed due to shifting from hunting and gathering to agriculture led to permanent settlements, the establishment of social classes, the eventual rise of urban living, and large civilizations. Today, Sustainability is a keyword in urban water supply systems. According to all these transitions, we as “humans” are finding some efficient methods to bring water to our landscape instead of changing our lands to find water. The earliest civilizations and water supply systems shaped where plentiful and reliable water supplies could be extracted from lakes, rivers, etc. we are facing two events, first, rivers in many parts of the world became fully allocated and aquifers became depleted, and second, huge growth in urban and agricultural demands, as a result, the need of importing water from distant sources. Today, more than 40% of the water consumed in major cities comes from water importation schemes (McDonald et al. 2014).

New technologies and infrastructure have improved the water supply for urban areas, such as through recycling wastewater, harvesting rainwater and stormwater, and ocean water desalination.

Now, according to the urban individuals' needs for water, an adequate and convenient supply network is required, which states providing safe water and affordable, meanwhile, this process is sustainable.

The tools for achieving this goal are: Reducing carbon emissions of the energy used to move and clean water, Eliminating the waste of water due to leaking pipes, mitigating the volume of water extracted from freshwater ecosystems that imperil aquatic species. Furthermore, some research expected a reduced water supply ratio as climate change, therefore water suppliers should consider this concern and find adequate policies to compensate for it.

Afterward, we all need to make the ground permeable again. Impervious surfaces in cities mean unbearable heat, dry aquifers, and violent runoffs. The city must change and offset the effect of sealed surfaces. 1.5 m^2 of infiltration area for every square meter sealed. Our planet is facing more heat, dryer soil, and more irrigation in the countryside. We should keep the water in the soil, maintain plant cover, replant hedges, and reduce drainage.

Wasting water is a big problem that humans are experiencing at this time, climate change means less available water. The drinking water networks are leaking. Often one liter out of two never reaches the tap. By repairing the leaks of the drinking water networks we will reach a yield of 85% by 2030. Improve the irrigation techniques brings a reduction in water for irrigation by 20% from now to 2030. Reduce water consumption by a factor of 10 by making every drop count. Reuse treated wastewater for watering green spaces. Another policy to improve the water supply conditions is giving more space to rivers. A channelized river is a vulnerable river. Recreate flood-prone areas on 20% of the rivers this year. "*Keep our rivers free and cool"*

Afterward, create wooded banks to provide cool shade and better quality of water, where fishes can find areas for resting and spawning. Weirs and dams stop pebbles and fishes from passing through, Remove the barriers that stop fishes, build fish passes.

More heat means that wetlands dry up. Reconnect wetlands to the river, it's called Higher biodiversity (The Rhone Mediterranean Corsica water agency, 2014).

The critical questions and the practical suggestions are the preliminary part of the possible solutions that can be envisaged and then implemented in the different urban sectors (those

described before). The financing matters have to be discussed in the light of this previous discussion and as the final topic after the identification and selection of the different possible solutions and interventions which should be implemented to make an urban environment more sustainable.

1.7. RELATED ACTIONS ARE TAKEN AT THE PUBLIC LEVEL

The following section of this study focuses on several important programs at this time. they are aimed to undertake the cooperation of several nations to combat Climate Change, as well as, to develop adaptation measures and tools to reduce the negative impacts produced by the events and disasters caused by Climate Change —one program on the global scale and another one on the EU scale.

As an abstract of the studies, a Public Program can act as a united legislator at the European and International levels. Cause the governments play such an important role in addressing the negative impacts of Climate Change, a Public Program that unifies all countries can enact strict environmental legislation to achieve a common goal.

As an example, the Paris Agreement will be briefly introduced, as it acts to obtain a clear and direct engagement of developed countries and developing countries activities to achieve the common shared and stated goal, with particular attention, according to the analysis filed, to the articles 9, 10, and 11; Finance, technology, and capacity-building support – which reaffirms Developed Countries' obligations to support Developing Country Parties' efforts to build clean, climate-resilient futures, while also encouraging voluntary contributions from other Parties for the first time.

The Paris Agreement

The Paris Agreement aimed to upgrade and replace the Kyoto Protocol, a previous international accord aimed at reducing greenhouse gas emissions. It was signed by 194 countries and ratified by 189 as of November 2020, and it went into effect in November 2016. Unlike the Kyoto Protocol, which sets legally binding emissions reduction objectives (together with penalties for non-compliance) for just industrialized countries, the Paris Agreement requires all countries—rich,

poor, developed, and developing—to do their share and reduce greenhouse gas emissions. In 2016, the Princess of Asturias Award for International Cooperation was given to the Paris Agreement.

The Paris Agreement builds on the Convention by bringing all nations together for the first time to commit to ambitious efforts to prevent climate change and adapt to its effects, with increased support for developing countries. As a result, it sets a new direction for the global climate effort.

The Paris Agreement's main goal is to enhance the global response to the threat of climate change by keeping global temperature rises well below two degrees Celsius above pre-industrial levels this century, and to pursue efforts to keep temperature rises even lower at 1.5 degrees Celsius.

In addition, the agreement intends to improve countries' ability to deal with the effects of climate change. Appropriate financial flows, a new technology framework, and a strengthened capacity-building framework will be put in place to help developing nations and the most vulnerable countries achieve their national goals. Through a more rigorous transparency structure, the Agreement also provides for more transparency of action and support (official website of the United Nations).

Timeline of the EU Programs

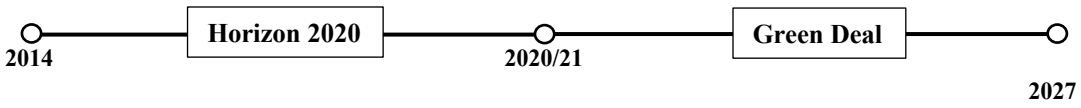


Figure 5. Timeline of the EU Programs (elaboration by the author).

Horizon 2020 Program

With approximately 80 billion euros in funding available over seven years (2014 to 2020), it is the largest EU Research and Innovation Program ever, in addition to the private investment that this money will attract. By bringing amazing ideas from the lab to the market, it promises additional breakthroughs, discoveries, and world-firsts.

It is based on an environmental research and innovation response that identifies smart, sustainable, and inclusive growth as a means of assisting the EU and the Member States in developing a resource-efficient, greener, and more competitive economy while maintaining high levels of employment, productivity, and social cohesion.

The EU Research and Innovation Program in the Environment focuses on challenges and funds the entire research and development cycle.

Horizon 2020s: "Climate action, environment, resource efficiency, and raw materials," which has three core aims, is where environmental research and innovation find their center of gravity.

This Challenge's activities will help Europe's competitiveness, raw material security, and overall well-being. At the same time, they will ensure environmental integrity, resilience, and sustainability, allowing ecosystems and society to adapt to climate change and other environmental changes.

This Challenge supports research and innovation with the following specific objectives:

1. To achieve a resource – and water-efficient and climate change resilient economy and society.
2. The protection and sustainable management of natural resources and ecosystems.
3. A sustainable supply and use of raw materials, to meet the needs of a growing global population within the sustainable limits of the planet's natural resources and eco-systems.

Part of the solution is to assist in the development of a green economy, a circular economy that is in tune with the natural environment. As a result, the first work program's activities will be centered on advancing toward a "green" society and economy. They will fill knowledge gaps to better comprehend environmental changes, identify policies, strategies, and tools that will most effectively address the challenges, and assist innovators and entrepreneurs in bringing green solutions to market.

Waste as a resource and water innovation has been chosen as a particular priority for the first two years of implementation because of their significant potential for commercial possibilities and job creation while addressing key resource efficiency concerns.

Furthermore, as part of a horizontal approach that is fully integrated into all Horizon 2020 priorities, activities are encouraged and supported to capitalize on Europe's leadership in the race

to develop new processes and technologies that promote sustainable development in general and combat climate change in particular.

Such a strategy will enable the EU to thrive in a low-carbon, resource-constrained world while also constructing a resource-efficient, sustainable, and competitive economy.

As a result, it is envisaged that sustainable development would account for at least 60% of the overall Horizon 2020 budget, and climate-related spending will account for more than 35% of the budget, including mutually compatible initiatives to improve resource efficiency.

As Pavlovic in Horizon Europe Article says (2020):

"To have a bigger impact on society in general and to move towards discoveries in science, the EU launches a new framework program every seven years. H2020 was the biggest research and innovation program of the EU available from 2014 to 2020. The 9th Framework Program, also known as Horizon Europe, will replace the framework program Horizon 2020 (H2020), as of January 2021."

The European Green Deal "*Striving to be the first climate-neutral continent"*

The following data is extracted from the official website of the European Union. Climate change and environmental deterioration are a threat to Europe and the rest of the world's existence. To meet these difficulties, Europe needs a new growth plan that will turn the Union into a modern, resource-efficient, and competitive economy, according to the European Commission, where:

- There are no net emissions of greenhouse gases by 2050
- Economic growth is decoupled from resource use
- No person and no place is left behind

This part is based on the European Green Deal (Roadmap with Actions) which is updated in 2019 on the European Union's official website.

The European Green Deal is our plan to make *the EU's economy sustainable***.** We can do this by turning climate and environmental challenges into opportunities and making the transition just and inclusive for all.

The European Green Deal provides an action plan to

i. Boost the efficient use of resources by moving to a clean, circular economy
ii. Restore biodiversity and cut pollution

The plan outlines the investments needed and the financing tools available. It explains how to ensure a just and inclusive transition. The EU aims to be climate neutral in 2050. They proposed a European Climate Law to turn this political commitment into a legal obligation.

Reaching this target will require action by all sectors of our economy, including investing in environmentally friendly technologies

- Supporting industry to innovate
- Rolling out cleaner, cheaper and healthier forms of private and public transport
- Decarbonizing the energy sector
- Ensuring buildings are more energy efficient
- Working with international partners to improve global environmental standards

The EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy. This is called the Just Transition Mechanism. It will help mobilize at least €100 billion over the period 2021-2027 in the most affected regions.

Policy Areas include Sustainable Mobility, Biodiversity, Sustainable Agriculture, Clean Energy, Sustainable Industry, Building and Renovating, Eliminating Pollution, Sustainable Food System, and Climate Action.

1.8. FINANCING SUSTAINABILITY

The economy and the environment are inextricably linked; awareness about this connection has developed, particularly since the United Nations Conference on the Human Environment in Stockholm in 1972 (Rasoolimanesh et al., 2012). Finance is an economics-based science that examines money, banks, credit, investments, and other facets of the financial system (Investopedia).

Financing is one of the most critical parts of implementing sustainability policies in urban areas.

Financial support is crucial for the long-term success and improvement of sustainability policies and initiatives (Wang et al., 2014). Finance is a critical issue, and economic and financial tools can help in the development of concrete interventions.

In Western cities, financialization and sustainable urban planning have become two significant components of urban production and landscape change. On the one hand, financial actors are increasingly owning urban property, particularly significant urban projects or megaprojects such as business districts, airports, sports stadiums, and even urban network infrastructures. These urban megaprojects, the other hand, have a considerable impact on the organization of urban functions and city planning, which is increasingly based on sustainable development principles (Theurillat and Crevoisier, 2012).

In this topic, we are facing two different concepts: financing sustainability matters, and financial sustainability, which means that no matter what the goals of action are, the interventions must be financially possible. There is no universally accepted definition of financial sustainability, but it refers to the ability to provide long-term support to your beneficiaries. It's the polar opposite of having to stop doing something because you've run out of money.

This part of the research mainly tries to explain financing sustainability matters. How officials and residents can engage to fund sustainable projects according to comprehensive programs and policies.

The keywords are funding sustainability, budgetary decision making, resource allocation, and financial capacity for sustainability.

What is the effective approach for enhancing financial capacity in an urban area to achieve sustainability goals? What is the role of local government and individuals? What is the effective relationship between local authorities and citizens? What is the right structure of this relationship? What are the features?

The sustainability initiatives mostly are known as indirect or un-immediate benefit projects for local authorities and the majority of citizens, therefore, local officials' efforts to support the sustainability implementation are challengeable.

Hence, two main aspects must be mentioned in this regard. First, the feasibility, effectiveness, and attractiveness of local authorities' plans for implementing sustainability initiatives, and second, involving residents as stakeholders in decision-making processes.

According to Wang et al. (2014), there is an interaction between citizens in the role of stakeholders (stakeholder engagement) and the financial capacity of an urban area that shapes the socio-political content of a local government.

Financial capacity for sustainability is made up of several interconnected components, they are listed below:

- Possibility of local government for providing the fund like taxation and inner-local revenues.
- The stakeholders' willingness to pay is a critical element of financial capacity. To encouraging the taxpayers to pay, realizing the value of sustainability, and implementing supportive actions in financial status by the local government is needed, in some cases like the projects in large scale investment which will be profitable in long-term the continuity of funding is necessary.
- The sustainability projects often compete with other local plans for limited resources, therefore, good flexibility in a financial capacity for sustainability initiatives is required.

Financial Capacity; *involving citizens as stakeholders / the role of community*

Boosting the stakeholders' support in this regard for a local administration is effective to have its requested approval. Urban politics and public budgeting theories are two wings of the funding sustainability process.

In general, the city and built environment have played a significant role in the accumulation and spatial expansion of capital (Harvey, 1982; 1985). Institutional investors, such as real estate corporations, banks, and even insurance companies, have traditionally been the typical urban investment actors in this setting (Fainstein, 2001). Nowadays, budgeting decision-making is focused on the roles and behaviors of institutional elites like managers, tech experts, legislators, etc. Indeed, many sustainable issues are technical, and implementing them is based on the technical support of professionals and experts – not residents. from a general point of view, Local Policies should create and improve jobs and shape business investment, hence, it is required an effective relationship between local authorities and business leaders. The question here is how urban elites can get support from stakeholders for funding policies? Meanwhile, the importance of involving the citizens in decision-making, planning, and implementing sustainability initiatives is

undeniable. Citizens can give some valuable information about local communities and their needs in sustainable development. The phase of gathering data, collecting local data then aggregate them, and create knowledge and solutions is critical in this field that states the fact of a relationship that is interactive between human behaviors and the natural environment (Leuenberger and Bartle, 2009).

Sustainability is about providing benefits for future generations "protection of our common future" (WCED, 1987). Therefore, it involves some long-term projects in nature. Funding this type of project support citizens as taxpayers, and this is the government that brings citizens (stakeholders) into decision-making processes. Sustainability states a local strategy for internationalization and modernization (Raco and Lin, 2012), as a solution to adapt the targets of environmental protection and economic development (Temenos and McCann, 2012), and as a means of accumulating possible co-benefits in the form of budgetary savings for people and businesses, health improvement, better living conditions, and ameliorated business environment (Kousky and Schneider 2003; Lindseth 2004; Jakob 2006). Involving citizens into the decision-making process for sustainability issues; *stakeholder engagement, the* process of engagement can influence participants' opinions about sustainability needs and encourage them to support and help in funding and implementation. One of the three sustainability systems is social equity, to achieve this goal is required more equitable resource allocation realized by the stakeholders engaged in the process, which will have greater public support for funding sustainability as the result.

2.1. PUBLIC TRANSPORTATION

2.1.1. Definition

Public transport (also known as public transportation, public transit, mass transit, or simply transit) is a system of transport, in contrast to private transport, for passengers by group travel systems available for use by the general public, typically managed on a schedule, operated on established routes, and that charge a posted fee for each trip (English Oxford Living Dictionaries, 2018).

Public transportation systems include a variety of transit options. Examples of public transport include city buses, trolleybuses, trams (or light rail) and passenger trains, rapid transit (metro, subway, underground, etc.), and ferries. Public transport between cities is dominated by airlines, coaches, and intercity rail. High-speed rail networks are being developed in many parts of the world. These systems are open to the general public, may charge a fare, and operate on a set schedule. The aim of implementing or improving public transportation is to improve public transportation access and usage while reducing motor vehicle miles driven and traffic congestion that leads to the reduction in GHG emissions (Public Transportation: System introduction or expansion, 2017).

Figure 6. Comparison of Bicycles, Cars, and Buses (Wright, 2002).

Shown is a creative visual comparison of the alternative modes of mobility available in cities. Prepared by the German city of Münster, these photographs show how the same number of people might be accommodated by bicycle, auto, or bus.

2.1.2. The History of Public Transportation in Urban Development

Since 1820, Various modes of public transit have come and gone around the world, influencing not just how we travel but also how cities are structured today. With the advent of the first bus services around the world, traveling from point A to point B became simpler than ever, widening the gap between urban city centers and suburban communities. With technological advancements, public transportation networks evolved from horse-drawn carriages to cable cars, heavy- and light-rail systems, and eventually electric and self-driving buses.

Timeline of Public Bus Transportation Evolution

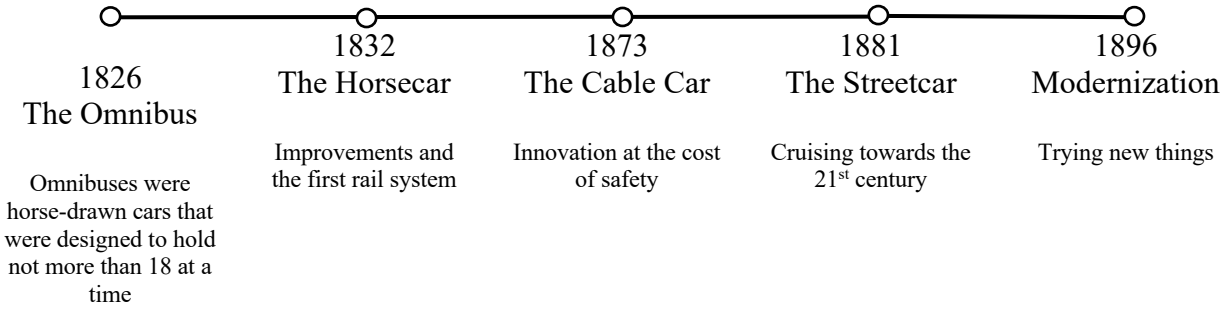


Figure 7. Timeline of Public Bus Transportation Evolution (Parks, 2020).

The current status of this evolution line is looking ahead "Electric and Self-driving Buses". Bus companies are looking to use the same technology as self-driving cars, which are still under production. Electric buses, which are expected to replace the majority of fuel-powered vehicles in the next 30-40 years, are on the horizon (Wallace, 2017).

Furthermore, as surface public transportation (buses and trams) evolved in both metropolises and small cities, underground modes of transportation emerged in large cities to address the issue of too much mess on city streets.

Metro Systems emergence

Figure 8. Metro Systems emergence (elaboration by the author).

As of December 2017, there were 182 cities in 56 countries around the world, carrying on average a total of 168 million passengers per day. 46 cities in Europe have metro systems, carrying roughly 11 million passengers annually. Europe has 2,921 km of track and 2,950 stations (UITP, World Metro Figures-Statistic Brief, 2018).

2.1.3. Public Transportation at the Local Level

It is known also as Local Public Transport (LPT). It is usually owned by the government, which may run it on its own or hire an external operator (public or private) to do so. The research for new ways to boost the efficiency of public transportation is where most public administrations are currently struggling this is a difficult task since each city has its morphology, network, specific dynamics, resources, infrastructure, geographical potentiality, limited budget, and operator availability. As a result, identifying general guidelines to achieve this aim is challenging.

2.1.4. Transport in the European Union

The information in this section is taken from "Transport in the European Union - Current Trends and Issues, Published by European Commission, 2019".

Transportation is a vital component of the economy. Transport networks encompass a diverse network of about 1.2 million private and public firms in the EU, hiring about 11 million people and delivering products and services to EU customers and trade partners. Transport also provides mobility for Europeans, adding greatly to the internal market's free flow of people.

The key challenges facing the EU's transport sector include establishing a well-functioning Single European Transport Area, linking Europe with new, multi-modal, and sustainable transportation connectivity networks, and transitioning to low-emission mobility, which includes reducing other negative externalities of transportation. Affordability, sustainability, and efficiency in transportation are critical from a social standpoint. Addressing these issues would aid the EU's pursuit of long-term development.

The European Commission aims to fix flaws in the market integration of road transport through a series of measures for a socially equitable transition to safe, competitive and linked mobility,

which was first introduced in its 2016 Low-emission Mobility Strategy and then in three waves of legislative proposals, known as Mobility Packages.

- **Europe on the Move** - An agenda for a socially fair transition towards clean, competitive, and connected mobility for all of 31 May 2017.

- **Delivering on low-emission mobility** - A European Union that protects the planet, empowers its consumers, and defends its industry and workers of 8 November 2017.
- **Europe on the Move – Sustainable Mobility for Europe:** safe connected, and clean of 17 May 2018.

The transition to low-emission mobility was already a goal in the 2011 Transport White Paper, and it was aided by several initiatives. The "European Strategy for Low-Emission Mobility" identifies the regions where the Commission is focusing its efforts:

- Fair and efficient pricing in transport (which should better reflect negative externalities of transport)
- Digital mobility solutions
- Interoperability and standardization for electro-mobility
- Promotion of multi-modality
- Roll-out of infrastructure for alternative fuels
- Framework for alternative energy
- Improvements in vehicle testing
- Post-2020 research and investment strategy for all means of road transport.

In addition, a "Multi-modal Year" in 2018 brought together related projects and activities, such as a "European Single Window" in maritime transport. The European Commission proposes a review of the Combined Transport Directive as part of the second Mobility Package.

2.1.5. Daily Mobility in the EU (according to the CAWI Survey Results)

The majority of respondents claim that driving is their preferred mode of transportation (56%). One out of every five respondents uses public transportation. Just 7% of respondents use the train as their primary mode of transportation, while cycling and walking account for 16%.

The Czech Republic, Hungary, and Romania have motorization rates below 40%; since car supply in these countries is far below the average, it can be said that motorization rate appears to be a key factor in mode preference. East Europe, but also Austria, Greece, and Sweden in West Europe, have a higher percentage of people using mass transportation and trains together. In general, there is a connection between the percentage of people who use public transportation and the quality of service in their neighborhood. Bicycles are used most commonly in Northern Europe, according to the report. Denmark and the Netherlands are mostly at the top of the list (bikes are the second most common mode of transportation in both countries), and Sweden, Finland, and Hungary are all above average.

Interestingly, cycling seems to be mostly an alternative to urban mass transportation in Denmark and the Netherlands. In reality, when the shares of public transportation and cycling are added together, the outcome for these two countries is less than 30%, which is comparable to other West European Countries (e.g., Austria, Germany, Greece) and far below many East European Countries.

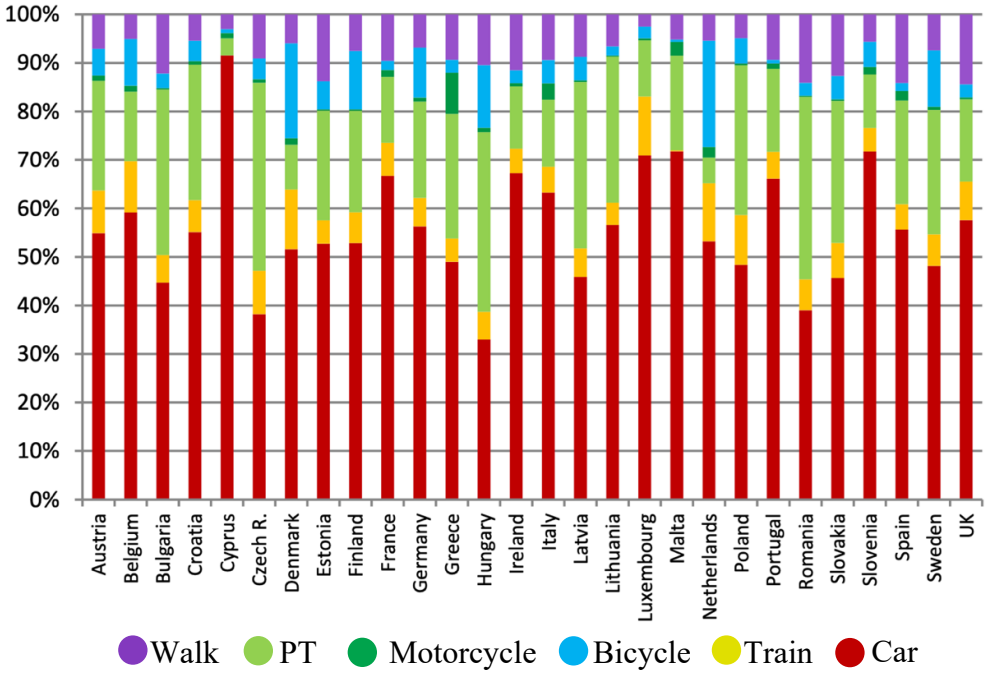


Figure 9. The Main Transport Mode used for the most frequent Trip by Country (Fiorello et al., 2016).

In the Consumer Markets Scoreboard, which ranks over 40 consumer sectors, the European Commission tracks the functioning of transportation systems for customers. According to the results of the 2017 study, rail services are one of the worst-performing business segments in the EU (21st out of 25 services industries surveyed in 2017), with a high rate of issues.

The disparity between the EU countries' ratings is almost twice as high as the average for all programs. The bottom five countries are Romania, Croatia, Bulgaria, Malta, and Italy.

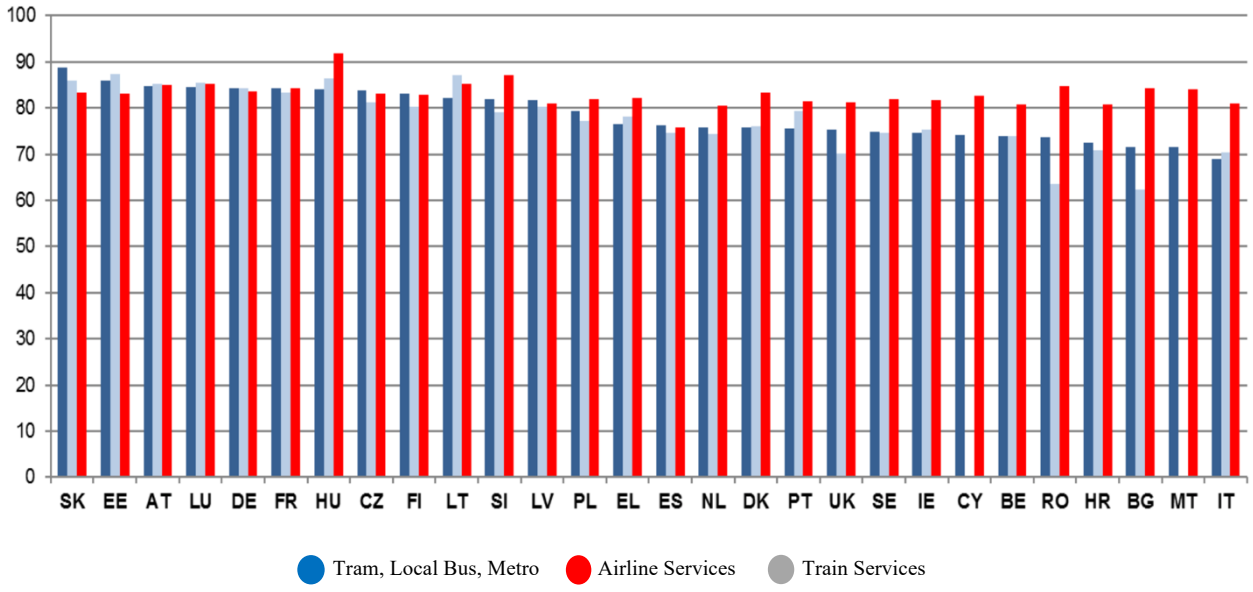


Figure 10. Market Performance Index for three transport markets of 2017

Source: European Commission Consumer Markets Scoreboard 2018. The Market Performance Index indicates to what extent a given market brings the desired outcome to consumers. It is a composite index incorporating five key components: *consumers' trust in retailers/providers, ease of comparing different offers, the extent of problems and detriment, expectations and choice.* Each component is weighted according to the importance it was given by the respondent and the maximum total score is 100.

2.1.6. The Role of Public Administration in the EU

A country's well-being is largely determined by the nature of its institutions, both governmental and judicial. Administrative ability is becoming more widely accepted as a requirement for

meeting the EU's treaty commitments and goals, such as achieving long-term growth and job creation.

Public Authorities must be able to adapt to the economy's and society's complex and sometimes disruptive changes. Policies and systems that have served citizens and businesses well in the past may not be adequate or necessary to serve citizens and businesses in the future in an increasingly "Connected" yet unpredictable environment. The capacity to represent current needs and predict future ones, as well as the flexibility to change, must become permanent features of the public sector. Above all, administrations must be built on a strong basis of ethics, efficiency, effectiveness, and accountability.

The most common objectives that Public Authorities aim to pursue are:

- To provide *efficient mobility* to the widest possible set of citizens, trying to be affordable for everyone and targeting all the different groups of people
- To propose an *attractive alternative* able to compete with private cars, considered a non-sustainable solution especially in big cities.

2.2. EMERGE OF A NEW TRANSPORTATION MODEL: MOBILITY AS A SERVICE (M-A-A-S)

The recent scenario must be linked to a new mobility paradigm that has emerged in recent years as a result of cultural shifts and the availability of new technical infrastructure that did not exist just a few years ago. The term "mobility as a service" refers to a transition away from privately owned modes of transportation and toward mobility services. Some examples of this new scenario are Sharing Mobility Services (Car, Bike, and Scooter sharing), and Public Transportation Systems. The trend, on the other hand, is driven by the expectation of self-driving vehicles, which calls into question the economic advantage of owning a personal car over using on-demand car services, which are generally predicted to become considerably more accessible once cars can drive themselves. In the M-a-a-S paradigm, Customers will be able to purchase mobility services

in bundles based on their specific requirements, and multiple transportation services will be integrated into a single platform.

It provides easier multimodal connections to users and makes an easier urban mobility service. Cities should consider the related conditions to be sustainable for implementing the M-a-a-S paradigm. This includes having a diverse range of transportation options. Local governments can launch the M-a-a-S system to make urban mobility in the city more sustainable, but it can also be operated in a city without official assistance if the essential prerequisites are met.

Note 1: According to the UN definition: “The access to public transport is considered convenient when a stop is accessible within a walking distance along with the street network of 500 m from a reference point such as a home, school, workplace, market, etc. To a low-capacity public transport system (e.g. bus, Bus Rapid Transit) and/or one km to a high-capacity system (e.g. rail, metro, ferry)”.

Note 2: At the same time, we are facing the first/last mile problem in our cities; The "last-mile" or "first and last-mile" connection describes the beginning or end of an individual trip made primarily by public transportation. In many cases, people will walk to transit if it is close enough. The M-a-a-S Paradigm has arrived to solve this issue by offering the Sharing Mobility Services (Car, Bike, and Scooter sharing).

2.2.1. Sharing Mobility In-depth

Shared mobility, or the sharing of a vehicle, bicycle, or another mode of transportation, is an innovative transportation concept that allows users to gain "as-needed" access to transportation modes. The usage of various shared mobility modes has been linked to a range of *environmental*, *social*, and *transportation-related* benefits. Household cost reductions, greater business activity around public transit stations and multi-modal hubs, and increased access could all be economic benefits of shared mobility (Shaheen et al., 2015). According to several studies, more individuals who share vehicles and utilize various means of transportation, such as bicycles and buses, resulting in lower CO_2 emissions. As a result, our roads will be less damaged, and more people will be able to access alternate modes of transportation.

Ending poverty and achieving the Sustainable Development Goals (SDGs) will be significantly more difficult—if not impossible—without access to sustainable mobility. Both greenhouse gas emissions and traffic accidents are on the rise, while impoverished and rural areas around the world remain mostly disconnected.

What has shared mobility?

A taxi or Uber ride can be *shared* by *numerous persons*. Vehicles can also be shared by making your vehicle available to others or by taking advantage of the many sharing options. Rather than purchasing a bike, you can rent one for as long as you need it. The latter sort of sharing, vehicle sharing is included in this approach. In other words, Shared Mobility is the Sharing Economy's division of mobility, which promotes access to shared items rather than ownership, and is one of the most significant worldwide socio-economic changes in the previous decade.

For a long time, bike and vehicle sharing have been an important element of the world of shared mobility. In recent years, the advent of new types of shared mobility, such as scooter sharing or e-kickboard sharing, has fueled the popularity of Mobility Sharing. Shared Mobility is becoming increasingly important, particularly in urban settings. Another reason for this is that not only are new automobiles being produced, but also new service models. New service models, such as the free-floating concept, have opened up new shared mobility possibilities. The automobiles in this model can be positioned within a set perimeter (for example, a city region) and can be located and unlocked using a smartphone. The car can be parked in any suitable position within the approved region once the excursion is completed. E-kickboard sharing has been popular since the year 2018. The free-floating service concept is ideal for these vehicles. The space demand is minimal, and the

maximum speed of 25 km/h eliminates the need for any further equipment. The kickboard's "mania" is already turning into negative news in some regions. The city of Berlin is being described as "flooding," and after less than two years, the adoption of a vehicle number limitation is being proposed (Shared Mobility 2019 Research, University of Zurich). Shared Mobility has several benefits, including lower ownership rates, reduced vehicle usage, lower greenhouse gas emissions, and lower transportation expenses.

2.2.2. Main Sharing Types

- Carsharing: Car-sharing companies have a variety of automobiles in various sizes that customers may choose from and hire via an app. The price includes repairs, maintenance, and insurance. Depending on the provider, the vehicle can be unlocked using a smartphone or a badge. Round-trip, one-way, and free-floating car-sharing options are available.

- P2P Carsharing: Private persons can use a platform provided by the Peer-to-Peer providers to make their automobile available to other users. The benefit is that your car is parked in your parking lot, causing costs while being unused for the majority of the time. Money can be earned with this service model while the car is not in use. Different unlocking systems are used when it comes to private autos.

  Smart-Door-System: A specific device in the leased automobile allows it to be unlocked and connected to the provider's app. The vehicle's ignition key is kept inside the car.

  Personal key handover: A message can be sent using a messaging app to schedule a time to hand over the rental car's key.

- Bike-sharing: it is similar to automobile sharing and has been around for a while. An app or a user card can be used to unlock the bikes. This necessitates registration with the appropriate service provider. One-way services and free-floating services are both offered. In several cities, free-floating services are becoming more popular. E-bikes, which are becoming increasingly popular, are another trend in the realm of bike-sharing. Electronic drive assist improves comfort and performance, allowing even steeper slopes to be successfully navigated.

- Scooter sharing: Scooters are ideal for relieving inner-city traffic congestion. There are both station-bound and free-floating scooters available for scooter sharing. An app can also be used to find and unlock the scooters. Electric scooters are available in addition to gasoline-powered vehicles. In contrast to bike or e-kickboard sharing, renting a scooter requires a category A or B driver's license. Furthermore, the majority of users must be at least 18 or 21 years old. Two different helmet sizes are available to ensure safety.

- E-kickboard sharing: In Europe, e-kickboards are currently on the rise. To hire an e-kickboard, a smartphone with the corresponding provider's App is required, the same as it is for bike-sharing. The free-floating method predominates in e-kickboard sharing. The only restrictions are so-called "no-parking zones," which make it illegal to park an e-kickboard. The e-kickboards may be found via the app. After paying a small cost to unlock the device, the price is computed based on the provider and the amount of time and/or distance traveled. The cars go at a top speed of 25 km/h. It is illegal to ride e-kickboards on sidewalks in cities where they are classified as motorcycles.

2.2.3. Stakeholders

Shared Mobility, like any other system, necessitates the participation and interaction of several stakeholders, each of whom has a specific role to play in making the system operate. Users (actual and future), operators, public bodies and regulators, and transportation experts are among the most important parties participating in shared mobility.

2.2.4. Users

Members of a shared mode platform and/or those who use shared vehicles for their mobility needs are referred to as users. All people who are legally allowed to drive or use a shared service are considered potential users. They play a crucial role because they are the ones who are supposed to spread the shift in mobility perception, moving away from the ownership paradigm and toward a new one centered on access to meet their mobility requirements. Users of Shared Mobility entrust this form of transportation with their mobility demands because public transit does not always suit their travel plan's routing or timeline. However, to avoid owning a car, people may expect a pleasant mobility experience with shared modes. Users of Shared Mobility may benefit from cost

savings or perhaps a healthier lifestyle. People who utilize multiple shared modes on regularly bike-sharing, car-sharing, and ride-sourcing, save the most money and own half as many home cars as those who just use public transportation.

2.3. MULTIMODAL TRANSPORTATION*: SHARING MOBILITY + PUBLIC TRANSPORT*

A transportation system must be able to meet a variety of demands in order tolerant and fair. It would be inefficient, for example, if insufficient sidewalks and walkways force parents to chauffeur their children to local locations where they would rather walk or bike, or if insufficient mobility options force urban commuters to drive when they would rather rideshare or take public transportation. People who are physically, economically, or socially challenged, in particular, require a variety of mobility options, including walking and cycling for short excursions, public transportation for longer trips, and autos (ridesharing, chauffeuring, and taxi travel) when necessary. As a result, multimodal transportation is required to be efficient and equitable (Todd Litman, 2021). Walking, bicycling, and public transportation was recognized as important forms of transportation before 1940, but transportation planning was dominated by automobiles for most of the twentieth century.

As a result, most cities now have well-developed road systems that allow motorists to drive to most places with relative ease and safety; at worst, they may be delayed by peak-period traffic and be required to pay tolls and parking fees at some destinations. Non-automobile transport demands, such as those listed below, were overlooked in the Multimodal Transportation Planning.

- Seniors who are unable or unwilling to drive (5-15 percent).
- Adults who are unable to drive because of a disability (3-5 percent).
- 10 to 20-year-old people (10-30 percent of the population).
- Visitors to the community who do not have access to a vehicle or a valid driver's license.
- Lower-income households are burdened by vehicle expenses (15-30 percent).
- Residents who wish to see less traffic, accidents, and pollution.
- People who desire to enjoy and benefit from walking or biking.

- Drivers who desire to avoid the hassles of chauffeuring.
- Law-abiding drinkers and others who are inebriated (a small but important demand to serve).

Different views can be used to assess travel demand and, as a result, the usefulness of greater multimodal planning. Only persons who now rely on a specific model are counted in the narrowest category. This, however, is frequently a self-fulfilling prophecy: a lack of interest in these forms makes them harder to use. External impacts (benefits to other people when visitors may walk, bike, or take public transportation instead of driving) and strategic community objectives (reduced traffic and parking congestion, affordability, and enhanced quality of life) are also considered in a broader context (reduced traffic and parking congestion, affordability, improved non-driver mobility, and so forth). More multimodal planning is often justified as a result of these factors. As a result, many people all over the world are becoming more aware of the variety of travel demands and the need for multimodal planning.

Multimodal Planning Concepts: Multimodal Planning refers to planning that takes into account various modes (walking, cycling, driving, public transportation, and so on) as well as links between them. Several different types of transportation planning reflect different scales and goals, some of them are mentioned below:

- Traffic impact studies examine traffic impacts and mitigation methods, For a specific development or project.
- Local transportation planning: they develop Municipal and neighborhood transportation plans.
- Regional transportation planning is the process of creating plans for a metropolitan area.
- Mode- or area-specific transportation plans highlight approaches to improve a certain mode (walking, cycling, public transportation, etc.), or area (a campus, downtown, industrial park, etc.).

The following steps are usually included in a *Transportation Planning Process*:

- Keep an eye on the current situation.

- Identify main growth corridors and forecast future population and employment growth.
- Identify present and future transportation problems and demands, as well as various projects and solutions to meet them.
- Assess and rank the importance of proposed improvement initiatives and strategies.
- Create long- and short-term plans that specify particular capital projects and operational initiatives.
- Develop a financial plan for implementing the projects and initiatives that have been chosen.

Figure 11. Transport Planning Process (FHWA and FTA, 2007).

CHAPTER 3: THE METHODOLOGY OF THE ANALYSIS AND INTRODUCTION TO CASE STUDIES

3.1. INTRODUCTION TO THE DISCUSSION STRATEGY

The purpose of the case studies analysis is to provide suggestions to the decision-makers for the development of mobility and accessibility-related plans, rules, and operational strategies based on sustainability priorities. In chapter 4 an E-Mobility Consolidated Plan will be introduced in this regard, based on the analyses of two case studies. As a preliminary analysis of the current situation of these cities in the field of Sustainable Mobility and Transport, Zürich and Amsterdam will be evaluated, using the Urban Mobility Index, which contains four analysis issues: Connectivity, Affordability, Innovation, and Sustainability.

Some different alternatives will be discussed, for improving existing procedures and infrastructures in Public Transportation Systems in a more detailed perspective, developing in the Local Transportation Sector what has been discussed in the previous part, in general terms, about Urban Sustainability. First, the Evolution of Urban Transportation Systems throughout history (involving the current state of Public Transport Systems and Sharing Mobility) has been discussed. The second step was the introduction to the new mobility paradigm known as Mobility as a Service (M-a-a-S) and the importance of a multimodal approach. Then the exploration of the current state of the objects described in the case studies follows.

This section focuses on the Urban Mobility Index, which includes four analysis issues that are discussed in two case studies (a comparison between case studies), and finally, this research considers E-Mobility solutions as a smart city revolution will be considered, with special reference to the new or renewed infrastructures that this new form of mobility necessitates.

The study question can be characterized as follows: What function may electric vehicles play within the Mobility paradigm, and how can EV charging stations be increased, keeping in mind the exploratory objective of this work. What kind of infrastructure do you have? Who are the people who are involved and might take advantage? What are the policy's potential challenges and barriers?

In the next chapter, this study looks at the current situation of E-Mobility in two different case studies. One main indicator will be considered in the analysis about the need for interventions at the infrastructure level: the number of charging stations, to clarify the difference between two case studies in the implementation of E-Mobility policies is; One might build many charging stations "Amsterdam with 1629 stations per one million people", while the other is in the process of developing" Zürich with 104 stations per one million people".

Figure 12. EV charging stations, Zürich (HERE Urban Mobility Index, 2018).

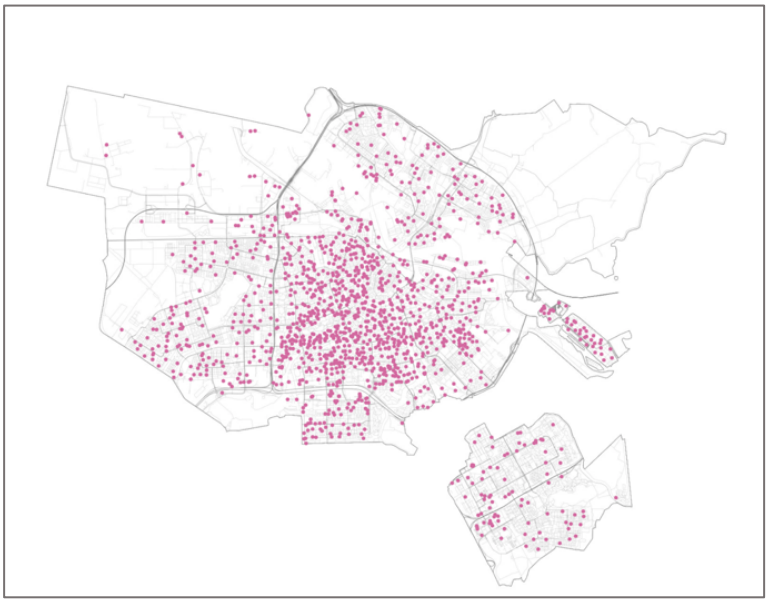


Figure 13. EV charging stations, Amsterdam (HERE Urban Mobility Index, 2018).

3.2. METHODOLOGY

The starting point is to understand the most important elements in the framework of Sustainable Urban Transport and Mobility concern city under study. Indeed, it was vital to comprehend what the primary city levers in sustainable mobility issues are on which to work to affect the sustainable mobility concept's output. This initial step resulted in the selection of a small number of items on which the focus is maintained throughout the process.

As a result, a specialized framework ("HERE", Urban Mobility Index) was employed to determine which elements would be more attractive for this goal. "HERE" is an innovative platform that studied several cities across the world for the Urban Mobility Index, which focuses on four key factors: connectivity, sustainability, affordability, and innovation. Therefore, the current chapter is based on the findings of HERE's data analysis.

In the first part of the analysis, this research shows the results from the HERE database platform for the cities of Amsterdam and Zurich. This study offers the key conclusion of this data presentation at the end of the third chapter, which indicates rises and downfalls in each case study by benchmarking two cities.

The second step is a competitive benchmarking analysis of Amsterdam and Zurich in the topic of EVs, where Amsterdam is considered a successful case in Electrification of Transportation Fleet, and Zurich is a city that is currently working on this topic; however, it is experiencing some policy implementation challenges.

The competitive benchmarking analysis contains the process and strategic benchmarking phase and performance benchmarking.

The process and strategic benchmarking are discussed between the national plans of the Netherlands (The Formula E-Team and Acceleration Program Electric Mobility) and Swiss (Roadmap for Electric Mobility 2022 Plan).

The final point in this regard is performance benchmarking, comparing the outcomes of Amsterdam (Dutch government) plans and Zurich (Swiss government) plans in the field.

According to the literature review and the discussion above this study compares Amsterdam and Zürich, as research case studies in the Urban Mobility Concept. The four analysis issues and the indicators and elements that shape each issue to develop this comparison are:

I. Connectivity: Public Transport Efficiency and Traffic Flow
II. Affordability: Public Transport Expense and Relative Fuel Cost
III. Sustainability: Green Spaces and Low Emission Zones
IV. Innovation: EV Charging Station Density, Metro Rail Automation, and Official Docked City Bikes

The sequence of this analysis is explained below.

I. Connectivity

How well linked are we within the city? Do we have a smart transportation system that makes moving between districts simple and efficient for everyone? Is there a way to alleviate traffic congestion? The way a city is connected has an impact on how we live.

This analysis issue is based on:

A. Public Transport Efficiency: Given by the sum of Frequency, Density, Coverage, and Public Transport & Car Speed.

Public Transport Efficiency discusses:

- Frequency: How long will I have to wait until the next bus? Will I be stranded for an hour if I miss this train? It is analyzed the frequency of public transport services around the city, identifying areas where you can get going quickly and others where you would have to wait.
- Coverage: which regions of the city are well served by Public Transport, and which are poorly connected? The density of public transport stops is a key indicator of mobility accessibility – something which can greatly impact quality of the life, economic opportunities, and social wellbeing.

Two topics are evaluated in this regard:

i. Public Transport Coverage: The total area of the city within 1km of a public transport stop, relative to the total area of the city.

ii. Public Transport Density: The number of Public Transport stops per 1000 city residents.

B. Traffic Flow: Given by the sum of Percentage of Congested Roads, Time delay in traffic and Congestion Index.

Congestion issue is involved in this part; By processing vast amounts of traffic data, it's generated rich insight into patterns of city congestion.

Here, three items are evaluated:

i. Traffic Congestion Index: A measure of city congestion during peak times. It's compared the flow of traffic during weekday rush hours (6-10 a.m. and 4-8 p.m.) to an ideal free-flow environment. This index is represented on a scale of 0-10 where 0 is least congested and 10 is most congested.

ii. Time Delay in Traffic: A measure of the extra time spent driving due to traffic congestion. Calculated by comparing journey times for 100km (62 mi) traveled during peak times (6-10 a.m. and 4-8 p.m. on weekdays) with journey times for those roads when traffic moves freely.

iii. Percentage of Congested Roads: The percentage of roads congested at peak time. Calculated by comparing the total length of congested roadway segments with the total length of a city's road network.

II. <u>Sustainability</u>

Smart cities of the future will prioritize sustainability, aiming for a low-carbon future that enhances people's health and quality of life.

This analysis issue is based on:

A. Percentage of Green Spaces: As a percentage of the city area

The percentage of a city which is covered accessible space. Calculated by considering the area covered by green spaces, such as parks, lakes, and woodland, relative to the total area of the city.

Green spaces not only improve air quality but enhance citizen wellbeing and provide green areas for active forms of mobility, such as cycling. Many cities are now introducing Low Emission Zones to provide similar benefits.

B. Percentage of Low Emission Zones: As a percentage of the city area

The proportion of a city's area for which a restrictive low emissions policy is in place. Calculated by considering the area of a city covered by a Low Emission Zone relative to the total area of the city.

III. Affordability

Affordable mobility changes how a city moves, enabling the flow of people, boosting economic potential, and enhancing social wellbeing.

This analysis issue is based on:

A. Public Transport Expense: As a percentage of monthly income

The cost of transport is a key factor in determining the equality and accessibility of mobility.
The cost of a monthly transport pass as a percentage of monthly income. It's calculated based on the relative costs of a monthly public transport ticket and mean net monthly income.

B. Relative Fuel Cost: As a percentage of monthly income

The average cost of fuel relative to income per capita. It's calculated the affordability of fuel by averaging prices from the city's gas stations and comparing them to mean net monthly income.

IV. Innovation

Cities that respond to changing mobility demands with innovative solutions and new technologies will be the early winners of the smart city revolution. This analysis issue is based on:

A. EV Charging Station Density: Stations per 1m people

As the EV revolution gathers pace, smart cities must adapt to provide the infrastructure this new form of mobility demands.
Here, there is a measure of the availability of EV charging stations within a city. Calculated based on the number of charging stations available per million city residents.

B. Metro Rail Automation: As a percentage of the metro rail network

The percentage of a city's metro rail system automated to Grade-of-Automation 3 or 4 as defined by the IEC 62290-1 standard. It's calculates using measurements based on online service length.

C. Official Docked City Bikes: Bikes per 1000 people

The number of official city bikes provided per 1000 city residents. Calculated based on the number of dock-based, city-approved schemes.

Gathering Data

During the development of the analysis, various data collection procedures were used.
One of the most significant challenges has been the research for available data and databases. It is important to mention that the data belonging to multiple and different sources are many times not comparable because of different definitions, measure units, and samples used for the surveys. The main data sources are books, articles, websites, and statistical reports.

In the light of the specificity of the topic of the analysis, data mainly come from the "HERE Urban Mobility Index". "HERE" identifies four major themes to assess a city's mobility performance.

To perform the HERE Reality Index also open-source data are needed, such as

- Traffic analysis
- Mobility management
- Smart city technologies

Combining the data, fourteen indicators can be developed, that track different elements of city mobility, providing an image of the current local specificities. The final results of the analysis

represent the knowledge base for providing decision-makers with a complete view of how a city moves.

The "HERE Urban Mobility Index" is intended to be a tool for city planners, corporations, and residents, assisting them in identifying opportunities and reinventing urban movement for future cities.

“HERE” evaluates 38 cities[1] around the world are dealing with the challenges of mobility across four major themes. 20 of these cities are in Europe.

Other sources for this section include “open data Zürich (stadt-zuerich.ch), numbeo (numbeo.com), Züri Velo - Publibike (publicbike.ch), Gemeente Amsterdam (data.amstersam.nl)”.

[1]**Europe:** Amsterdam, Barcelona, Berlin, Birmingham, Brussels, Copenhagen, Dublin, Hamburg, Helsinki, Lisbon, London, Madrid, Milan, Moscow, Paris, Rome, Stockholm, Vienna, Warsaw, Zurich, Copenhagen, Rome, London. **North America**: Chicago, Dallas, Houston, Los Angeles, Mexico City, New York City, San Francisco, Seattle, Toronto, Vancouver. **Asia**: Melbourne, Mumbai, Singapore, Sydney. **South America**: Buenos Aires, Rio de Janeiro, Sao Paolo.

About HERE

HERE Technologies (doing business as HERE) is a firm established in the Netherlands that provides mapping and location data as well as associated services to individuals and businesses. A coalition of German automobile corporations (particularly Audi, BMW, and Daimler) and American semiconductor company Intel own the bulk of the company, with minority stakes held by other companies. Its origins can be traced back to Navteq in the United States, which was acquired by Nokia in Finland in 2007. Currently, HERE is based in the Netherlands.

The HERE location platform provides a comprehensive set of location data in a flexible architecture that can adapt to changing requirements. Because of their unique focus on location data and services, they are today's and tomorrow's partners with whom cities and enterprises can grow and innovate.

HERE Team believes that location data can assist people in making better decisions and providing better services to citizens through Smart Transportation Solutions. The HERE Urban Mobility Index examines the Smartness of Mobility in more than 35 major cities around the world.

The HERE location platform offers a uniquely complete location data set in a flexible framework that can adapt to complex needs. One integrated platform with unique capabilities, the HERE platform lets you make the most of the world’s location data.

Location DNA: Deep location expertise with the industry's largest location datasets covering more than 200 countries and territories.

Flexible and customizable: Configurable to any participant or dataset through standardization and data interoperability.

HERE Awards: rank #1 in Strategy Analytics Report and Omdia's Location Platform Index in the last years.

3.3. INTRODUCTION TO THE CASE STUDIES

Cities around Europe have made significant investments in public transportation and taken a variety of other steps to promote and support more environmentally friendly modes of transportation. Cities exemplify the high levels of mobility found in many European Cities through a combination of urban form, land use decisions and policy, and transport spending.

According to British Planner Peter Hall, significant new investment in public transportation in European towns has been witnessed in recent decades. This investment can take five different forms:

1. Extensions of the existing heavy rail system (e.g., the Paris metro).
2. New heavy rail systems in second-rank cities (e.g., Brussels, Amsterdam, and Vienna).
3. The "transformation of old tram systems into full-fledged light rail systems generally in third-order major provincial capital cities" (e.g., Hannover, Frankfurt, Stuttgart, Nantes, Toulouse, and Grenoble).
4. New express rail systems (e.g., the S-Bahn trains in many German cities).
5. High-speed intercity rail (Hall, 1995). Considered together, this level of collective investment in transit is impressive (Beatley, 2000).

In this study, two case studies were chosen for comparative analysis. In recent decades, both have made significant investments in improving public transportation and shared mobility systems. These cities aspire to be more innovative in the field of sustainable mobility and transportation, which is a policy that reduces GHG emissions significantly. The electrification of the entire fleet is their solution to achieve this goal; one of them, Amsterdam, is working very quickly and with a more comprehensive national plan that has been allocated a large budget, but another, Zürich, is still under development; the government plays only a supporting role in this regard, and private parties are facing some challenges in putting the electrification plan into action. As a result, this study examines Amsterdam (the Netherlands) and Zürich (Switzerland) intentions and accomplishments. In the next stage, Amsterdam with Zürich is compared in terms of the Urban Mobility Index. The following part provides an overview of these two cities.

3.3.1. The City of Zürich

Zürich, Switzerland

Population	428,737
Population Density	4,660pers/km^2
Persons transported per Year	302.1 M
• Tram	202.6 M
• Bus	45.4 M
• Trolly bus	54.1 M

Figure 14. Shared Mobility 2019
Research of Zurich University

Zürich is Switzerland's largest city and the Capital of the canton of Zürich. It is situated at the northwestern extremity of Lake Zürich in north-central Switzerland. Zürich is divided into 12 districts and 34 quarters. Zurich has a unique position in Switzerland. It is the country's largest city and home to an internationally reputed financial center as well as being the focus of an economic region which acts as the motor of Switzerland, and along with Geneva is the most important gateway to the country.

Zürich is pursuing an all-encompassing and long-term mobility policy. Public spaces can be used for more than just transportation; they can also be used for living and recreation. With targeted initiatives, the City of Zürich enhances public transportation correspondences and relieves stress on the inner city and residential neighborhoods. Zürich boasts a contemporary public transportation system that extends far and wide: trams, buses, ferries, suburban trains, and funiculars combine to provide a diverse and efficient range of transportation alternatives.

History of Zürich Transportation Systems

The information of this part is based on the Book of Green Urbanism by Beatley (2000).

Cities like Zürich have made Public Transportation a top priority and worked hard to make these developments a reality. Priority can take many shapes. Trams and buses in Zürich move on

designated, protected lanes. at intersections, a traffic control system gives trams and buses green lights. To reduce the interference of automobiles with transit movement, the city's roadway infrastructure has undergone numerous adjustments and enhancements (e.g., bans on left turns on tram line roads, prohibiting stopping or parking in certain areas, building pedestrian islands, and so forth). A single ticket can be used on all types of public transportation in the city (including buses, trams, and a new underground regional metro system). The frequency of service is great, and few places in Canton Zürich are more than a few hundred meters away from a station or stop.

These communities take a variety of steps to make public transportation a more appealing and feasible alternative to driving. Many tiny but cumulatively significant enhancements have been implemented, such as real-time information of when the next tram, train, or bus will arrive.

Multimodal (Integrated Systems)

In these European cities, transport modes are often well integrated, which means that investments and routes are coordinated so that transit modes complement one another. Regional and national train systems, for example, are fully integrated within local transport routes in most of the cities analyzed and switching from one mode to another is simple. The effort put into making public transportation appealing and comfortable is astounding. Cities such as Zürich and Freiburg are working hard to increase tram speed and dependability.

The cumulative effect of many individual acts and design features aimed at improving the speed, comfort, and enjoyment of taking public transportation in these studied cities is impressive.

Systematic Transit Priority

Few cities have been as aggressive in their efforts to extend and improve their public transportation networks as Zürich. The trams and buses that make up the backbone of the Zürich system have been given priority over automobiles in several inventive ways. The initiatives in Zürich have been incremental and long-term, involving considerable system upgrades over twenty years. In 1990, a regional (underground) train system (the S-Bahn) waBahnstalled, which serves the entire Canton of Zürich (1,728 square kilometers). The S-Bahn lines all come together at Zürich's central rail station. The Zürich Transit Authority (Verkehrsbetriebe Zürich) is in charge of the entire public transportation system. Within the city, the transportation system provides 270

kilometers of the line (including 117 kilometers of tram line). The cantonal system as a whole has 262 lines and covers 2,300 kilometers.

For numerous reasons, the tram and bus system in Zürich is innovative in its approach. The first design feature is the stated priority given to public transportation, which was adopted by the public through a referendum. The attention accorded to public transportation is manifested in a variety of ways. Trams and buses move on private, reserved lanes in several places. Through the use of separate signal transmitters that allow each bus or tram to signal its approach to a traffic light, a traffic control system is utilized to give trams and buses green lights at junctions (the city's goal is "zero waiting time" at crossings). The location of transport vehicles is tracked (to within 10 meters) by a central computerized control system, and bus and tram drivers are immediately informed of how close they are to their schedules. As difficulties in the system development, the control center can initiate remedial actions, and in the event of breakdowns or other problems, there are always two trams and five buses strategically situated to spring into action when needed. These several steps have resulted in an efficient, well-functioning transport system that citizens can rely on for transportation. There are few places in Canton Zürich where you can't find a station or a stop within a few hundred meters, and the regularity of operation is fairly outstanding (most trams and buses in the city run every six to eight minutes). Furthermore, one ticket is valid for all types of public transportation in the city.

Controlling and restricting auto traffic is also an essential part of Zürich's transportation policy, which has been achieved progressively through a variety of methods. Several traffic-calming measures have been implemented by the city. One strategy is to manage and slow down auto traffic as it passes through the city. This is done, once again, by a centralized computer system and traffic signal regulation, to minimize excessive vehicular congestion that would impede transit vehicle travel. The city has also lowered speed limits in several regions and implemented major parking restrictions under its Parking Ordinance. The number of mandatory spots has been decreased in half for all new or rebuilt buildings, and no new spaces are permitted in the city's older historic district. Parking fees have also been significantly increased, as a result of a popular referendum in 1994 (City of Zürich, 1995). Other road and traffic measures have been implemented to ensure that automobiles do not obstruct the passage of trams and buses (e.g., left-hand turning or a twenty-year initiative to give public transportation precedence in the road and traffic system). The Zürich transportation system and policy are a success on practically every level. The service has gradually

grown and enhanced. Traveling by tram, bus, or metro is simple and enjoyable, and it is usually faster than driving. People of cities such as Zürich will tell you that taking the bus or tram is not a second-class mode of transportation; as one interviewee informed me, even the city's wealthiest residents use the system to get around. When compared to many other cities, ridership is strong, and the mode split is outstanding. The transit authority has also been proactive and imaginative in its public marketing, co-sponsoring sporting and entertainment events where the cost of transportation is included in the ticket’s price.

3.3.2. The City of Amsterdam

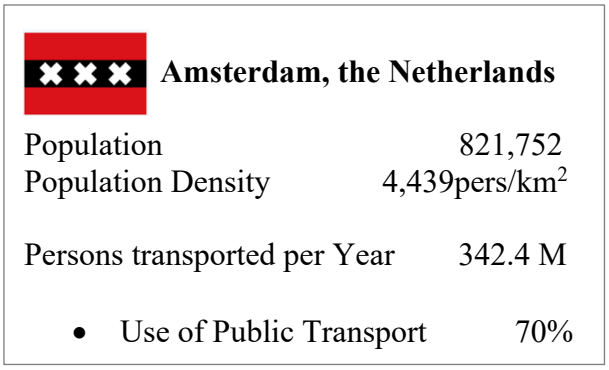


Figure 15. Amsterdam Public Transport Company GVB

Amsterdam is the Netherlands' capital and most populated city. Amsterdam is situated in a flat and low-lying area mainly on the south bank of the IJ, an inland arm of the former Zuiderzee, now the IJsselmeer, connected by canal with the North Sea. Amsterdam is broken up into seven city districts (stadsdelen).

The Bus and Tramlines operated by Gemeentelijk Vervoerbedrijf, Connexxion, and Arriva provide Public Transportation in Amsterdam. Three metro lines serve Amsterdam, with a fourth, the North/South line, now under development. Several free boats go across the IJ for pedestrians and bikes. Amsterdam is regarded as one of the world's most bicycle-friendly cities. Bike pathways may be found on most major streets, bike racks are plentiful, and the city has about 700,000 bicycles. The Nederlandse Spoorwegen has eight stations in Amsterdam (Dutch Railways). Sloterdijk, Zuid, Amstel, Bijlmer ArenA, and Amsterdam Centraal are the five intercity stops.

History of Amsterdam Transportation Systems

The Dutch government has adopted a national locational policy intended to strongly support public transit and reduce auto use. Called the A-B-C policy, it seeks to steer large institutional and commercial activities to sites where public transit can be utilized. A distinction is established between three types of locales in particular (Elsenaar and Fanoy, 1993):

A-locations - Locations of public transportation in city centers, close to the main railway station, that are difficult to reach by automobile and have restricted parking.

B-locations - Locations of public transportation that are easily accessible by both public transportation and auto and are frequently located near a suburban railway station or other high-quality public transportation modes.

C-locations - Locations on the outskirts of the city that have a direct connection to the trunk road network but are difficult to reach by public transportation.

Large institutions, including hospitals and national government buildings, are typically erected in A-locations, and the policy has been vigorously enforced by the national government. National standards also exist that limit the number of parking spaces depending upon the type of location, again with the intent to reduce auto reliance and promote public transit. When it comes to company placement, local governments are in charge of implementing the A-B-C policy and enforcing parking regulations, while the national government can intervene to prevent a project from being built in a specific location. Although some private businesses have been placed in more auto-oriented locations than necessary and given more parking spaces than necessary, the overall locational approach appears to be succeeding (especially in the Randstad). The A-B-C policy, understandably, is a vital mechanism for executing the compact cities strategy, and it aids in the strengthening of cities and the promotion of a denser, more compact urban form (Beatley, 2000).

3.4. THE CITY OF ZÜRICH IN MOTION

Traffic Congestion Index
3.7 out of 10
3rd of 38 Cities

Percentage of Green Spaces
19% of city area
11th of 38 Cities

Public Transport Expense
1.63% of monthly income
3rd of 38 Cities

Official Docked City Bikes
2.83 bikes per 1000 people
6th of 38 Cities

3.4.1. Connectivity

Overview

A graphic comparison of all cities' important connection indicators.

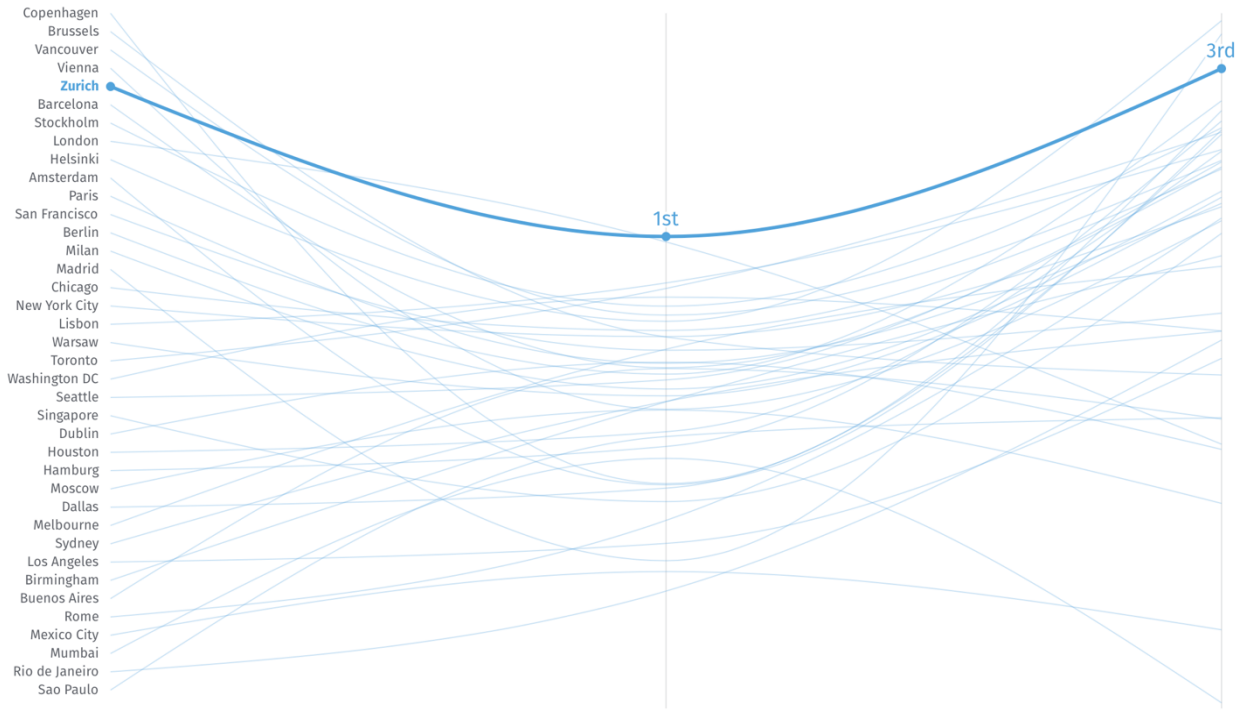


Figure 16. Comparison of Zurich Connectivity Indicators (HERE Urban Mobility Index, 2018).

A. Public Transport Efficiency

- **Frequency**

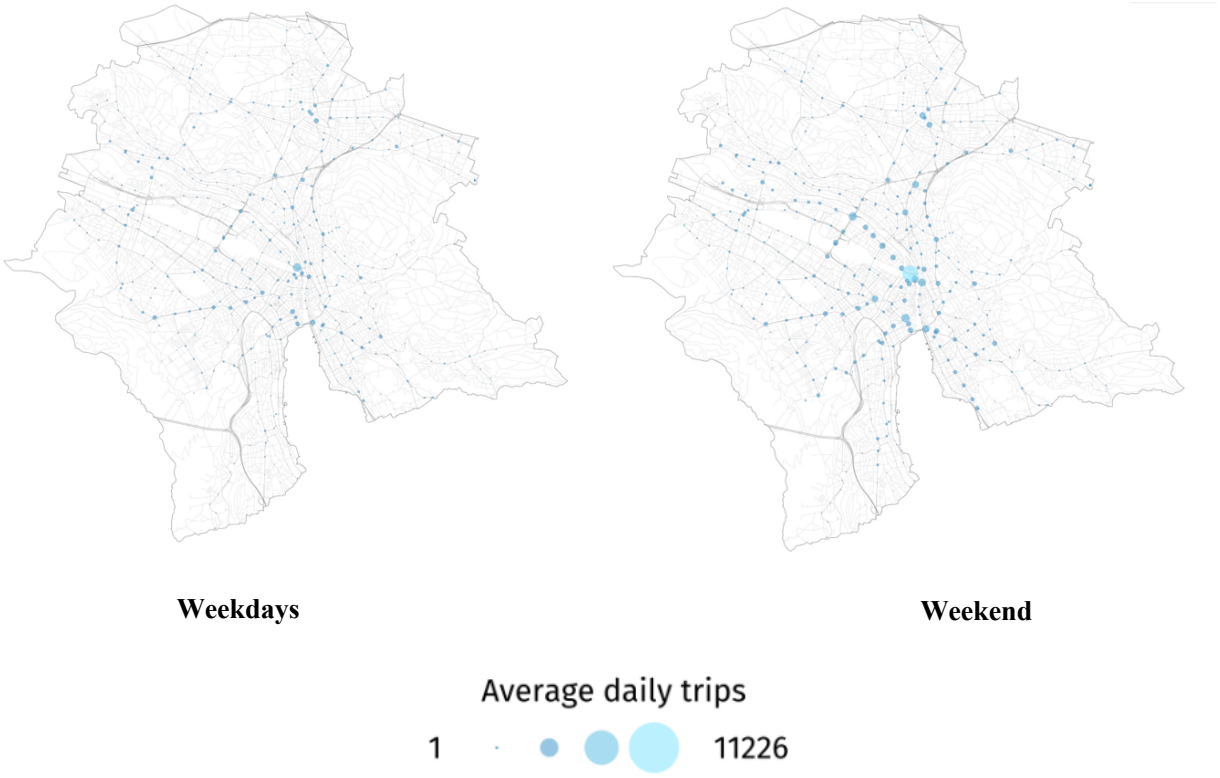


Figure 17. Zurich Frequency (HERE Urban Mobility Index, 2018).

I. Public Transport Frequency
826 trips per stop per day
1st of 38 Cities

II. Public Transport and Car Speed
9th of 38 Cities

- **Coverage**

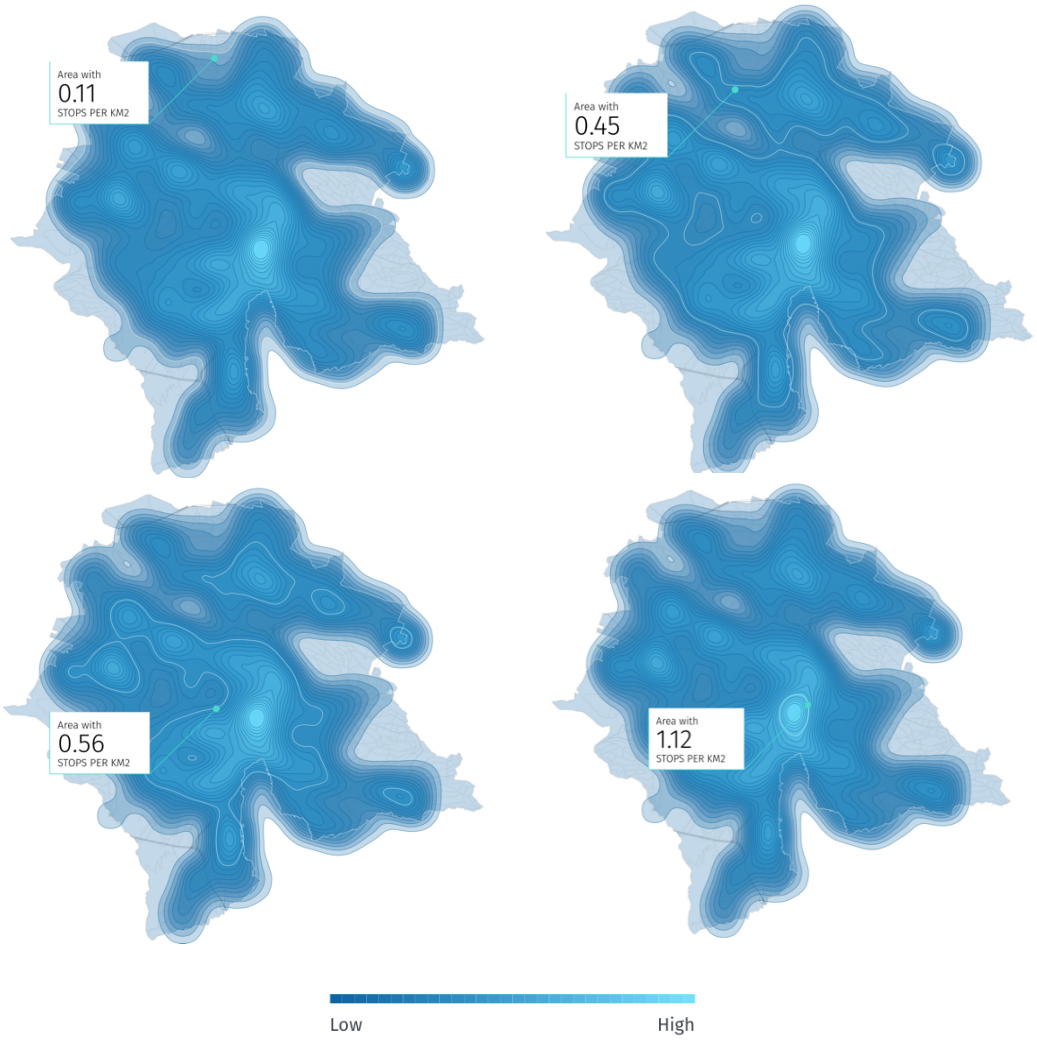


Figure 18. Variations in Stop Density of Zurich (HERE Urban Mobility Index, 2018).

I. Public Transport Coverage
81 % of city area
17th of 38 Cities

II. Public Transport Density
1.03 stops per 1000 people
24th of 38 Cities

B. Traffic Flow

Congestion Issue

i. Traffic Congestion Index: 3.7 out of 10 (3rd of 38 Cities)
ii. Time Delay in Traffic: 18 mins per 100 km (4th of 38 Cities)
iii. Percentage of Congested Roads: 1.85 % of the road network (2nd of 38 Cities)

3.4.2. Sustainability

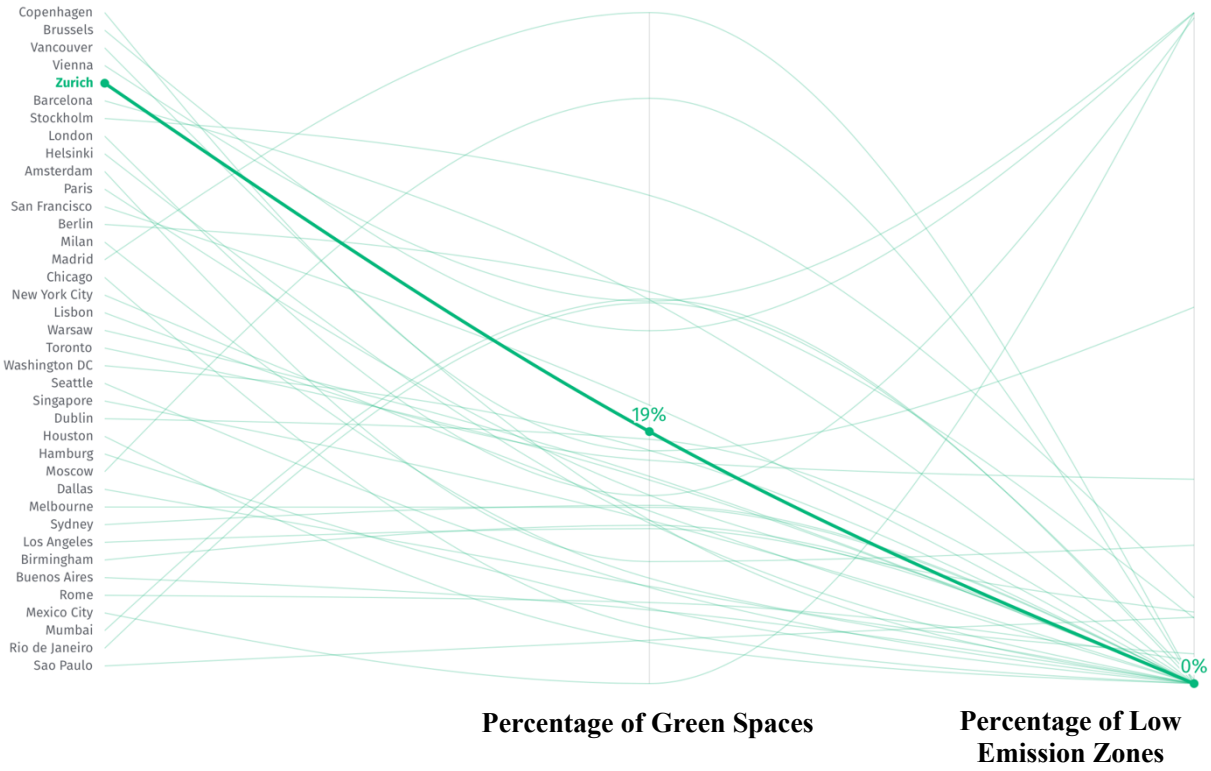


Figure 19. Zurich's Percentage of Green and Low Emission Zones (HERE Urban Mobility Index, 2018).

A. Green Spaces

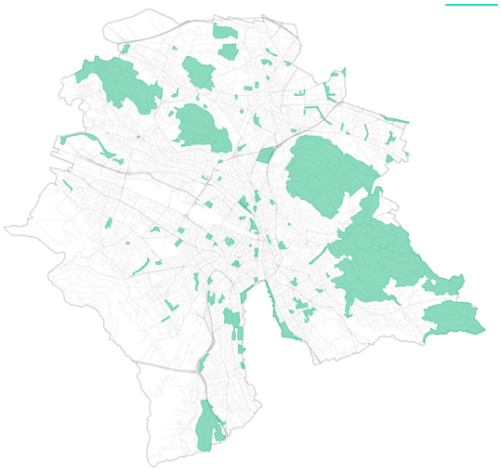


Figure 20. Zurich Green Spaces Map
(HERE Urban Mobility Index, 2018).

- Percentage of Green Spaces: **19 %** of the city area (11th of 38 Cities)
- Percentage of Low Emission Zones: **0 %** of the city area (38th of 38 Cities)

3.4.3. Affordability

Overview

A graphic comparison of key affordability indicators across all cities.

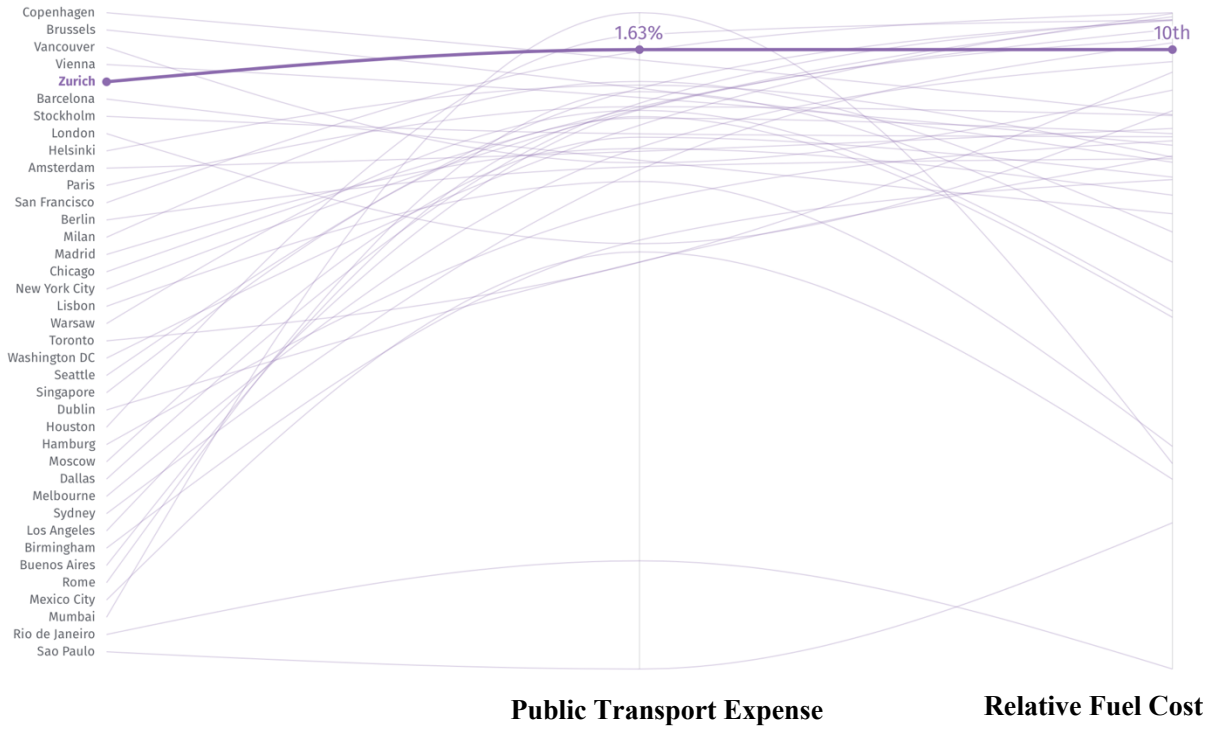


Figure 21. Comparison of Zurich Affordability Indicators (HERE Urban Mobility Index, 2018).

A. **Public Transport Expense**: 1.63 % of monthly income (3rd of 38 Cities)
B. **Relative Fuel Cost:** 10th of 38 Cities

3.4.4 Innovation

Overview

A graphic comparison of key innovation indicators across all cities.

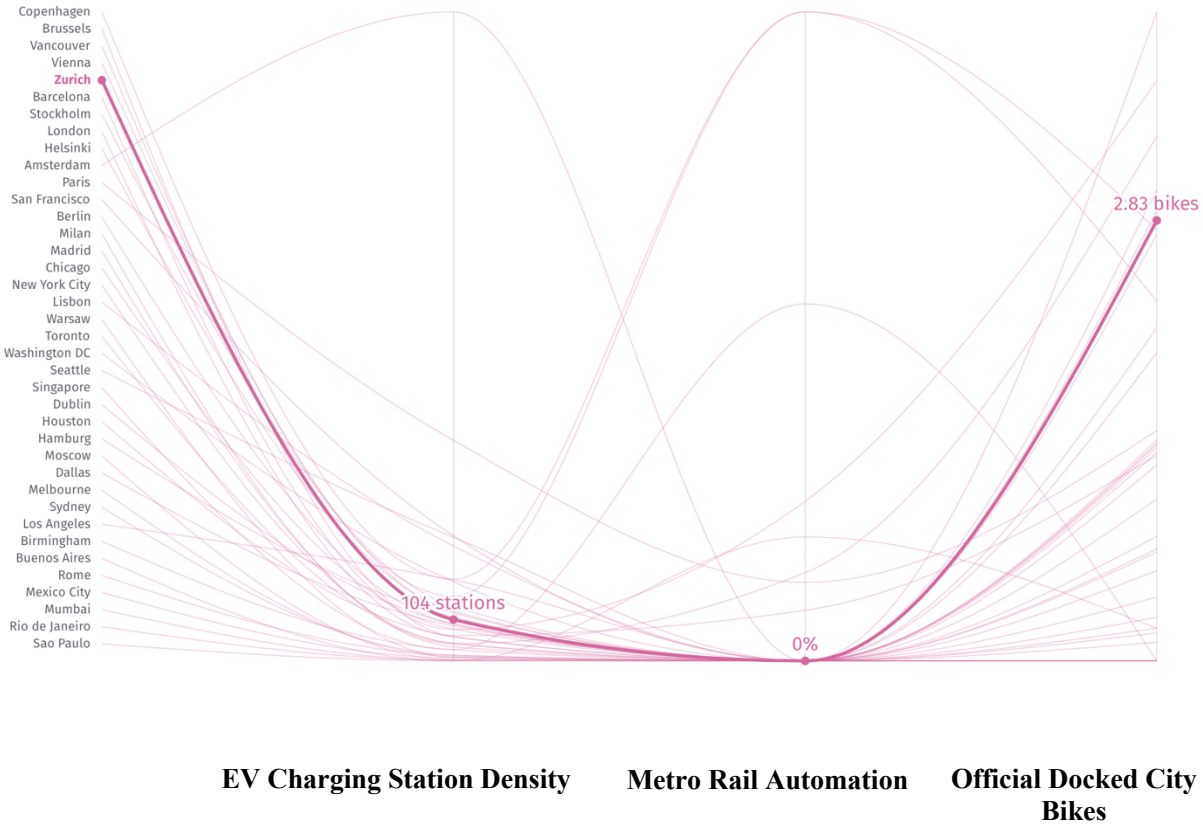


Figure 22. Comparison of Zurich Innovation Indicators (HERE Urban Mobility Index, 2018).

EV Charging Stations

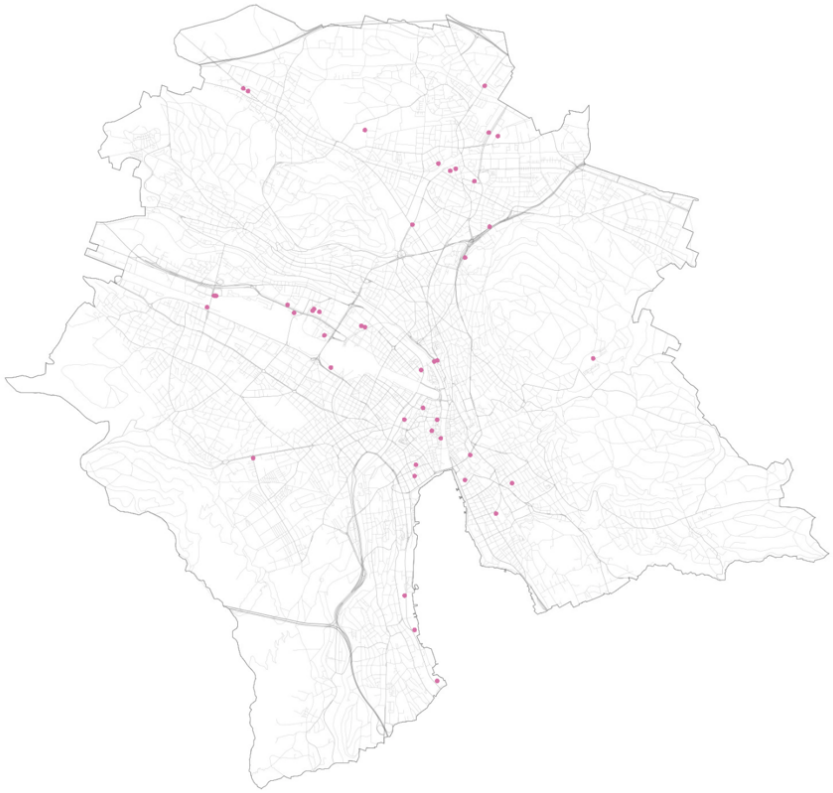


Figure 23. Map of Zurich EV Charging Stations (HERE Urban Mobility Index, 2018).

A. **Official Docked City Bikes**: **2.83** bikes per 1000 people (6th of 38 Cities)
B. **EV Charging Station Density**: **104** stations per 1m people (14th of 38 Cities)
C. **Metro Rail Automation**: **0 %** of the metro rail network (38th of 38 Cities)

3.5. THE CITY OF AMSTERDAM IN MOTION

Traffic Congestion Index
4.3 out of 10
12rd of 38 Cities

Percentage Of Green Spaces
11% of city area
28th of 38 Cities

Public Transport Expense
3.62% of monthly income
25th of 38 Cities

Official Docked City Bikes
0 bikes per 1000 people
38th of 38 Cities

3.5.1 Connectivity

Overview

A graphic comparison of key connectivity indicators across all cities.

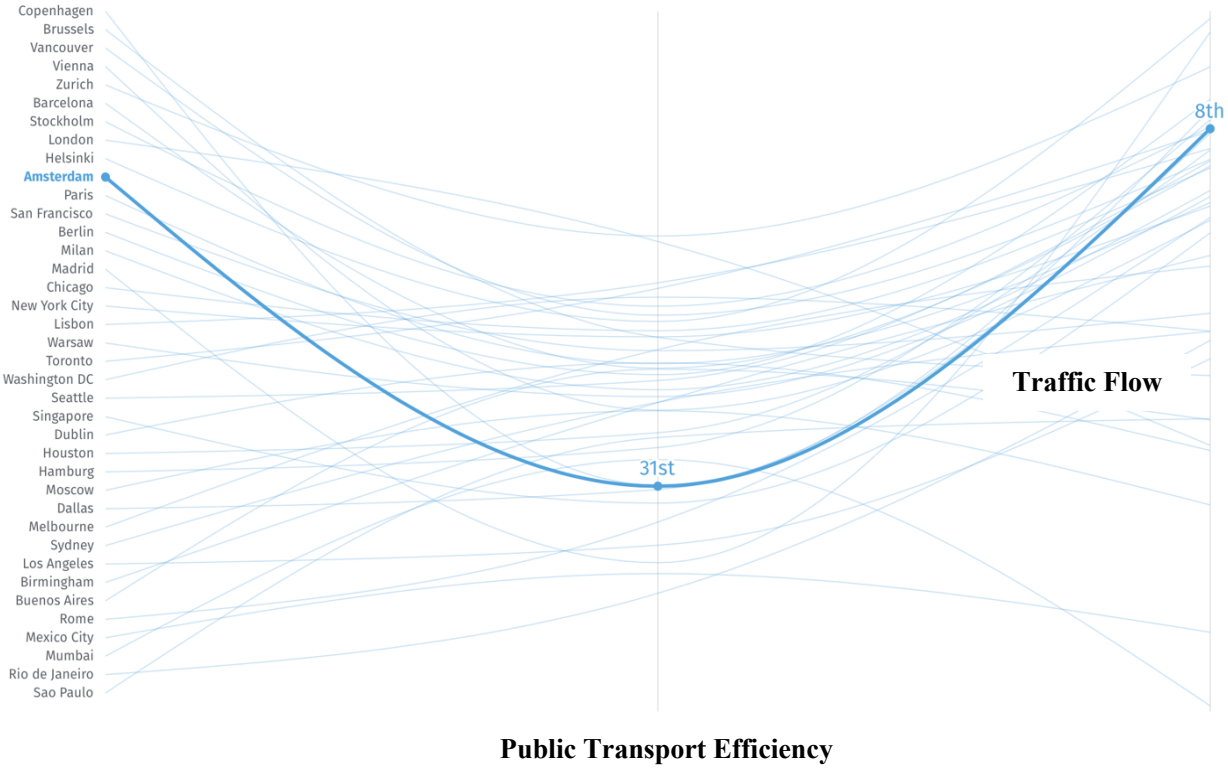


Figure 24. Comparison of Amsterdam Connectivity Indicators (HERE Urban Mobility Index, 2018).

A. Public Transport Efficiency

- Frequency

Figure 25. Amsterdam Frequency (HERE Urban Mobility Index, 2018).

I. Public Transport Frequency
198 trips per stop per day
17th of 38 Cities

II. Public Transport and Car Speed
26th of 38 Cities

- Coverage

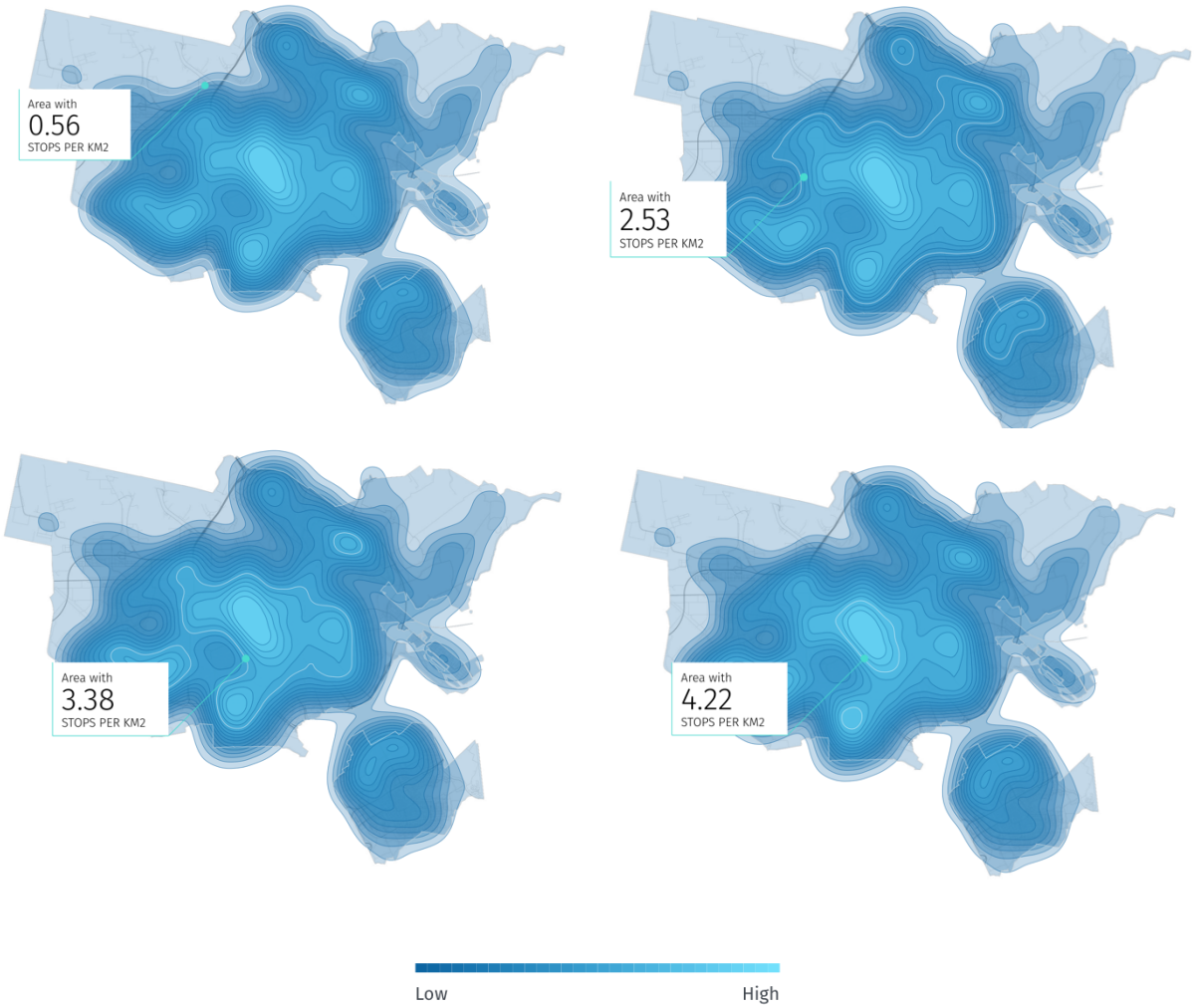


Figure 26. Variations in Stop Density of Amsterdam (HERE Urban Mobility Index, 2018).

I. Public Transport Coverage
66 % of city area
28th of 38 Cities

II. Public Transport Density
1 stops per 1000 people
27th of 38 Cities

B. Traffic Flow

Congestion

i. Traffic Congestion Index: 4.3 out of 10 (12th of 38 Cities)

ii. Time Delay in Traffic: 22 mins per 100 km (9th of 38 Cities)

iii. Percentage of Congested Roads: 4.72 % of the road network (7th of 38 Cities)

3.5.2. Sustainability

Overview

A visual comparison of key sustainability indicators across all cities.

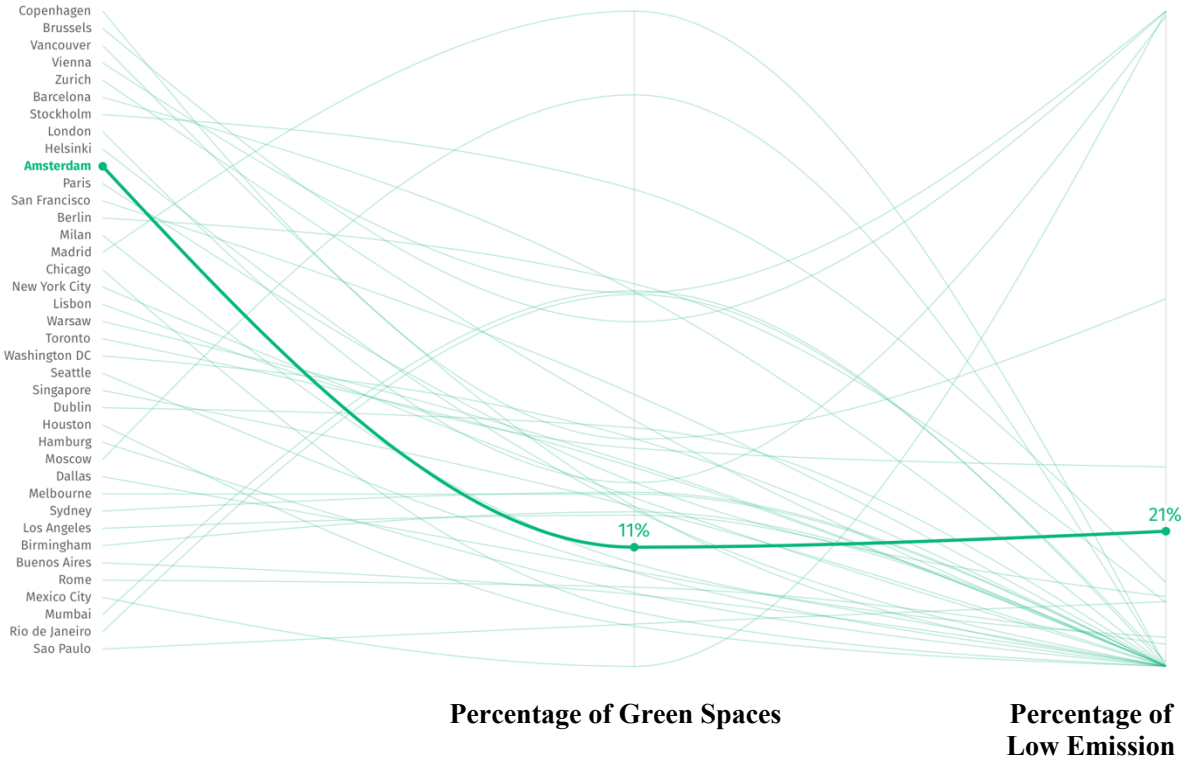


Figure 27. Amsterdam's Percentage of Green and Low Emission Zones (HERE Urban Mobility Index, 2018).

A. Green Spaces

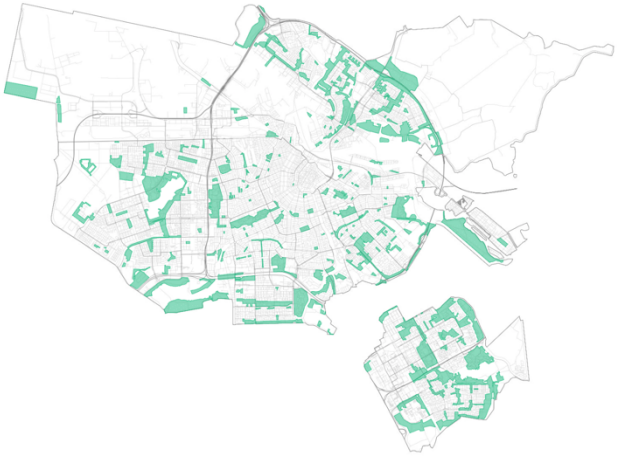


Figure 28. Amsterdam Green Spaces Map
(HERE Urban Mobility Index, 2018).

- Percentage of Green Spaces: 11 % of the city area (28th of 38 Cities)

B. Low Emission Zones

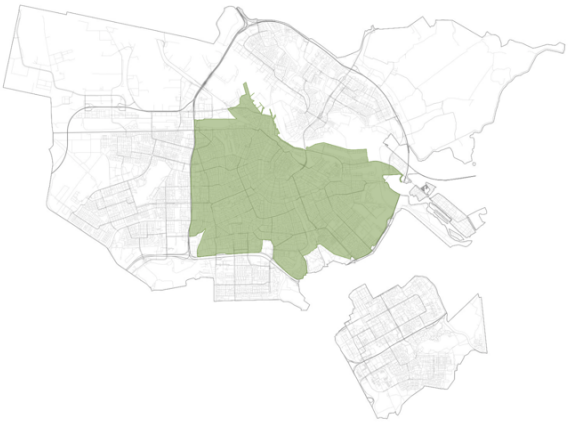


Figure 29. Amsterdam Low emission Spaces Map
(HERE Urban Mobility Index, 2018).

- Percentage of Low Emission Zones: 21 % of the city area (7th of 38 Cities)

3.5.3. Affordability

Overview

A graphic comparison of key affordability indicators across all cities.

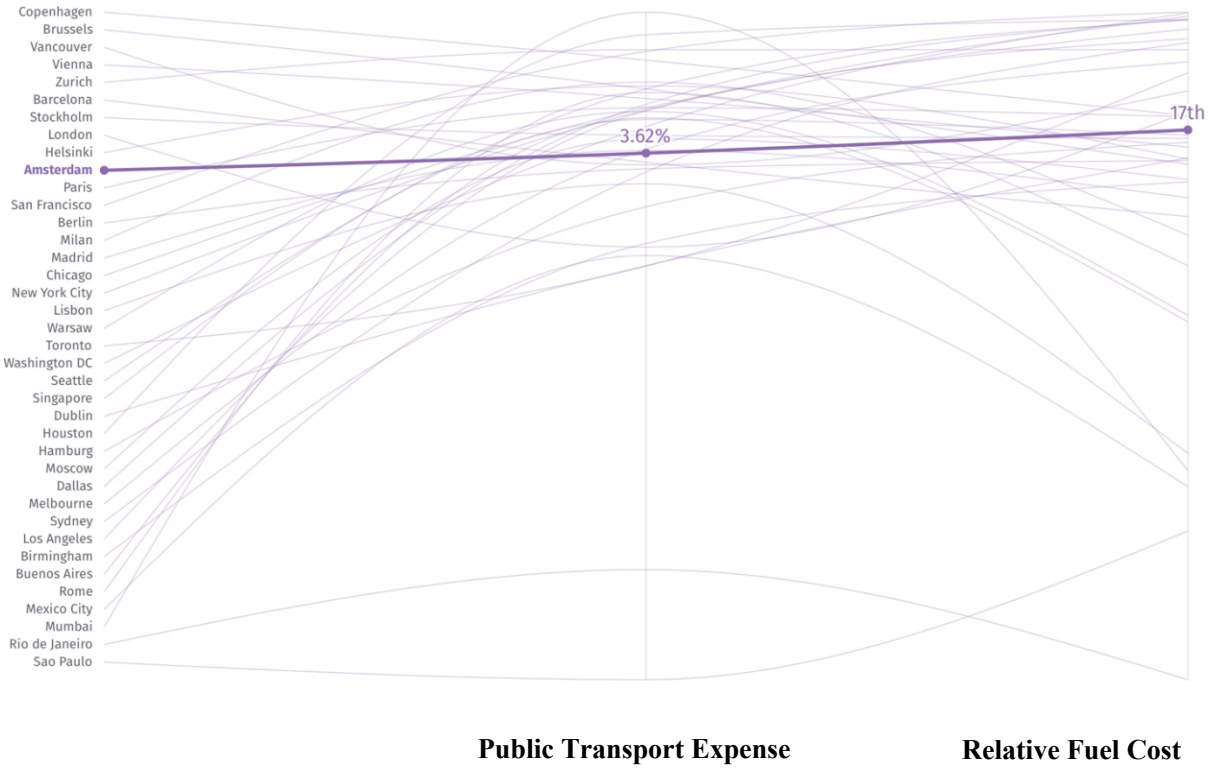


Figure 30. Comparison of Amsterdam Affordability Indicators (HERE Urban Mobility Index, 2018).

A. **Public Transport Expense**: **3.62 %** of monthly income (25th of 38 Cities)
B. **Relative Fuel Cost**: **17th** of 38 Cities

3.5.4. Innovation

Overview

A graphic comparison of key innovation indicators across all cities.

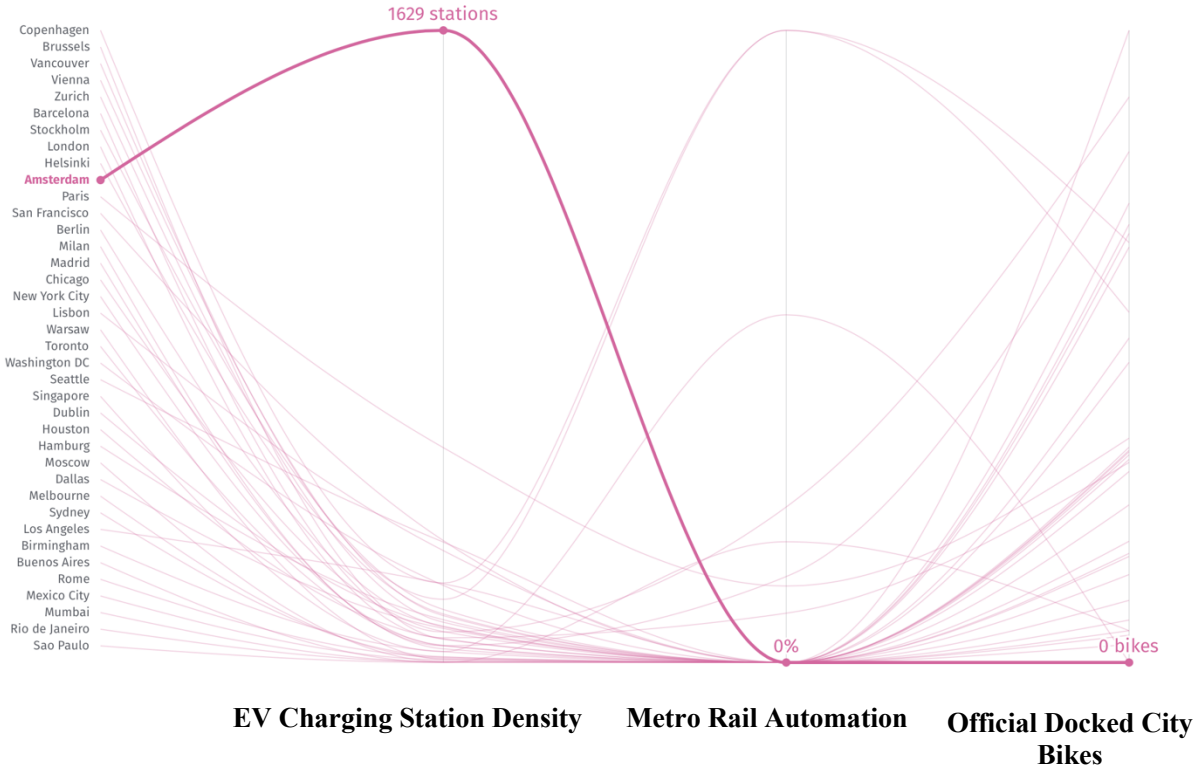


Figure 31. Comparison of Amsterdam Innovation Indicators (HERE Urban Mobility Index, 2018).

EV Charging Stations

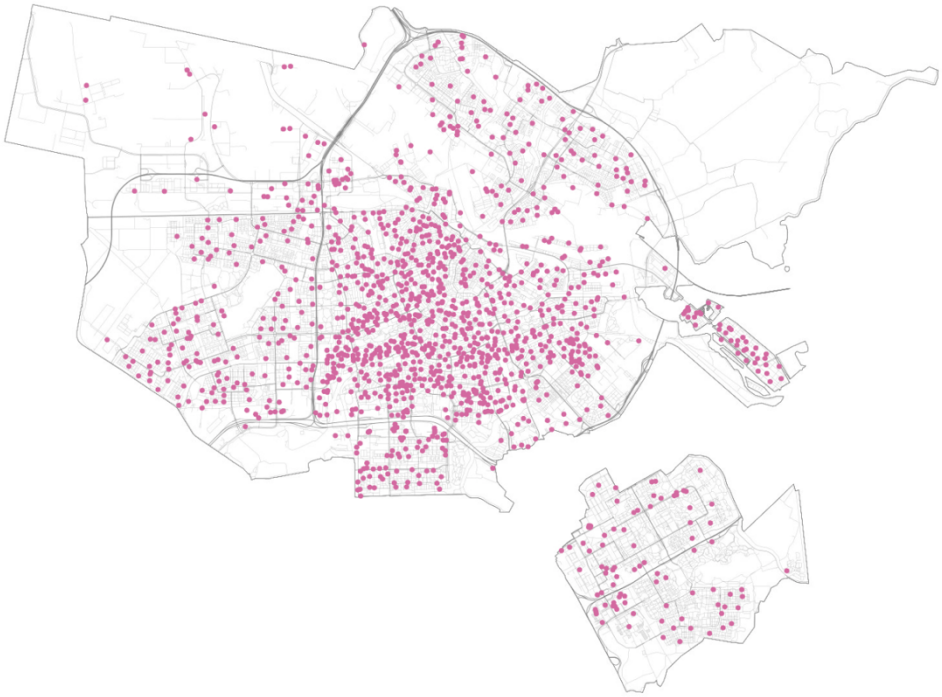


Figure 32. Map of Amsterdam EV Charging Stations (HERE Urban Mobility Index, 2018).

A. **Official Docked City Bikes**: **0 bikes** per 1000 people (38th of 38 Cities)
B. **EV Charging Station Density**: **1629 stations** per 1m people (1st of 38 Cities)
C. **Metro Rail Automation**: **0 %** of the metro rail network (34th of 38 Cities)

3.6. MAIN FINDINGS

The City of Zürich: Zurich is a global benchmarking city in the field of public transportation efficiency. It covers more than 800 journeys per stop every day, making it the first city in the HERE evaluation program's 38 cities. However, in terms of public transportation coverage and density, it is in the middle. Approximately 80% of the city is served by public transportation. In this investigation, the traffic congestion index and time delay in traffic are in perfect condition compared to other cities. Zurich's primary shortcoming is the lack of Low Emission Zones. Green spaces account for only 19% of the city's total area. Zürich is also a benchmarking city in terms of public transportation costs, with citizens paying less than 2% of their monthly income to travel inside the city using public transit. Zurich also suffers from a lack of metro rail automation (0 percent of the metro rail network).

However, this city's Official Docked City Bikes are in good condition, with approximately 3 bikes per 1000 persons. Finally, the city of Zurich has 104 electric vehicle charging points per 1 million residents, placing it in the mid-tier of global cities in this field.

The City of Amsterdam: The frequency of public transportation in Amsterdam has to be increased. It has 198 trips per stop each day, placing it in the middle of the 38 cities studied by HERE. Amsterdam has a public transportation coverage of 66 percent of the city area, which is a low percentage among the greatest global cities in this field. In both cases, Amsterdam lies in the middle, with green spaces accounting for 11% of the city area and low emission zones accounting for 21% of the city area. The cost of public transportation is one of Amsterdam's major issues. a citizen must pay 3.62 percent of her monthly salary to use public transportation for her internal trips.

However, Amsterdam is the top city in the sector of EV charging stations among the 38 cities studied by the HERE analysis tool, with 1629 stations per 1 million people (1st of 38 Cities).

CHAPTER 4: THE REVOLUTION OF ELECTRIC MOBILITY: *DYNAMICS AND DEVELOPMENTS IN AMSTERDAM AND ZÜRICH*

4.1. INTRODUCTION TO ELECTRIC VEHICLES

Electric vehicles have been pursued to their mechanical simplicity and lack of direct pollutant sources, while emissions from the power source must be considered (Faiz et al., 1996).

Since the industrial revolution, global atmospheric concentrations of Greenhouse Gases (GHGs) such as CO_2 have risen dramatically because of human activity, and humans are influencing the climate system (IPCC, Climate Change 2013: The Physical Science Basis, 2013).

Between 1970 and 2004, energy supply, industry, and transportation accounted for most of the increase in anthropogenic GHG emissions. Transportation is heavily reliant on fossil fuels, accounting for almost a quarter of worldwide energy-related GHG emissions (IEA, 2016).

Currently, transportation contributes around a quarter of all energy-related carbon dioxide emissions to the environment, with that percentage expected to rise to one-third by 2050, faster than any other industry. By 2050, the worldwide passenger automobile fleet is expected to double, with the majority of the growth occurring in developing markets, where three out of every four cars will be found. Although developing countries have the fastest-growing fleets, the majority of them lack vehicle emissions standards, programs, or incentives to encourage the use of zero-emission vehicles (UN Environment Program).

By bringing people to work and permitting the transfer of goods and services, transportation is a vital enabler for economic growth within conurbations and their catchment areas, which are all keystones of the economy. As a result, it's critical to strike a balance between the need to travel and the need to reduce transportation-related carbon emissions. This is especially difficult in the post-2008 austerity era when economic development and productivity are at least as important as decarbonization (Heidrich et al., 2017).

For coping with the issues that climate change may bring, it is critical to focus on cities and their sustainable transportation policies. Today, 54% of the world's population lives in cities, with

that number expected to rise to 66% by 2050 (U.N., 2015). International and national commitments have a positive impact on European city strategies (Heidrich et al., 2016).

Urban areas in general and cities, in particular, are the hub of innovation, power, and wealth (Bettencourt and West, 2010) and can also influence socio-technical transformations. However, they are responsible for a high percentage of worldwide energy-related carbon emissions (IEA, 2008).

According to the Project Drawdown of Paul Hawken, there are nine sectors where immediate action is needed to limit *Catastrophic Climate Change,* they are Health and Education, Industry, Coastal and Ocean Sinks, Engineered Sinks, Electricity, Land Sinks, Buildings, Food, Agriculture, and Land Use, and Transportation (building compact cities, active transport, and electric vehicles).

UN Environment Program says, "to achieve a cleaner transport sector, a combination of measures needs to be implemented worldwide: better-designed cities; non-motorized transport facilities; more public transport; and cleaner and more efficient on-road fleets, including electric vehicles."

Now, electrification of the fleet through the replacement of existing vehicles with electric equivalents is one potential technique for reducing emissions from cars and light vans.

The policy to adopt might be to reduce GHG emissions by rapidly introducing and disseminating low-emission vehicles while also developing or maintaining their automotive industry and competitiveness (Mazur et al., 2015).

In this regard, an economic package could be considered for the development, supply, and use of low and ultra-low emission vehicles. It could contain an amount for recharging infrastructure provision. The Plugged in Car Grant, which lowers the upfront cost of acquiring EVs and qualifying Plug-in Electric Vehicles, could be included in this package. Public charging infrastructure at train stations, on government property, and on-street and quick charging networks are also being invested in.

According to the findings, having a climate change mitigation strategy that includes EVs has no statistically meaningful impact on EV adoption or public charging infrastructure deployment. some results say cities or urban areas may just mention EVs in their climate change mitigation programs as a token gesture. Cities must aggressively support the adoption of electric vehicles (EVs), enhance the infrastructure required for their ergonomic usage, and remove or at least

decrease some of the barriers that hinder drivers from acquiring these vehicles, whether those barriers are directly related to EVs or not.

According to Heidrich et al. (2017)'s research across 30 UK cities, there are two tips to consider:

i. Motivating factors for purchasing and using EV: They may be fundamentally beyond the ability of cities to change. The cost and range of electric vehicles have been mentioned as a limiting factor in the purchase of such a car in several polls. Indeed, it is possible that in the future, customers, particularly city dwellers, may gravitate toward alternate modes of transportation such as electric bikes. These are factors that no single city can change (except giving subsidized purchases). It would be justified if cities did not include particular policies targeting EVs if the limiting criteria for EV purchase are all on a national scale.

ii. While it may be possible to assign a cost for the implementation of any given strategy, its effectiveness is more difficult to determine so this issue is more difficult to quantify.

We, in our researches in the future, maybe should break down each city's climate change policy and strategy into its constituent pieces, and then break down each policy into a series of particular activities that were planned and implemented. If a city takes action (rather than simply stating it in policy documents), there should be a corresponding expected outcome, such as free parking and charging, EV access to "no automobile lanes," and other policy-friendly incentives.

UN Environment Program

This section looks at the UN Environment Program's Electric Mobility Initiative in general. The data is based on UNEP research titled "What Does Electric Mobility Matter?" that can be seen on their official website.

UN Environment’s Electric Mobility Program supports countries, with a special focus on emerging economies, in introducing electric mobility. The Program will be a major contribution

to UN Environment's work on air quality, in specific the UN Environment Assembly's Air Quality Resolution and the implementation of the Paris Climate Agreement.

The Electric Mobility Program is currently the only global program that supports electric mobility for developing and transitional countries. As of today, UN Environment is supporting over 50 countries and cities to introduce electric buses, cars, and two and three-wheelers:

- 2&3 wheelers: UN Environment is supporting eight countries to develop national roadmaps and conduct pilots for the introduction of electric two and three-wheelers in Africa and Southeast Asia.

- Light-Duty Vehicles: UN Environment is currently supporting fifty countries in developing fiscal and regulatory policies and programs to promote efficient vehicles including electric cars.

- Buses: UN Environment, along with partners, developed a clean bus fleet program providing support to twenty cities in Asia, Latin America, and Africa to prepare roadmaps for low emission public transport, including the introduction of electric buses.

4.2. THE MAIN ANALYSIS ELEMENTS IN THE FIELD OF ELECTRIC VEHICLES

This section is a study recommendation based on the results of a comparison between Amsterdam and Zurich. When each part is described in-depth, the resource is mentioned.

I. Analysis of the Status of Transition from Normal Vehicles to the Electric Vehicles

This part of analysis work aims to investigate how E-Mobility is becoming the main vehicle in the shared mobility system (as a multimodal option) for urban mobility in various European cities, to identify its role as the "mobility of the future", as well as potential challenges and barriers that may arise during the integration. This research investigates the rising use of electric buses, private vehicles, motorbikes, quadricycles, mopeds, and e-scooters in transportation fleets.

Two implementation scenarios in the cities of Amsterdam and Zürich are offered to demonstrate this. The first is about achieving a successful transition from normal vehicles to electric vehicles through massive national policy actions where the private party is an arm of government. In this subject, the Netherlands today has a lot of private-public collaboration. The second one, Zürich, is about a policy that is being developed mainly in collaboration with private parties, where the government has a supportive role.

The outcome of this stage is that how E-Mobility can play a role as the main vehicle for urban mobility as support for multimodal option policy (all vehicles in the transportation fleet; Shared Mobility System + Public Transport System).

An issue to mention, the transition from normal vehicles to electric vehicles can be implemented in the smooth slope thanks to the Comprehensive National Policy (such as tax exemptions and incentives to purchase the electric cars) and with a focus on the Potentiality Role of the Private Sector.

II. A Proposal for the Electrification of the Transportation Fleet as the Result of the Comparison between Amsterdam and Zurich

This section discusses a potential plan for the electrification of a transportation fleet. This plan is based on the lesson learned from two case studies, as well as the findings of various publications and articles in the field.

III. Analysis of the Use of Transportation Fleet Monitoring and Controlling Application

To keep track of how each traveler utilizes different means of transportation and integrate this data to issue a single bill to a single user, only one application is used as a single identity for every user to travel with diverse modes. Open data and open payment mechanisms are also necessary for establishing an M-a-a-S system among the many operators of various types of transportation.

ICT development, such as smartphone applications, is a critical component in meeting these goals.

The information obtained from this application can also assist local officials in expanding charging stations and establishing car, bike, and scooter-sharing stations in the most needed areas of a city.

4.3. ANALYSIS OF THE STATUS OF TRANSITION FROM NORMAL VEHICLES TO ELECTRIC VEHICLES: *THE ANALYSIS IN AMSTERDAM AND ZURICH*

4.3.1. The Amsterdam Success Story

The information in this section is based on the EVBox website report (EVBox company is the main charging station provider in Amsterdam).

2000 Charging Ports	20,000 Electric Vehicle Drivers	400 Full Electric Taxis	30,000 Charging Sessions/Month

Figure 33. Charging electric cars in Amsterdam (EVBox).

Amsterdam is one of the most advanced cities in the world when it comes to electric mobility. Amsterdam, the 2016 European Innovation Capital, is a Living Lab for research institutes, corporations, and startups. The city fosters the emergence of new solutions for clean and sustainable mobility aimed at improving air quality and public health by bringing these parties together. As a result, Amsterdam has set a lofty target of becoming a zero-emission city by 2025.

Why is Amsterdam City going electric?

To meet the 2025 target, all motorized road traffic (including trucks, public buses, and private passenger cars) would be either clean or emission-free (including taxis, vans, motor scooters, and passenger ferries). Today, Amsterdam has about 19,000 electric drivers and approximately 400 full-electric taxis, and 300 fully electric Car2Go cars to assist citizens and tourists in getting around the city.

The city is now putting even more money into incentives, support, and laws to encourage everyone to switch to electric vehicles. Parking privileges for emission-free taxis, clean zones to keep away “dirty” vehicles, subsidies for business fleets and private owners, and even the exclusion of petrol-powered vehicles from parking permits are just a few of the measures. In

addition, the city intends to invest heavily in charging infrastructure. A collaboration between energy company Nuon, installation partner Heijmans, and charging station provider EVBox is in charge of this project.

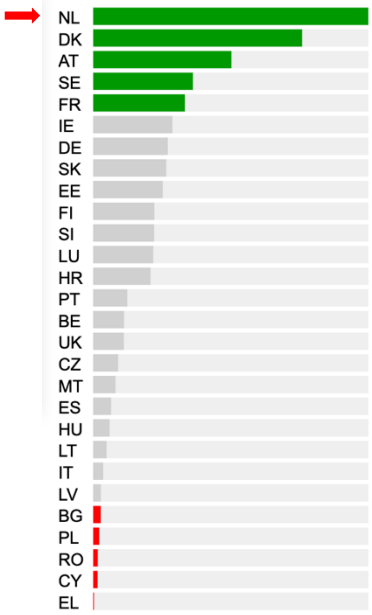
A network of smart charging stations and fast chargers will be installed in public spaces in the coming years. Charging stations are installed by commercial businesses and apartment buildings to provide infrastructure outside of public spaces. Data on charging is analyzed to determine driver usage trends and how many chargers are required in which areas.

With a major increase in electrification, sustainable energy generation and management have become one of Amsterdam's key objectives. Local windmills presently provide all the electricity required for the public charging outlets. In the next three to four years, the city hopes to raise local solar energy output from 5,000 to 92,000 families**.**

This research discusses the state of e-mobility in the Netherlands in the following section. Apart from the status of the city of Amsterdam, there are two reasons to discuss the entire Netherlands territorial status on this topic. First, a city cannot act effectively in the field of e-mobility on its own. The local approach will be shaped by “National Policy”. Second, the data in this field isn't segregated between the Netherlands and Amsterdam. The politics of the Netherlands and Amsterdam are inextricably linked. According to studies, the city of Amsterdam is responsible for the majority of the Netherlands' successes in this subject. This advice is equally applicable to Swiss and the city of Zürich analysis.

4.3.2. An Overview of the Netherlands' Actions in the E-mobility Sector

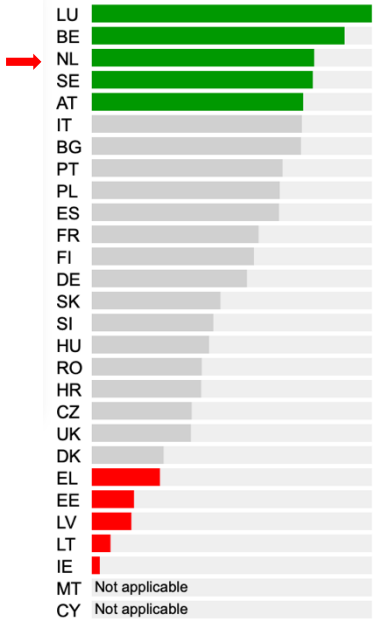
This section's data is based on the IEA (International Energy Agency) 2019 Hybrid and Electric Vehicles Report and the 2019 HEV TCP Annual Report.



Number of electric vehicles charging points per 100,000 urban inhabitants. Urban population living in "predominantly urban areas", except for CZ, LU and SI (people living in "intermediate regions"), based on the DEGURBA classification of urban/rural regions.

Source: Estimates based on European Alternative Fuels Observatory and Eurostat.

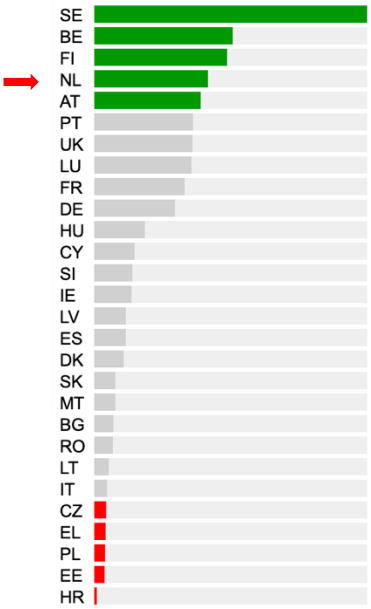
Figure 34. Electric Vehicle Charging Points, 2017



Percentage of Electrified Railway Lines (out of total lines in use).

Source: UIC Synopsis, IRG-Rail reports, national sources, and estimates (BE, IE).

Figure 35. Electrified Railway Lines, 2018



Percentage of newly registered Plug-in Electric Vehicles (PEV) in the indicated year (M1 vehicles). This includes Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV).
Source: European Alternative Fuels Observatory.

Figure 36. Market Share of Electric Passenger Cars, 2017

I. Major Development

In the Netherlands, only zero-emission vehicles will be sold by 2030. That is the Dutch government's objective. With this purpose in mind, the Formula E-Team, a Dutch public-private platform that promotes e-mobility and accelerates the transition to electric vehicles, brings together corporations, social institutions, academic institutions, and the government.

The goal is to assist in meeting climate targets while also taking advantage of the associated economic opportunities. In 2018, their efforts were fruitful. The number of fully electric passenger cars has more than doubled, hundreds of electric buses are now in service daily, and cities are seeing an increase in the number of electric taxis. Companies from the Netherlands are engaged in other countries and can benefit from their domestic experience. In terms of policy, a draft National Climate Agreement was presented, along with a proposal for several additional measures to encourage e-mobility.

II. Policy Developments

Preparations for a National Climate Agreement took up a lot of time in 2018. For Industry, Agriculture and Land Use, the Built Environment, Electricity, and Mobility, five sectoral tables

were developed, with numerous key stakeholders from market parties, NGOs, and research institutes as participants. There were also representatives from local and national governments. These tables were required to develop sectoral plans to achieve "their share" of CO_2 emission reductions by 2030.

In 2030, the Dutch government plans to cut greenhouse gas emissions by 49%. This equates to an additional 7.3 M ton of CO_2 emissions that must be reduced by 2030 in the mobility sector. Several sub-tables were set up where subthemes were discussed (for mobility on innovative fuels, logistics, etc.). The Formula E-Team served as the sub-table for E-Mobility. The proposed e-mobility solutions in the draft National Climate Agreement's mobility chapter are good for half of the CO_2 emissions reduction needed for mobility by 2030. The planned initiatives, in addition to a continued focus on strict CO_2 requirements (both nationally and concerning the European Union), are as follows:

i. Stimulation of the financial and fiscal systems:
   - Until 2025, zero-emission vehicles are exempt from purchase tax and (national) road tax.
   - Until 2025, there will be a lower income tax levy for company cars compared to normal vehicles.
   - From 2021 to 2030, private customers will receive a purchase subsidy.

ii. National Infrastructure Charging Agenda:
   - Developed together by municipalities, provinces, the federal government, DSOs, and sectoral groups.
   - Consists of agreements between parties that lead to the coverage of national (quick) charging infrastructure for the growing number of electric vehicles.
   - Themes covered in the agreements include charging infrastructure acceleration, open protocols and price transparency, smart grids, innovation, and logistics charging infrastructure.

iii. Private-sector and local-government support measures include:
   - Activities that lessen the barrier to switching to electric vehicles

– Communication measures, battery inspection, and guarantee for used automobiles, e-leasing, e-car sharing, and e-scooters.

The draft agreement was submitted towards the end of December 2018. The Netherlands Environmental Assessment Agency (PBL) calculated the costs and impacts of all actions in the first quarter of 2019. The national government then selected which initiatives would be implemented and incorporated into national policy. The Dutch partners in the European Commission's Innovation Deal "From E-Mobility to Recycling: The Virtuous Loop of the Electric Vehicle" include the Ministries of Infrastructure and Water Management and Economic Affairs and Climate Policy, LomboXnet, and the province of Utrecht. The European Commission, as well as the French Ministries of the Ecological and Inclusive Transition and Economy and Finance, Renault s.a.s., and Bouygues, are signatories. This Innovation Deal will address the issue of electric vehicle battery recycling and reuse.

In February 2018, the State Secretary for Infrastructure and Water Management, along with representatives from the Ministry of the Interior and Kingdom Relations, seven cities, a province, and many private parties, signed the City deal Shared E-mobility in Urban Planning and Development. The city of Amsterdam and some others will welcome more shared electric cars in the next years. Each community will experiment with the deployment of shared electric automobiles for creative housing developments and acquire experience. Local solar panels provide electricity, while the automobile battery is utilized to temporarily store excess electricity. 32 municipalities and the Ministry of Infrastructure and Water Management have signed an administrative agreement to make their dedicated social support transportation completely zero-emission by 2025. The transportation of the elderly, schoolchildren, and those with a physical or mental condition that prevents them from traveling independently is known as social support transportation.

III. Financial and Fiscal Incentives

The national government has allocated a total of 7.2 million euros as part of the Green Deal on Publicly Accessible Charging Infrastructure to help municipalities establish public charging outlets. A continuously declining contribution per pole was granted from mid-2015 to mid-2018,

on the condition that the municipality contributed the same amount per pole and a market party also contributed. 250 towns have requested funding for 8,847 public charging poles as a result of the Green Deal.

In the Netherlands, fiscal stimulus is the main driver of the rise in electric vehicles. Because the focus is on promoting zero-emission vehicles, tax incentives for plug-in hybrids will be gradually decreased to the same level as those for normal vehicles. Until 2021, the package will remain mostly unchanged. The incentives that were in existence in 2018 are summarized in the following table.

Policy Major	Details
Registration Tax	Vehicles with zero emissions are exempt from paying registration fees. The scheme for normal cars is progressive, with a starting tariff and five tiers of CO_2 emissions and registration tax amounts. In comparison to normal cars, plug-in hybrids receive a discount, do not have a starting tariff, and have three levels of CO_2 emissions and registration tax.
Road Tax	Road tax is not required for zero-emission vehicles. Plug-in hybrid automobiles emitting less than 51 grams of CO_2 per kilometer pay half the rate (up to 2020). This tax ranges from 400 to 1,200 euros for ordinary vehicles (depending on fuel, weight, and address).
Surcharge on income tax for the private use of company cars	The private use of a business car in the Netherlands is subject to income tax. This is accomplished by levying a fee on taxable income of 4 or 22 percent of the catalog value. This amount is 4% for zero-emission vehicles. It is 22% for all other vehicles, including plug-in hybrids.
Tax-deductible investments	The Netherlands has a framework in place to encourage clean technology expenditures by allowing these investments to be partially deducted from company and income taxes. zero-emission and plug-in hybrid cars emitting less than 31 grams of CO_2 per kilometer (no diesel engine) are deductible investments, as are charging stations.

Table 1. Fiscal incentives in the Netherlands in 2018 (2019 HEV TCP Report).

IV. Market Developments

Electric buses were added to the public transportation fleets of several provinces and municipalities in 2018. The world's largest electric bus fleet operates in and around Schiphol Airport, where Connexxion, Transport Region Amsterdam, and Schiphol put 100 electrics articulated VDL Citea SLFA buses into service on April 1, 2018. The buses' operational availability has been increased thanks to a new rapid charging design that includes 23 Heliox rapid chargers (450 kW) and 84 Heliox depot chargers (30 kW). In 2021, the contract is expanded to include 258 zero-emission buses.

Electric buses have been ordered by the cities of Amsterdam and Rotterdam. The Ebusco 2.1 electric bus, in addition to various foreign bus brands including VDL's Citea buses, is also used in Dutch public transportation regions. The Netherlands' fast charging coverage is expanding all the time, and it's now available in more places than simply along motorways. With McDrive, Nuon will install fast chargers at all Dutch McDonald's locations, with the first 168 fast charging poles being installed in 2018. Fastned has begun a pilot program with rapid charges at Albert Heijn XL supermarkets.

V. Innovation and Research

The Formula E-Innovation Team and Acceleration Program Electric Mobility (IAP), an integral research-and-innovation program designed to improve the Netherlands' lead in electric driving, has officially begun. It is supported by a network of 200 affiliated corporations, knowledge institutes, and government agencies. Heavy-duty commercial vehicles, light electric vehicles, charging infrastructure, and the energy market are all high on the initial agenda.

The Netherlands Knowledge Platform for Public Charging Infrastructure (NKL) has published its annual cost benchmark for public charging infrastructure. The use of public charging stations is continuously increasing, with a 15% rise in 2018.

While the average cost of a new charging station is constantly decreasing, market predictions for the years 2025-2030 indicate a more gradual decline. The aim right now is to continue to expand and professionalize the sector to ensure that it can handle the predicted rise of electric transportation. According to the findings, the key focus should now be on themes like developing a consistent application method and assuring the availability of appropriate technical experts.

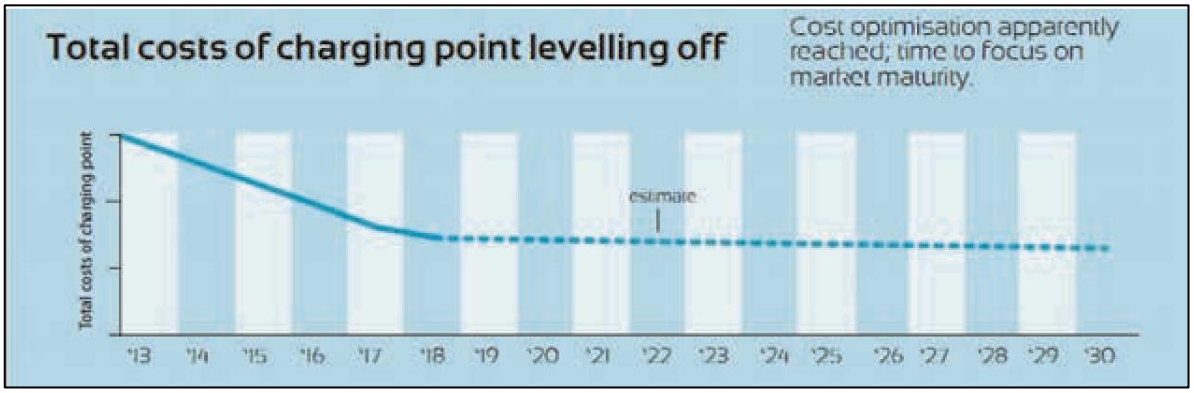


Figure 37. Cost Development of Public Charging Points (nklnederland.com).

The Smart Charging Challenge was established by the Dutch Living Lab on Smart Charging. During the 28-hour Hackathon, students and experts discussed a variety of difficulties in the realm of smart charging. It resulted in four winning perspectives on how renewable energy and electric vehicles can coexist:

1. Align employees' daily plans and activities with time windows for smart charging their cars.
2. Batteries are used to balance the energy grid and autonomous electric vehicles charged outside of the city center.
3. Speech-controlled charging, which allows the automobile to buy and sell energy when it is needed and profitable.
4. Locations for charging that are the cheapest or use the most renewable energy.

VI. EVs on the Road

In 2018, the number of Battery Electric Vehicles (BEVs) in the Netherlands increased significantly. The number of fully electric vehicles more than doubled between December 2017 and December 2018. There were 21,115 BEV passenger cars at the end of 2017, and 44,984 at the end of 2018, an increase of 113%. The fleet of electric passenger cars is rapidly becoming all-electric. BEVs accounted for 31.5 percent of all-electric passenger vehicles at the end of 2018, compared to 17.6 percent at the end of 2017. In the Netherlands, 50 Fuel Cell Electric Vehicles (FCEVs), passenger automobiles, were registered at the end of 2018, compared to 41 FCEVs at the end of 2017. At the end of 2018, the overall number of Plug-in Hybrid Electric Vehicles

(PHEVs) in the Dutch fleet had declined by 0.5 percent, to 97,702 passenger cars. New PHEVs were still being registered, but some older ones were being exported, leading to a somewhat negative fleet balance.

Fleet Totals on 31 December 2018					
Vehicle Type	**EV**	**HEV**	**PHEV**	**FCV**	**Total**
Bicycles	n.a.	n.a.	n.a.	n.a.	-22,900,000
Mopeds	32,647	n.a.	n.a.	n.a.	1,211,522
Motorbikes	608	n.a.	n.a.	n.a.	661,639
Quadricycles	1,634	n.a.	n.a.	n.a.	n.a.
Passenger vehicles	44,984	180,562	97,702	50	8,373,244
Commercial vehicles	3,196	n.a.	n.a.	n.a.	883,350
Buses	436	n.a.	n.a.	7	5,147
Trucks	92	n.a.	n.a.	2	139,656
Total without bicycle	**83,597**	**180,562**	**97,702**	**59**	**11,274,558**

Table 2. Distribution and sales of EVs, PHEVs, and HEVs in 2018 (Data source: Dutch Road Authority, edited by RVO.nl; fleet totals: CBS except for buses: CROW; 2018 new registration totals: BOVAGIRAI, Bicycles: GFKIBOVAG).

Vehicle Type	**EV**	**HEV**	**PHEV**	**FCV**	**Total**
Bicycles	409,000	n.a.	n.a.	n.a.	1,011,000
Mopeds	8,419	n.a.	n.a.	n.a.	59,791
Motorbikes	212	n.a.	n.a.	n.a.	13,104
Quadricycles	222	n.a.	n.a.	n.a.	n.a.
Passenger vehicles	25,065	28,109	4,094	14	447,367
Commercial vehicles	1,012	n.a.	n.a.	n.a.	79,171
Buses	108	n.a.	n.a.	2	n.a.
Trucks	16	n.a.	n.a.	n.a.	16,533
Totals without bicycles	**35,054**	**28,109**	**4,094**	**16**	**562,166**

Table 3. Netherland's Total Sales/Registration during 2018 (HEV TCP Report).

4.3.3. An Overview of Switzerland's Actions in the E-mobility Sector

This section's data is based on the IEA (International Energy Agency) 2019 Hybrid and Electric Vehicles Report, 2019 HEV TCP Annual Report, and the Roadmap for Electric Mobility 2022 Plan of Swiss Federal Department of Environment, Transport, Energy and Communications DETEC; Federal Office of Energy SFOE Federal and Road Office FEDRO issued in 2019.

I. Swiss Electromobility Roadmap 2022

Representatives of the automobile, electricity, property, and fleet vehicle branches and their associations, as well as representatives of the federal government, cantons, cities, and municipalities, signed a joint roadmap to promote electric mobility in December 2018 at the invitation of Federal Councilor. By 2022, the goal of the strategy is to increase the share of electric vehicles (BEVs and PHEVs) among newly registered automobiles by 15%.

More than 50 organizations and businesses from diverse sectors collaborated to develop concrete roadmap recommendations and strategies within their spheres of influence. A comprehensive generally supported package to promote electric mobility in Switzerland could be developed thanks to the strong commitment of all partners. The Electromobility Roadmap 2022 lays forth tangible actions in three main areas: successful car market development, appropriate charging infrastructure, and incentives and framework conditions. All of these areas of action will be pursued together.

Charge points in buildings, the installation of a national fast-charging network for electric vehicles, specific training and credentials for tradespeople, regulatory adaption, and rapid market expansion of the vehicles are only a few of the initiatives recommended. Synergy effects will be utilized, and the impact of the measures will be strengthened, thanks to additional coordinator measures and collaborative actions.

The roadmap's implementation began in January 2019, and it is accessible to other groups and businesses who want to help achieve the goals.

II. Tendering Procedure for Fast-Charging Points at Motorway Service Stations

In the coming years, the Federal Roads Office (FEDRO) will ensure the establishment of a dense, nationwide network of high-capacity fast-charging stations across the whole national road network. From 1 January 2018, it is permissible to establish additional charging ports at eligible rest places to enhance the existing charging infrastructure at motorway service stations. To reach this goal, a tendering process to locate operators for 100 rest spots was launched in 2018 (bundled as five packages each with 20 rest areas).

FEDRO will provide the required electrical infrastructure to enable the charging stations to be set up promptly. As a result, around 160 charging stations will be available at motorway service stops and rest areas, making this network one of the densest and most powerful in Europe.

III. New Instruction Sheet on the Infrastructure in Buildings for Electric Vehicles

The Swiss Society of Engineers and Architects (SIA) develops legally obligatory standards, rules, and recommendations for the Swiss construction industry. The society published a new instruction sheet, SIA 2060, to improve the situation for electric mobility in the building sector (e.g., in apartment houses). This should ensure that electric mobility is taken into account when new buildings or renovations are being designed. The information sheet included standardized suggestions and detailed procedures for all stakeholders (engineers, architects, investors, building owners, and operators).

IV. New Fact Sheet on the Environmental Impact of Private Vehicles

A new information sheet and background study from SwissEnergy provide an overview of the environmental damage caused by today's private vehicles as well as future vehicles. The results of the life cycle evaluations show levels of greenhouse gas emissions, primary energy consumption, particulate matter pollution, and air pollution emissions, among other things. The life cycle analyses reveal a clear picture: electric vehicles are only effective in terms of climate change if the electricity used as fuel comes from a low-CO_2 source. That is currently the situation in Switzerland, where the greenhouse gas emissions of a battery-powered automobile “tanked up” with the present mix of energy are just half that of a comparable petrol-powered car.

V. EVs on the Road

For the first time in seven years, the number of new private car registrations in Switzerland fell short of 300,000 in 2018. Compared to vehicles with conventional drive systems, the number of alternative fuel vehicle registrations has hit a new high of 21,552 vehicles, accounting for 7.2% of the market (market share in 2017: 5.6 %). More than half (11,272) of these vehicles were hybrids. In addition, 9,469 electric vehicles, including plug-in hybrids, were initially introduced on the road in 2018. This represents a 12.9% increase. For the first time since 2012, e-scooter sales increased in 2018. E-scooters gained a 3.5 percent market share with 1,555 new registrations. On the one hand, the Swiss Post revitalized this market sector by replacing the first three-wheeled motorcycles (Kyburz DXP) after seven years of service. Mobility's sales development has resulted in a surge in the tiny e-motorcycle sector. For its fleet, the car-sharing firm received 200 Etrix S02s. This shows how, like in the past, independent actors now dominate the e-scooter market.

Vehicle Type	EV	HEV	PHEV	FCV	Total
Mopeds	8,965	5	0	0	n.a.
Motorbikes	1,579	n.a.	n.a.	n.a.	n.a.
Quadricycles	2,026	n.a.	n.a.	n.a.	n.a.
Passenger vehicles	18,783	72,346	14,308	36	4,622,652
Commercial vehicles	1,171	n.a.	n.a.	n.a.	n.a.
Buses	21	117	0	2	n.a
Trucks	27	22	0	1	n.a.
Totals without bicycles	**32,572**	**72,490**	**14,308**	**39**	**n.a.**

Table 4. Distribution and sales of EVs, PHEVs and HEVs in 2018 (estimated data)

Total Sales in 2018					
Vehicle Type	**EVs**	**HEVs**	**PHEVs**	**FCVs**	**Total**
Passenger Vehicles	5,110	11,272	4,359	n.a.	n.a.

Table 5. 2018 Swiss Total Sales (2019 HEV TCP Report).

VI. Charging Infrastructure or EVSE

By the end of 2018, the Swiss national database has recorded 2,323 public charging places with a total of over 5,800 charging points. In Switzerland, the private sector is primarily responsible for expanding the public charging infrastructure. Concerning the coordination and planning of this expansion, the federal government plays a supportive role. In 2018, two new projects in this area were initiated. The federal government has recognized that workplace charging is critical to accelerating electric mobility market penetration.

As a result, the Swiss e-mobility Association developed a project (charge4work) with the support of SwissEnergy to provide neutral information and consulting services to promote the installation of charging stations at the workplace and on business premises.

The Swiss Federal Office of Energy (SFOE), the Federal Office of Topography (Swisstopo), and the operators of electric mobility charging infrastructure will collaborate to create a publicly accessible database with real-time data by establishing a national electric mobility data infrastructure (DIEMO). By directly connecting the charging infrastructure operator to the federal geographic data infrastructure, a high-quality database is formed, allowing dynamic data (availability of charging stations) to be provided.

Charging Infrastructure on 31 December 2018	
Chargers	**Quantity**
AC Level 1 Chargers (up to 3.7 kW)	850
AC Level 2 Chargers (up to 22 kW)	1,248
AC Fast Chargers (up to 43 kW)	186
CHAdeMO	224
CCS	208
Tesla	26
Inductive Charging	0
Totals	**2,323**

Table 6. Swiss Charging Infrastructure, 2018 (2019HEV TCP Report).

VII. EV Demonstration Project; Electric Buses

New drive and charging systems for public suburban buses were tested in a variety of demonstration projects in 2018. The prototype of Carrosserie Hess AG's "SwissTrolley plus" was tested in daily traffic in Zurich. Unlike traditional trolleybuses, this bus is an electric bus with a large battery that is charged using the trolley wire. Similarly, regardless of the state of the network, braking energy can be recovered and sent to the battery, and current spikes in the network can be smoothed out. Such vehicles have already been ordered by some cities, notably Bern (Switzerland) and Salzburg (Austria).

4.4. A PROPOSAL FOR THE ELECTRIFICATION OF THE TRANSPORTATION FLEET AS THE RESULT OF THE COMPARISON BETWEEN AMSTERDAM AND ZURICH

As the main result of the analysis of the two case studies, the electrification of the entire transportation fleet will be discussed in terms of intervention needs in the urban environments to allow the development of such a mobility model. the approach looks at the electrification of all vehicles' categories: individual cars, shared mobility vehicles, and public transportation systems.

In shared mobility, a city needs to bike, e-scooters, electric shared cars, and full electric taxis while, in the public transportation aspect, a city requires electric buses, electric metro wagons, electric trams, and electric passenger ferries. Meanwhile, local policymakers should improve the number of electric private cars thanks to a national/state plan. governments at all levels must support the stages of the conversion with incentives, regulations, and supporting policy. This proposal includes encouraging individuals to purchase electric vehicles by providing tax exemptions and low-interest long-term loans, as well as encouraging enterprises that manufacture or provide associated services to electric vehicles by lowering taxes and providing other monetary/social incentives.

Improvement of charging infrastructure, EV chargers at homes, fast and smart charging, charging stations at the workplace, McDonald's and on business premises, creating limited traffic zones and free parking areas for EV, and other innovative concepts are all on the table. in this among, issue of market conditions is precious to mention; increasing the availability of charging infrastructure is critical for the growing market, as more private and public charging is key to making electric vehicles as convenient as conventional vehicles (Hall and Lutsey, 2020).

Here, the key implemented plans in each case study are highlighted following the discussion in the last stage, which identifies the strengths and weaknesses of each city in the field.

4.4.1. Zürich (Swiss) Plan Overview

In Switzerland, the private sector is primarily responsible for expanding the public charging infrastructure. Concerning the coordination and planning of this expansion, the federal government plays a supportive role.

The e-mobility improvement plans in Zürich (Switzerland) cover these items, a successful car market development, appropriate charging infrastructure, incentives, and framework conditions. Fast-Charging Points at Motorway Service Stations, an instruction to improve the situation for electric mobility in the building sector, new drive and charging systems for public suburban buses, and creating a national database for electric mobility infrastructure (strengths). but these issued policies don't cover these necessities; a comprehensive plan for increasing bikes, e-scooters and in a general aspect, it doesn't plan for improving the entire electrized multimodal transportation systems (weakness).

4.4.2. Amsterdam (the Netherlands) Plan Overview

The Formula E-Team of the Dutch Government is a public-private platform that promotes e-mobility and accelerates the transition to electric vehicles, brings together corporations, social institutions, academic institutions, and the government. It covers a plan for increasing the electric taxis, buses, passenger cars, and e-scooters.

The planned initiatives are stimulation of the financial and fiscal systems, national infrastructure charging agenda, private-sector, and local-government support measures. In addition, creative housing developments and acquire experience. The national government has allocated a total of 7.2 million euros as part of the Green Deal on Publicly Accessible Charging Infrastructure to help municipalities establish public charging outlets. The incentives are Registration Tax, Road Tax, Surcharge on income tax for the private use of company cars, Tax-deductible investments.

The Netherlands faces a huge market development on electric buses. The Formula E-Innovation Team's and Acceleration Program Electric Mobility (IAP), an integral research-and-innovation program designed to improve the Netherlands' lead in electric driving, has officially begun. It is supported by a network of 200 affiliated corporations, knowledge institutes, and government agencies.

4.4.3. E-Mobility Consolidated Policies

Finally, as a result of the aforementioned examination of two case studies and other studies in the field of e-mobility, this section represents successfully implemented policies in two case studies in a united figure.

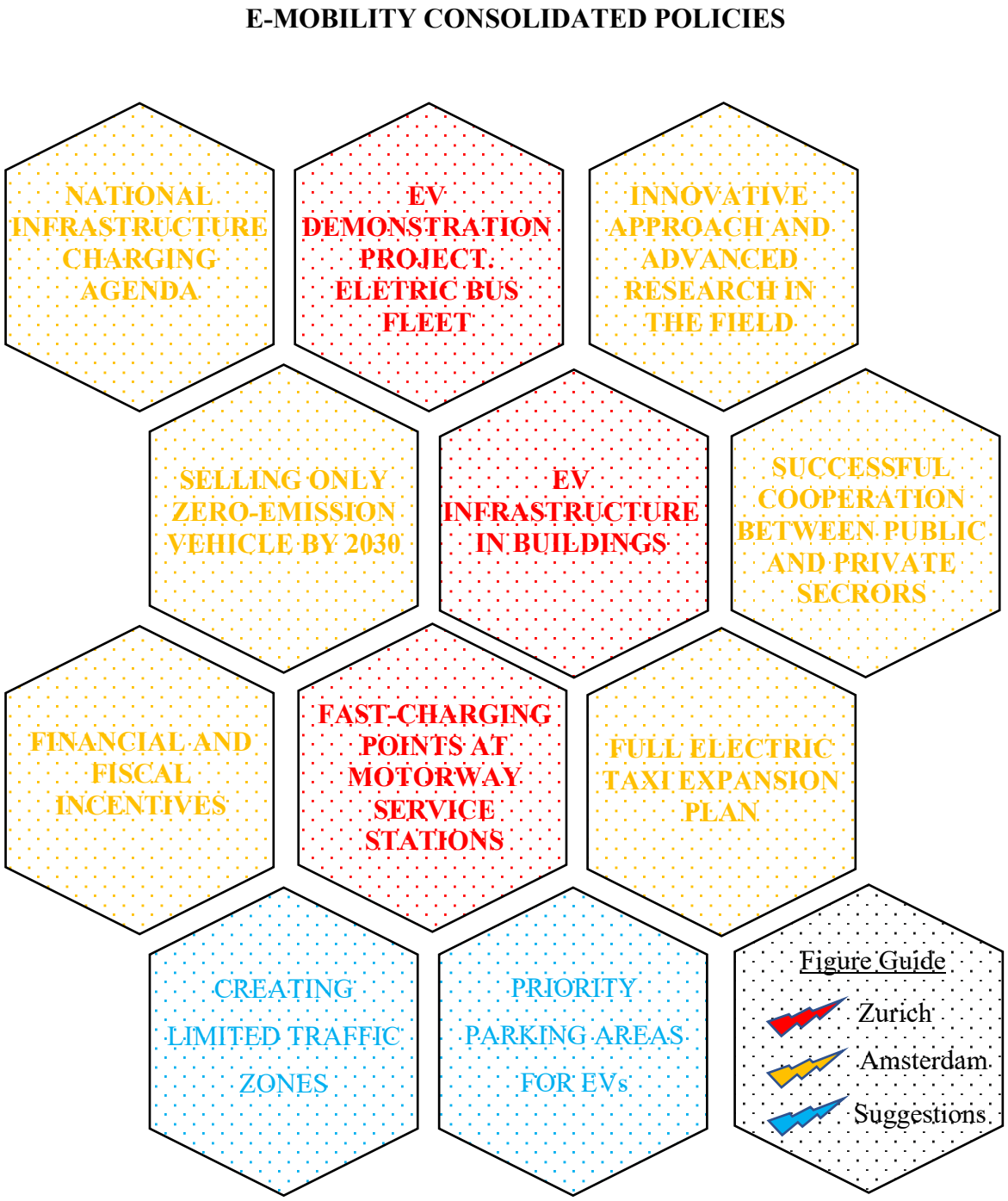


Figure 38. E-Mobility Consolidated Policies (elaboration by the author).

In the previous stage of this study, nine of the eleven policies specified in the E-Mobility Consolidated Policies Figure were discussed. This section delves into Limited Traffic Zones (Low Emission Zones), which Amsterdam is working on, but Zürich has yet to enhance. Furthermore, this study suggests improvement: the implementation of the Priority Parking for Electric Vehicles Policy, which is now being developed in Europe.

4.4.4. Low Emission Zones (LEZs)

The information of this part is based on the Renault Group Report (2020) “Electric Mobility; Low Emission Zones in Europe”.

Only the least polluting cars are allowed on the road in Low Emission Zones (LEZs). The goal of these zones is to reduce air pollution in urban areas. The concept is gaining traction among local governments: ten European countries have already enforced this form of "greener" space.

Low-emission zones are urban areas where only the cleanest automobiles are permitted to drive. The public authority determines the criteria for entering certain places depending on the cars' age and technical specifications. Older engines and cars without anti-pollution filters are generally disallowed. Because of the daily telemetry of air pollution, the benefit of LEZs can be quantified in terms of public health. The establishment of a restriction on high-emission vehicles reduces fine particle emissions and greenhouse gas emissions, therefore the fewer of these vehicles on city streets, the lower the environmental impact. Drivers that violate the driving restrictions in Low Emission Zones are typically fined. Special stickers (placed on a visible part of the dashboard) or cameras (connected to vehicle registration databases) are used in several countries to verify if a vehicle has the necessary certification to drive in these zones.

Eco-Districts, which encourage the use of soft transportation, are included in several Low Emission Zones. Certain European countries that are at the forefront of electric mobility have taken further steps to make their cities more ecologically friendly. This is a logical step toward the creation of smart cities, which are futuristic conurbations where energy efficiency, automated traffic flow management, and data collecting improve residents' living conditions and reduce the neighborhood's environmental effect.

4.4.5. Priority Parking for EVs

The information of this part is based on the Priority Parking for Hybrid and Electric Vehicles Report by Kyler Massner (2018).

Local governments can remove obstacles, offer incentives, or impose regulations to encourage the use of electric vehicles. Citizens may be encouraged to use EVs by incentives such as free or discounted parking, or restrictions such as priority parking minimums.

Part of the reason for the lack of EV infrastructure is because of obstacles embedded into the development code. one such stumbling block is the misclassification of EV infrastructure. Electric charging stations are often lumped in with standard gas stations in local legislation. As a result of this classification, EV charging stations must have the same amenities and safety features as standard petrol stations. Furthermore, their classification precludes them from many of the zoning areas where they would be most useful. Local governments may remove barriers to investment and improve the availability of EV infrastructure by appropriately categorizing and designating EV infrastructure as distinct from typical gas stations.

Local governments may also consider implementing priority parking programs or enforcing a minimum number of priority parking slots to encourage the use of electric vehicles. Priority parking schemes are adaptable and can make use of existing parking infrastructure at little or no cost to local governments. Non-monetary and monetary incentives are also possible. Non-monetary incentives include things like parking near entrances, while monetary incentives include things like subsidized or free parking for electric vehicle owners. Regulations like these can specify how much parking must be set aside for electric vehicles and/or how many electric charging stations must be established.

4.5. Analysis of the Use of Transportation Fleet Monitoring and Controlling Application

A digital platform (available via mobile apps) can serve as a multimodal route planner, recommending combinations of multiple modes of transportation (Public Transportation and Shared Mobility Vehicles), as well as a booking system, easy payment, and real-time information.

Another aspect that could be addressed in these types of Apps, according to this study, is the assessment of air pollution-related to the use of each vehicle in comparison to other accessible possibilities. This is especially true when it comes to the utilization of low-emission vehicles and electric vehicles rather than normal vehicles. This feature can raise user knowledge of the pollution caused by their decision to rent a low-emission vehicle or an electric vehicle, as well as provide them with a discount to use these vehicles instead of traditional ones, such as by giving them more credits in the App.

A large range of transportation modes must be available to have a suitable App, and the majority of transportation operators must be willing to transfer their data to a third party, allow that third party to market their service, and accept e-payment to utilize their service.

This research mentions some of the keywords related to the App:

- ICT integration: a single app can be used to access real-time information about all the modes.

- Payment integration: all modes are billed to a single account.
- Counting commutes: the average amount of time/distance spent traveling by various forms of transportation. The findings may aid decision-makers in expanding the use of shared mobility vehicles. It assists in identifying users' preferred zones for renting bikes, scooters, and shared automobiles, as well as determining which locations require additional charging stations (in which area the requests for EVs rent are higher).
- Pollution index: the difference in CO_2 emissions from driving an electric vehicle vs a typical car. a mobile app that tracks and informs users about their exposure to air pollution (PPI). This program combines pollution data with location and rented vehicle recognition, as well as the user's physiological state (e.g., age, gender, health conditions). This type of

app could be a terrific tool for citizen research and community engagement in public health protection in the future.

The study reports on the present state of transportation Apps in the case studies in the following part. These two cities offer some transportation apps, but they do not cover the complete fleet; they are primarily designed for public vehicles and do not include shared mobility vehicles such as bikes, scooters, or shared cars.

Amsterdam Transportation App

The official app from the GVB – Amsterdam's primary public transport operator – covers the data related to the city's tram bus, tram, and metro lines. Some features of the App are up to date information on detours and disruptions, See the difference in CO_2 emissions from travel by public transport compared to an average car, covers bus, tram, metro, train, and ferry, Real-time departure, and arrival information, Save the favorite trips to easily access frequent routes.

Zürich Transportation App

ZVV app – the smart companion for traveling with public transport. It shows the fastest connections throughout Switzerland and helps to find the right ticket with just a few taps. ZVV and Z-Pass travelcards and multiple tickets can also be purchased directly in the app. short overview of the App; direct access to real-time connection searches and a map of the area with the next departures, Smart journey planner with personalized connection suggestions, Overview of all status updates affecting the ZVV network, Easy and secure payment.

4.6. AN OPERATIONAL POLICY

In this step, based on the lessons learned from the studies of Amsterdam (the Netherlands) and Zurich (Switzerland), this dissertation recommends forming a unified organization to implement all related policies for the transition to an EV transportation fleet: "*Organizing an EV Executive Management Team".*

This organization could be a public-private platform that promotes e-mobility and accelerates the transition to electric vehicles, brings together corporations, social institutions, academic institutions, and the government.

This synthetic team could be based on an organizational structure with some departments that are interconnected.

The funding, department structure, and staff are determined by the state or country in charge of the EV initiatives, but the main policy is that this team should be a partnership between the public and private entities.

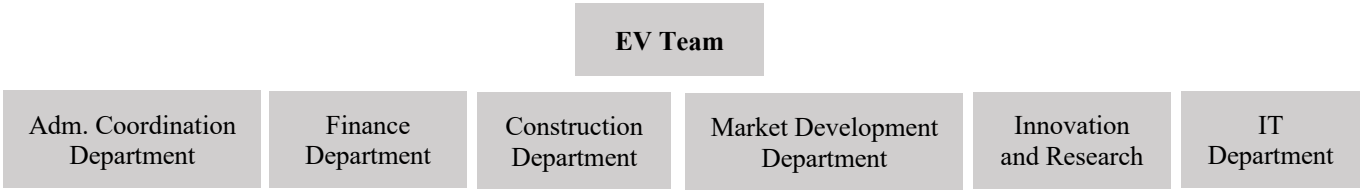


Figure 39. EV team organizational structure (elaboration by the author).

Explanation of the departments is as follows:

Finance Department: this department is in charge of obtaining funds for the team, managing funds within the team, and budgeting for various assets.

The primary core of a budget is a national or state budget. Some unique government incentives encourage private parties to invest. This department will work on the necessary budget of incentives for residents, businesses that provide EV services, as well as EV projects that cover all infrastructure improvements in streets, buildings, and roadways. The following are some of the most important activities to include:

- Exempting zero-emission vehicles from purchase tax and (national) road tax.
- Allocating a purchase subsidy to private customers
- Considering a lower income tax levy for company cars that are working in the EVs segment compared to normal vehicle companies.

Administration and Coordination Department: This department is responsible for the coordination of all public authorities participating in the transit of electric vehicles in a city or urban area. Also, it can help project organizers understand the rules and regulations that apply to EV projects.
Some duties are:

- Developing the activities for transition together by municipalities, provinces, the federal government, and sectoral groups.
- Perform the agreements between parties that lead to the coverage of national (quick) charging infrastructure for the growing number of electric vehicles. Themes covered in the agreements include charging infrastructure acceleration, open protocols and price transparency, smart grids, innovation, and logistics charging infrastructure.

Construction Department: it arranges for the provision of services, construction work, material support, equipment provision, and manufacturing. This department has the authority to carry out the following tasks:

- Make a construction schedule (collecting data, resource allocation, execution, etc.)
- Communication measures, battery inspection, and guarantee for used automobiles, e-leasing, e-car sharing, and e-scooters.
- Manage to use the batteries to balance the energy grid and autonomous electric vehicles charged outside of the city center.
- Finding the locations for charging that are the cheapest or use the most renewable energy.
- Speech-controlled charging, which allows the automobile to buy and sell energy when it is needed and profitable.

Innovation and Research Department: it establishes a data network of allied companies, research institutes, and government bodies. collecting and analyzing statistical data in the field, doing in-depth study in the field, discovering and supporting new and innovative ideas, commercial activities to motivate citizens to buy EVs, knowledge enhancement, and so on.

Market Development Department: this department's strategies are based on a growth plan for EVs and EV infrastructures that discovers and develops new market niches. It can take some measures to encourage individuals and businesses to increase the electric vehicle market by installing charge points in buildings, offices, quick and smart charging, workplace charging stations, McDonald's charging stations, and on corporate premises.

IT Department: it might be a data center that collects all of the commuting data for the entire fleet of vehicles. It can also calculate the associated emissions for each travel. As a result, a digital platform accessible via mobile apps can be built (As stated in the previous section).

CONCLUSIONS

This dissertation has argued the urbanization phenomenon and growth of climate temperature come from inexplicable emission of green gases in recent decades. To address mentioned issues, among all the possible solutions, “Innovative Transportation” which promises green transportation has been attracting attention and becomes a cornerstone of the smart mobility scenario. For such a solution to flourish, adopting solutions that are user-centric, easily accessible, convenient enough, cost-effective, and capable of reaching all groups of people in cities, as well as following significant sustainability trends is necessary. M-a-a-S, Multimodal Transportation Systems (Public Transportation Systems + Shared Mobility), and a new paradigm of Electric Mobility are examples explored in this paper.

This work explored how the comprehensive national plan for the “Electrification of Transpiration Fleet” could be vital. In doing so, this thesis studies the related implemented plans in Amsterdam (the Netherlands) and Zurich (Switzerland). The current research revises the ways in which these case studies have worked on this fleet transition. The Dutch governments created a public-private platform that promotes e-mobility and accelerates the transition to electric vehicles, bringing together corporations, social institutions, academic institutions. Their strategy of providing incentives to buy electric vehicles is based on 4 major policies: Registration tax, road tax, tax-deductible investments, and surcharge on income tax for the private use of company cars were the primary policy incentives. As result, the city of Amsterdam is on the top of the EV ranking.

In Switzerland, the private sector is primarily responsible for expanding the public charging infrastructure. Concerning the coordination and planning of this expansion, the federal government plays a supportive role.

Consequently, EV sales climbed significantly in 2018, with 562,166 vehicles sold at the end of the year, bringing the total number of EVs in the fleet to 111,274,558. At the same period, without a government-sponsored incentive, the total number of electric vehicles sold in Switzerland was around 120,000.

Moreover, the current study can provide some general advice. The following are some suggestions:

– Attempt to do "electrification of the entire transportation fleet" in a seamless manner, ideally at the same time. replace electric buses, trams, and metro carriages, as well as e-scooters, e-bikes, and electric shared automobiles when a fully electric taxi expansion plan is being explored.

– Working on Innovative Approach and Advanced Research in the Field. The creation of an innovation-and-research body can form a network of several knowledge institutes. Collecting and analyzing statistical data, doing in-depth study in the field, discovering and supporting new and innovative ideas, commercial activities to motivate citizens to buy EVs, knowledge enhancement, and so on.

– Improve the infrastructures in both public and private (buildings, firms, offices, etc.) areas. For instance, EV Infrastructure in Buildings and Fast-Charging Points at Motorway Service Stations (the policies performed in the case studies).

– Creating Limited Traffic Zones.

– Priority Parking Areas for EVs.

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