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Understanding Sustainable Urban Mobility: Exploring the New Ways of Mobilities. Case study of Padova.

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Abstract

This thesis undertakes a comprehensive exploration of sustainable mobility in contemporary urban contexts. Drawing on the mobilities turn in the social sciences and the concept of mobility justice, this research seeks to reveal the multifaceted nature of sustainable mobility in the context of environmental sustainability within the urban transport sector. The research begins by analyzing the notion of sustainable urban mobility within the broader discourse of mobility studies. It examines the evolving understanding of mobility, covering the transformative approaches that have emerged in response to the complex demands of urbanization. Italy, as the setting for this study, provides a unique context for inquiry into urbanization and sustainable mobility. The study provides insights into the state of urbanization and sustainability in Italy, highlighting the unique challenges and opportunities presented by the country's urban landscape. For the case study of Padova, the transport landscape and the diverse transportation solutions available in the city, including public transit, bicycle infrastructure, pedestrian networks, and emerging mobility technologies are explained. The study also examines the city's sustainable urban mobility plans, assessing their effectiveness in promoting sustainability in the urban context. This work therefore contributes to the understanding of sustainable urban mobility using Padova as a lens to explore the complexities and possibilities of urban mobilities.

Keywords: SUMP, sustainable urban mobility, smart city, MaaS, cycling

Extensive Summary in Italian

In un mondo in rapida urbanizzazione, le città, cuori pulsanti dell'attività umana ed epicentro degli spostamenti, affrontano sfide significative legate all'urgente necessità dello sviluppo di una mobilità urbana sostenibile. Crescenti problematiche sociali, ambientali e climatiche, unite ad una scarsità sempre maggiore delle risorse, accompagnano l'evoluzione del paesaggio urbano. Si pone quindi una domanda cruciale: come conciliare l'espansione urbana con l'imperativo della sfida climatica?

Basandosi sul "mobilities turn" nelle scienze sociali e sul concetto di "mobility justice", la dissertazione affronta il tema della mobilità urbana sostenibile nell'ottica di ridurre l'impatto ambientale dei trasporti urbani.

Considerando gli approcci trasformativi emersi per le esigenze dell'urbanizzazione, si trattano successivamente i recenti sviluppi dei modelli di mobilità.

Approfondendo l'indagine, si contestualizza quindi la teoria nel panorama italiano, esplorando le svariate sfaccettature della mobilità sostenibile ed evidenziando le sfide e le opportunità del paesaggio urbano del Paese.

Si arriva dunque ad un'analisi dettagliata del caso di studio di Padova, di cui vengono valutati i modelli di mobilità urbana sostenibile, indagandone l'efficacia in relazione alle soluzioni di trasporto disponibili (tra cui il trasporto pubblico, le reti ciclo-pedonali e le tecnologie emergenti).

La ricerca si concentra infatti sul Piano Urbano della Mobilità Sostenibile (PUMS) di Padova, analizzandone strategie e azioni per valutarne l'allineamento con i principi della sostenibilità. Dal quadro ottenuto, si evince la coerenza del PUMS rispetto agli obiettivi di sostenibilità ambientale, ma se ne riconosce l'inefficacia rispetto a mobilità integrata, sostenibilità economica ed equità sociale.

In definitiva, questa tesi si propone di evidenziare come la mobilità urbana sostenibile e i PUMS, rivoluzionando i paradigmi degli spostamenti urbani, possano essere una risposta alla sfida pressante che riguarda la transizione delle città verso modelli più sostenibili, per trasformarsi in comunità più resilienti, accessibili e connesse.

INTRODUCTION

In a world characterized by ever-expanding urban landscapes, cities have become the centers of mobility and human activity. Increased urbanization over the years has changed the very fabric of our societies, shaping the way we live, work, interact, and, of course, the way we move. As urban areas transform, significant challenges appear on the horizon - and an important concept emerges: sustainable urban mobility.

The relentless march of climate change. Vehicle emissions, infrastructure strain, and natural resource exhaustion are all consequences of the urbanization boom. It's a dilemma that forces us to face an urgent question: How can we reconcile the dynamics of urban growth with the imperative of climate action?

In this journey through the urban jungle, we find ourselves at a critical juncture where the fate of our cities and the planet are intertwined. Sustainable urban mobility is proposed as a way forward to a greener, more livable future. It is a multifaceted concept that challenges us to rethink how we move within and around cities, addressing not only transportation but also broader urbanization issues.

Urbanization challenges in today's world

The rate of urbanization has accelerated in recent years and is expected to increase even further in the coming years. This rapid urbanization presents both opportunities and challenges. Cities offer economic opportunity, cultural diversity, and access to essential services. They are centers of innovation and creativity. Yet they are also places of environmental degradation, social inequality, and resource scarcity. As the world becomes more urbanized, cities must find ways to adapt and transform to accommodate the influx of people and the increased demands on urban infrastructure and resources.

One of the most pressing challenges facing cities is transportation. The traditional urban mobility model, which relies heavily on private vehicles, contributes significantly to traffic congestion, air pollution, and carbon emissions. It also consumes vast amounts of urban land for road infrastructure and parking, limiting green space and exacerbating environmental problems.

At the center of this challenge stands the climate crisis. The undeniable impacts of climate change in cities show that current urbanization trends and mobility patterns are unsustainable. Greenhouse gas emissions from the transportation sector are considered one of the main causes of global warming. The burning of fossil fuels in cars, trucks, and public transportation is responsible for a significant portion of the carbon emissions that trap heat in the atmosphere, leading to rising global temperatures and all the associated consequences - extreme weather events, sea level rise, and disruption of ecosystems.

The urgency of addressing climate change has never been more evident. The Intergovernmental Panel on Climate Change (IPCC) has issued dire warnings about the consequences of global warming. As cities continue to expand, the transportation sector's contribution to emissions is becoming increasingly alarming, making the need for sustainable urban mobility strategies even more critical.

Sustainable urban mobility as a solution

Sustainable urban mobility is not just a snappy term; it is a holistic approach that aims to revolutionize how we move around our cities. It encompasses a wide range of strategies, policies, and technologies aimed at making urban transportation more environmentally friendly, socially equitable, and economically viable. At its core, it responds to the challenges confronting urban environments and, more broadly, the climate crisis.

Sustainable urban mobility planning envisions a future where cities prioritize walking, cycling, and public transport over individual car use. It promotes the development of efficient and accessible public transportation systems and the creation of pedestrian-friendly streets and bike lanes. It seeks to reduce the environmental footprint of transportation by transitioning to clean energy sources, electric vehicles, and more efficient infrastructure.

Moreover, sustainable urban mobility is not only about transportation modes but also urban planning. It encourages the creation of compact, mixed-use, well-connected urban environments that reduce the need for long commutes and foster vibrant, self-sustaining communities.

The Intersection of Urbanization, Mobility, and Sustainability

In the search for sustainable urban mobility solutions, we face a complex web of interconnected challenges. Urbanization, mobility, and sustainability are inextricably linked, and addressing one requires addressing all. Urbanization patterns shape the demand for mobility solutions, which, in turn, influence climate outcomes, that affect the sustainability of the actions.

Sustainable urban mobility isn't just about finding alternative modes of transportation; it's about reimagining the city itself. It is about shifting the mindset of people to alter the traditional understanding of mobilities. It is about creating a city where there is equity of access. It requires urban planners, policy makers and citizens to work together to create cities that are efficient, equitable and environmentally responsible. As cities expand and transform, we have a unique opportunity to shape them into sustainable, resilient, and vibrant spaces by putting our collective efforts into creating them.

Sustainable urban mobility is an opportunity to reconcile the dynamics of urban growth with the imperative of climate action. It is a pathway to cleaner, more efficient and more inclusive cities.

In the following chapters, we will delve deeper into the multifaceted world of sustainable urban mobility. We will explore the strategies, innovations, and policies that are driving change in our cities. We will also discuss the role of individuals, communities, and governments in shaping the future of urban mobility.

A Comprehensive Analysis of Padova's Sustainable Urban Mobility Plan

Urbanization is a global phenomenon that cannot be ignored. Against the backdrop of this urbanization surge, cities worldwide grapple with redefining their mobility systems to harmonize progress with climate action. This thesis aims to understand the challenges of urbanization by focusing on Padova, a northern Italian city, and examining the city's efforts to create a sustainable urban mobility plan. Before delving into the case study, this work explains the concept of sustainable urban mobility.

Sustainable Urban Mobility Initiatives: A Global Perspective

In various parts of the world, cities have implemented diverse initiatives towards sustainable urban mobility. Urban areas are rethinking their mobility systems by implementing innovative smart city projects and promoting active mobility and micromobility solutions. Cities such as Copenhagen, Amsterdam, and Singapore have set the bar high with exemplary sustainable urban mobility initiatives, demonstrating the feasibility and impact of such strategies.

The legal framework and historical background of sustainable urban mobility in the European context also play a significant role. Sustainable urban mobility policy has been a priority for Europe for several years. White papers, conferences, and policy initiatives have laid the groundwork for a comprehensive legal framework aimed at promoting sustainable urban mobility. The European Union's goal of reducing greenhouse gas emissions has prompted numerous initiatives, including the development of Sustainable Urban Mobility Plans (SUMPs). These Sustainable Urban Mobility Plans (SUMPs) serve as strategic tools to tackle urban mobility challenges and promote sustainability goals.

Italy's Urbanization and Mobility Trends

Italy is currently dealing with its own set of urbanization issues, which have greatly impacted the nation's approach to urban mobility. The current urbanization trends, accompanied by the historical context of urban development, have shaped Italy's mobility challenges and solutions.

National policies and plans have been crucial in directing urban mobility efforts in Italy. However, the absence of a national mobility plan is a notable pitfall in the Italian case. Instead, the Italian system enables local governments to develop their own sustainable mobility plans. Recent efforts have increasingly focused on reducing emissions, improving public transport, and promoting alternatives to private car use.

Padova: An Urban Portrait

Located in the Veneto region, Padova is an Italian city rich in history and culture. Its urbanization features and mobility dynamics offer a distinctive framework for sustainable mobility planning. The

compact, historical city center of Padova, together with its expanding suburbs, creates unique mobility challenges that need to be addressed diligently.

The Sustainable Urban Mobility Plan (SUMP) of Padova

The research focuses on the Sustainable Urban Mobility Plan (SUMP) of Padova, which outlines the city's vision for a greener, more accessible, and efficient transport system. The plan includes several strategic measures aimed at reducing traffic and emissions and improving residents' quality of life. The SUMP of Padova presents a range of actions targeting different aspects of mobility. From promoting public transportation to developing cycling infrastructure and enhancing urban green spaces, these actions demonstrate a comprehensive approach to transforming urban mobility.

Nonetheless, to grasp the sustainability initiatives in Padova, a critical analysis of SUMP of Padova is presented through the lens of three essential concepts for achieving sustainable urban mobility. The evaluation examines the effectiveness of Padova's plan in promoting environmental sustainability, social equity, and economic viability.

Significance of the study

In the face of escalating urbanization challenges and the imminent climate crisis, the choices we make today regarding sustainable urban mobility, in medium sized cities like Padova resonate far in scope both in size and temporality. This study is not only an investigation into Padova's efforts, but also a contribution to the global dialogue on urban mobility, looking at local efforts to create a just, sustainable, and equitable urban environment. By analyzing Padova's experiences, obstacles, and solutions, we can gain crucial insights and lessons that extend beyond borders and offer inspiration to cities with similar characteristics to Padova.

This research is a testament to the important role that cities have in the shaping of our world's future. The choices made in Padova, and similar urban centers will determine whether the urban landscape of the 21st century will be regarded as one characterized by sustainability, resilience, and prosperity. Other international regions can watch and learn from the successes and failures of cities like Padova as they lead the way to a more sustainable urban future.

However, the challenge of doing so remains on the agenda: Is Padova's experience capable of leading the way for cities worldwide to grab this opportunity? To understand, the research question of this thesis poses as to what extent does Padova's SUMP align with the principles of sustainability, and how effectively does it address the specific urban mobility challenges in the city?

To address these questions, we started to analyze the existing literature on this topic. This research comprehensively examines existing literature to provide a nuanced understanding of sustainable urban mobility. The analysis is grounded in a crucial shift in scholarly perspective, referred to as the "mobility turn" in the social sciences. This shift recognizes that mobility is more than just physical movement; it's a complex phenomenon intricately linked to social, economic, and environmental dynamics. Scholars who have adopted the mobility turn have highlighted how mobility is connected to broader societal structures, leading to a more holistic understanding of urban movement.

Mimi Sheller's concept of "mobility justice" serves as a vital framework for evaluating how mobility affects diverse communities. Sheller's research underscores the uneven dispersion of mobility advantages and disadvantages, emphasizing the need for an inclusive approach that ensures equitable access to transportation resources. Understanding mobility justice is essential for evaluating urban mobility plans' effectiveness.

David Banister's presentation on sustainable mobility paradigms emphasizes the evolving nature of comprehending transportation planning and sustainable urban mobility. The shift from a focus on technological solutions to a more holistic viewpoint highlights the increasing complexity of urban mobility challenges. Similarly, Erling Holden also recognizes the complexity of planning for sustainable mobility and identifies the necessary elements for achieving it. These identified elements assist in evaluating the presented case study.

This study investigates Padova's SUMP and consolidates the varied publications on the topic. The mobility turn and mobility justice establish a conceptual framework, and Banister's theories offer viewpoints to assess the city's initiatives. Through an interdisciplinary perspective, this study aims to evaluate Padova's SUMP against theoretical ideals while also contributing to the ongoing discourse on sustainable urban mobility.

In the subsequent chapters, the inquiry unfolds as we explore the historical context of sustainable urban mobility, examine new paradigms in mobility, scrutinize urbanization trends in Italy, delve into Padova's unique urban characteristics, and critically analyze the city's SUMP. Each chapter presents

a progressive approach toward comprehensively understanding theoretical foundations, empirical insights, and practical implications related to advancing sustainability in urban mobility. The text achieves this by carefully navigating through these crucial concepts.

The Research Objectives and Scope

The primary objective of this research is to conduct a comprehensive analysis of Padova's SUMP. This analysis involves a thorough examination of the plan's objectives, strategies, and actions aimed at achieving sustainable urban mobility.

The goal is to evaluate the plan's alignment with established sustainability principles and goals and assess its sustainability. This assessment includes examining environmental, social, and economic aspects of mobility in Padova. Furthermore, it seeks to uncover sustainable urban mobility solutions or aspects that may have been overlooked during the evolution of the SUMP. To achieve this, a critical examination of the plan is carried out to identify any potential mobility challenges that have not been adequately addressed.

Given positionality as a resident of Padova, as the author of this work, the work conducted seeks to provide a local perspective by considering the daily mobility experiences and challenges faced by residents. This firsthand insight is aimed at providing a valuable dimension to the analysis.

The scope of this research is centered on Padova's Sustainable Urban Mobility Plan (SUMP). It encompasses the following key elements:

SUMP of Padova and the CoMePa (Conferenza Metropolitana di Padova) area: The study focuses on an in-depth analysis of the SUMP of Padova, including its objectives, strategies and planned actions to achieve sustainable urban mobility.

Sustainability assessment: The research comprises a thorough evaluation of the actions within the SUMP against sustainability parameters, such as their environmental impact, social inclusiveness, and economic feasibility.

Thesis Statement

The study illustrates that Padova's SUMP provides a robust framework for sustainable urban mobility, with a strong emphasis on environmental sustainability. Nevertheless, achieving further alignment with economic viability and social equity, and incorporating previously sidelined solutions are necessary to ultimately contribute to a more comprehensive and effective mobility strategy for the city.

Research Design

The study's research design primarily uses qualitative methods and literature review techniques. Its objective is to thoroughly analyze and synthesize a broad range of resources, including academic articles, books, newspaper articles, municipality documents, and policy papers on the topic. Utilizing a qualitative approach, this study aims to achieve an in-depth understanding of the subject matter as well as to critically evaluate and synthesize existing knowledge related to the scope of the study.

Relevant information on sustainable urban mobility practices, policies and strategies was gathered by reviewing a broad variety of academic articles from journals related to mobility, urban planning, transportation, sustainability, and other related subjects. Technical terms are explained when first used and clear structure and logical progression are emphasized throughout. Citations and footnotes are formatted consistently, and spelling, grammar, and punctuation errors are avoided. The language is formal, unbiased, and objective with a preference for precise subject-specific vocabulary. The bibliography provides theoretical insights, case studies, and empirical data that contribute to the study's theoretical framework and analysis. Furthermore, the analysis includes articles that focus on Padova's mobility landscape as well as those exploring broader urban mobility trends. Specialized books on urban mobility, sustainability, urban planning, and Padova's urban development were consulted to obtain a comprehensive understanding of the subject matter.

Newspaper articles from local and national publications provided insights into public perception, discourse, and events related to urban mobility in Padova. They also offered a real-time view of the societal context and public awareness of mobility issues.

In addition, we consulted official documents, plans, and reports released by the Municipality of Padova to grasp the objectives, strategies, and planned actions of Padova's SUMP. These documents are key primary sources for comprehending the local context and the municipality's vision for

mobility. Reports and white papers from government bodies, international organizations, and policy think tanks were reviewed to comprehend the broader policy framework and international understanding related to sustainable urban mobility planning.

Data Analysis

The collected data was subjected to a thorough analysis process. This involved a systemic categorization of the data into relevant themes and topics such as sustainable urban mobility principles, strategies, challenges, and Padova's specific mobility context. Each source was disguised to identify key concepts and findings. Following step, the distilled information from the various sources was synthesized to form a coherent narrative. The study analyzed and distinguished various findings from multiple sources, identifying correlations and patterns in the realm of sustainable urban mobility practices.

Ethical considerations have played an important role in data collection and analysis. All sources were properly cited and referenced, giving credit to the original authors and sources. The study respected intellectual property rights and adhered to the principles of academic integrity.

Limitations

It is essential to acknowledge the limitations of this methodology. The study primarily relied on existing secondary data sources, which may be subject to biases, shortcomings, or variations in quality. The research's scope was also limited to the available literature and documents, which may not comprehensively cover all aspects of sustainable urban mobility in Padova. However, there were no limitations regarding access to Italian resources despite the fact that the language used in this work is English. All Italian resources were accurately translated by the author in order to analyze the situation of sustainable urban mobility practices in Padova.

The methodology utilized a qualitative approach with a focus on content analysis and literature review to explore the SUMP of Padova. The research aimed to provide an in-depth comprehension of sustainable urban mobility practices, policies, and strategies in Padova by systematically analyzing a diverse range of resources. The findings of this study provide a foundation for a thorough examination and evaluative analysis of Padova's SUMP regarding the attainment of sustainable urban mobility.

The structure of the thesis

Chapter 1 delves into the historical roots of sustainable urban mobility, exploring the origins of the term within Banister's sustainable mobility paradigm and Sheller and Urry's new mobility paradigm. It follows a conceptual framework that discusses sustainable development, the significant role of UNEP, and major international conferences. The chapter examines the EU's endeavors to address climate change through sustainable urban mobility. It spotlights the Single European Transport Area strategy and the emergence of Sustainable Urban Mobility Plans (SUMPs). The differentiation between conventional transportation plans and the SUMPs is defined with worldwide and European examples.

Chapter 2 examines the emerging approaches to urban mobility, introducing innovative concepts such as smart cities, Mobility as a Service (MaaS), and the promotion of active travel. This section delves into the interdisciplinary characteristics of mobility and transportation studies, emphasizing the importance of the "mobility turn." The text explores the intersection of justice and transportation by examining mobility justice, with a particular focus on Mimi Sheller's concept. This chapter establishes a foundation for comprehending opportunities to achieve sustainable mobility in the future.

Chapter 3 analyzes Italy's urbanization trends, examining the legal and contextual background of urban mobility plans. It sheds light on the municipal-level importance in shaping urban areas and offers insights into strategies during the COVID period. The chapter outlines the framework of SUMPs in Italy, thus providing a comprehensive view of the sustainable mobility landscape.

Chapter 4 narrows its focus to Padova, offering a brief exploration of its geographical position and historical significance. The chapter gives an overview of the city's primary mobility project—the tram lines—along with future plans. It also provides additional insights into bus and tram networks to enhance readers' holistic understanding of Padova's urban characteristics.

Chapter 5 shifts attention to alternative modes of mobility in Padova, including cycling, walking, and micro mobility modes. The chapter outlines the initiatives, businesses, and projects that promote diversified mobility. Statistical data on the ways people move in Padova and the Veneto region further enrich this exploration.

Chapter 6 analyzes official documents from the municipality outlining Padova's SUMP. The significance of the plan is highlighted through the presentation of strategies, actions, and plans for the future. The analysis is presented through different lenses, including environmental and temporal considerations, and explores collaborative efforts with nearby municipalities.

Chapter 7 provides a thorough assessment of Padova's SUMP's sustainability. Drawing on the essential elements proposed by Holden et al., this chapter scrutinizes the actions outlined in the plan across different sections. This chapter, showcasing the observations of the reports, identifies shortcomings in the SUMP and offers a comprehensive critique.

The conclusion chapter provides a summary of the overall work. It provides a clear and concise overview, highlighting significant discoveries, consequences, and potential forthcoming steps in the field of sustainable urban mobility.

CHAPTER 1 Sustainable Urban Mobility

This chapter explains the term sustainable urban mobility and how it gained more recognition throughout the years with the ever-increasing effects of climate change, especially on cities.
Climate change has gathered widespread attention and coverage across media platforms in recent decades. The increased coverage by the media had a crucial role in ensuring that individuals recognized the gravity and urgency of the situation. According to the UN, 55% of the global population resides in urban areas. This percentage will rise significantly, reaching 68% by 2050. The forecasted trend of urbanization, which involves the move from rural to urban areas, will reach approximately 2.5 billion individuals in urban centers by 2050. Nearly 90% of this urban population growth will take place in Asia and Africa (United Nations 2018).

Furthermore, the times we live in mark a critical moment wherein the effects of climate change are no longer theoretical or distant but have materialized within our immediate surroundings. Urban areas have become focal points for experiencing these effects. Consequently, residents of urban environments are seeing firsthand the various indicators of climate change, ranging from extreme weather events and rising temperatures to increased air pollution and water scarcity to changes in sea-level rise. Moreover, authoritative sources show that this record-breaking trend will persist and be recurrent in the future (Paddison, Shveda, and Manley, 2023).

Considering all these events and developments and ever-increasing urbanization, sustainable urban mobility has emerged as a critical concept. It addresses the challenges of rapid urbanization, population growth, and increasing environmental concerns and provides solutions for the mobilities in the cities. As cities strive to become more livable, inclusive, and environmentally friendly, the need for efficient and sustainable transportation systems becomes paramount. This chapter explores the origins of the term sustainable urban mobility, the policies that have created it, and the organizations involved in its creation, followed by an explanation of the elements of sustainable urban mobility and the tools available for its implementation.

1.1 The Inception of the Term Sustainable Urban Mobility

To define sustainable mobility, we can argue that it refers to mobility systems and practices that are socially, economically, and environmentally sustainable. Sustainable mobility emphasizes the need for efficient and affordable transportation options while minimizing negative environmental and

public health impacts. The concept of sustainable mobility includes various mobilities, such as walking, cycling, public transit, and low-emission vehicles.

Recent discussions have increasingly emphasized the importance of designing transportation systems that align with environmental concerns. This focus encourages investment in the expansion of non-motorized transport infrastructure. These developments coincide with the emergence of sustainable mobility as a new paradigm. The persistent increase in motorized traffic negatively affects the environment and public health. As Balant and Lep discussed, "…While mobility has brought about positive economic and social effects, such as wealth, international collaboration, and exchange, there are also negative aspects including a high proportion of urban land used by transport, urban sprawl, congestion, traffic noise, energy use, and social and environmental problems…" (Balant and Lep 2020, 2).

The demand for implementing sustainable mobility measures arose from several factors, including excessive reliance on motorized vehicles and a heavy dependence on private cars. These circumstances can be attributed to the influence of transport planning practices observed in North America and Europe, adding to the tendency to neglect the importance of integrated transport system planning. Traditional urban mobility planning had some negative aspects, such as the extensive use of urban land for transportation, noise pollution, traffic, urban sprawl, energy consumption, and inability to adapt to crises related to energy.

Banister argues that "Sustainable mobility provides an alternative paradigm within which to investigate the complexity of cities and to strengthen the links between land use and transport" (Banister 2008,1). Excessive land use for transportation means creates problems that lead to sustainable mobility. Among the uses can be included social spaces, sports and activity areas, or spaces where kids can play. In this way, those negative impacts arising from extensive private car use, such as reduced physical activity and health, limited social interactions, and increased risk of accidents, can be lowered. Another important aspect is that these social spaces, freed from motorized traffic, promote effective active mobility for those who are able. Active mobility is the most beneficial mode of transportation in terms of health, environmental impact, economic viability, and social fairness. It aligns with the goals of creating green, healthy urban environments that enhance the quality of life and overall well-being (Balant and Lep 2020, 3). To further encourage active mobility in the daily life of urban residents, changes in traditional urban planning should be made, and sustainable urban mobility plans should be implemented.

1.2 The History of the Concept of Sustainable Mobility

The concept of sustainable mobility was mentioned for the first time in the 1992 EU Green Paper on the Impact of Transport on the Environment as a response to the growing concerns about the environmental impacts of transportation. The Green Paper recognized the need for a more holistic and integrated approach to transport planning that considers economic, social, and environmental aspects (European Commission 1992, 4).

Within the Green Paper, sustainable mobility is defined as a way to reconcile the increasing demand for mobility with the imperative to reduce the negative impacts of transport on the environment. The definition of sustainable mobility here calls for a change in the transportation systems. Following, the Green Paper mentions the importance of adopting a comprehensive and balanced approach to transportation, considering factors such as energy consumption, emissions, land use, and the overall quality of life (European Commission 1992, 5). It emphasizes the need to promote active mobilities, such as public transit, cycling, and walking, while exploring technological advancements and alternative fuels to minimize environmental harm.

"This Green Paper provides an assessment of the overall impact of transport on the environment and presents a Common strategy for 'sustainable mobility' which should enable transport to fulfil its economic and social role while containing its harmful effects on the environment" (European Commission 1992, 7).

With this mention, the 1992 EU Green Paper on the Impact of Transport on the Environment laid the foundation for sustainable mobility by recognizing the need to integrate environmental considerations into transportation planning and promoting a more sustainable and environmentally friendly approach to mobility. Even though the concept of sustainable mobility was first noted thoroughly in the 1992 EU Green Paper, there were also attempts to create more environmentally friendly transport plans by countries' planning styles. In the past six decades, some European countries have started the development of innovative policies regarding transportation and land use. Particularly Sweden, Germany, and France took the lead in these policies. According to R. Hickman et al., these countries demonstrated remarkable foresight by anticipating the principles of sustainable urbanism that are still relevant today (Hickman, Hall, and Banister 2013, 211). For instance, Stockholm made a bold decision in its 1952 General Plan to grow by establishing a new system called the Tunnelbana—the planning process aimed to integrate urban planning with transportation infrastructure investment.

Paris also adopted a similar approach to Stockholm in 1965 and worked on connecting the city through a new express rail system called the RER (Résau Express Régional). The RER extended well beyond the historic city of Paris, serving more distantly spaced station stops than the older Métro system, enabling higher speeds and interchangeability at key stops. When we look at Germany, we can see a different strategy than Sweden and France with the development of S-Bahn networks. The characteristic differentiating Germany from the others can be explained by the S-Bahn extending far beyond the city, up to 30-40 km into open countryside, reaching smaller towns and villages and connecting them to the city's extended commuter orbit. Similar systems were implemented in Vienna, Zürich, and Copenhagen, providing models for connecting urban centers with the broader region. R. Hickman et al. also points out a notable trend in many European cities during the 1990s and forward, which is the reintroduction and expansion of city tram networks. They argue that after the disappearance of the city tram in the 1950s and 1960s, exemplary cases emerged, particularly in France and Germany, with the resurgence and extension made to the surviving networks. The authors categorize these developments even earlier than the EU Green Paper on the Impact of Transport on the Environment as examples of European good practice. It can be asserted that sustainable mobility practices were already in use in different countries on different levels. The Green Paper recognized that conventional transportation systems significantly depended on fossil fuels, resulting in detrimental environmental consequences such as air pollution, traffic congestion, and other adverse impacts. Although there was no explicit mention of climate change and its adverse effects in the Green Paper, it is still considered a decisive action since it acknowledges the intricate correlation between the beneficial outcomes of transportation and its detrimental social, environmental, and health-related effects. By creating this concept of sustainable mobility, specifically in the EU context, a clear statement was made on how to counter the harmful effects of transport and plan the transport systems for a better future.

In their article *Sustainable Mobility at Thirty*, Holden, Gilpin, and Banister, published in 2019, reflect on the development and progress of sustainable mobility over the past three decades. The article explores the evolution of sustainable mobility, its achievements, challenges, and prospects. What is highlighted in their work is that sustainable mobility has emerged as a crucial response to the negative impacts of transportation on the environment, public health, and social equity. Later, it gained recognition as a paradigm that promotes more efficient, clean, and inclusive transportation systems. Later in this chapter, we will look at Banister's explanation of the sustainable mobility paradigm.

Moreover, the authors discuss various achievements in sustainable mobility, including advancements in public transit, the promotion of active transportation modes like walking and cycling, and the

integration of intelligent transport systems. They acknowledge the positive impacts of sustainable mobility on reducing greenhouse gas emissions, improving air quality, and enhancing urban livability. To describe the evolution and interpretation of sustainable mobility by varying actors, they trace the progression of sustainable mobility across six dimensions: research and policy, transport impacts and categories, scientific disciplines, methodological approach, and research questions. Based on this analysis, they categorize the mainstream understanding and interpretation of sustainable mobility into four generational phases. In the first generation of studies (1992-1993), authors called it "techno-centric," aimed at limiting the adverse environmental effects of transportation by improving the existing technology of the time. The above-mentioned Green Paper belongs to the authors' first generation of study conceptualization. The Green Paper's endorsement of exploring technological advancements and alternative fuels as a means to reduce environmental damage aligns with the categorization put forth by the authors.

Furthermore, subsequent generations (1993-2000, 2000-2010, and 2010-2018) increasingly recognized the limits of previous efforts and embraced a broader range of alternatives. Over time, sustainable mobility has evolved into a more interdisciplinary domain, incorporating insights and perspectives from various disciplines. In this context, we can see two significant paradigms: the new mobilities paradigm and the sustainable mobility paradigm.

The new mobilities paradigm (Sheller and Urry, 2006) signifies a shift in understanding mobility beyond a mere focus on transportation systems and infrastructure. It recognizes the intricate connections between social, cultural, and technological dimensions of mobilities. This broader perspective acknowledges that mobilities are not limited to physical movement but encompasses diverse societal practices and patterns. In their article, "Mobilizing the New Mobilities Paradigm," Sheller and Urry delve into the concept of the mobilities paradigm and its implications for understanding mobility patterns. They argue that traditional approaches to studying mobility have been limited because they mainly focus on transportation systems and infrastructure while overlooking the broader social, cultural, and technological aspects of mobility (Sheller and Urry 2016, 16). By introducing the new mobilities paradigm, a more comprehensive understanding of mobility arises, highlighting its intricate and interconnected nature.

Similar to the viewpoints of Holden, Gilpin, and Banister, Sheller and Urry emphasize the changing landscape of mobility studies within transportation research. They propose that the "mobilities turn" (Sheller and Urry, 2006) has significantly influenced the field of transport studies and transport planning, challenging established approaches, and fostering the development of fresh methodologies

and theories. This impact becomes particularly notable when comparing the different generations of mobility classification proposed by Holden, Gilpin, and Banister.

Similarly, the sustainable mobility paradigm emphasizes the need for environmentally and socially responsible approaches to transportation. It recognizes that mobility systems should be designed and managed to minimize negative environmental impacts and enhance social well-being. Banister explores the concept of sustainable mobility and its implications for transportation planning and policy. In his article, Sustainable Mobility Paradigm, he argues that traditional approaches to transportation have been unsustainable, leading to various negative impacts such as congestion, pollution, and social inequalities (Banister 2008, 76).
Banister introduces the sustainable mobility paradigm as a new framework that emphasizes the integration of environmental, social, and economic considerations in transportation planning. This paradigm seeks to shift away from car-dependent systems and promote more sustainable modes of transportation, including public transit, cycling, and walking. He suggests that by embracing this paradigm, policymakers and planners can create transportation systems that are environmentally friendly, socially inclusive, and economically viable.

Both the new mobilities paradigm and the sustainable mobility paradigm have enriched the study of sustainable mobility by encouraging interdisciplinary collaborations and fostering a holistic understanding of mobility issues. By incorporating insights from multiple disciplines, researchers, and practitioners can address the complex challenges associated with sustainable mobility comprehensively and effectively. While mentioning the concept of sustainable mobility and the new mobilities paradigm, it is crucial to address the distinction between sustainable mobility and sustainable urban mobility. While sustainable mobility encompasses broader considerations of transportation and mobility practices, sustainable urban mobility focuses specifically on the context of urban areas and their unique mobility challenges. For the scope of this thesis and to be able to focus more on the specific considerations and strategies related to achieving sustainable mobility in urban areas, we will now delve into sustainable urban mobility. In urban environments, the concept of sustainable mobility takes on a more nuanced form known as sustainable urban mobility.
Urban areas, also called cities or metropolitan regions, are defined as densely populated regions characterized by significant human settlement and infrastructural development (United Nations, Department of Economic and Social Affairs, Population Division (2019). World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420). New York: United Nations). These areas serve as hubs of economic, social, and cultural activities, attracting diverse populations and offering a range of opportunities and services. According to the United Nations, an urban area typically has a

minimum population threshold, ranging from a few thousand to tens of thousands of inhabitants. It is marked by a high population density compared to surrounding rural areas. Urban areas are distinguished by their built environment, including residential, commercial, industrial, and institutional zones, transportation networks, public services, and amenities (Angel et al., 2011). Urban areas vary in size and complexity, ranging from small towns to mega-cities with millions of residents. These areas are dynamic and constantly evolving, shaped by migration, economic growth, and urban planning policies.

1.3 On the way to the Sustainable Urban Mobility Plans

To trace back the evolution of Sustainable Urban Mobility Plans, we can look at the emergence of the sustainable development concept.
As a well-established concept, sustainable development has evolved through a series of international conferences and summits aimed at addressing pressing global challenges such as poverty, inequality, and environmental degradation in the late 20th century. The 1972 Conference on the Human Environment in Stockholm marked the first major international gathering focused solely on environmental issues. Experts at the conference emphasized the intrinsic connection between environment and development, recognizing that these two aspects are interconnected. Additionally, the United Nations Environmental Program (UNEP) was established as a result of the Stockholm Conference, with a mission to inspire and enable nations to improve their quality of life while safeguarding the environment for future generations.

While the Stockholm Conference was vital in promoting subsequent international agreements on issues like ocean dumping and endangered species trade, it had limitations. Environmental protection and development were seen as competing priorities and were often addressed separately, hindering effective coordination. Critics argued that the conference focused more on trade-offs between environment and development rather than fostering harmonious linkages between the two. Recognizing the need for a more integrated approach, the growing consensus was that economic development and environmental considerations should be more effectively intertwined.

In response to this need, the UN General Assembly established the World Commission on Environment and Development, also known as the Brundtland Commission, in 1983. The Commission, led by Gro Harlem Brundtland, published the landmark Brundtland Report in 1987

titled *Our Common Future* This report gave a politically significant definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The definition highlighted two crucial concepts: prioritizing the essential needs of the world's poor and recognizing the limitations imposed by technology and social organization on the environment's capacity to meet present and future needs.

The UN Conference on the Environment and Development (UNCED), also known as the Rio Earth Summit, held in Rio de Janeiro in 1992, marked a significant milestone in international efforts toward sustainable development. The summit brought together 114 heads of state and thousands of representatives from countries and non-governmental organizations, resulting in several key outcomes.

The conference's notable outputs were the Rio Declaration, Agenda 21, and the Commission on Sustainable Development. These documents explicitly emphasized the concept of sustainable development, reflecting a global commitment to address the interplay between environment and development.

Agenda 21, a comprehensive document consisting of recommended practices and advice, outlined strategies for achieving sustainable development across various domains. It recognized the need to address severe poverty, wasteful resource consumption, and environmental management in both developing and industrialized countries.

While the Rio Conference aimed to implement sustainable development, there were debates regarding its meaning and implications. The focus shifted towards developing approaches for its effective implementation, emphasizing principles of equity and ecological limits. Flexibility and integration of social, political, and economic systems were seen as essential for achieving sustainability. In 1997, the Kyoto Conference on climate change resulted in the Kyoto Protocol, where developed countries agreed to specific targets for reducing greenhouse gas emissions. However, the complex negotiations surrounding compliance and the reluctance of some countries, including the United States, to ratify the protocol created challenges in its effective implementation.

The Millennium Summit in 2000 led to the establishment of the Millennium Development Goals (MDGs). With a timeframe until 2015, these goals addressed poverty, hunger, education, gender equality, and other key development issues. The MDGs reflected the practical expression of the equilibrium between economic, social, and environmental aspects of sustainable development.

While progress has been made, challenges remain, such as the failure of some countries to reduce carbon emissions and the ongoing debates surrounding international agreements like the Kyoto Protocol. Overall, these international conferences and agreements have played a crucial role in shaping the understanding and pursuit of sustainable development, emphasizing the need for coordinated efforts to address the interconnected challenges of poverty, inequality, and environmental degradation.

It is evident that, regarding the challenges of environmental degradation, transportation planning plays a crucial role. The excessive use of land for transport planning, CO2 emission from motorized vehicles, and other negative environmental and social aspects of increased private car ownership clearly illustrated the need to shift from the understanding of traditional transport planning. The holistic perspective of the sustainable development concept influenced urban planning and transportation policies, paving the way for sustainable urban mobility initiatives.

As previously stated, throughout the 20th century, various transport planning approaches were introduced in different countries, aiming to enhance the connectivity of transportation networks. However, we can argue that these partial initiatives fall short of fully addressing the broad scope of sustainable development and sustainable mobility.

In the context of European countries' implementation of the concept of sustainable urban mobility, the European Union played a crucial role in promoting sustainable urban mobility. M. Ponti et al. argues that transport is one of the European Union's foremost common policies. (M. Ponti et al. / Case Studies on Transport Policy 1 (2013) 53–62) The EU has also recognized the importance of sustainable urban mobility in achieving its environmental, social, and economic objectives. Several key initiatives and policies have been implemented to support sustainable urban mobility within the EU.

The EU has made significant strides in promoting sustainable urban mobility throughout its history. Recognizing the significance and expansion of urban areas, and also the issues deemed from factors such as population size, density, economic factors, and traffic issues in urban areas, the EU has prioritized cities in its transport policy. To address transportation problems in urban environments, the EU Commission has adopted several key documents. Among these are the Green Paper "Towards a new culture for urban mobility" and the Action Plan on Urban Mobility and The Roadmap to a Single European Transport Area. These documents are published by the European Commission,

respectively, in the years 2007, 2009, and 2011. These documents highlight the importance of tackling transportation issues in EU cities (Brčić, Šoštarić, and Šojat 2016, 375).

The Green Paper "Towards a new culture for urban mobility" is a comprehensive analysis of urban mobility challenges, and it proposes strategies for creating sustainable and efficient transport systems in urban areas. The Green Paper emphasizes the need for a shift towards more sustainable modes of transportation, such as walking, cycling, and public transport, while reducing reliance on private cars while also exploring the role of technology, innovation, and integrated planning in promoting sustainable urban mobility. The concept of sustainable urban mobility proposed in this document acts as a point of discussion and development for effective policies and initiatives from stakeholders. Encouraging and engaging public participation in the future of urban mobility is also present in this document. Collaboration between different levels of governance, public authorities, transport operators, and civil society to achieve sustainable and inclusive urban mobility is strongly suggested.

Furthermore, the Green Paper sets out a range of policy options and measures to promote sustainable urban mobility, such as promoting low-emission vehicles, improving accessibility and connectivity, enhancing urban planning and design, and supporting research and innovation in mobility. For the research and policies, the Green Paper served as an initial point in 2007 to discuss further European urban mobility issues. It provides a strategic vision and policy framework to manage the development of sustainable urban transportation systems, which are also human-centered in the European Union.

Furthermore, in 2009, the European Commission published the "Action Plan on Urban Mobility" to outline a set of actions and initiatives to promote sustainable urban mobility across the European Union. The critical issues in urban areas include congestion, inefficiency of transport systems, and air pollution. Actions centered on six themes. The first theme is about promoting integrated policies. It is discussed that the complexity of urban transport systems, governance issues, interconnections between cities and their surrounding areas or regions, and interdependence of various transport modes needs an integrated approach. With this approach, it is noted that urban mobility policies focus not only on the development of transportation infrastructure but also include the integration of environmental, health policies, land use planning and social aspects of mobility. The actions proposed under this theme include sustainable urban mobility and regional policies and accelerating the adoption of sustainable urban mobility plans. The second theme focuses on citizens, and the actions proposed are related to passenger rights, accessibility for people with reduced mobilities, education, and campaigns for sustainable mobility initiatives in urban areas. It is stated in the report that persons with reduced mobility have the right to access urban transport on equal terms with the rest of the

population, but access often remains insufficient. The Commission aimed at taking action in this regard in the second theme. The third theme explains the greening of urban transport with actions related to electric vehicles on transport and supports stakeholders in funding policies regarding environmentally friendly transportation. In 2009, the Commission was set to provide funding for new initiatives centered on electric vehicles, concerning aspects like battery life, electric power systems, information and communication technologies, as well as projects on electromobility. The fourth theme elaborates on strengthening funds related to sustainable urban mobility. For instance, in one of the sub-actions of the fourth theme, the Commission states that they will continue to support the CIVITAS Initiative financially. The fifth theme is about experience and knowledge sharing. The actions include developing a data collection scheme to enhance sustainable mobility policies and setting up an urban mobility observatory in the form of a virtual platform to share information, data, and statistics, monitor developments, and facilitate the exchange of best practices. The sixth theme is about optimizing urban mobility. The actions exhibit interest in the integration and interconnection of diverse transport networks. The interest is on encouraging citizens to use public transport and active mobility modes and explore new ways of mobility.

Overall, the Action Plan on Urban Mobility is a strategic framework to guide European Union member states and local authorities in developing and implementing sustainable urban mobility policies and initiatives.

Additionally, in 2011, the European Commission published The Roadmap to a Single European Transport Area. This document presents a comprehensive strategy for achieving a competitive and resource-efficient transport system across the European Union. The roadmap focuses on enhancing mobility, connectivity, and sustainability within the European Union. The vision for a unified and integrated transport network through the European continent was set in the roadmap. Not only road transport but also rail, maritime, and aviation transportation.
Acknowledging that oil will become scarce in the future decades, the Commission emphasizes the importance of using clean and energy-efficient technologies for economic security and concerns over the environment. It is stated in the document that:

"At the same time, the EU has called for, and the international community agreed, on the need to drastically reduce world greenhouse gas emissions, to limit climate change below 2ºC. Overall, the EU needs to reduce emissions by 80-95% below 1990 levels by 2050, in the context of the necessary reductions of the developed countries as a group, to reach this goal. Commission analysis1 shows that while deeper cuts can be achieved in other sectors of the economy, a reduction of at least 60% of

GHGs by 2050 with respect to 1990 is required from the transport sector, which is a significant and still growing source of GHGs. By 2030, the goal for transport will be to reduce GHG emissions to around 20% below their 2008 level. Given the substantial increase in transport emissions over the past two decades, this would still put them 8% above the 1990 level." (COM 2011)

While acknowledging the achievements of the previous documents, such as strengthened cooperation within the EU and increased safety and security of all transport modes, the roadmap states that "Still, the transport system is not sustainable." It is evident that, according to the roadmap, transport policies cannot develop in the same old ways. The approach should be changed to achieve the targets.

The European Commission concedes that new mobility concepts cannot be imposed (COM 2011 P13). To encourage a new way of thinking about mobility and promoting sustainable transportation for all, they argue:

“To promote more sustainable behaviour, better mobility planning has to be actively encouraged. Information on all modes of transport, both for travel and freight, on possibilities for their combined use and on their environmental impact, will need to be widely available.
In the urban context, a mixed strategy involving land-use planning, pricing schemes, efficient public transport services and infrastructure for non-motorized modes, and charging/refueling clean vehicles is needed to reduce congestion and emissions. Cities above a specific size should be encouraged to develop Urban Mobility Plans, bringing all those elements together. Urban Mobility Plans should be fully aligned with Integrated Urban Development Plans. An EU-wide framework will be needed in order to make interurban and urban road user charging schemes interoperable." (COM 2011)

Overall, the roadmap to a Single European Transport Area serves as a strategic framework for shaping EU transport policies and initiatives. It outlines a long-term vision and sets out specific actions and targets to be achieved in the field of transportation, intending to create a more integrated, sustainable, and efficient transport system for the benefit of European citizens and businesses.

Another critical role of the European Union in fostering cooperation and sustainability in transportation networks and understanding a new mobility concept is through policy frameworks such as the Sustainable Urban Mobility Plans (SUMPs). The Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, developed within the framework of the SUMPs-Up project, defines a sustainable urban mobility plan as follows:

“A Sustainable Urban Mobility Plan is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles.” (Consult 2019)

As stated in the Urban Mobility Package, the European Commission has actively advocated for adopting sustainable urban mobility planning. It is dedicated to assisting national, regional, and local authorities in developing and implementing SUMPs. This commitment includes support through various funding mechanisms. The Urban Mobility Package includes a set of measures and initiatives promoted by the European Commission to tackle the urban mobility challenges and support the European sustainable transport area. Sustainable Urban Mobility Plans are included in the strategies European Union promotes.

The package includes initiatives such as the promotion of sustainable urban mobility plans (SUMPs), the development of intelligent transport systems, the advancement of clean and low-emission vehicles, the enhancement of public transport networks, and the implementation of innovative mobility solutions. The Urban Mobility Package seeks to support the development of integrated and sustainable urban mobility strategies across the European Union to achieve more efficient, greener, and people-centric transportation in urban areas.

It is claimed that the Sustainable Urban Mobility Plans have been a triumph in Europe, attracting numerous contributors and a wide array of cities and their citizens, reaping its benefits. It is stated that this success has been realized by robust European policy coordination and support, with the development of practical guidelines through comprehensive consultation with practitioners and the active engagement of a vibrant community dedicated to this cause. (Consult 2019)

The publication of the Urban Mobility Package marked a significant milestone, bringing increased importance to promoting Sustainable Urban Mobility Plans (SUMPs). The foundational principles and critical topics for these plans were outlined within The Urban Mobility Package. Subsequently, in 2013, the Sustainable Urban Mobility Guidelines were established to provide specific steps for implementation. Both in Europe and globally, SUMPs began to be put into action, leading to the recognition of the necessity to update the guidelines to ensure their continued relevance and effectiveness. Consequently, the recommendations for implementing a SUMP have been revised

while preserving the core concept. The second edition of the Sustainable Urban Mobility Guidelines was published in 2019.

SUMP is a comprehensive approach addressing the complexities of urban transportation effectively. Its primary aim is to enhance accessibility and quality of life by promoting sustainable mobility practices. SUMP advocates making decisions based on factual information while guided by a long-term vision for sustainable mobility. To achieve its objectives, SUMP requires a thorough assessment of the current and future transportation situation, establishing a shared vision with strategic goals that can gather broad support, and implementing an integrated set of measures involving regulations, promotions, finances, technology, and infrastructure. The progress of these measures should be continuously monitored and evaluated. Unlike traditional planning methods, SUMP significantly emphasizes engaging citizens and stakeholders, coordinating policies across various sectors such as transport, land use, environment, economic development, social policy, health, safety, and energy. It also stresses the importance of extensive collaboration between different levels of government and private entities.

Furthermore, SUMP cohesively considers all aspects of mobility, including people and goods, various transportation modes, and services. Additionally, it encourages planning for the entire functional urban area rather than focusing solely on a single municipality's administrative boundaries (Consult 2019).

The term "functional urban area" refers to a geographical area that includes a core city and its surrounding commuting zone, where a significant number of residents live and work in the vicinity of the city. It encompasses the daily commuting patterns and interactions between the central city and its surrounding suburbs or satellite towns, forming an integrated economic and social unit. In urban and regional planning, transportation, and demography studies, functional urban areas are often used to understand better the dynamics of urbanization, and commuter flows, and the interconnectedness of urban centers and their hinterlands. It is vital to specify that the definition above can change according to the different countries and contexts it is used on. Different countries may use different methodologies and criteria to delineate these areas based on factors like commuting patterns, population density, and economic ties.

1.4 The Difference Between Traditional Transport Planning and SUMPs

A sustainable urban mobility plan, and specifically a sustainable transport system, has to be based on the eight principles accorded and communicated by the Guidelines. Those eight principles, which are explained in the Guidelines, are as follows:

- Plan for sustainable mobility in the functional urban area
- Cooperate across institutional boundaries
- Involve citizens and stakeholders
- Assess current and future performance
- Define a long-term vision and a clear implementation plan
- Develop all transport modes in an integrated manner
- Arrange for monitoring and evaluation
- Assure quality

In contrast, if we investigate traditional transportation planning, the conventional approaches used in the past decades for the needs and challenges of an urban or a regional area, we can see that these principles differ significantly. The traditional approach typically focused on constructing and expanding roadways and highways to accommodate increasing vehicular traffic. The main focus given by the planners is to develop the transportation infrastructure, particularly roads and highways, to accommodate increasing traffic demands and growing mobility needs. Since the emphasis is on infrastructure and creating more roads and highways, private automobile usage has been presented as the primary choice. Insufficient integration of different modes of transportation and non-funding ways for other modes of transportation, such as cycling and walking, makes traditional transportation planning inherently car-centric. This planning mode also fails to consider the impact on sustainability and climate change concerns.

Another key aspect of traditional transportation planning is its reactive nature. It tends to respond to immediate transportation issues, such as traffic congestion, without taking a comprehensive, long-term strategic perspective. This can lead to solutions that only save the day and that do not address the root causes of problems in transportation. Furthermore, traditional planning may involve limited public and stakeholder engagement. The lack of community input can result in overlooking different population groups' diverse transportation needs and preferences.

Environmental considerations are also often given insufficient attention in traditional planning. The environmental impact of transportation projects, such as air pollution and greenhouse gas emissions, may not be adequately assessed, leading to potential negative consequences for sustainability and the overall quality of life. This approach typically relies heavily on technical engineering solutions, overlooking broader considerations, such as land use planning and policy changes, which can significantly impact transportation patterns and choices.

While traditional transportation planning has contributed to shaping transportation systems in various areas for decades, there has been a growing recognition of its limitations and shortcomings. Sustainable Urban Mobility Planning seeks to overcome these shortcomings by adopting more comprehensive and sustainable strategies. These new approaches prioritize multi-modal transportation, consider environmental impacts, involve the community in decision-making, and integrate land use and transportation planning more effectively to create more livable and sustainable urban environments.

Table 1 Differences Between Traditional Transportation Planning and SUMP

Aspect	**Traditional Transportation Planning**	**Sustainable Urban Mobility Planning (SUMP)**
Approach	Infrastructure-focused, car-centric approach	A comprehensive and multi-modal approach
Focus	Individual transportation modes in isolation	Integrated and interconnected transportation modes
Goal	Address immediate traffic demands and congestion	Achieve long-term sustainable mobility goals
Stakeholder Engagement	Limited public and stakeholder involvement	Extensive community engagement and participation
Environmental Considerations	Often lacks comprehensive environmental assessment	Emphasizes sustainability and eco-friendly solutions
Decision-making	Reactive problem-solving	Proactive and strategic planning
Governance	Centralized decision-making	Collaborative and cooperative governance
Community and Livability	May overlook diverse transportation needs	Prioritizes livability and community well-being
Land Use Integration	Often separate from land use planning	Integrates transportation and land use planning

1.5 SUMPs - The Global Context

Sustainable urban mobility plans help cities worldwide, and their residents have the right improvements and projects for their own tailored needs. Since every country and city has to have its own SUMP, there can be differences in the plans stemming from geographical differences, policy

contexts, and specific challenges. Mobilise Your City, a partnership that was launched at COP21, Paris, in 2015, defined itself as the leading global partnership, including nearly 100 partners, to develop sustainable urban mobility plans, policy enhancement, and increasing funding for sustainable transport in developing and emerging economies.

To prosper transformative change in urban mobility, this partnership supports member countries and cities. We can take examples of how they do this among their published reports. Due to analyses of diverse cities, the partnership claimed to have gained unique insights into different local cases and their challenges, especially in the Global South. These challenges range from cities like Ahmedabad, with a population of 7.8 million, to smaller cities like Kurunegala, with 122 thousand inhabitants. The specific conditions observed in different cities offer insightful opportunities that differ from those encountered in European cities. They claim the necessity for tailored solutions and guidelines for SUMPs in Africa, Asia, and Latin America. Although recently, there are guidelines published in a non-EU context, there is still a need for a more comprehensive global understanding of SUMPs.

To be able to understand the differences between different parts of the world and how diverse cases present different understandings of SUMPs, it is essential that we also explain what a National Urban Mobility Plan (NUMP) is. A NUMP is:

"A National Urban Mobility Policy and/or Investment Programme (NUMP) is a strategic policy or program developed by national governments to enable local governments to tackle urban mobility challenges. It enhances the capabilities of cities to plan, fund & implement sustainable transport projects." (Cleuet and Jehanno 2023, 16)

Both a NUMP and a SUMP are strategic frameworks providing the urban mobility challenges occurring in places and to combat them, offering sustainable transportation solutions. They differ in terms of scope, level of implementation, and the target audience. A NUMP is developed by the government of a country on a national level. It has a comprehensive vision and strategies encompassing the entire nation. Highlighted topics can be regional connectivity, infrastructure in different regions, coordination of policies, and investments on a national scope. A SUMP focused more on localized plans aimed at specific cities. SUMPs focus to urban mobility challenges in a specific urban area. They are designed to generate sustainable transportation systems regarding the factors such as public transportation, active and other modes of transport. Another difference between NUMPs and SUMPs is their target audience—the reports for NUMP interest national and regional

government authorities and national stakeholders. For the SUMPs, the interests shift to local city governments, urban planners, and local communities. The figure below explains the different levels of policies.

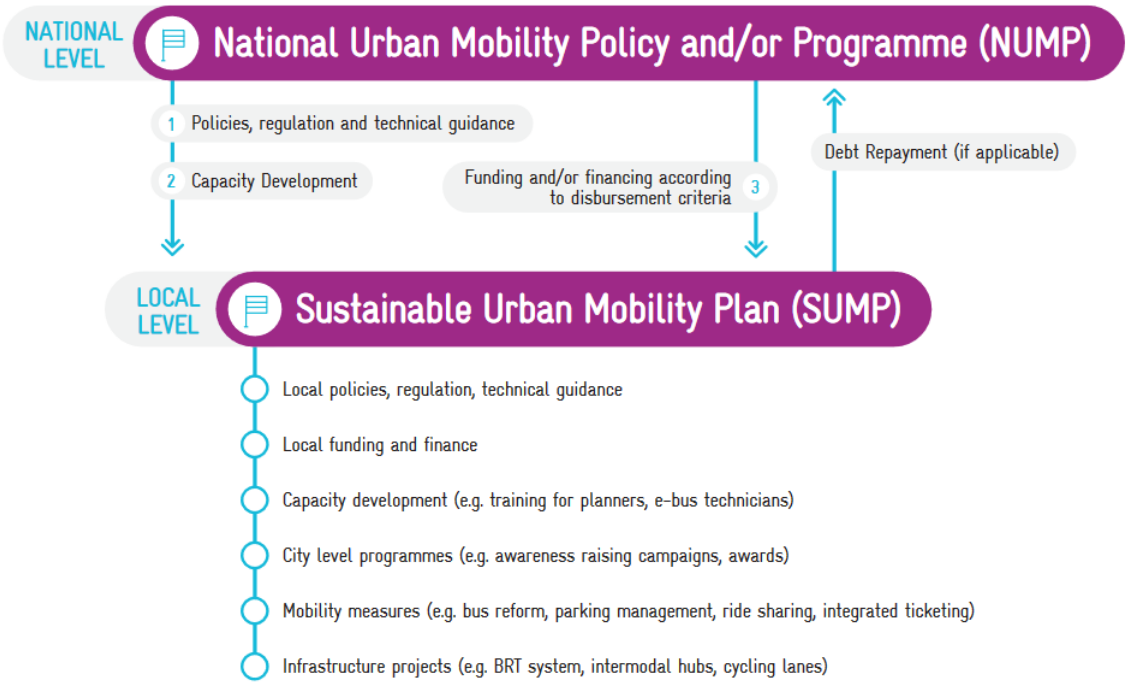


Figure 1 National Urban Mobility Policy Source: MobiliseYourCity NUMP Guidelines

SUMPs also vary between Europe and North America and the Global South. This is due to differences in urban contexts and development levels. Since urban context differs significantly, the plans should adapt to the differences. That is why there is an urgency for more cases examined other than EU and North American context. The guidelines presented by *Mobilise Your City Partnership*, explain that in the context of Global South, existing governance and institutional frameworks exacerbate the lack of local capacities by restricting municipalities from carrying out essential regulatory, managerial, and administrative functions. The limitations posed in many instances often lead to a growth in paratransit services which are not regulated, and an increase in private vehicle use. However, compared to cities in Europe and North America, most cities in Global South still have lower levels of private car ownership. This situation presents an opportunity for implementing sustainable urban mobility systems before the car-centric understanding of transport takes over. It is stated in the guideline that, in contrast to the struggle in developed cities to reverse unsustainable trends, developing cities can adopt new mobility solutions that are inclusive, attractive, and environmentally friendly (Cleuet and Jehanno 2023, 12).

They present the common challenges of implementing a SUMP in diverse contexts. They point to four main challenges:

1. Lack of Technical Capacities and Awareness:
   - Technical capacities for urban mobility planning and monitoring are commonly lacking in local governments
   - The benefits of sustainable options and integrated mobility planning have not yet been understood by the decision-makers

2. Governance and Institutional Frameworks:
   - In many cases, governance structures further limit local capacities, hindering essential functions.
   - This limitation can pose uncontrolled paratransit services and importance given to road infrastructures while neglecting infrastructure for walking and cycling.

3. Different Contexts in the Global South:
   - Developing cities in the Global South, compared to Global North, have lower private motorization levels
   - This situation posits the possibility of creating innovative and sustainable mobility systems.

4. Role of Paratransit and Addressing Negatives:
   - Paratransit is an essential mode of public transport in many Asian, African, and Latin American cities.
   - It is vital to understand its contribution to the status quo of transport planning in the Global South. In this regard, the primary objective of SUMP, in these cases, should be recognizing the crucial role of paratransit in sustainable mobility and addressing the associated negative impacts, such as lower service quality and environmental pollution.

There are different implications of SUMP in contrast to the established rules of European SUMP guidelines. For instance, the functional urban area in European SUMPs may not find their own reflection in the Global South SUMPs. This is regarding the urban development patterns' differentiation. In the urban areas of the Global South, which are growing rapidly, administrative boundaries might not align with current development patterns. Implementation of SUMPs, in this case, can help by guiding the establishment or enhancing the local transportation and mobility institutions. Another point mentioned concerns mitigation and adaptation to climate change in cities. Two factors influencing this assessment in Global South are the responsible authorities' capabilities

and the transportation system's overall financial performance. Both aspects are important for comparing the feasibility of different scenarios and identifying measures for capacity-building. This process is also vital in the later step of preparing financial mechanisms (Cleuet and Jehanno 2023).

Overall, SUMP implementation processes aim to embrace contextually tailored and regionally structured strategies. To have the best results, a mobility policy should be firmly rooted in local customs and take into account factors that are influencing mobility.

1.5.1 SUMP Implementation in Latin America

We can examine some examples around the world of sustainable mobility discourse. According to this report, transport planning in Latin American cities has traditionally centered on enhancing traffic, focusing on vehicle flow quantity and speed rather than prioritizing people's movement and accessibility (Moscoso, van Laake, and Quiñones 2020, 80). Although a global shift towards sustainable mobility has emerged, this change has not yet resonated with policy adjustments within Latin America (Moscoso, van Laake, and Quiñones 2020, 83). However, the practical implementation of policies contrasts with this discourse, as investment levels and quality often do not align with these new priorities. Even though sustainable mobility improvements have happened, motorization still rises, and urban highways are being constructed throughout the region (Moscoso, van Laake, and Quiñones 2020, 83). It is stated that:

“In contrast to the slow progress in practice, talk of sustainable mobility is widespread in government discourses. The reality is that mobility policy in Latin America is constrained by a series of entrenched, reactionary, and highly politicized discourses that classify certain policies and interventions as viable or necessary, while others are perceived to be undesirable or unfeasible.” (Moscoso, van Laake, and Quiñones 2020, 83)

According to the report, the significant challenge in the case of Latin American cities is the difficulty of challenging the dominance of cars (Moscoso, van Laake, and Quiñones 2020, 94). It is stated that only promoting other sustainable modes and ways to move will not produce substantial improvements unless the car-centric system is replaced. The priority given to cars has proven to lead to unsafe roads for not only cars but pedestrians, cyclists, and other users.

1.5.2 SUMPs in the Southeast Asia

Another example is from the Guidelines for the Development of Sustainable Urban Mobility Plans (SUMP) in the ASEAN Metropolitan Region. The ASEAN Region is the association involving the member countries Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. According to the guideline, the mobility system in metropolitan areas in ASEAN did not yet keep pace with increasing urbanization and transport demand (ASEAN Secretariat 2022, 17). It is reported that public transport does not fully cover the urban areas, and the service levels are inadequate. It is mentioned that:

"The combined urban sprawl and the absence of attractive, sustainable transport alternatives increasingly shift transport to private automobiles. The number of private vehicles has increased by 3.2% annually from 2005 to 2015 and is forecasted to grow further in the coming years." (PWC, 2015; OECD 2019 cited in ASEAN Secretariat 2022, 17)

One of the examples given among the good practices of SUMPs is regarding Singapore and its long-term strategies. It is noted that:
"Singapore developed a comprehensive strategy, the "Land Transport Master Plan 2040," that includes long-term perspectives, clear visions, and a strategy for urban life in Singapore." (ASEAN Secretariat 2022, 50)

Singapore's mobility plan encompasses not only infrastructural improvement and technological progress but also focuses on the population's well-being. The envision of a city where commute time is at most 45 minutes, combining different modes of transport, including walking, cycling, and public transport, is among the mobility plans. This plan is presented under a 45-minute city together with 20-minute towns, where an individual can reach the nearest neighborhood center in 20 minutes by walking, cycling, or public transportation (ASEAN Secretariat 2022, 50).
Singapore's mobility plan also prioritizes creating spaces for active mobility and community use. This involves creating dedicated areas for pedestrians and cyclists, as well as enhancing public transport stations. Through different sessions, online or in person, held by stakeholders and planners, they also got feedback from citizens, therefore, gaining public support in the implementation of the plans.

1.5.3 The USA and the Sustainable Mobility Trends

To continue with examples of SUMP in different parts of the world, we can look at the United States. This report shows the challenges and opportunities for implementing sustainable urban mobility plans in the US on different federal, state, and city levels (Borade et al. 2020, 5). They analyze each case study looking at how new technological developments are spreading, the regulations change accordingly, and how society is affected by these changes. The main themes of their examination are environmental sustainability, equity, inclusion and access, and data management and security.

When examining the mobility trends in the US, they state the dominance of automobiles and highways. They explain that:

"Mobility in the United States has long been characterized by high private car use and ownership. There are about 766 cars for every 1000 people, whereas Europe has only 507 and China, 74.5 A high share of the population, 70 % have drivers' licenses." (Borade et al. 2020, 8)

However, this trend is decreasing, according to the report. It is stated that "Americans are also increasingly less likely to own a car than in the past." (Borade et al. 2020, 9)

Decreased car usage and ownership can be due to urbanization and internet technology (Borade et al. 2020, 9). The growing urban population in the country and people living in densely populated areas are among the reasons.

One of the case studies presented in the report is Michigan. With its 10 million population, Michigan is the 10th most populous state in the US. Most of the citizens live in urbanized centers, and there is a significant automotive industry presence in the city. They state that despite its significant automotive industry, Michigan lacks a state-level policy to support the adoption of electric vehicles (Borade et al. 2020, 34). They analyze the electric vehicle framework in Michigan. Other mobility services such as bike sharing, micro-transit, and ride-hailing in Michigan are also examined. It is stated that these services are transforming transportation modes and altering travel habits. However, there is still the need to update the laws, regulations, and infrastructure to accommodate the demand for these services (Borade et al. 2020, 36).

1.5.4 A look at the European cases of SUMPs

We can look at the state-of-the-art changes in SUMPs in Europe to further analyze the SUMP implementation worldwide. According to this report, of those cities that took part in the assessment survey in 2017, %37 answered having a qualified SUMP (Durlin et al. 2018, 7). Their analysis has identified that half of the SUMP adoption is in Belgium and Spain together.

They also analyzed the barriers and challenges of implementing a SUMP in Europe. Among these are lack of political will, national support, and capacity, together with challenges in the cooperation of different levels, which are city, regional, and national (Durlin et al. 2018, 8). Adding to these, they mention the absence of SUMP activities and awareness at the national level, along with insufficient collaboration among national institutions, coupled with a lack of interest and awareness about the SUMP concept among politicians at all levels, results in the potential benefits of having a SUMP being overshadowed by the necessity of having one solely to obtain EU funding (Durlin et al. 2018, 8).

The report proposes the necessary steps to develop SUMPs in Europe. They argue that those countries who already have an established SUMP should emphasize consistently enhancing the national SUMP initiatives and enhancing the monitoring and evaluation efforts, securing national funding to support the development and implementation of SUMPs. For those countries who are new to the process of starting a SUMP, there is a need for financial and institutional support for realizing SUMPs.

The European Union supports the implementation of Sustainable Urban Mobility Plans through various initiatives, programs, and funding. Some of the key organizations and mechanisms supported by the EU for implementing SUMPs include:

1. **European Commission - Directorate-General for Mobility and Transport (DG MOVE):** DG MOVE plays a crucial role in promoting sustainable mobility across Europe and supports the development and implementation of SUMPs through policy coordination, research, and funding programs.

2. **CIVITAS Initiative:** CIVITAS is an EU-funded initiative encouraging and supporting cities in implementing ambitious sustainable mobility measures and SUMPs. It provides guidance, expertise, and funding to cities and offers a knowledge exchange and networking platform.
3. **EU Urban Agenda - Partnership on Urban Mobility:** The EU Urban Agenda fosters cooperation between member states, cities, and stakeholders on various urban issues, including urban mobility. The Partnership on Urban Mobility supports the implementation of SUMPs by sharing best practices and developing policy recommendations.
4. **EU Funding Programs:** The EU provides funding opportunities for sustainable mobility projects through various programs, including the Connecting Europe Facility (CEF), Horizon Europe, and European Structural and Investment Funds (ESIF). These funds support projects focusing on sustainable transportation, urban mobility, and infrastructure development.
5. **European Platform on Sustainable Urban Mobility Plans:** This platform facilitates the exchange of experiences and knowledge among cities, regions, and organizations involved in developing and implementing SUMPs. It is a valuable resource for cities looking to adopt best practices and learn from successful SUMP implementations.
6. **European Mobility Week:** Organized by the European Commission, European Mobility Week is an annual campaign that encourages cities and towns to promote sustainable urban mobility and raise awareness about the benefits of sustainable transportation choices, including implementing SUMPs.
7. **European Green Deal:** The European Green Deal is a comprehensive policy initiative that aims to make the EU's economy sustainable. It emphasizes the need for sustainable urban mobility and supports initiatives that reduce greenhouse gas emissions and improve air quality in cities.

8. **European Innovation Partnership (EIP) Smart Cities and Communities:** The EIP Smart Cities and Communities initiative promotes sustainable urban development and supports projects integrating energy, transport, and information and communication technologies to create smart and sustainable cities.
9. **Intelligent Energy Europe program (STEER):** The STEER program supports energy-efficient transport and sustainable mobility projects. It funds initiatives that promote using renewable energy sources in transport, encourage the adoption of electric vehicles, and develop sustainable mobility plans and strategies.
10. **European Mobility Week:** European Mobility Week is an annual EU-funded campaign that promotes sustainable urban mobility and encourages cities to implement initiatives such as

car-free days, cycling events, and public transport promotions. It aims to raise awareness and encourage behavioral changes towards more sustainable transport choices.

The EU works to support the inclusion of sustainable and efficient urban transport systems throughout Europe. The above-mentioned projects and initiatives show a range of EU-funded efforts to advocate sustainable urban mobility, create better-functioning cities, and reduce the environmental harm cast by traditional transportation planning methods in urban areas. Through its extensive support, the EU drives to create more sustainable and livable cities across Europe.

In general, SUMPs are gaining more attraction on the global scale as a transformative way to shape the future of urban mobility. Diverse regions, countries, and cities recognize the need for human-centered, climate-resilient solutions prioritizing safety, accessibility, and inclusivity while reducing emissions and increasing the quality of life. Looking at the international scene on the implementation of SUMPs is essential to learn from other cities' challenges and successes. As more and more cities adopt SUMPs and change their policies to have sustainable mobilities, we can witness the transition to better, more equal, livable urban environments.

CHAPTER 2 The New Ways of Mobilities

Globally, unprecedented rates of urbanization, forthcoming climate change challenges, and an ever-growing need for sustainable systems are causing a profound transformation in the concept of urban mobility. As explained in the first chapter, recent decades of rapid urbanization and population growth have posed unprecedented challenges for urban transportation systems worldwide. The imperative actions taken to tackle climate change - decrease greenhouse gas emissions, and advance resilient urban areas - have influenced the evolution of new approaches to urban mobility. As cities work towards resolving challenges such as congestion, pollution, and limited accessibility, the need for innovative and sustainable mobility solutions for a better urban experience becomes urgent. Not only is the pursuit of livable and environmentally conscious urban spaces prioritized in new understandings of urban planning, but also new ways of mobilities have emerged, featuring cutting-edge concepts and innovations for navigating urban areas. This chapter specifically focuses on mobility solutions promoting and enhancing sustainable urban transportation.

The critical concept of mobility justice, which focuses on fairness, accessibility, and inclusiveness, particularly in transportation, comes into play when examining how to create more sustainable and equitable urban areas. We explain the concept of mobility justice and how it can either hinder or facilitate access to opportunities. Additionally, we consider the role of mobility justice in shaping more equitable urban futures.

At the center of this chapter is an examination of current initiatives and projects aimed at creating more sustainable urban areas while addressing the challenges of climate change and creating more resilient cities. These initiatives, frequently supported by holistic urban planning, aim to transform the way people move within cities. Based on in-depth research, this chapter outlines concepts and projects developed by urban planners, academics, government officials, and innovators.

Key topics addressed in this chapter include Mobility as a Service (MaaS), Smart Cities, and the promotion of Active Travel. These are innovative pathways towards an urban mobility future that is efficient, environmentally responsible, and inclusive. These are not just buzzwords, but they signify crucial fields of research and technologies that can help make urban mobility more efficient, environmentally responsible, and inclusive.

Mobility as a Service (MaaS) envisions a user-focused and interconnected transportation ecosystem, incorporating multiple modes of transit into a single accessible platform. The MaaS offerings promise to simplify the daily commute, reduce reliance on the private vehicle, and optimize transportation resources.

Smart Cities, on the other hand, are redefining urban landscapes by incorporating enhanced data, technology, and interconnected infrastructure to improve urban mobility, resource management, and overall quality of life.

Another aspect of this transformation is the promotion of Active Mobility, which includes walking and cycling but is not limited to them. Encouraging and facilitating the most sustainable modes of transportation not only contributes to reduced emissions but also promotes healthier and more lively urban communities.

Throughout this chapter, we will delve into the elaborations of these new mobility keywords, exploring the principles, challenges, and opportunities they present. By explaining these seemingly newer trends, we aim to create a deeper understanding of sustainable urban mobility plans and how they shape urban areas, and conduct the cities toward a future of efficient, equal and sustainable urban mobility.

2.1 Transportation and Mobility

While transportation has always been vital for societies, after the Industrial Revolution, the rapid urbanization afterward, and the increasing growth of the cities, transportation planning has matured to become a powerful institution, providing clear rules on how to conduct planning in the transportation domain. Especially throughout the 20th century, transportation planning evolved further with the rise of the automobile and the expansion of road networks. City planning and engineering disciplines became more focused on designing transportation infrastructure to accommodate the growing needs of urban populations. In the latest decades, traditional transportation planning has started to be severely criticized. The outcomes of these criticisms shaped and continue to shape the new understanding of urban mobility planning. Today, transportation is a multi-disciplinary subject involving urban planners, engineers, economists, and environmental experts. It

comprises various aspects, including infrastructure development, public transit systems, traffic management, environmental impact assessments, and sustainability considerations.

In the article, *The Design, Experience, and Justice of Mobility*, the authors discuss the two types of mobilities: practice mobility and transport mobility (Ernste, Martens, and Schapendonk 2012). While transport mobility focuses on the movement between places with various transportation modes, practice mobility is concerned with how mobility is embroidered in everyday life practices and searches for the social and cultural aspects of mobility and how mobility shapes human experiences and interactions. Conventional transportation research sees mobility as a secondary need, as a reality to connect desired activities. According to this view, traveling between places is regarded as a hindrance or time-consuming activity that needs to be minimized (Ernste, Martens, and Schapendonk 2012, 509). Transport mobility research puts the main focus on efficiently organizing and managing physical infrastructures to facilitate mobility (Ernste, Martens, and Schapendonk 2012, 509).

Both practice mobility and transport mobility arose from the broader mobility studies. However, they developed from different academic traditions and perspectives. In the early 2000s, with the emergence of the mobilities turn, a significant shift towards studying mobility from a non-sedentary understanding, including the social and cultural dimensions of mobility, started to happen. Scholars began emphasizing mobility's social and cultural dimensions thanks to the theoretical shift with the mobilities turn. Therefore, we can talk about the existence of practice mobility. On the other hand, transport mobility has already been at the center of traditional transportation studies, where the main focus is on the physical aspects of transportation systems, infrastructure, and operational efficiency. Engineering and urban planning subjects were the leading producers of the transport mobility approach.

Practice mobility can be described as the theoretical approach and perspective in mobility studies. The main focus of practice mobility is understanding how people engage in practices related to mobility, such as how they move from one place to another, their travel habits and experiences, and the meaning they attach to these movements. Practice mobility research aims to analyze the social and cultural aspects of mobility, emphasizing the everyday experiences and practices of individuals and communities. It seeks to understand the ways in which people think and talk about their mobility, how they make decisions about their transportation choices, and how these movements are affected by broader power structures and societal understandings. How cultural and social factors shape people's mobility and how different gender roles, classes, and age groups experience mobility have been aimed in the research. Sustainable mobility also has become a subject of interest within the

practice mobility research lately by questioning how mobility practices can be sustainable and environmentally conscious.

Here, the authors argue that the discussion would be around three dimensions: designs, experiences, and justice, to bring these two strands of mobility concepts closer (Ernste, Martens, and Schapendonk 2012, 510). In this case, the ideal transport design would eliminate geographical friction entirely. Both transport design and research have been primarily motivated by the goal of efficiently addressing travel needs, viewing the transport system merely as a neutral connector (Baeten 2000 as cited in Ernste, Martens, and Schapendonk 2012, 510). The authors argue that transport mobility puts physical infrastructures first place in the discussion, while practice mobility emphasizes the role of social infrastructures. Both approaches to mobility apply a system perspective rather than focusing solely on individuals. Various actors and power relations shape mobility patterns in both of the approaches. They argue that both fields could benefit from incorporating their analytical focuses.

In transportation mobility research, there is a need to give more attention to the physical aspects of mobility and the movement of people and goods. The issues at stake are related to accessibility, efficiency, and infrastructure planning. Transport mobility research emphasizes the processes of understanding who gets to use transportation systems and who does not and the reasons behind fast or slow transportation. While doing these, the justice concerns are not paid much attention. Also, the environmental impacts and sustainability may be addressed regarding transportation.

On the other hand, practice mobility research could be enhanced by explicitly considering the role of fixed physical infrastructures in shaping mobility outcomes. By integrating these aspects, both fields can deepen their understanding and provide more comprehensive insights into mobility phenomena. Practice mobility comes across as an alternative understanding to the traditional transportation studies in which often the focus is on technical and infrastructural aspects of a movement. The human experience and social and cultural dimensions of movement, with a greater understanding of mobility, are researched in practice mobility studies.

In summary, practice mobility and transport mobility are two distinct approaches to understanding mobility. Practice mobility focuses on the social and cultural aspects of mobility practices and the everyday experiences of individuals. In contrast, transport mobility primarily looks at the physical aspects of transportation systems, accessibility, and efficiency. Both approaches emerged from the broader field of mobility studies but developed from different academic traditions with distinct research interests and methodologies.

All in all, the emerging new mobilities literature, the mobilities turn in social sciences, and the new understandings of mobilities, as argued, have the potential to substantially enrich mainstream transportation research (Ernste, Martens, and Schapendonk 2012, 512).

2.2 The Role of Mobility Justice in Fostering Equitable Urban Environments

Having understood the concepts of practice mobility and transport mobility, we can also turn our attention to an essential concern in the realm of urban transportation and, in broader terms, mobility: mobility justice. The challenges posed by increasing urbanization, climate change, and the need for sustainable mobility solutions have become paramount. As we explained before, the policies regarding transport have already started to shape into producing more sustainable outcomes, more in some countries and less in others. To incorporate these sustainable policies, to implement them, we can move towards creating urban spaces that are not only environmentally conscious but also prioritize the well-being of all their inhabitants. Mobility justice covers common goals with sustainable urban mobility concepts. Some common goals include environmental consciousness, resilience, a long-term perspective on planning mobility, and equitable access.

Sheller, when she coined the term mobility justice, described it as:

“an overarching concept for thinking about how power and inequality inform the governance and control of movement, shaping the patterns of unequal mobility and immobility in the circulation of people, resources, and information.” (“Theorising Mobility Justice” 2019, 30)

She adds that mobility justice can be conceptualized across various levels, ranging from individual interactions and relationships to urban transportation justice and the concept of the "right to the city," and even extending to international travel dynamics and border considerations ("Theorising Mobility Justice" 2019, 31). She stresses the need to establish a cohesive framework that unites different levels – encompassing the individual body, street, urban environments, nations, and the planet – into a comprehensive theory of mobility justice ("Theorising Mobility Justice" 2019, 31).

Sheller discusses the triple crises in her book *Mobility Justice: The Politics of Movement in an Age of Extremes*. These parallel crises are climate, urbanization, and migration, and she presents that they all revolve around the questions of mobility and immobility, and in cohesion, they bring out unjust power relations and uneven mobility (Sheller 2018, 16). She claims that mobility justice is one of the most crucial political and ethical facets of contemporary times. She explains the broad range of the concerns of mobility justice:

"It focuses attention on the politics of unequal capabilities for movement, as well as on unequal rights to stay or to dwell in a place. It is concerned with sexual harassment as much as transport access and with racist violence as much as resource extraction. It allows us to think more clearly about the intertwined relations between bodies, streets, transport systems, urbanization (including not just cities but also suburbs and rural hinterlands), regional and transnational infrastructures, national borders, and wider planetary mobilities. It reveals the relation between the urban crisis, the migration crisis, and the climate crisis." (Sheller 2018, 16)

Sheller shows in her book that the triple crises are actually arising from one common problem: the politics and power relations of (im)mobilities (Sheller 2018, 17). The way that the word (im)mobilities are formed is so to show that mobility and immobility are invariably linked, interrelated, and co-dependent, and this suggests that we should consistently consider them as interconnected concepts rather than contrasts.

According to Sheller's perspective, if we focus on the interconnected and varied nature of (im)mobilities across different scales, we can re-evaluate the politics surrounding accessibility, transportation, urban development, infrastructure, borders, and environmental factors. This understanding of mobility justice expands into the current discussions regarding sustainable transportation, transitions towards low-carbon practices, urban planning, and issues commonly regarded as localized urban transportation justice concerns within a broader framework (Sheller 2018, 20). Mobility justice acknowledges the presence of diverse modes of mobility systems, ranging from personal and close connections to an extensive global movement. These modes encompass not only people but also involve the use of energy and resources. In essence, it recognizes that mobility systems encompass a broad spectrum.

Sheller delves into the urban mobility problems in her book and asks the relevant question:

"How will the world's megacities, not to mention average cities, suburbs, and rural places outside of cities, adapt to the growing (and uneven) vulnerability to climate change and the need to manage mobility, logistics, and settlement in new ways?" (Sheller 2018, 20)

Sheller examines the analyses pertaining to these complex challenges, notably observing the transition toward a new mobility paradigm and the emerging modes of mobility. Continuing with this chapter, we will further examine the newly emerging forms of mobility.

Another scholar who took an approach of justice on transportation and, more generally, mobility, Karel Martens, emphasizes the importance of providing accessible and affordable transportation options to all members of society. He claims that transport is used as a field of government intervention (Martens 2012, 1035).

The last two centuries have seen a change in thinking about transportation in society. In the past times, in simple societies, walking was enough to get around and organize one's life (Martens 2012, 1045). By all means, this was excluding people who had trouble walking, and social norms were also limiting certain groups of people, such as women or lower-class people going to certain places while expanding the movement of particular groups of people, such as the wealthy, who could afford to travel by horse or carriage. The introduction of motorized vehicles, especially private cars, changed this situation completely (Illich 1974 cited in Martens 2012, 1045). People's approach to transportation has changed with the inclusion of private cars and roads. Motorized transport had become a necessity rather than a luxury (Martens 2012, 1045). The ability to move around became a big part of how we live (Kaufmann and others talked about this in 2004, and Urry in 2000, cited in Martens 2012, 1045).

Because of this rise in motorized transportation, the way we see transportation has changed. The ability to travel started to be seen as an advantage, a plus; it was not a natural part of life like back in simpler societies. Martens argues that whether we have access to transportation or not affects our opportunities in life (Martens 2012, 1046). That is the change of the discourse on transportation that Martens discusses. From this point of view, Martens discusses transport as a good and whether or not it should be set apart as a separate good. He claims that:

"Transport has developed from a taken-for-granted and hardly disputed good to a highly desirable good, an indispensable resource shaping one's life path, and a good whose availability is subject of public debate." (Martens 2012, 1046)

Transportation planning for sustainability and transportation planning for accessibility provide alternative sets of rules. Based on the literature, Martens defines the rules of these alternatives. The author shows that they have not yet developed comprehensive alternatives to the traditional approach. Many rules leave the role of the transportation planner ill-defined and do not provide enough guidance regarding the type of information to be delivered to decision-makers. Furthermore, the rules substantially enlarge the scope of transportation planning beyond the comfort zone of many transportation planners. The author concludes that it will require a substantial effort to develop a consistent alternative to traditional transportation planning that can both take away some of the criticism of traditional transportation planning and can provide transportation planners with the guidance needed to carry out their role in the complex decision-making processes around interventions in the transportation system (Martens 2012, 1048).

Moreover, Martens argues that existing policy structures shape the allocation of transportation resources to be primarily influenced by financial means, leading to significant differences among diverse population groups. This situation may even lead to a notable absence of accessibility for a considerable part of society. Drawing among these conclusions, Martens argues the need to "draw boundaries around the transport good and set it apart from other goods." (Martens 2012, 1046)

While Martens' ideas on transport justice focus mainly on the equal distribution of transportation resources and opportunities, Sheller's concept of mobility justice takes on a broader perspective that even surpasses transportation. The common argument between the two scholars is that they are concerned with promoting fairness in transportation. Meanwhile, Sheller encompasses a broader vision of transforming the entire mobility system to be just, sustainable, and socially inclusive.

In recent decades, mobility justice gained significant attention from scholars and researchers across different academic disciplines. Apart from the already mentioned scholars Mimi Sheller and Karel Martens, scholars such as David King and Karen Lucas contributed with their research on the subject. King's research focuses on transportation equity and justice in urban areas, and he puts forward the importance of considering the needs of populations, such as low-income groups and communities of color, while planning transportation in cities. Lucas centers her research on transport-related social exclusion and its impact on vulnerable groups. Likewise, in Martens' research, Lucas also emphasizes how limited access to transportation can result in exclusion from essential services and economic opportunities. The significant contributions to the discourse on mobility justice and, more specifically, transport justice from scholars continue to shape the understanding of how mobility

systems can affect social inequalities. Scholars advocate for policies addressing inequalities and promoting inclusive, accessible, just, and sustainable transport systems.

2.3 Smart Cities

A Smart City is an urban area that uses technology and data to increase the quality of life for its residents, improve the efficiency of services, and optimize resource usage. It uses various digital and communication technologies to collect, analyze, and share data across different domains, including transportation, energy, healthcare, public safety, and more. The key characteristics of a Smart City include connectivity, data-driven decision-making, and the integration of technology into the urban infrastructure. Technology is vital in today's world across various domains. In the context of urban transportation and smart cities, electrification, smart grids, solar power, digital bus shelters, smart ticketing systems, public transit apps, and automation ("Smart Urban Mobility as a Regulatory Challenge" 2020, 8) can be listed as technologies that are used. The European Commission considers the smart city as:

“A place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business” (European Commission, n.d.)

The commission argues that:

"A smart city goes beyond the use of digital technologies for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities, and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces, and meeting the needs of an aging population." (European Commission, n.d.)

Smart city forerunners like San Diego, San Francisco, Ottawa, Brisbane, Amsterdam, Kyoto, and Bangalore are all now setting the trend for others to follow from intelligent to smart cities, as Deakin and Al Waer wrote in 2011 (Deakin and Al Waer 2011, 140). In Qatar, smart parking and intelligent transportation systems have improved traffic flow and reduced air pollution (Gracias et al. 2023, 1734). Similarly, Amsterdam's Connected Mobility Platform has reduced the number of cars on the

road, resulting in lower carbon emissions and improved air quality (Gracias et al. 2023, 1734). While Barcelona's smart lighting system reduces energy consumption and light pollution, Oulu's smart lighting system and mobile app have enhanced the quality of life for residents by providing real-time information on public transportation (Gracias et al. 2023, 1734).

Hollands claims that we consistently encounter new terms, such as smart, intelligent, wired, digital, creative, innovative, and cultural when defining the urban context (Hollands 2008, 304). These discourses on defining cities usually connect technological informational transformations with economic, political, and socio-cultural change (Hollands 2008, 304). The term smart city has recently gathered great attention and investment, leading to numerous initiatives worldwide (Gracias et al. 2023, 1722). Apart from all the interest in the subject and investments, there is no widely accepted definition of what constitutes a smart city. This lack of consensus can pose challenges for policymakers, urban planners, and stakeholders aiming to develop and implement smart city projects (Gracias et al. 2023, 1722). Next to the definition of smart, cities are also called intelligent, digital in the place of smart. This situation results in the way that the concept of a smart city remains ambiguous. While the common smart city endeavours prioritize sustainability, efficiency, and increasing the quality of life of its citizens, the absence of a universal definition stems from the diverse ideas and initiatives covered under this term (Gracias et al. 2023, 1722). The word cloud analysis conducted by Gracias et al. shows that when defining a smart city, organizations first and foremost focus on improving the well-being of residents. The term technology follows this definition and implies that technology plays a vital role as the primary tool for smart cities (Gracias et al. 2023, 1724). Based on their analysis and literature review, Gracias et al. suggest a definition of smart cities:

"Smart cities use digital technologies, communication technologies, and data analytics to create an efficient and effective service environment that improves urban quality of life and promotes sustainability." (Gracias et al. 2023, 1724)

The smart city concept represents technological advancements that shape urban organization and the interactions among citizens within urban contexts (“Smart Urban Mobility as a Regulatory Challenge” 2020, 11). An emerging subset of this notion, which is 'smart mobility', has been significantly shaped by ecological, demographic, and economic forces. As much as these concepts can potentially resolve long-term issues in urban environments, they also introduce new social, economic, and legal problems ("Smart Urban Mobility as a Regulatory Challenge," 2020, 13). Hollands suggests that smart cities should focus on people and human capital first; they should not

believe only that information technologies can magically transform and improve cities (Hollands 2008, 315). He proposes that cities that aspire to get the title of ‘smart’ must:

- Embrace much greater technological risks
- Delegate authority
- Address disparities
- Re-evaluate the very concept of ‘smartness’ itself (Hollands 2008, 316)

Following the steps of Hollands, we can criticize the smart city concept on the grounds of technological determinism. When cities claim smart and believe that technology alone can shape and drive social change, they would be overlooking the influence of social, cultural, and economic factors. Prioritizing the technological solutions and sidelining the importance of social and cultural contexts possibly undermines the fact that urban challenges are complex and multifaceted, therefore requiring complex and multidimensional solutions. Another aspect to consider is that the technological solutions must align with the resident's needs, values, and preferences. It would be wrong to assume that positive outcomes and positive reactions from the population will be received once technological solutions are implemented. The solutions should be long-term, address the root causes of the urban challenges, and be accepted by the local population. Gracias et al. argue that social media is a powerful tool for citizen engagement in the context of smart cities (Gracias et al. 2023, 1737). They claim that social media platforms can serve as a means to share details about upcoming smart city projects and gather input and opinions from residents. The active participation of citizens is vital for the effective implementation of smart city initiatives (Gracias et al. 2023, 1737). It should be noted that the benefits of smart city technologies are equally distributed among different population groups in society.

Sheller also criticizes smart cities and, in general, the concept of smart mobilities with a lens of mobility justice. She argues that there has been a substantial push for transportation policies packaged under terms like "Complete Streets," "Livable Cities," "Transit-Oriented Development," and "Vision Zero" (Sheller 2018). According to Sheller, these policies aim to curb the dominance of automobile use in various ways, blending aspects of sustainability and transport justice. She notes that smartness is in the sense of taking the human operator "out of the loop" to enable the "technologies to work autonomously, based on massive data collection and processing, complex algorithmic calculations, and automated transactions that they are programmed to perform" (Sheller 2018, 139).

In the context of internet technology solutions, Sheller says:

“New internet technology companies poetically valorized narratives of speed, acceleration, connectivity, and openness even as they politically entrenched infrastructural multipliers, switches, and topologies that supported highly uneven access to the WiFi-enabled urban spaces that networked technologies were making.” (Sheller 2018, 139)

Sheller goes on to argue that mobility systems are growing in complexity, becoming more reliant on each other, and increasingly dependent on computer technology and software (Sheller 2018, 139).

However, those who are working together to bring about change and value mobility justice should question the usual ideas that support how we value different ways of moving around. They should suggest different ideas that encourage other ways of moving, such as taking care of the environment and being sustainable, being healthy, connecting with others, sharing, and working together for everyone's benefit, to create just mobilities. Sheller claims it is essential to reconfigure our cities so that people take precedence over vehicles (Sheller 2018).

Moreover, if we look at smart cities on the concept of sustainability, we can see that sustainability is an important aspect of considering smart cities. Creating environmentally friendly cities and reducing the carbon footprint in urban areas is an important aspect of creating smart cities. Among the positive outcomes of smart cities on the ground of sustainability, we can count that they can optimize the use of resources, water, and electricity and reduce waste. However, smart city solutions include the use of data centers, communication networks, sensors, cameras, and so on. This increased energy demand, in return, can contribute to other environmental challenges in the future. The fast-paced progress of technology within smart cities can generate electronic waste, as new technologies will rapidly replace the old ones.

It is crucial to highlight that creating a smart city is an ongoing process that requires continuous evaluation and improvement (Gracias et al. 2023, 1735), and the goal is creating one that emphasizes long-term sustainability, inclusivity, and responsible use of technology to realize truly resilient and livable urban environments.

2.4 Mobility as a Service (MaaS)

This section will shed light on the Mobility as a Service (MaaS) concept, which aims to provide users with comprehensive, seamless transportation options through integrated platforms. We will analyze successful MaaS implementations and their implications for offering flexible, sustainable, and user-centric urban transportation solutions.

Among the solutions offered to the urban challenges, Mobility as a Service (MaaS) strikes as another popular one. Although there is still not a unified definition, such as in the case of the smart city concept, MaaS can be described as:

"The integration of various forms of transport services into a single mobility service, which is accessible on demand. To meet a customer's request, a MaaS operator facilitates a diverse menu of transport options, be they public transport, ride-, car-, or bike-sharing, taxi or car rental/lease, or a combination thereof" (MaaS Alliance 2017, 2)

According to Cruz and Sarmento, the concept of MaaS is understood in diverse ways; this can be suggested as a reason behind a not unified definition (Cruz and Sarmento 2020, 3). Some scholars define MaaS in a technologically focused manner, considering it a technical system, namely a digital platform. This platform facilitates the combination of purchasing various separate journeys and travel components (Cruz and Sarmento 2020, 3). In contrast, others interpret MaaS in a broader sense, encompassing not only the technological solution itself but also the entire process of integrating transportation and transforming transportation infrastructure into a commodity (Cruz and Sarmento 2020, 3). The transportation infrastructure mentioned here not only refers to roads and railways but also includes the hardware that facilitates the delivery of transport services, such as vehicles, stops, and charging stations (Cruz and Sarmento 2020, 3).

MaaS has gained attention from policymakers, industry experts, and academia as an emerging solution with the potential to support sustainable mobility (Servou, Behrendt, and Horst 2023, 1). Different strategies have been implemented for creating MaaS systems in diverse parts of the world through different initiatives. Some strategies position MaaS to manage the transportation demands (Farahmand et al., 2021, cited in Servou, Behrendt, and Horst 2023, 1), while others anticipate a focus on user preferences and convenience (Feneri et al., 2020, cited in Servou, Behrendt, and Horst, 2023, 1). Ultimately, the central expectation associated with MaaS is its potential contribution to achieving sustainable mobility objectives (Servou, Behrendt, and Horst 2023, 1).

The MaaS Alliance, a public-private partnership aimed at creating a common framework for MaaS, claims that a successful MaaS can bring new business models and ways of organizing and operating different transportation options into play (MaaS Alliance, n.d.). MaaS not only changes how transportation options are managed and offered but also benefits transport providers by giving them more information about what users want and presenting opportunities to address the needs that are not fulfilled yet. MaaS intends to offer a convenient and sustainable choice for private cars, potentially reducing traffic congestion while also possibly being more affordable. Audouin and Finger explain that the only way to offer an alternative to owning a personal car is to create a convenient service that combines all kinds of shared and private transportation options into packages that are just as convenient as using your own car (Audouin and Finger 2018, 25). This idea is at the core of the creation of the MaaS concept. MaaS suggests that if we provide a really easy and efficient way for people to use different types of transportation such as buses, trains, and even taxis, all together, it could replace the need for everyone to have their own car in the city. The idea is to make it so convenient that people might not feel the need to rely on their own cars as much anymore. If the quality of this service is good enough and benefits people in their daily lives, maybe people will not have the need to buy their own private cars anymore for their travel needs, at least in the urban sphere. MaaS, in the last few years, has been seen as a potential game changer in the field of transportation. By potentially encouraging a transition from using private cars to utilizing shared transportation options, including public transit, MaaS is frequently portrayed as a potential revolutionary factor in the realm of mobility (Jittrapirom et al., 2017; Mulley, 2017, cited in Audouin and Finger 2018, 25).

Some examples of how MaaS presented in the highlights of the news outlets and reports are:

- Mobility-as-a-Service (MaaS) can help developing cities make the most of complex urban transport systems—if they implement it right (Moody and Bianchi Alves 2022)
- Why Mobility as a Service is the future of transportation (Allan 2021)
- How Mobility as a Service is Revolutionizing Public Transit (Barik n.d.)
- The Mobility as a Service - Reshaping how urbanites get around (Warwick Goodall 2017)
- The economic reflection of MaaS and the expected growth is calculated as US$ 358.35 billion by 2025from US$ 38.76 billion in 2017 (Research and Markets 2018)

Pangbourne et al. discuss the MaaS concept and its implications for transportation and urban development. They mention that MaaS is also referred to as a multi-sided platform ("The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility

Governance" 2018, 34). They agree with the potential of MaaS in integrating different transport modes in one platform, adding to that the possibility of extending the MaaS concept to include urban logistics and other services, connecting them with transportation services (The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance 2018, 34). In addition, the authors also pinpoint the fact that, behind the user apps and service packages, there are business models at play (The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance 2018, 34). This situation raises important questions about fairness and the environment, which could affect the overall well-being of communities. They explain different business models and their objectives, which are crucial to MaaS implementation. One example is aggressive business models, which are some of the earliest in the market, such as Uber, disrupting the traditional taxi markets, challenging the jurisdiction of city authorities, and not actually creating a sustainable solution to the transport problems.

Another example is that, particularly in the United States, shared service providers are increasingly being used as an alternative to public transportation (The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance2018, 38). For instance, local governments subsidize residents' Uber rides in areas like Florida instead of expanding bus services (The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance 2018, 38). Local governments' reliance on services like Uber can disrupt the development of urban mobility systems.

Apart from connecting all mobility options in one platform, facilitating payment, and creating a digital system, MaaS also receives and produces massive amounts of data. Cruz and Sarmento argue that these data are crucial for planners to "understand the dynamics of the mobility system and identify the bottlenecks" (Cruz and Sarmento 2020, 2). MaaS systems gather and consolidate data from various sources. This data collection results in a valuable collection of information that can offer insights into passengers' travel patterns, preferences, and decisions. These insights are significant for decision-makers as they assist in developing improved transportation systems. Moreover, users of MaaS systems can reach the flow of real-time information. The ability to reach this information is useful for both the user and provider of the services to adjust the needs on time. However, here comes another discussion regarding data privacy from the citizen's point of view. It is stated that data gathered in MaaS systems primarily aims to extract economic value from diverse sets of information rather than utilizing it to advance public benefits (Servou, Behrendt, and Horst 2023, 3). They show that implementing smart mobility card systems utilizing big data has often been designed to aid policymakers in shaping future cities and cutting costs in public transportation operations (Servou, Behrendt, and Horst 2023, 3). The question here is if the users of MaaS are guided by the suggestions

from the system for commercial interests rather than broader public interest and sustainability objectives. They claim the shift towards a business-oriented approach can lead to treating data as a commodity rather than a tool for creating societal value regarding accessibility, reduced emissions, and traffic congestion (Servou, Behrendt, and Horst 2023, 6). This treatment can also disrupt power inequalities, transferring power from users to private companies and sidelining the sustainability goals set by the public sector (Servou, Behrendt, and Horst 2023, 6).

Another important subject when looking at MaaS related to the use of big data is the discourse on data justice. Servou et al. argue that it is important to acknowledge inherent inequalities in the production of big data itself (Servou, Behrendt, and Horst 2023, 3). Some groups in the population use digital sources more than others, so this leads to disparities in their representation. As a result, MaaS platforms may be favoring hyper-connected users and unintentionally perpetuating existing mobility inequalities in cities (Servou, Behrendt, and Horst, 2023, 3). Authors claim that data collection and utilization are not impartial processes since they carry assumptions, biases, and values.(Servou, Behrendt, and Horst 2023, 3).

Pangbourne et al. claims:

“The further commodification of urban mobility, while offering opportunities to some consumers, is not synonymous with being able to steer mobility systems to more desirable outcomes.” (“The Case of Mobility as a Service: A Critical Reflection on Challenges for Urban Transport and Mobility Governance” 2018, 43)

To address the issue of commodification of urban mobility and the privatization of transportation solutions, Servou et al. argue that the MaaS platforms "need to be collectively determined through governance processes involving both public and private stakeholders, rather than relying solely on individual choices or corporate interests" (Lyons 2021 cited in Servou, Behrendt, and Horst 2023, 3). The claim here is that making data collection and deployment explicit and transparent components of MaaS governance processes is crucial.

Analyzing the MaaS concept through a lens of mobility justice, we encounter new challenges in the transportation ecosystems in the world, new forms of injustice, and, on the other hand, opportunities for empowerment, independence, and potentially democratic results (Paredes 2023, 2).

Paredes talks about excluded groups of people in the MaaS concept, such as those who do not have access to or choose not to have or use credit cards (Paredes 2023, 2). The other marginalized groups in the context of MaaS users are those outside the system, such as those who reside in remote areas

where the MaaS concept did not exist or those who do not have access to the internet and low-income communities (Paredes 2023, 2). The author also mentions the debate regarding whether MaaS should also count people with a disability and technologically disadvantaged people. In general, the author mentions the need to emphasize the human aspect of technology use, which can offer valuable perspectives on how MaaS can be designed to offer just results for those outside of the system.

According to Behrendt and Sheller, the mobilities turn in social sciences has already started to concern datafication regarding the production of uneven mobilities and differentiated mobile subjects (Behrendt and Sheller 2023, 30). Authors claim that "the 'datafication' of mobility raises new questions with regards to justice" (Behrendt and Sheller 2023, 1). In the article, they look for the answers to the new questions by linking mobility justice scholarship and data justice to develop a mobility data justice framework. The article highlights this growing convergence of two distinct yet interconnected fields and tries to fill the gap with a new hybrid approach. The authors explain how different data-use and gathering processes impact mobility systems and practices. They seek how this connection of mobility and data can amplify the existing inequalities and create new ones. They explain how data is in interplay with mobilities by saying:

"Being mobile, nowadays, more often than not involves the production, storage, and sharing of data (consciously or not), from car sensor data for diagnostics and car insurance apps to ticketing apps for public transport, geofencing of urban bike or scooter share schemes, use of Google maps, step counting or running fitness and well-being app, Internet of Things (IoT) data from traffic lights or car parks, air pollution data from airports." (Behrendt and Sheller 2023, 4)

In the case of smart cities and MaaS, the growing use of big data reaches diverse domains and becomes more prevalent. However, as argued by Behrendt and Sheller, the potential uses associated with these data-centric applications extend beyond altering mobility patterns and injustices; they also influence how we gather and interpret information about mobility (Behrendt and Sheller 2023, 13).

They state that:

“Mobility data justice is crucial to all forms of public formation and communication, political organizing and protest, physical movement, and mobility, while it also concerns the mobility of data itself.” (Behrendt and Sheller 2023, 5)

Their study builds on existing literature to explore questions related to inequalities increasing with the interplay of mobility and datafication. They emphasize that a perspective centered on mobility-data justice is essential, particularly when considering technology-driven changes in transportation

like MaaS, which could unintentionally exclude certain social groups or reinforce technological divides, as explained before in this chapter. They claim that:

"As data is central to MaaS, this comes with 'the threat of potential enclosure of our mobility systems by allowing private entities to control the products that enable people access to transport through integrated platforms as well as through data monetization" (Pangbourne et al. 2020, 47 cited in Behrendt and Sheller 2023, 14)."

The role of data-driven AI in mobility systems' governance and the privatization of mobility systems raises challenges. It is essential to ensure that data collection and use works for the common good.

The influence of major tech corporations on mobility infrastructure is also discussed in the article, with the concept of 'tech mobility' examining their role in reshaping urban mobility. Henderson's research on tech mobility and the focus on the influence of big data companies such as Google and Uber ask the question of whether technology-enabled modes of transportation can be used in a manner that does not simply support the existing car-centric transportation system and the inequalities present in cities (Henderson 2018 cited in (Behrendt and Sheller 2023, 20). Instead, can these technological advancements be directed towards initiatives reinforcing to enhance cycling infrastructures, improve public transit options, and increase population density in remote and suburban areas, is the main concern in Henderson's research, for an equitable urban future.

Finally, Behrendt and Sheller state that environmental considerations are not persistently included in the discussions of data justice while asserting that this is something that needs urgent attention. They claim that environmental concerns are addressed already, but there is still room for further exploration of how environmental factors intersect with data justice. According to the authors, a mobility-centered perspective, looking at the environmental and ethical impacts of data usage and examining environmental data justice can impact future studies. Overall, they claim that mobility, data, and justice are interconnected concerns for any study regarding mobility and (im)mobilities since data is interpreted into almost any aspect of mobility. Any research that delves into data at various scales will likely encounter elements of mobility – data movement, physical movement of people or objects, financial transactions, and so on. All in all, 'justice concerns pertain to all mobility and data issues' (Behrendt and Sheller 2023, 26).

2.5 Promotion of Active Travel Modes

Urban dweller is argued to be a pedestrian first and then becomes multi-modal traveler with the help of the latest technology and digitalization (Copenhagen: WHO Regional Office for Europe 2022, 2). While explaining the new ways of moving in the urban area, it is also essential to mention the active travel modes, also concerning sustainability. It is claimed that a truly sustainable mobility paradigm must include a large share of investment in walking and cycling (PATH 2022) but also, in wider terms, investment in active mobility. In scholarly research, it is important to recognize the term active travel and how it has been shaped throughout the years. Cook et al. argue that the term 'active travel' is relatively new compared to other terms that have historically covered walking and cycling. Terms like 'non-motorized modes,' 'slow modes,' and 'low-speed modes' were previously used to refer to walking and cycling, but they were not entirely satisfactory (Cook et al. 2022, 152). The term sustainable transport, including walking, cycling, and environmentally friendly modes such as trains and buses, has widened the scope further (Cook et al. 2022, 152). Lately, the term micromobility has been involved with the emergence of lightweight personal vehicles.

When Cook et al. conducted a literature review on active travel to see which disciplines are engaged with this term, they found out that the articles covered represent two main disciplines, transport and health (Cook et al. 2022, 152). These findings imply that the historical background and implied meanings of active travel emphasize physical activity over the intended purpose or the mode of transportation (Cook et al. 2022, 152). A fundamental goal within public health strategies is the promotion of active mobility, which involves incorporating physical activity into daily routines (Koszowski et al. 2018, 2). The incorporation of physical movement not only boosts overall physical activity levels but also aligns with transportation planning objectives. Modes of active mobility offer adaptable space-efficient options, have minimal costs for both individuals and society, and, when used alongside public transportation, can effectively address a wide range of mobility requirements (Koszowski et al. 2018, 2). Overall, active mobility is at the intersection of subjects of public health, transport planning, and urban planning.

Cook et al. aim to enlarge the definition and scope of the term active travel while seeking to explain it beyond walking and cycling. (Cook et al. 2022, 153) Their definition is as follows:

"Travel in which the sustained physical exertion of the traveler directly contributes to their motion." (Cook et al. 2022, 154)

In their definition, they claim that they intentionally do not specify the exact level of effort required for active travel. This information is excluded due to not wanting to exclude certain forms of active travel. (Cook et al. 2022, 154) They allege that 'walking, running, scooting, wheeling, at any pace, whatever its effect on heart rate, is active movement' (Cook et al. 2022, 154).

However, they assert the difference between an exerted effort that contributes to continuous motion. In the meaning that they do not include the action of initiating movement on an e-scooter or e-skateboard, which does not demand sustained physical effort to maintain motion (Cook et al. 2022, 154).

Apart from the efforts of various scholars such as Cook et al., there exist other definitions of active travel and active mobility. Although there is still not a unified definition like the others explained previously in the chapter, there are similar characteristics in diverse definitions. Here are some of the definitions:

“Active mobility covers walking and cycling as well as other human-powered modes (scooters, skateboards, etc.) as modes of urban – or in some cases even inter-urban – transportation.” (Mobility Academy 2020)

“Active mobility is a regular physical activity undertaken as a means of transport. It includes travel by foot, bicycle, and other vehicles, which require physical effort to get moving. It does not include walking, cycling, or other physical activity that is undertaken for recreation purposes.” (EIT Urban Mobility 2020)

“Active mobility is defined as utilizing walking and cycling for single trips or within a trip in combination with public transport.” (PATH 2022)

Adding to this definition, Gerike et al. explain that:
“Walking and cycling for transport solely or in combination with public transport, also referred to as active mobility (AM), are well suited to provide regular PA. In contrast to sports or exercise, AM requires less time and motivation; it is convenient as a mode of transport and as a form of exercise, and it is economically affordable.” (Gerike et al. 2015, 2)

As can be seen, the emphasis on walking and cycling is evident in these definitions. Another point is that these active modes should not be used for recreational purposes and should be used solely as transport means. However, it is defined, active travel has started to be included as an alternative to motorized transport since cities worldwide recognize that a well-balanced set of strategies, which rebalance the distribution of transportation modes and redistribute public areas – prioritizing humans over cars – has the potential to shift the narrative around transportation towards a more favorable direction (Cook et al. 2022, 159).

Regarding the inclusive definition from Cook, here is a figure that shows active modes of transportation with different categorizations.

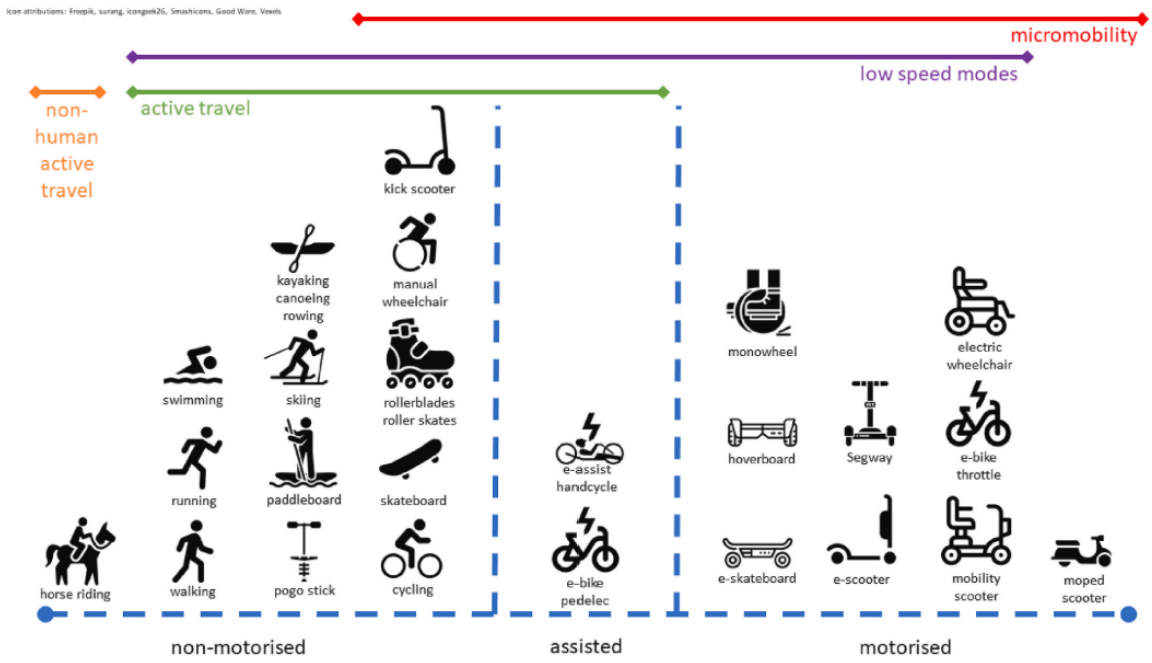


Figure 2 Active travel modes and their categories. Source: Cook et al., 2022

In the article, the authors categorize different ways of active travel. They show four categories with three classifications explaining the vehicles and the way they move. According to this figure, we can take a look at micro-mobility solutions. The definition is as follows:

"Micromobility refers to a range of small, lightweight devices operating at speeds typically below 25 km/h (15 mph) and is ideal for trips up to 10 km." ("Defining Micromobility" n.d.)

Micromobility considers lightweight, compact travel modes, and the design aims to cover short-distance trips in urban areas. These modes can be motorized, assisted, or non-motorized, as shown in Figure 1. Micromobility solutions can help navigate congested urban areas. As it is a relatively new concept and there should be more research on it, it can be said that micro-mobility solutions can offer more sustainable and environmentally friendly options to traditional motorized vehicles, especially for short journeys. Its rise has been facilitated by technological advancements such as lightweight materials, better battery life, and increasing app-based sharing services so that users can easily use and adapt to the technology. It is important to mention that micro-mobility is also a growing business, as can be seen in this passage:

"As of August 2020, there are more than 260 shared micro-mobility systems, including docked and dockless bike-share and e-scooter systems, in the United States, and the largest of these shared systems include several thousand micro-mobility devices. According to a recent National Association of City Transportation Officials (NACTO) report, users took 136 million trips in 2019 on shared micromobility systems, a 60 percent increase from 2018" ("Shared Micromobility in the US: 2019" 2019).

As in all transportation methods, safety in micro-mobility is an important aspect. There are still a lot of advancements necessary to improve the safety and comfort of the users. US Department of Transportation notes that, regarding the report that discusses shared micro-mobility, *Shared Micromobility in the US: 2019, "...* findings calling for more attention to the need for a connected network of facilities dedicated to serving micro-mobility" (Price et al. 2021).

The future of micro-mobility holds a significant role in the new ways of moving in urban areas, contributing to efficient, sustainable mobility options for short distances. However, planners, policymakers, and technology developers must collaborate to realize the most efficient way and full potential of micro-mobility to shape the future of urban mobility. After explaining micro-mobility solutions, this chapter will continue with an emphasis on the more traditional active travel modes: walking and cycling.

Active mobility has a wide range of advantages encompassing health, environmental well-being, economic benefits, and so on. The transition towards active travel modes in urban areas plays an important role in tackling the numerous challenges stemming from existing transportation methods. Among the challenges of traditional transportation approaches are air pollution, greenhouse gas

emissions, noise, traffic, and congestion, and decreased public space. Leyendecker and Cox, while mentioning cycling, explain that its value is recognized by international declaration as "an equal mode of transport and as an integral part of an intermodal mobility chain" (Leyendecker and Cox 2022, 2). The authors discuss the impact of active travel, particularly cycling, on both those who use cycling as a mode of transportation and those who do not. Active travel, such as cycling, has positive effects on both the well-being of the individual and society. Among the benefits of active mobility are reductions in greenhouse emissions, improved air quality, decreased noise pollution, and enhanced social and economic equity. Active travel proves to be efficient in terms of space, affordable, and provides an inexpensive commute to work or school. Furthermore, it can contribute to users' independence and overall health.

Leyendecker and Cox, in their article, mention the concept of a 'just city' by Fainstein. According to Fainstein, just cities are composed of values of democracy, equity, diversity, growth, and sustainability (Fainstein (2005) Urb. Affairs Rev. 41). The concept refers to development that revolves around creating equitable, inclusive, and fair cities for all its residents, regardless of their socioeconomic status, race, ethnicity, gender, and any other characteristics. The creation of the idea of a just city relies on the principle that urban spaces should be designed and managed in a way that ensures access to fundamental services and resources, and opportunities for each resident, especially those who are disadvantaged or marginalized. Leyendecker and Cox state that Fainstein emphasizes that her use of the term 'city' is not confined solely to urban areas; rather, it is defined as any spatially defined unit that serves as the focus of planning (Leyendecker and Cox 2022, 3). Feinstein claims that the policies implemented in cities fundamentally affect people's quality of life. Achieving a just city requires a holistic approach that considers both spatial and social dimensions of urban development. It involves addressing systemic injustices, advocating for policies that promote social and economic inclusion, and ensuring that urban planning processes prioritize the well-being of all residents. The concept of a just city tackles discussions on social justice, human rights, and sustainability in urban contexts. In this regard, the concept of a just city and the concept of mobility justice are closely related. Both concepts consider the idea of creating a fair urban environment that places importance on the well-being of all residents. A just city strives to terminate systemic injustices and create an urban area where everyone is treated equally, such as mobility justice also recognizes the historically marginalized communities and the barriers they face when accessing transportation, which then leads to limited opportunities in different aspects of life. In sum, both terms share the same goal: creating urban environments that are inclusive, fair, and provide equal opportunities; while just city considers mostly urban planning, the context of transportation is just one aspect among other systematic challenges in mobility justice.

Regarding the issue of urban cycling, Leyendecker and Cox mentioned in their article the women activists' struggle in the cities. According to the authors, activists claim the issue of urban cycling is a matter of spatial justice (Leyendecker and Cox 2022, 7). At this point, the authors explain the creation of cycleways and separated lanes to promote cycling in cities. The cycleways remove the dangers arising from fast motorized traffic. These separated lanes can also benefit people with disabilities as they enhance a slower, more relaxed movement. Moreover, the authors also explain how the efforts of activists to push for change in space also had political implications (Leyendecker and Cox 2022, 8). Although they claimed to acquire space from the dominance of automobiles, their call for space was taken as political.

Examples of cycling initiatives in various parts of the world include information from China and France. In Hangzhou, China, a bike-sharing program has been established, comprising 2,700 bike stations and an ever-growing fleet of over 85,800 bicycles (Oldaker 2022). This establishment has gained attention from the population and reached a certain popularity and reached 115 million bike rentals in 2017 (Oldaker 2022). It is amongst the most impressive examples of a bike-sharing system globally.

Another example is Paris City's implementation of cycle lanes. During the COVID-19 pandemic, Paris has taken important measures to re-evaluate its cycling infrastructure. In 2021, Mayor Anne Hidalgo announced that they would turn Champs-Élysées into an 'extraordinary garden' with cycling lanes, with an investment of 250 million euros (Willsher 2021).

Paris's ambitious bicycle plan for 2021-2026 strives to render the city completely cyclist-friendly, to reduce car usage in favor of cycling. This initiative could potentially position Paris as one of the most bicycle-friendly cities worldwide.

With the cycling network starting to be implemented at the city's heart, citizens' life quality improved. It is stated that:

"The three-meter-wide bidirectional bike lane on Boulevard de Sébastopol moves 19,000 cyclists/day. The remaining 10-meter width moves 15,000 cars/day." (Bruntlett 2022)

Another significant improvement is that:

“In Paris, emergency response times have fallen because firefighters can now use the growing bike lane network - and cyclists disperse much easier than cars.” (@fietsprofessor 2023)

According to Pucher and Buehler, the strategies and policies required to enhance pedestrian and cycling infrastructure have been successfully implemented in various European cities for decades (Pucher and Buehler 2010, 409). Authors argue that a single approach alone that fits all is invalid and insufficient. What cities need is a collective and holistic strategy highlighting the promotion of walking and cycling (Pucher and Buehler 2010, 409). Another point is to effectively communicate the societal benefits of walking and cycling that have a wide range and, in this way, collect public and political support to implement the policies successfully.

After looking briefly at the discourse on cycling, we can also observe some of the research on walking. Walking, as a mode of transportation, can be considered the most sustainable solution. Using walking as transport can reduce physical inactivity, air pollution, and emissions of greenhouse gases (Copenhagen: WHO Regional Office for Europe 2022, 5). The report prepared to measure the effects of walking and cycling states that 'investments in policy actions that promote walking and cycling can contribute directly to achieving many of the Sustainable Development Goals (Copenhagen: WHO Regional Office for Europe 2022, 5). The COVID-19 pandemic has also been a catalyst for change, according to the report; with the emergence of the pandemic, people had the opportunity to try alternative transportation options.

Apart from the influence of the pandemic, climate change and its tangible impacts started influencing transport planning. A crucial aspect of solving climate-related issues needs decreasing private cars and motorized traffic. A shift from using cars for short travels to adopting active mobility modes, like walking and cycling, is among the strategies to mitigate climate change (Copenhagen: WHO Regional Office for Europe 2022, 5). Not only the transport sector but also the health sector is promoting the gains that society can acquire from active travel modes used as transport. Walking is not only healthy for the individual but is also one of the most sustainable ways to travel. Walking along with cycling are travel modes that use space efficiently, a characteristic that gains significance as urban populations continue to grow, leading to increased competition for limited space within urban environments (Copenhagen: WHO Regional Office for Europe 2022, 21). The fact that walking is highly space-efficient and the amount of space an individual uses walking as transportation points to the intensity of roadways and parking spaces allocated for motorized vehicles. Numerous sources have drawn attention to the contrasting space demands across different modes of transportation (Copenhagen: WHO Regional Office for Europe 2022, 21). These comparisons clearly reveal that cars demand the largest share of space, while pedestrians need the least. As such, public transportation is also noted

as an efficient use of space, similar to walking (Copenhagen: WHO Regional Office for Europe 2022, 25).

Another point when looking at walking and active modes of travel is that they are mostly considered slow modes of travel (Copenhagen: WHO Regional Office for Europe 2022, 24). When considering motorized options, active modes of transportation are taken as slower. However, suppose the consideration is considered in densely congested urban areas. In that case, cars can be seen as slow modes too, since their average speed would be much lower than expected and also the waiting time would be added to the journey. In this case, WHO argues that while active modes may lag in terms of travel speed, they can compensate by providing greater reliability in travel time (Copenhagen: WHO Regional Office for Europe 2022, 24). The potential delays, congestion, being stuck in traffic, and so on make the travel time for motorized vehicles unpredictable. However, walking and cycling remain unaffected by those external factors, so the travel time is more predictable.

Furthermore, policymakers advocate various strategies and approaches to attain sustainable mobility goals. These efforts range from transport policies, urban planning, and technological innovations to awareness campaigns targeting both citizens and operators. Rietveld puts out a classification among how governments can stimulate non-motorized transport and promote active mobility. The list (Rietveld 2001, 311) goes as follows:

1. physical planning,
2. infrastructure planning,
3. regulation of transport,
4. technological development,
5. financial instruments,
6. organizational measures (stimulation of other actors), and
7. policies with respect to other transport modes.

To briefly explain, we can look at the importance of physical and infrastructure planning. Rietveld states the significant role urban planning plays in influencing the use of non-motorized transportation modes (Rietveld 2001, 303). Walking, specifically, is affected by the design and layout of the physical environment. Factors such as the presence of sidewalks, bike lanes, pedestrian-friendly streets, proximity to destinations, and accessibility to public transportation, are affecting the promotion of active mobility. Rietveld gives an example from the European Union policies, which often implement

strategies to ensure minimal residential density and restrict residential construction locations based on government guidelines (Rietveld 2001, 311). Giving space when planning to cycle paths and sidewalks and separating motorized and non-motorized traffic are among the traditional ways to include active travel modes in transport networks.

Another noteworthy point is the regulation of transport by implementing diverse strategies. The introduction of pedestrian zones in urban cores is already implemented in some European cities, such as Freiburg, Nuremberg in Germany, and Groningen in the Netherlands (Rietveld 2001, 312). Implementing pedestrian and biking zones in historic urban centers can influence the use of active modes of travel when moving into those areas.
Moving on to other considerations in promoting active travel, safety and accessibility are of great importance. Safety constitutes a crucial concern regarding the strategies to adopt active mobility (Rietveld 2001, 312), Rietveld especially takes a look at the safety concern for the children and explains how parents serve as personal drivers for their children to accompany them to school or other destinations. Not only children but also adults can be discouraged if they feel that the use of active modes is not safe enough to adopt in their cities. Establishing safer transportation networks would create opportunities for a shift towards non-motorized modes of travel (Rietveld 2001, 312). Accessibility also plays a significant role in implementing active mobility; if there is an ease of reaching desired destinations, such as workplaces, schools, stores, and recreational facilities using active transportation modes, more and more people will adopt them.

Overall, the determinants of adopting active mobility are multifaceted and interconnected, ranging from policy decisions to individual preferences, environmental factors, and societal norms. Understanding these determinants is essential for promoting and facilitating active transportation as a sustainable and healthy mode of travel. Highlighting the diverse advantages encompassing health, environmental well-being, economic prosperity, and societal progress forms a compelling rationale for adopting active mobility.

In sum, this chapter has provided an exploration of sustainable transportation options and new mobility solutions. By examining the evolution of transportation systems, from traditional modes to innovative, environmentally friendly alternatives, we can gain a deeper understanding of the pressing need to transition towards more sustainable forms of mobility. The integration of technology-driven solutions, innovations on transport systems that allows people to reach the services easily, such as MaaS, presents a promising path forward in reducing the environmental impact of transportation

while enhancing accessibility and convenience. It is also noteworthy to always consider the active travel modes, which are in the end, the most sustainable options, environmentally. However, it is clear that achieving a truly sustainable transportation system requires a multifaceted approach, including policy support, infrastructure development, and public awareness. This chapter has set the foundation for information regarding opportunities in realizing a more sustainable future for mobility.

CHAPTER 3 Italy's Sustainable Mobility Landscape: Current State and Urbanization Trends

Europe constitutes an alliance of cities and towns, with approximately 75% of the population of the European Union opting to reside in urban areas (European Environment Agency 2017). Nevertheless, the consequences of urbanization transcend the borders of cities. Europeans have embraced urban ways of life and used urban conveniences, including cultural, educational, and healthcare facilities (European Environment Agency 2017).

Italy, officially known as the Italian Republic or the Republic of Italy, is a nation located in Southern and Western Europe. Covering an area of 301,340 square kilometers, Italy is home to a population of roughly 60 million people, and it holds the rank of the third most populous member state within the European Union, stands as the sixth most populous European country, and ranks as the tenth largest country in terms of land area on the continent (Wikipedia, 2023).

As of 2023, Italy's urban population constitutes approximately 72% of its total population. The country's urbanization rate is estimated to experience an annual change of 0.27% between 2020 and 2025. Significant urban centers include Rome, the capital city, with a population of 2,318,895 million; Milan with 1,236,837 million; Naples with 959,470 million; Turin with 870,456 million; and Palermo with 648,260 million residents (https://worldpopulationreview.com/countries/cities/italy).

To take a look at the urbanization trend in Italy, we can observe the urbanization rate. This rate demonstrates the proportion of the overall population residing in urban areas. To visualize this trend, the graph presented below can be employed to depict Italy's urbanization rate over a specific period between 2000 and 2030.

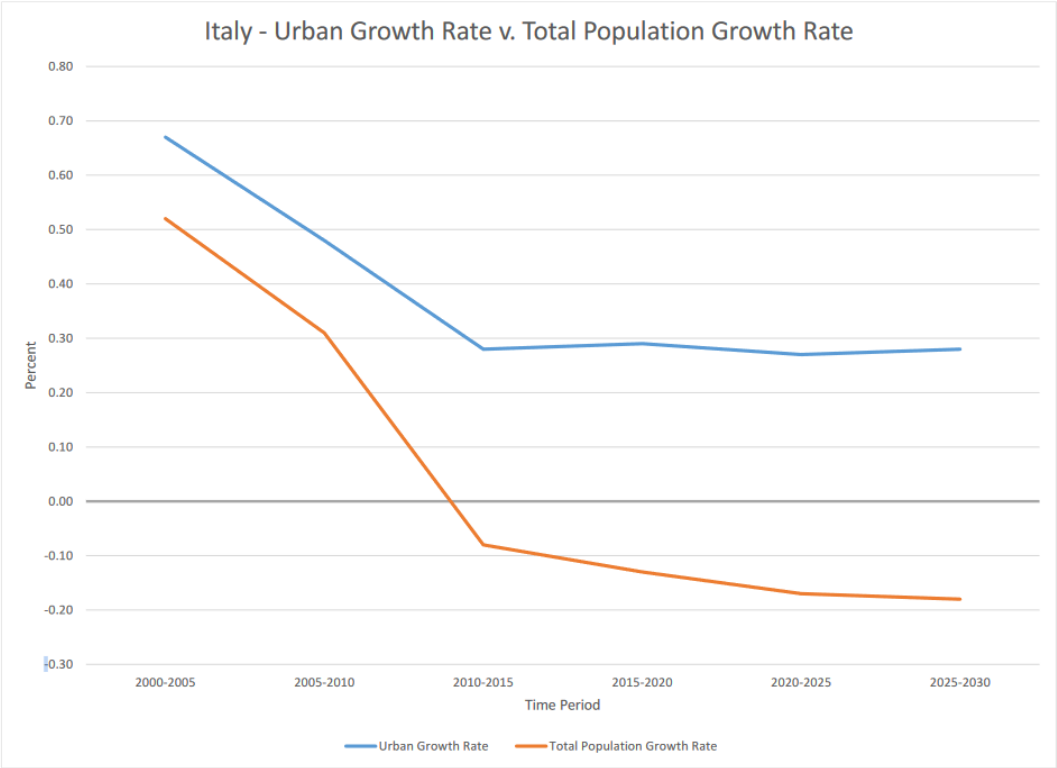


Figure 3 Italy's Urban Growth Rate Source: ("The World Factbook" 2023)

While the total population growth rate shows a negative trend after the 2010-2015 period, the urban growth rate stays on the positive side, showing a slight increase. The next graph shows the degree of urbanization in Italy over ten years, from 2012 to 2022.

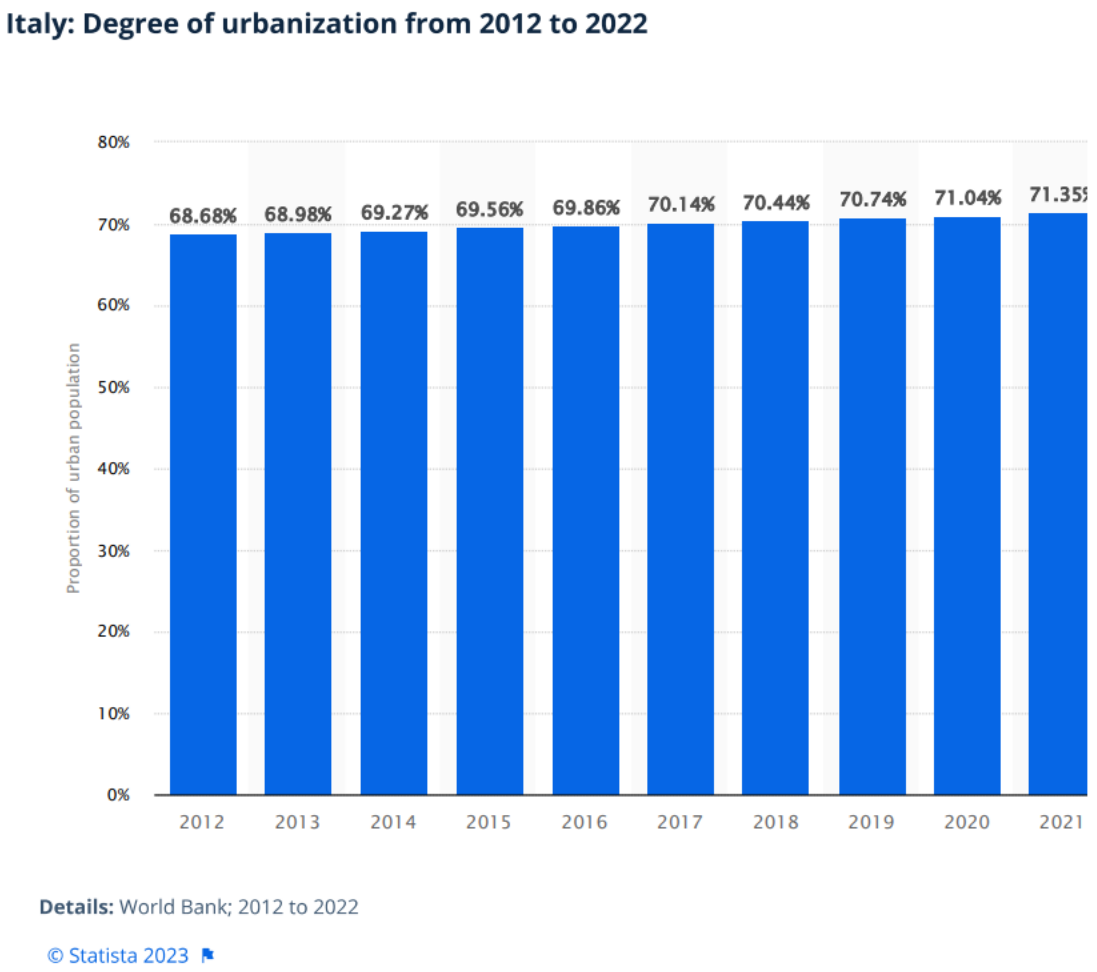


Figure 4 Italy: Degree of urbanization from 2012 to 2022 Source: (O'Neill 2023)

All in all, it can be seen that Italy has experienced increased urbanization rates in the last decades, and today, a significant portion of Italy's population has been residing in urban areas. Diverse reasons can explain the population movement from rural to urban areas, economic reasons being the most important. Offering a wider range of employment opportunities, better education facilities, healthcare services, and cultural amenities, urban environments attract many people looking for a life better lived. Although urbanization has many benefits, it also comes with diverse challenges. Issues such as environmental degradation, increased housing demands, congestion, and traffic can impact the overall sustainability and well-being of both people living in urban areas and the urban environments. To combat the challenges of urbanization, the government of Italy has implemented various measures and policies over the years. The efforts are designed to address the challenges posed by urbanization and promote sustainable mobility and urban development, bettering public transportation, creating climate-resilient cities, and increasing citizens' quality of life.

Following this chapter, we will first look briefly at the challenges that Italy faces, then continue with the measures taken by the government.

To understand the urbanization trends and the challenges in Italy, we can take a look at the changes in land use over the years. The transformation of land in Italy in the past decades has been shaped clearly by the force of urbanization. Like in many countries developing over the years, as in Italy, urban development has manifested in the form of sprawling. This development created settlements that extend across vast and low-density areas. This pattern, known as "sprawl," has been a defining characteristic of urban expansion worldwide (Romano et al. 2017, 387). Romano et al. state that urban sprawl within the context of Italy shows the intricate interplay of historical events, urban planning policies, and economic dynamics. This situation has resulted in a unique urban development landscape requiring detailed examination.

The comprehensive study undertaken by Romano, Zullo, Fiorini, Marucci, and Ciabò explored the evolution of Italy's settlements starting with the aftermath of World War II, tracing the path of urbanization over a span of fifty years. This research aimed to present the road of urbanization that Italy underwent over fifty years following the war. The significance of this investigation lies in its revelation of a complex and multifaceted web of growth dynamics that set Italy apart from other European nations, comparing the urbanization patterns (Romano et al. 2017).

As Romano et al. explain, the aftermath of World War II witnessed a paradigm shift in Italy's urban scene. The introduction of the "Marshall Plan," followed by the "Fanfani law" and the INA Housing program, led to transformative changes across the country (Romano et al. 2017, 387). Between the years of 1949 and 1963, the country saw increased amounts of opening of building sites, in the building of over 350,000 dwellings. This exceeding expansion significantly affected Italy's urban fabric, resulting in rapid growth (Romano et al. 2017, 387).

By the mid-1960s, a shift in urban dynamics became evident as economic pressures on land use had intensified. The consequences of this shift were seen in the uncontrolled proliferation of urban development. The economic pressure drove uncontrolled, often unauthorized, and illegal territory expansion (Romano et al. 2017, 387).

Throughout the 1980s and beyond, urbanization, often characterized by its sprawling nature, extended across various landscapes, including rural plains, river valleys, and hill areas. This expansion was costly, as it built upon vulnerable hydrogeological zones, exposing settlements to increased risks.

Adding to these concerns, ongoing climate change further exacerbated the vulnerability of these settlements (Romano et al. 2017, 388).

As Italy confronts the challenges posed by uncontrolled urban expansion, there is a growing recognition of the need to rethink urban areas that align with environmental, social, and economic sustainability. Understanding the diverse urbanization models that have shaped Italy's landscape is significant in shaping future frameworks that cater to the unique settlement patterns of different regions (Romano et al. 2017, 388).

It is noteworthy that in the Italian context, urban transformation is first and foremost regulated at the municipal level (Romano et al. 2017, 389). While regions provide laws and framework plans, municipalities hold the authority to make concrete urban planning decisions. This decentralized approach can lead to diverse outcomes regarding urban development patterns. Romano talks about how the concept of “sprinkling” has emerged to encapsulate Italy's distinct land take pattern, characterized by partially spontaneous development with limited controls. Unlike the internationally recognized urban “sprawl” model, the term “sprinkling” involves dispersed settlements of varying sizes and uses, reflecting a mosaic of rural, residential, industrial, and other functions (Romano et al. 2017, 1).
The importance of accurate data collection and analysis in understanding urban growth patterns cannot be overstated. Unfortunately, Italy's planning landscape has been criticized for its inefficiency, leading to challenges in obtaining comprehensive data on urban expansion. In stark contrast, other countries have actively modeled urban growth, utilizing advanced computational methods to explore various facets of urban development (Romano et al. 2020, 10).

A significant example in the context of the urbanization trend in Italy is the case of the Po Valley, which is characterized by rapid urbanization and economic productivity. The urbanization of this vast area poses unique challenges to emerge. Despite its economic importance, the Po Valley grapples with high pollution levels, posing environmental and sustainability concerns. The convergence of economic dynamism and population growth has resulted in an urban transformation characterized by dispersed settlements across the territory. The Po Valley, spanning multiple regions across the country, highlights the need to balance economic growth with environmental preservation and quality (Romano and Zullo 2015, 115).

In light of the unsustainability of past planning strategies, Italy faces a pressing challenge in effectively managing the pressure resulting from unregulated urbanization. Formulating national and regional legislation is necessary to address this issue, providing a comprehensive framework to guide urban transformation while promoting sustainability (Romano et al. 2017, 15).

Overall, Italy's path to urbanization has been shaped by diverse factors, from historical events to economic pressures and planning policies. The diverse landscape of Italy's settlements reflects the nation's unique path in responding to the necessities of growth, sustainability, and quality of life. As Italy struggles with the implications of urban expansion, it is evident that a strategic approach to urban development, backed by comprehensive data and innovative paradigms, will play an important role in shaping the nation's urban future.

3.1 Urbanization strategies during the pandemic

A significant challenge in the last years that led countries worldwide to realize the importance of greener and more sustainable cities is the COVID-19 pandemic. When a new type of Coronavirus, now called COVID-19, emerged and spread globally and rapidly in 2019, it was clear that the urban areas and the activities around it were the ground zero of the pandemic. (Angiello 2020, 272) The density of people and activities in urban areas has generated a large debate about the future role of cities in the post-Covid scenario. In this regard, some scholars have argued that vast urban areas are nearly defenseless in times of unprecedented disease outbreaks (Desai, 2020, cited in Angiello 2020, 273) and that dense urban settlements are not compatible with the needs of social distancing (Naglaa and Ghoneim, 2020 cited in Angiello 2020, 273). Adding to some scholars' concerns, others advocated for that time to be an opportunity to reshape the cities so that they become greener, cleaner, and more resilient cities in the future.

Italy, being one of the countries that was hit hard by the pandemic and affected significantly, scholars investigated it. Angiello states that Italy's response to the pandemic was in three primary levels of governance. The national, regional, and local levels provided strategies and measures. Particularly in this framework is the noteworthy role played by municipalities enforcing measures taken by observing the unique circumstances within their respective areas (Angiello 2020, 272). In his study, Angiello focuses on Italy's response to COVID-19 by focusing on the four main cities and examining

the policies and actions taken to combat the effects of the pandemic. Rome, Milan, Naples, and Turin are examined. Angiello discusses the challenges in urban areas while providing insights into the measures taken by local administrations. The author's assessment also considers the broader goals of enhancing the sustainability and resilience of urban communities while dealing with the pandemic. One of the assessment measures is the expansion of cycling infrastructures in Milan, Roman, and Naples. This is due to the possibility of social distancing, minimizing the risk of contamination of the virus, and reducing the crowdedness of public transportation. With the promotion of cycling, cities allow residents to meet their needs while engaging in physical activity, even during pandemic situations (Angiello 2020, 276).

Another measure involves increasing walking paths and pedestrian areas in cities like Milan and Naples. This not only encourages sustainable mobility by shifting away from private vehicles to walking but also creates more space for safe physical distancing. Another promotion of healthier forms of transportation, together with improvements in urban sustainability, can be seen in this measure (Angiello 2020, 276). These two improvements contribute to urban sustainability, reducing the reliance on cars and, in the context of the pandemic, supporting businesses to be able to reopen by accommodating longer lines while maintaining safe distances (Angiello 2020, 276). The extension of green spaces is another focus of the measurements. Expanding green and open spaces in urban environments positively affects the environment and improves public health and quality of life (Angiello 2020, 277).

In summary, Italian cities have undertaken various measures to address the COVID-19 pandemic's immediate challenges while aiming to improve their urban communities' sustainability, resilience, and well-being in the long run.

The response of the four cities in Italy, examined by Angiello, showed a reaction to the challenges posed by the COVID-19 pandemic through a mix of interventions aimed at promoting sustainable mobility and digitizing public services. However, he also argues that while many cities have taken individual steps to encourage activities like walking and cycling and improving digital services, these efforts have often lacked synchronization and a broader vision (Angiello 2020, 278). According to the author, the consideration lacks a look at how these measures fit into the larger picture of urban resilience and sustainability, apart from the example of Milan (Angiello 2020, 278).

3.2 Urban Mobility Plans in Italy

To address the obstacles posed by years of unregulated and extensive urbanization, as well as global issues such as climate change and pandemic, Italy has been actively promoting sustainability in urban areas for the last decade. Sustainable Urban Mobility Plans represent a crucial instrument in this effort, presenting the most comprehensive strategies for urban mobility throughout Italy.

Although, as explained in the first chapter, even before the implementation of SUMPs all over Europe, there were single examples, also in Italy, where various cities were already experimenting with measures to address traffic congestion and air pollution, such as implementing limited traffic zones and promoting public transport. However, they were single efforts not combined with future inclusive plans. It is stated that the regulation of local public transport in Italy requires close national regulation (Cassa depositi e prestiti, Rivolta, and Reviglio 2013, 33). The local public transportation industry has faced regulatory uncertainty and inefficiency because of the instability of public resources and inadequate governance solutions (Cassa depositi e prestiti, Rivolta, and Reviglio 2013, 36). Consequently, various regulatory measures were implemented over the last decade of the 20th century. Nevertheless, a ruling by the Constitutional Court has mandated a return to the rules governing local public transportation services as set out in Legislative Decree no. 422/1997, Burlando Decree, was issued by the delegation of Law no. 59/1997 (Bassanini Law). This regulatory framework follows the principles introduced in 1997, which granted legislative authority to the regions and decentralized administrative functions, such as planning and programming, to them. In general, this return to the previous regulatory framework aimed to establish stability and transparency in the local public transportation sector. The analysis of the local public transport (LPT) industry exposes a challenging scenario that requires a coordinated intervention capable of generating a transformative impact (Perretti 2014, 120). Perretti stated that the Burlando Decree addressed planning, efficiency incentives, and a novel market and governance framework.

However, despite several years and reforms, the Italian LPT sector continued to face challenges that will influence its future structure. The economic crisis in the early 2000s led to decreased resources and reduced demand for mobility among people. Nevertheless, the escalating fuel cost and a reduction in disposable income have led to an increased public transportation demand. This did not necessarily imply a shift in transportation modalities, but it allowed Italy to enhance its competitiveness and

development, particularly given its high motorization rate. The LPT sector should be restructured to become a proper industry, although defining its future was complex due to different variables (Cassa depositi e prestiti, Rivolta, and Reviglio 2013, 85). Taking action was essential to ensure that LPT meets the characteristics of a strong industry. According to Perretti, immediate and decisive action was necessary for companies to regain control over their revenue mechanisms and accept complete managerial responsibility. Failing to intervene would have extremely costly consequences (Perretti 2014, 121). The intervention would benefit Italian citizens, who incur an additional mobility cost of approximately €6 billion annually compared to other EU nations (Cassa depositi e prestiti, Rivolta, and Reviglio 2013, 85).

The inefficiencies in the LPT affect not only the economic and social aspects but also the health and quality of life of the citizens, as well as climate change and the environment. The integration of a more comprehensive urban mobility planning was also significantly underlined by the European Union, with the European Commission's White Paper in 2001 on transport, and later with the adoption of SUMPs. The need for integrated, sustainable, comprehensive, and efficient urban mobility planning throughout Europe has impacted several countries. The adoption of SUMPs across Europe has been facilitated by various EU initiatives that aim to fund their implementation, offer strategic guidance, and create networking opportunities for cities and functional areas (Angiello 2022, 557). Italy, in accordance with the principles and initiatives put forth by the European Union, has also begun to focus on this objective, aiming to create better, greener, and more efficient transportation systems. In 2017, with the publication of Decree No. 397 by the Ministry of Infrastructure and Transport in the Official Gazette, SUMPs were regulated in Italy (Eltis 2022). In August 2019, the regulation was updated through the issuance of Decree No. 396, which intends to promote a unified and coordinated method for the nation's Sustainable Urban Mobility Plans development. The decree consists of 6 sections, namely: Article 1, "Objective," Article 2, "Principles," Article 3, "Adoption of SUMPs," Article 4, "Updates and Monitoring," Article 5 "Clause of Invariability," and Article 6 "Revisions." Additionally, two attachments are titled "Procedures for Creating and Endorsing SUMPs" and "Objectives, Strategies, and Measures of SUMPs." The guidelines provide a standardized process for designing and approving SUMPs and identifying strategies mentioned in the plans. These strategies include both macro-level and specific goals, along with the corresponding actions required to achieve them (Eltis 2022). The Italian translation of Sustainable Urban Mobility Plans is "Piano Urbano della Mobilità Sostenibile," and the abbreviation used is PUMS.

Some key information regarding the rules and regulations of SUMPs in Italy, as stated on the Eltis database, are as follows:

- It is obligatory for municipalities with populations exceeding 100,000 inhabitants to adopt SUMPs, according to National Decree No. 396. However, this requirement does not apply to municipalities within Metropolitan Areas, as they must have their own comprehensive integrated SUMP.
- In 2022, municipalities and metropolitan areas that have already implemented SUMPs are planned to be rewarded with funding to support rapid mass transportation and cycling projects.
- Starting January 2023, the adoption of a SUMP will be mandatory to access funding for public transport and cycling promotion programs.
- The Ministry of Infrastructure and Transport has established a dedicated office to review draft SUMPs. These reviews ensure alignment with the European Commission's guidelines and suggest necessary improvements.
- The Ministry has introduced a platform for monitoring 17 key performance indicators (KPIs). Municipalities and Metropolitan Areas must provide input to ensure continuous tracking of progress and achievements related to these indicators.

In most EU cities, SUMPs have replaced the main strategic transportation planning documents, making them a crucial planning tool (Gallo & Marinelli, 2020, cited in Angiello, 2022, 557). Italy is no exception, as 116 SUMP initiatives have been implemented in its cities since the launch of the SUMP framework, according to the Eltis database (Angiello 2022, 557). This high number may result from innovative transportation sector regulations, incentives, and the law mandate that local authorities have to approve SUMPs in their cities to get state-level public funding for transport projects (Angiello 2022, 557).

3.3 Implementation of SUMPs in Italy

There are three crucial stages in the implementation of a SUMP: draft, adopted, and approved. These stages represent key milestones in the process of developing and formalizing the plan within the governance and bureaucratic levels of a city or urban area. The draft stage involves planning and developing the plan, where urban mobility planners work on creating the initial draft. This process involves analyzing data, involving stakeholders, and creating a complete set of strategies, actions, and measures to tackle the city's mobility challenges and align with sustainability objectives. The adoption stage is the moment when the draft of the SUMP has undergone review revision and received feedback. The responsible decision-making authority of the area is presented in this phase. If the decision-makers approve the plan, it will be formally adopted, indicating the city's dedication to the

SUMP. Adaption and approval also show the aim to implement the strategies and measures outlined in the plan. After adoption, in the latest phase, approval, the plan may require additional endorsement from higher administrative levels, such as regional or national authorities, particularly if it involves significant funding or regulatory changes. The approved SUMP will need adjustments to conform to legal and institutional frameworks. This step ensures that the plan complies with relevant laws and regulations and has the necessary institutional support for implementation.

After passing through these three stages, the SUMP becomes the official urban mobility plan for the city or urban area. Regular check-ins and reviews are necessary to ensure that the SUMP stays relevant and aligned with changing urban mobility needs and sustainability goals.

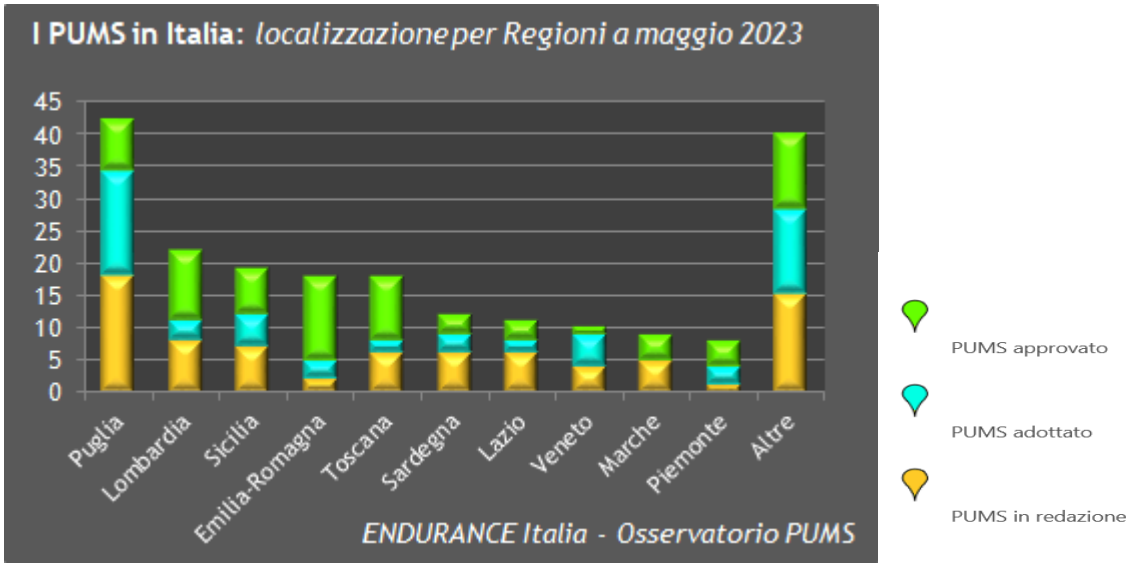
According to the data provided by the Osservatoria PUMS (SUMP Observatory), as of May 2023, there are 209 SUMPs in total in Italy. The observatory offers an overview of the status of SUMPs in Italy, using ISTAT information, surveys, and official documents from the decision-makers (Osservatorio PUMS 2023).

Table 2 State of the SUMPs in Italy (Adapted and translated from Osservatorio PUMS 2023)

State of the SUMPs	Numbers
Approved	76
Adopted	55
In Draft	78
Total	209

The table below shows the distribution of the total number of SUMPs in different regions in Italy. The information was last updated in May 2023.

Table 3 SUMPs in Italy showed by region Source: (Osservatorio PUMS 2023)



3.4 Other initiatives of sustainable mobility in Italy

Apart from adapting and implementing the SUMPs, Italy aims to achieve the Sustainable Development Goals (SDGs) related to the environment and create resilient urban communities. The SDGs were established during the United Nations Sustainable Summit in 2015, where global leaders convened to create the comprehensive framework known as "Transforming our World: The 2030 Agenda for Sustainable Development." (European Environment Agency and Karayaka 2020, 5). This framework comprises 17 global SDGs with 169 specific targets. The primary goal of the 2030 Agenda is to direct the world towards a sustainable and resilient future.

The SDGs are classified into five main areas, known as the '5Ps' of the 2030 Agenda: people, planet, prosperity, peace, and partnership. The planet category concentrates on SDGs with environmental perspectives and aims to protect the Earth from degradation (European Environment Agency and Karayaka 2020, 5). One of the most crucial steps under this category is promptly responding to climate change.

To combat the challenges of climate change and create resilient urban areas with equitable mobility, Italy has prioritized achieving SDGs 9, 11, and 13. These goals include Industry, Innovation, Infrastructure, Sustainable Communities and Cities, and Climate Action. By prioritizing these goals, Italy aims to establish strong eco-urban rural connections and promote the sustainable conservation of territories, cultural heritage, and landscapes. In this regard, Italy has developed a comprehensive

'National Sustainable Development Strategy 2017-2030' (NSDS) that the Council of Ministers endorsed in October 2017 (European Environment Agency 2020).

Almost two years later, in May of 2019, the Italian National Institute for Environmental Protection and Research (ISPRA) and the Regional and Provincial Environmental Agencies Network established the Agenda 2030 Task Force. The task force aims to coordinate and harmonize activities that support regional and provincial strategies. Later, in June 2019, the Italian Presidency of the Council of Ministers created the Cabina di regia 'Benessere Italia,' a coordination body responsible for enhancing and coordinating sustainable and equitable well-being policies and initiatives and implementing the NSDS. The Cabina di regia Benessere Italia serves as a technical-scientific support body to the Prime Minister and is focused on well-being policies and citizen quality of life assessments.

Apart from implementing SDGs and following the policies of Agenda 2030, Italy also participates in and follows the actions presented in The European Green Deal. The European Green Deal is a comprehensive policy initiative of the European Commission that was approved in 2020. According to the European Commission, the goal of The European Green Deal is to make Europe the first climate-neutral continent in the world (European Commission 2021).

The deal aims to transform the EU into a more sustainable and resilient economy. The European Green Deal covers various policy areas, including climate action, clean energy, circular economy, biodiversity, and sustainable agriculture (Grubnyak 2022). Key goals of the European Green Deal are:

- Making transport sustainable for all
- creating markets for clean technologies and products, therefore leading the third industrial revolution
- Cleaning the energy system and reducing greenhouse gas emissions by at least 55% by 2030
- Renovating resilient homes and buildings against climate change and energy poverty
- Restoring nature, enabling biodiversity to thrive, and circular and sustainable management of the natural resources
- Boosting climate action globally by working with international partners.

In parallel with the goals of the European Green Deal, Italy published on February 2022 a new inter-ministerial decree involving the Ministries of Economic Development (MISE). This decree, also known as the MISE Decree, aims to allocate financial resources to support research, development,

and innovation projects concerning ecological and circular transition. Their projects align with the "Italian Green New Deal" goals with a budget of €750 million (Dentons 2022).

The objectives of the decree and the Italian Green New Deal are in line with the goals of the European Green Deal, aiming to support the transition of economic activities into more environmentally sustainable and circular. With a green focus, goals include climate action, environmental sustainability, and economic growth. The MISE Decree represents a government initiative in Italy to provide financial support to businesses engaged in research and innovation activities that contribute to ecological and circular transition goals. This support aims to stimulate environmentally friendly and sustainable economic development, aligning with the broader vision of the Italian Green New Deal and, in the European context, aligning with the European Green Deal.

In summary, Italy has undergone increased urbanization and faced challenges in the last decades. During the 2000s and 2010s, the Italian government took steps to address the unplanned and negative impacts of urbanization and climate change. Also, with incentives and interest from the European Union regarding sustainability and equity in urban mobility, Italy has begun implementing new plans and projects on this subject. For the scope of this thesis, the focus is on the implementation of SUMPs in Italy and, specifically, the case study of the city of Padova, which we will delve into in the next chapter.

CHAPTER 4 Sustainable Urban Mobility in Padova: A Case Study

4.1 Navigating Padova: A Brief Perspective on Urban Transportation and the Characteristics of the city

Located in the heart of northern Italy's Veneto region, the city of Padova, or Padua in English, is a city characterized by its historical significance and cultural heritage, still preserving this heritage today in its ancient urban center. The ancient city of Padova has played a significant role in the history of academia, education, and culture. Padova is renowned for the University of Padova, which is the second in Italy after the University of Bologna, established in 1222.
As one of the world's oldest universities, the University of Padova has significantly influenced the city's historical development, a legacy that endures to the present day. With an enrollment of approximately 65,000 students, the university substantially affects Padova's cultural, artistic, recreational, and economic spheres. Moreover, the city has found itself twice on the UNESCO World Heritage List, once for its Botanical Garden, Orto Botanico di Padova, and for the collection of the 14th-century frescoes situated around the city, Padova Urbs Picta (Padua Painted City) by the master painter Giotto.

In addition to its remarkable antiquity, positioning it as one of the oldest cities in northern Italy with origins tracing back to 1183 BC (Samperi, Gastoni, and Castel 2023)—a historical depth beyond the scope of this study—Padova holds geographical significance worthy of examination. The city is situated in the northeastern region of Veneto and is positioned 35 kilometers to the west of Venice. Notable waterways and diverse landscapes define its geographical context. Geographically, it rests to the south of the Alps, occupying a vast plain that can be regarded as an extension of the Po Valley, Italy's most large plain (Pristeri et al. 2020, 4).

It is stated that Padova has always been a great water town within the Veneto region (Consorzio Battellieri di Padova e Riviera del Brenta, n.d.). Built between the Brenta River to the north and the Bacchiglione River to the south, Padova developed an intensive river navigation. The city was a reference point for trading activities and transport from the mainland to Venice. Additionally, the Brenta River, though no longer flowing through the city center, still touches its northern districts, preserving a connection to its aquatic heritage. With the past excavation of the Piovego Canal and the Portello port building, river navigation in Padova increased significantly (Consorzio Battellieri di

Padova e Riviera del Brenta, n.d.). It may seem unusual to think of Padova as a water-centric metropolis today, but in the past, this city flourished with a network of canals that connected various districts. These canals served as crucial arteries for both the transportation of goods and the movement of people.

However, the city's physical landscape has changed significantly throughout the decades. The city had recurring floods that awash the streets and caused damage. Furthermore, the development of industries and the emergence of automobiles in the 1950s significantly changed the urban landscape. Many of the historic canals were no longer needed; therefore, they were filled and hidden below the city's surface. The water mobility of Padova turned into a road-based mobility.

The geographical setting of Padova is also significantly characterized by the Venetian Plain, Pianura Veneta. Its agricultural and historical importance adds to the region's value and to Padova.

Combining all these geographical elements, including its water connections and surrounding natural landscapes, has played a pivotal role in shaping Padova's historical development, making it a city of historical and geographical significance.

Padova also took its share of the trend of urbanization and industrialization in Italy in the aftermath of World War II. The industrial area of Padova started to be established in 1946, situated in the eastern part of the city (Samperi, Gastoni, and Castel 2023). It has been one of the largest industrial zones in Europe, covering an area of 11 million square meters. The further implications- climate, health, and public - of hosting this large industrial zone on the city's borders will be discussed later in the chapter.

The overview of transportation in Padova can be explained by the road connectivity of the city, with its two major motorways, A4 Brescia-Padova, connecting Verona, Milano, and beyond, and A13 Bologna-Padova, connecting Ferrara and Bologna. The extension of road networks links Padova to diverse places in the region. Apart from the motorway, Padova has a railway station called Stazione di Padova, with 11 platforms, and ranks among Italy’s largest railway stations (Stazioni del mondo n.d.). It is stated that Padova railway station departs more than 450 trains daily and serves over 20 million passengers yearly while connecting the major Italian cities with high-speed connections. International and night trains are also available. Public transport will be discussed further in the chapter.

Beyond its historical significance and geographical situation, Padova is a city committed to addressing contemporary challenges. In this chapter, we will discuss Padova’s sustainable mobility

aims and sustainable urban mobility plans. The focus will be on the challenges of the city and the efforts to enhance urban transportation while also prioritizing sustainability, equity, and accessibility. Padova has already implemented some strategies to strengthen its urban mobility, which we will analyze and discuss. Throughout the essay, we will examine the city's transportation initiatives, green infrastructure projects, and strategies to reduce its carbon footprint. We will discuss the efforts demonstrated by policymakers of the city and the determination and dedication to preserving the city's heritage while adapting to the requirements of a more sustainable and accessible urban future.

Through this exploration, we will discuss if and how Padova balances preserving its illustrious past with pursuing a sustainable future.

4.2 Public Transportation Framework – From Canals to Trams

Padova's urban transportation system consists of public buses, a modern Translohr guided tramway, private taxi services, and recently introduced new mobility options such as bike and car sharing. Currently, the urban area of Padua is served by 22 bus lines and one tramway line (SIR 1), for a total of 23 local public transport lines (Comune di Padova 2022). The transportation network in the city is largely influenced by its urban layout, which has evolved in a star-shaped pattern from the entrances and exits of the historic center. Due to its historical significance and spatial limitations, access to a portion of the city center is restricted to residents and authorized vehicles, with limited vehicle traffic (https://www.blogdipadova.it/come-muoversi-a-padova-mobilita/). Surrounding the central district are designated parking areas, and some streets and squares have been set exclusively for pedestrian and bicycle use.

Busitalia Veneto S.p.A., a company operating in Veneto, manages urban transport services in Padova, as well as suburban routes within the province, after the merger process in 2014 with APS Holding. The holding has had the APS Mobility division with a service agreement with the Padova municipality and province. After the holding had an economic crisis due to failures over city ticketing, rising fuel prices, and budget cuts, the municipality of Padova, together with Busitalia Nord, culminated the creation of Busitalia Veneto S.p.A. in 2015 (“Trasporti, Fusione Aps Ed Ex Sita Costituita La ‘Busitalia Veneto.’” PadovaOggi 2015). The merged company takes the operation of the Veneto branch of Busitalia Nord. The bus station of Padova is located in the square, close to the

railway station. The 14-lane bus station was opened in 2010, with many provincial bus lines and some national companies also stopping at this station (FS Busitalia n.d.).

To cover nighttime mobility needs, the city offers the Night Bus service, a demand-responsive transit (DRT) system initiated by the Municipality of Padua and the University of Padova (https://www.blogdipadova.it/come-muoversi-a-padova-mobilita/). Started in 2019, this service claims to offer convenient and secure transportation, serving all Busitalia Veneto stops within the municipal boundaries, excluding tram stops. Operating daily, it runs from 9 p.m. to midnight on Mondays, Tuesdays, Thursdays, and Sundays, while on Wednesdays, Fridays, and Saturdays, it extends service hours from 9 p.m. to 3 a.m. Users need to book their trips through the Night Bus app to utilize this service. They need to specify the starting and ending stops, desired departure or arrival times, and the number of passengers. This service costs €1.50 per person per ride, payable in cash on board or via credit card directly through the app.

Apart from the bus, the city also has the infrastructure for the tramway. The tramway in Padova is a captive-guided transportation system that runs through the city of Padua utilizing 18 trams, which are three-car trainsets that were designed and built for operation. The system used is the Translohr type, rubber-tired. This line of the tram is called the SR1 line. The system is in service daily from 6:20 a.m. to 11:30 p.m. The tickets for the tram are the same as the ones for the bus and can be purchased via different methods. The APS holding also operated the tramway, which was launched in 2007 and later in 2009 extended to cover an extensive route (Wikipedia 2023).
In the case of Padova, the trams are equipped with batteries that allow them to run autonomously over a short distance without an overhead line. The acceleration and deceleration of the vehicles are very appreciable, and they cover the section in service in about 35 minutes. Tram users in Padova account for more than 10% of the overall service offered by APS, and the numbers are increasing (https://www.sustainable-bus.com/trolleybus-tramway/padua-new-tram-line-sir3-revamping/).

The first project of the Padova tramway is the SIR 1 (Sistema Intermedio a Rete 1 - Intermediate Network System 1), the line which involves creating a route along the North-South Pontevigodarzere-Centro Storico (Historical Center) - Guizza within the project area. The course spans 10.3 kilometers and takes around 35 minutes to complete. The line is on a guided track system consisting of a metal rail set into a concrete base and securely attached using a special glue called resin. The vehicle is connected to this rail with wheels that are inclined at a 45-degree angle. This process is the working principle of this type of guided track system, the Translohr line. In the case of Padova, the surface is

made of thin reinforced concrete panels. Inside these panels, there are electrical cables for power and data transmission. Along the route, there are 24 stops with a frequency of runs every 4-5 minutes in the rush hours. Here is the map of the SIR1 Line:

Figure 5 Map of the SIR1 line Source: (https://www.padovanet.it/allegati/C_1_Allegati_14269_Allegato.pdf)

The characteristics of the line and the vehicle, as explained in the research of APS Holding, consist of technical explanations of the project (APS Holding 2011). They claim that building the tramway and the line in the city is a 'structural solution' for the city's mobility problems. According to the research done in 2001 for the Piano Urbano della Mobilità (PUM), which translates as the Urban Mobility Plan, the population of Padova was 220,000 people, and the total number of daily trips was 793,000. Of these trips, 74 percent of them were made by private means, and only 26 percent were with public transportation. The number of daily transit vehicles was 190,000. As for the purposes of the PUM, a solution that addresses a long-term strategic plan that solves the people's mobility problems was necessary. Therefore, investment in this case for the city was needed. The historical timeline of the tramway line in Padova, starting with a hypothesis in 1990, was finalized with APS Holding winning the bidding process for the realization of line SIR1 in 2001. The result of the competition was 58.3 million euro (113 billion lire) for the total contract value. On 24 March 2007, the first tramway trip was held (APS Holding 2011).

APS Holding presents the tramway as a new design of the public transport network as being the backbone of the other transportation lines and with the belief that it will provide more frequent and on-time service. The tramway is seen as an integrated mobility system for the city and the province. Other positive outcomes of the tramway, specifically choosing to implement the Translhor, a rubber-based tramway, are explained as:

- Quiet operation
- Adherence
- Lightness
- Soft suspension
- Easy maintenance
- Bidirectionality, without a return loop, is an additional bonus for the Padova system.

Apart from the line SIR1, two more lines are planned for the tramway, SIR2 and SIR3.

The SIR 2 tramway line, with its 17.5-kilometer route served by 36 stops, passes Padova from east to west, in between Vigonza and Rubano. This project will take part as the east-west axis of the city’s axis. Among the important stops on the route are the Hospital area, the new Police Headquarters, the University Area, the Court, and the Fair area. The project involves along the tram route an addition of a bicycle path (Comune di Padova 2022).

The funding of this project totals €335,211,901.76, including €238,057,777.66 from the Green Revolution and Ecological Transition mission of the National Plan for Recovery and Resilience (Piano Nazionale per la Ripresa e la Resilienza - PNRR) and €97,154,124.10 from the state.

Below is the map of the SIR 2 line,

Figure 6 Map of the SIR2 line Source: (Comune di Padova 2022)

Along the development of line SIR 2, the construction of a parallel bidirectional cycling path has been added to create a Mobility Corridor. The proposed transportation plan suggests the creation of the Mobility Corridor for usage of all forms of public transportation, which also has a continuous cycling route along its entire length. A mobility corridor is defined as:

"a non-compact arterial that has a posted speed limit of 40 mph or more and is part of an arterial corridor between urban compact areas or service centers with an average annual daily traffic of at least 5,000 vehicles per day for at least 50% of its length; or is part of a retrograde arterial corridor located between mobility arterials." (MaineDOT 2003)

The SIR 2 line is expected to create an efficient public transportation route. This route is separated from regular traffic, ensuring reliability and quicker access to Padova Center compared to the current bus service. The examination made of the rush hour travel times for the current U10 bus line into the city shows that it takes approximately 25 minutes from the western endpoint and about 30 minutes from the eastern endpoint. However, with the introduction of the SIR 2 line and the Mobility Corridor and comparing travel times from the same starting and ending points to the center of Padova, they find that it only takes 19 minutes from the west endpoint and 23 minutes from the east endpoint. The SIR 2 line represents a 25%- and 23%-time savings, respectively (Comune di Padova 2022).

Here is the advancement of the project so far, published by the Municipality of Padova:

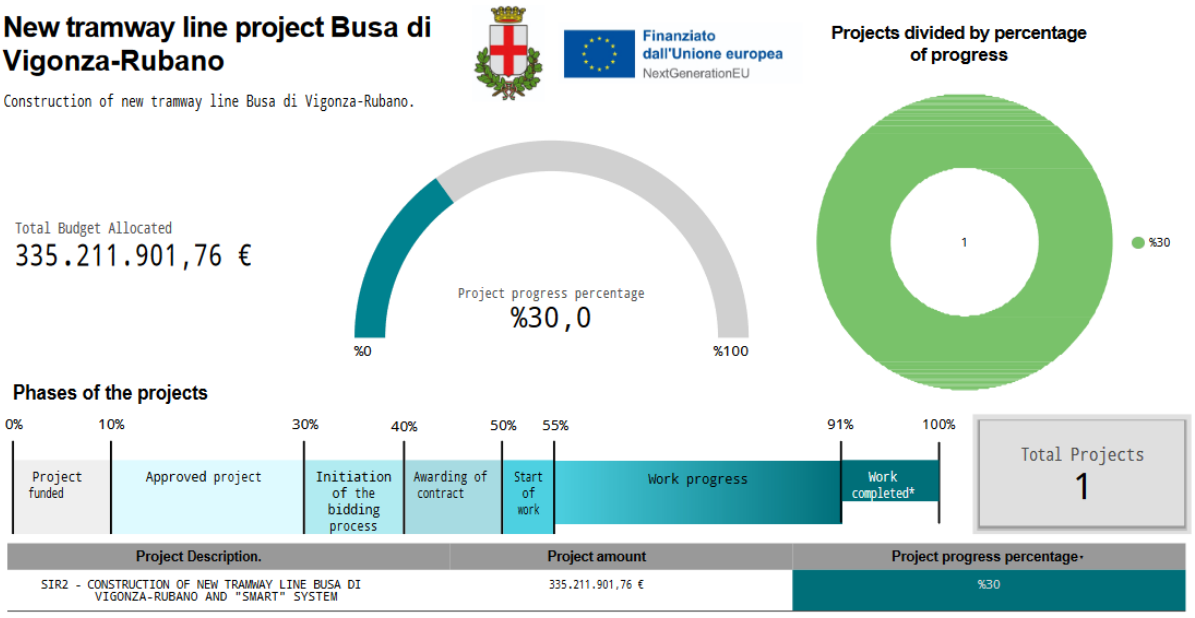


Figure 7 Tram project information (Translated by the author, for the original: Comune di Padova - Stato PNRR - Progetto nuova linea tramviaria Busa di Vigonza-Rubano (Sir 2)

The work of line SIR 2 is expected to be completed by 30 June 2026.

The SIR 3 line, on the other hand, is planned to run from the train station to Voltabarozzo, spanning a total length of 5.4 kilometers with 13 stops. Tramways are scheduled to run at an interval of 8 to 10 minutes to ensure frequent service, and the average travel time for the full route is approximately 18 minutes.

Here is the view of the planned project with the stops:

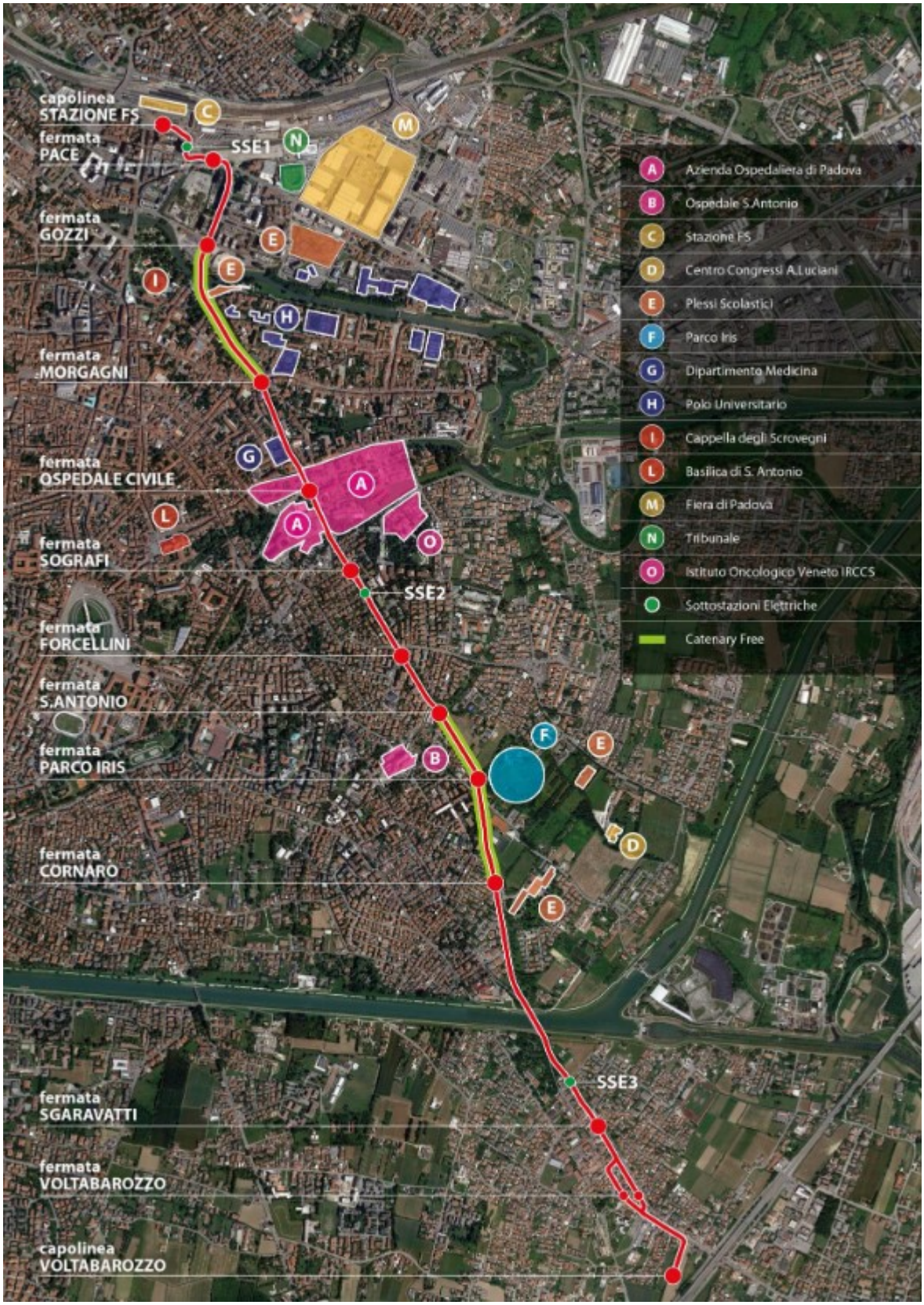


Figure 8 Project of SIR 3 Line Source: (Comune di Padova and Net Engineering 2018)

The SIR3 tram line has been designed to operate without overhead wires for significant portions of its route, which is important for preserving the aesthetics of the city and also focusing on minimizing noise and vibrations. The tram vehicles are designed to take up less space on the road, allowing for dedicated lanes on 70% of the route and reducing disruptions on regular streets. Each tram can carry about 180 passengers, ensuring efficient service with an estimated speed of 18 kilometers per hour during operation (Comune di Padova and Net Engineering 2018).

The initial project estimated the construction cost, purchasing tram vehicles, and available funding at around €56 million in 2003. Later, these estimates, adjusted for inflation to 2018, resulted in a total expenditure of about €68.5 million (Comune di Padova and Net Engineering 2018).

The APS Holding got approval from the European Investment Bank (EIB) for a loan of 43.5 million euros for the construction of the Padova SIR 3 tramway line and for the modernization of the existing SIR 1 line. The total estimated value of the entire project is 105 million euros (European Investment Bank 2022).

From the total amount, 34 million euros will be allocated to developing the new SIR3 tram line. Apart from the SIR 3 line that connects the southeastern part of Padova to the train station, the project also involves a park-and-ride facility that offers 383 parking spaces at the southeast endpoint of the line in Voltabarozzo (European Investment Bank 2022).

The remaining of the funding, 9.5 million euros, will support upgrading the SIR 1 line, which is expected to be completed in 2026. This renovation includes integrating advanced battery technology to enhance performance, durability, and the ability to operate without overhead lines. The upgrading process will also involve the expansion of the Guizza depot (European Investment Bank 2022).

Here is the total look of the tramway network of Padova:

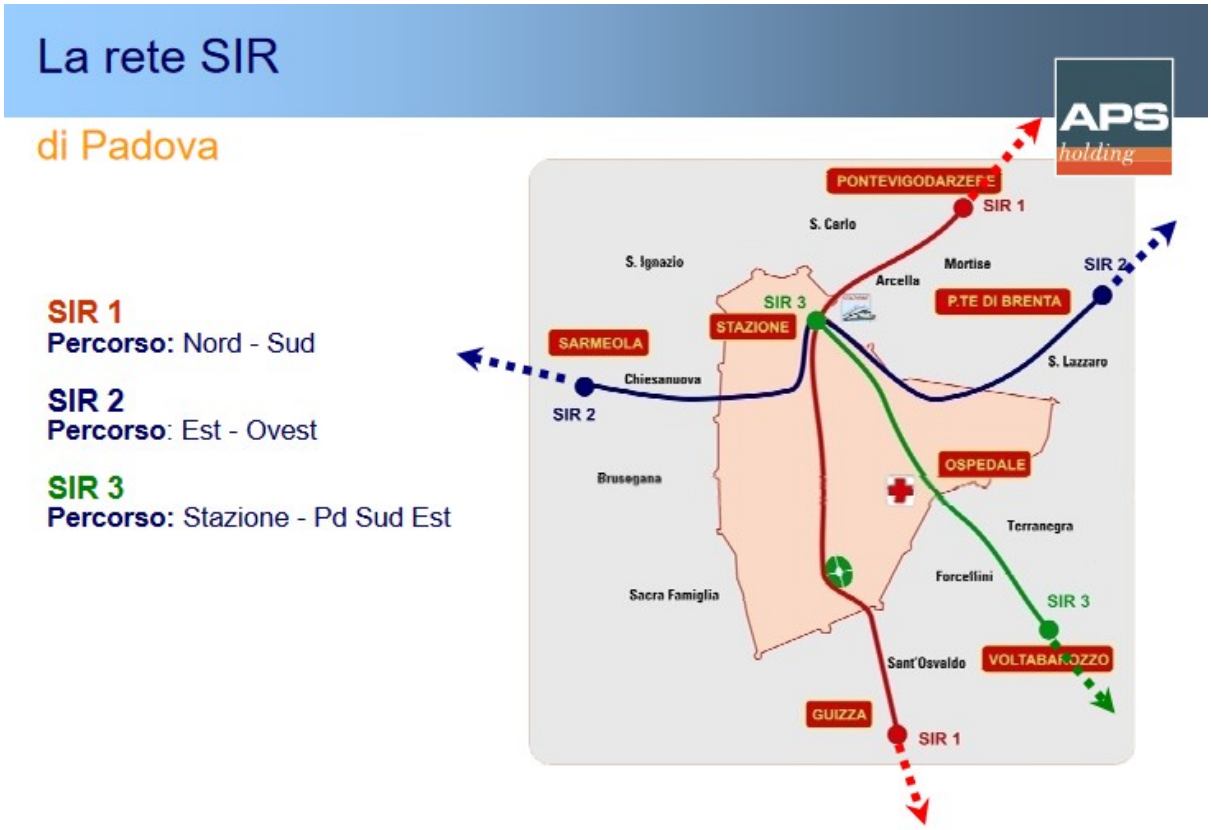


Figure 9 The tram line project of Padova Source: (APS Holding 2011)

As part of the extensive research conducted for the SIR2 and SIR3 project, the municipality has published information regarding existing public transportation routes and related statistics. The following are the findings:

- SIR1: Primary tram line, carrying over 30% of the city's total public transportation users.
- U10 Line: Serving approximately 10% of the urban network, which will be replaced by the SIR2 line in the future.
- U14 and U16 Lines: Part of the future SIR3 line, collectively accommodating around 5,600 passengers daily.
- U22 Line: A significant bus line with high ridership, serving about 6,300 passengers daily.
- Medium-Strength Urban Lines: Including U03, U06, U09, U11, U11B, U12, U13, U15, and U15B, with passenger boardings ranging from 3,300 to 5,200 per day.
- Other Medium-Strength Urban Lines: Comprising U02, U04, U05, U19, U24, and U88, with passenger loads ranging from 1,400 to 2,300 daily. An exception is the U02 line, which has about

700 daily passengers. Additionally, some lines connect areas outside Padova to SIR1 terminals, including U04, U19, and U88 (Comune di Padova and Net Engineering 2018).

Table 4 Complete look at bus and tram lines in Padova. Created by the author

Transportation Line	**Description**	**Users**
SIR1	Primary tram line	over 30% city's users
U10 line	Serving 10% of the network, future SIR2	10%
U14 U16 lines	Part of future SIR3	5,600 passengers daily
U22 line	Significant bus line	6,300 passengers daily
U03, U06, U09, U11, U11B, U12, U13, U15, U15B	Medium-Strength Urban Lines	3,300- 5,200 daily
U02, U04, U05, U19, U24, U88,U02	Other Medium-Strength Urban Lines Some lines connect to SIR1 terminals (U04, U19, U88)	1,400- 2,300 daily, exception: 700 daily U02 line

This analysis provides a clearer overview of Padova's different bus and tram lines and their relative passenger volumes.

The tram project is an integral part of the long-term environmental sustainability strategy of the city of Padova. The project is also within the frameworks of the Sustainable Urban Mobility Plan of Padova and the EIB's Climate Bank Roadmap, which supports zero emission and sustainable mobility. All in all, the project also has a leading part to play in the Italian environmental transition towards more environmentally friendly transportation and an economy with less environmental impact.

The train station is also an important element of the city besides the bus and tram lines. Padova railway station (Stazione di Padova, in Italian) is the city's main station. It has been in service since 1842 and is managed by Rete Ferroviaria Italiana (RFI, Italian Railway Network in English). The train station

is in the north of the city center, in Piazzale Stazione. Padova train station is one of the main railway connections of the Italian system, with an average of 18.5 million passenger mobility per year (Stazioni del mondo n.d.). The main destinations served by the station are Venice, Genova, Torino, Milano, Bolzano, Trento, Bologna, Udine, Trieste, and Roma.

As reported in a recent newspaper article, the mayor and stakeholders of transportation in Padova and the province convened to address the public transportation crisis. The discussion covered various topics, including the significant decrease in passengers after Covid 19, the shortage of drivers, and the increase in operating costs (https://www.padovaoggi.it/attualita/vertice-busitalia-trasporto-pubblico-padova-11-settembre-2023.html).

The discussion emphasized the significance of incorporating Trenitalia, as local transportation should be viewed holistically rather than as a mere addition of diverse road and railway options. One objective is to enhance integration between road and rail transportation to prevent unnecessary overlaps, to try to strengthen services where demand is not satisfactorily met and to guarantee a service throughout the territory. The meetings and discussions will continue periodically. They are expected to result in interesting proposals, which could serve as a model for other regional provinces.

As we conclude this subsection exploring urban transport options in Padova, it becomes evident that the city's network plays a significant role in the daily lives of its residents. On a typical weekday, approximately 103,600 passengers rely on the urban network lines. Notably, the SIR1 tramway line stands out as the most used transport option, carrying 33,000 passengers daily, constituting 32% of the city's daily passenger traffic. Even on Saturdays, when overall ridership drops to 78,000 passengers per day, the SIR1 tramway remains a persistent choice, accommodating 32,500 passengers (42% of Saturday travelers). Holidays bring a reduction in demand, with approximately 28,000 passengers on the network, of which more than half, about 54%, continue to rely on the SIR1 tramway. These significant numbers show the integral role of the SIR1 line in the city's transport landscape. The data for the urban travel analysis of Padova public transport was gathered and structured by various ways, as stated by the Municipality of Padova (Comune di Padova. 2022. “Dossier di Progetto Linea Tramviaria SIR 2 e Sistema Metropolitano a Rete Tramviaria - Smart.”) Travel demand data was collected using various sources, including the PUMS survey from 2016, later updated to 2018, for road traffic and surveys related to the public transport service in Padova conducted by Busitalia Veneto S.p.A. in 2018. The study area covered is the City of Padova and its municipalities. Finally, the road network data was derived from OpenStreetMaps and used for

modeling purposes. Further investigation into the alternatives to transport in Padova will be discussed under the Sustainable Urban Mobility Plans in the later sections.

CHAPTER 5 Alternative Mobility Options in Padova

5.1 Cycling

Besides bus and tram lanes, Padova has also increased the development of a network of cycling paths throughout the city. These lanes are separated from motor vehicle traffic and navigate through the city through many major roads. There are also bike paths with panoramic and scenic routes through parks and green areas around and out of the city.

In recent years, like many other European cities, Padova has introduced bike-sharing schemes to encourage cycling as a mode of transportation. Bike-sharing stations are located around the city, making it convenient for both residents and visitors to access bicycles for short trips. For now, two companies have bike-sharing stations across the city. These are Ridemovi and GoodBike Padova. The service provided by Ridemovi Mobike allows the free flow service, with the possibility to use a bike without the obligation to return it to the designated stations. Instead, users can leave the bikes within the zones the Ridemovi service allows. The Ridemovi platform offers 700 lite bikes and 50 eBike pedal-assist bikes, as of 2021, available 24 hours a day (Comune di Padova 2021).

Mobike is a Chinese bicycle-sharing company that gained significant prominence in the bike-sharing industry while an emergent tech trend started in China (Russell 2019). The company has garnered significant attention, becoming one of the pioneers in the dockless bike-sharing market. With over 100 million registered users and a presence in over 100 Chinese cities, Mobike has established itself as a key player in the on-demand bike-sharing industry (Russell 2019). The company also had ambitious plans, which included an international expansion. This drive for growth has positioned Mobike as a significant player in the global bike-sharing landscape (Russell 2019). Mobike has ventured into international markets, such as in the United Kingdom, Singapore, and several European cities, including Germany, Spain, France, and Italy. When in 2017, Mobike started to launch in the European market, there was not much competition for the company to face, apart from the station-based bike-sharing services examples in Paris and London (Gauquelin 2020). With the entrance of Mobike and the following years, numerous free-floating operators have emerged. This shift in competition has been said to bring dynamic changes to the European urban mobility scene, creating new opportunities and challenges for companies like Mobike (Gauquelin 2020).

Defined as a free-floating bike sharing (FFBS) system (Lan et al. 2017, 2), Mobike service is available in many Italian cities, including Padova. Jing Lan et al. define the FFBS system as an influential case

study and analyzes the system from the lens of consumer co-creation behavior and active value in the sharing economy (Lan et al. 2017, 2). They see it as a fast-developing business model in the sharing economy, creating a different understanding of urban transport in China and beyond. They analyzed the role played by the users as significant and observed how people's behavior changes as they get more involved in bike-sharing.

Mobike started to provide service in Italy, Florence being the first Italian city to welcome Mobike, RideMovi sharing system, in July 2017. The operations continued with Milan in August, Turin and Bergamo in November, Pesaro and Mantova in March 2018, Reggio Emilia in May, and Bologna in June. Today, they also have operations in Caorle, Imola, Lignano Sabbiadoro, Padova, Palermo, Pesaro, Pisa, Portofino, Rapallo, Santa Margherita Ligure, Vicenza, and Venice (“Cities”, n.d.).

Users in Padova are said to be liking the FFBS service, as it is stated that it has reached its pre-Covid numbers and is boasting ("Cambiano le MoBike, in strada le nuove RideMovi più leggere e maneggevoli" 2021). It is explained that today, there are 23,392 registered users in Padova since the service began. From July 2021 to October 2021, 116,291 rentals were made for lite bikes and 34,042 for pedal-assisted bikes. The average trip duration is 14 minutes for lite bikes and 14 minutes for e-bikes ("Cambiano le MoBike, in strada le nuove RideMovi più leggere e maneggevoli" 2021).

Davide Lazzari, the head of business development at RideMovi, states that:

"These new vehicles with improved performance contribute to the success of sustainable mobility in Padova, which in terms of numbers is one of the best cities in Italy. If we think that each bike is rented on average three times a day, so with a very high turnover, we realize how much the service in Padua is appreciated. We have also introduced the service in Vicenza, and with Mestre, we are therefore offering a territorial bike-sharing service. With the same app and with the same subscription, you can take bikes in all the cities that have the service, and this is a great innovation." (Quotation translated by the author, "Cambiano le MoBike, in Strada le nuove RideMovi più leggero e maneggevoli" 2021)

Ridemovi users need an application on their mobiles. The bikes are equipped with GPS that can track the bike's location, a SIM card, and a patented lock. The patented smart lock can be unlocked/locked through the Ridemovi app ("Ridemovi: il servizio di bike sharing a flusso libero disponibile in città" 2021).

Facilitating the app, users can report any defects and malfunctions easily and check from the map where the nearest bike is and the scope of the area where parking is allowed. The app is necessary to

use the Ridemovi bikes and can be downloaded freely. After downloading the app, it is necessary to create an account using the cell phone number to which the verification code to be entered will arrive, followed by entering a password.

Payments to top up the wallet or buy a Pass are made by credit/debit card, Apple Pay, and Google Pay ("Ridemovi: il servizio di bike sharing a flusso libero disponibile in città" 2021).

Once the user locates the bike they want to use, they can simply click the “Scan to Unlock” button and scan the QR code on the handlebars or lock to be able to use the bike or e-bike. When the user reaches the destination, they can park the bike responsibly, as suggested by Ridemovi, end the ride in the app, and follow the instructions that appear on their smartphone.

Figure 10 RideMovi in Prato della Valle Source: (“Padova, ecco il bike sharing “libero” di Mobike: 120 biciclette nelle strade” 2019)

The other bike-sharing system that can be found in Padova is the GoodBike Padova. It is the service provided by the Municipality of Padova, aimed at anyone who moves in Padova, whether for work, tourism, or leisure. This service consists of a network of stations where users can pick up the bikes and must return them. If the user wants to take a route from the train station to the city center, they

can easily pick up a bike from the station and leave it at the bike station in the city center upon arrival (“Goodbike Padova”: il servizio di Bike sharing disponibile in città”, n.d.).

This service of bike sharing is presented with contributions from the Ministry of the Environment, private bodies from the Chamber of Commerce and the Fondazione Cassa di Risparmio di Padova e Rovigo, and the Alpine Space Transnational Operational Program (“Goodbike Padova”: il servizio di Bike sharing disponibile in città", n.d.).

To use the service, it is necessary to download the Weelo app and register freely; then, users can choose to buy available subscriptions.

Figure 11 GoodBike in city center Source: "Padova: GoodBike, il bike sharing di Padova - laPiazzaWeb", n.d.

5.1.1 Cycling initiatives in the city

Padova city has been working on promoting sustainable and bike-friendly mobility options. There are initiatives to raise awareness about cycling and encourage residents to use bikes for moving around the city. Padova often prepares and hosts cycling-related events, festivals, and awareness campaigns. These activities help promote cycling as a healthy and sustainable mode of transportation. One example of the cycling events was the Padova Bike City project. It was a program of events related

to cycling and active mobility organized in the European Sustainable Mobility Week framework in September 2019.

The event was organized by 3parentesi and Ciclica under the supervision of the City of Padova (Padova Bike City 2019). During the course of Sustainable Mobility Week, through 16-22 September 2019, a variety of events were organized aimed at sustainable mobility, along with workshops to educate and shows to entertain and talk about cycling. Here is the brochure of the event:

Figure 12 Brochure of Padova Bike City event Source: ("Gli eventi, i luoghi e le persone che muovono Padova." 2019)

For the European Mobility Week, Padova has already prepared events 22 times, the first one being in 2002 ("Participating towns and cities", n.d.). This year, the contribution to the European Mobility Week from Padova was focused on the theme of shared mobility. The operators of shared mobility services, such as Ridemovi and BitMobility, have promoted their services between 16 and 22 September. These shared mobility services, which are already established in Padova, to promote their services, offer discounted access to their vehicles, with free test drives or subsidizing prices on the subscriptions to those who check their stand in Mobility Week.

Apart from the shared mobility service initiatives, in the Mobility Week, there is also the service of "Marcatura Biciclette e Monopattini" - Marking of Bicycles and Scooters. This marking of bicycles and scooters is defined as a system to combat theft of the vehicles and easier trace in case of theft. The system works as they stamp the owner's tax identification number - codice fiscale - on the bicycle frame or the scooter. After the stamping, the vehicle is marked with a non-removable label with the coat of arms of the City of Padova. In case of theft and discovery, law enforcement can trace the owners with the help of this identification system ("Marcatura biciclette e monopattini", n.d.). This service is completely free of cost and has been organized by the Municipality of Padova. The University of Padova also assists this initiative of the municipality by promoting this service to their students and having events where the marking procedure takes place in different university departments.

Another initiative the Municipality of Padova proposed for the European Mobility Week is The Giretto d'Italia. It is organized by Legambiente, a non-profit environmental association, to promote travelling to work or school by bicycle - bike-to-work or other micro-mobility means- based on rewarding people who use this mode of commuting ("Giretto d'Italia - Campionato urbano della ciclabilità", n.d.). This initiative has become a tradition of the European Mobility Week, involving more than 20 Italian cities, including Padova. The event works as monitoring those who commute by bike or other micro-mobility transportation modes at various points around the city between 7 and 10 a.m. on the day of the event, with the help of volunteers from the FIAB Padova, Friends of the Bicycle, and Legambiente, and staff from the municipality. The University of Padova also supports the event by having checkpoints in its departments. Cyclists passing in the vicinity of the streets dedicated are invited to cross the checkpoints, also being able to report their names and the company or employer they work for. The competition works by every city registering points every time a bicycle passes by, and the highest number of cyclists in a city determines the winner. This competition is organized to promote cycling and sustainable mobility, taking place every year in September within the initiatives planned for European Sustainable Mobility Week ("Giretto d'Italia - Campionato urbano della ciclabilità", n.d.).

It is explained by Legambiente as:

"It is a proposal addressed to Italian municipalities, Mobility Managers of institutions and companies, associations, and all interested citizens. The Giretto is a competition between cities aimed at promoting home-to-work and home-to-school trips made by bicycle or by using other means of

electric micro-mobility (electric scooters, monowheel, E-bikes, electric scooters, hoverboards, segways)." ("Giretto d'Italia - Campionato urbano della ciclabilità", n.d.)

In 2022, Milano has become the winner in the ranking, with 6,020 bikes and other sustainable vehicles, and Padova followed Milano by 5,703 vehicles ("Giretto d'Italia – bike to work 2022: Milano campione di ciclabilità urbana" 2019).

In terms of bike parking facilities, throughout the city center, users can find parking facilities, although it has to be discussed if they are yet to fulfill the demand from the city. There are bike racks, especially in most of the key locations: in each department in the University of Padova, in every square of the city, and the square in front of the train station.

Padova has a growing cycling culture, with an active and conscious community of cyclists who are actively involved in implementing improved infrastructure, safety, and accessibility for cycling. There are local groups of citizens who are advocating for a city with better cycling infrastructure, wider usage of cycling, and education on the importance of using this sustainable mode of transport in their city. One example of this is a group called Critical Mass Padova.

Critical Mass is a cycling event that occurs in cities around the world. It typically takes place on the last Friday of every month and involves a large group of cyclists coming together for a mass ride through city streets. The primary goals of Critical Mass are to promote cycling as a sustainable and environmentally friendly mode of transportation, raise awareness about the rights of cyclists, and draw attention to the need for better cycling infrastructure and safety on the roads. Critical mass is a worldwide event organized by citizens to take the streets in a peaceful and organized way by respecting traffic rules and safety. The people gathered to draw attention to the cyclists and their needs, demonstrating the benefits of cycling, pointing out the importance of sharing the road, and advocating for improved cycling conditions in the city. In Padova, we can also see this event organized by citizens. The central idea of the event is to promote cycling as a means of sustainable urban transportation and advocate for safer conditions for cyclists.

5.1.2 Cycling infrastructure of Padova

The cycling paths in the city are condensed in the historic city center to promote and encourage cycling as a transportation method. The creation of cycling roads is crucial in the encouragement of cycling, providing not only ease but also safety for all mobile people.

From the latest data of 2021, 162 km of bicycle paths have been created in the territory of the Municipality of Padova (Comune di Padova, n.d.). The municipality is working towards creating an urban network of cycling and pedestrian paths to connect all city arteries and make the accessibility of the city easier (Comune di Padova, n.d.).

The development of this cycling network is useful for users who travel to work or school, allowing them to reach their destinations comfortably and safely.

Here is a general map of the cycling roads in the Padova city center.

Figure 13 Cycling roads in Padova city center Source: (Comune di Padova, n.d.)

On the other hand, this map shows the cycling roads that reach out to outer zones from the city center.

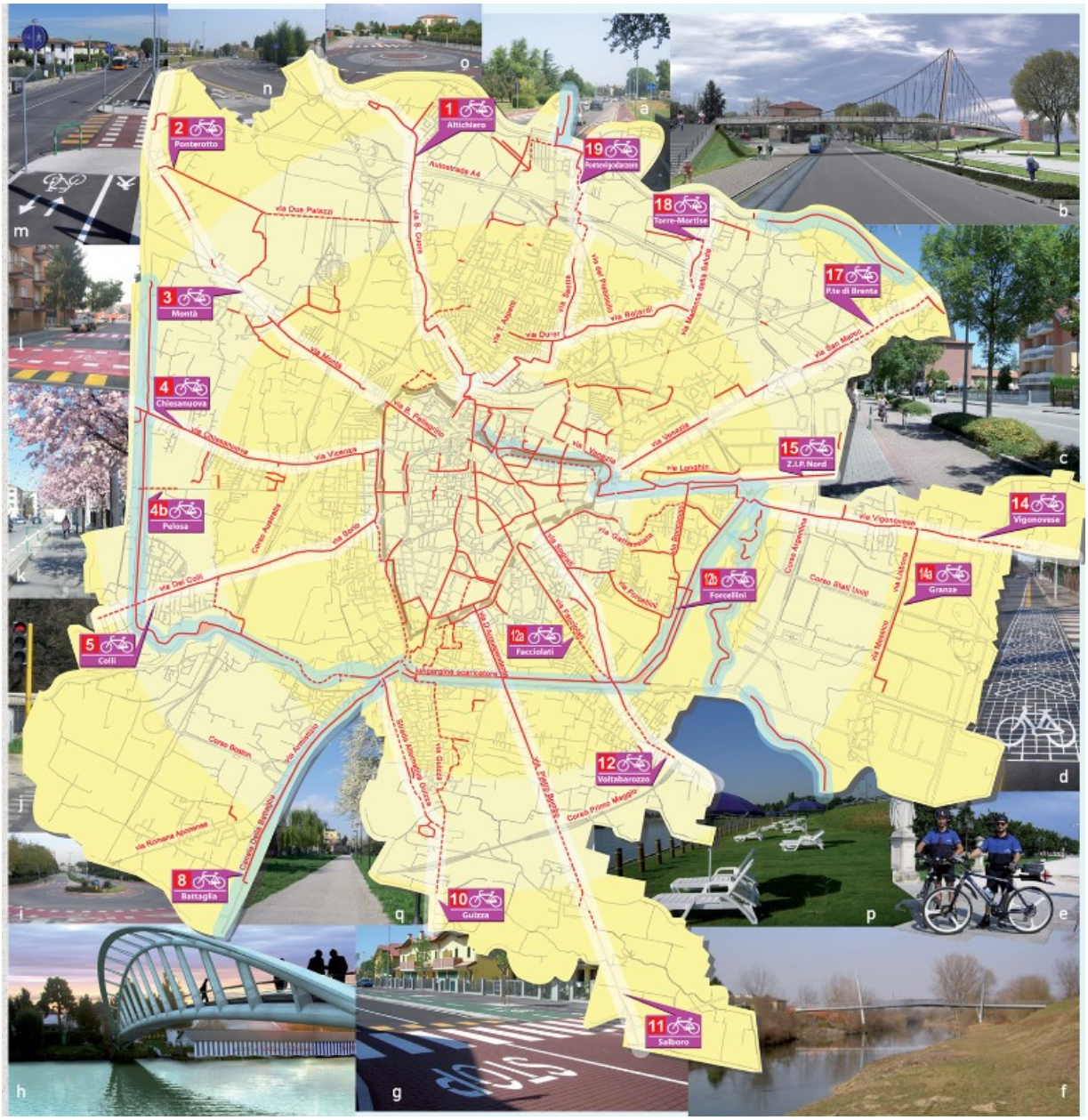


Figure 14 Cycling road reaching to extra urban zones Source: (Comune di Padova, n.d.)

These cycling paths are mostly considered for their sports-recreational activities in and around Padova, reaching other towns with remarkable natural views. In different seasons, these cycling paths become a hub of cyclers, walkers, and runners, whether locals or tourists.

In Padova, it is possible to tour the city, passing exclusively the side of rivers and canals ("Padova: anello fluviale ciclabile di Padova percorsi nordic walking e ciclo-pedonali, nw mtb run canoa jogging gps passeggiate itinerari parchi piste ciclabili sugli argini anello fluviale in bicicletta, parco naturale

del fiume Brenta, cicloturismo nordic", n.d.). The city of Padova presented a project called "La U Verde di Padova - The Green U of Padova" to create a system of network involving the rivers and canals of the city, where it is also possible to to practice outdoor activities and active mobilities in a setting that is away from the traffic. The Green U of Padova project aims to transform the public areas along their rivers into a unified green space. This effort encourages bicycle, pedestrian, and river mobility, featuring designated routes and exercise trails. The project comprises three color-coded routes: the yellow route along the San Gregorio Canal (4.5 km), the green route along the Drainage Canal (2.5 km), and the blue route along the Bacchiglione River and the Brentella Canal. Each route offers points of interest, including parks and gardens, with additional river kiosks for rest and refreshments. The Green U in Padoa is now a walkable and bikeable route catering to locals and visitors seeking an urban green experience (Comune di Padova, n.d.).

Table 5 The Green U of Padova. Table by the author.

Route Name	**Length (km)**	**Path Description**	**Places of Interest**
Yellow Route	4.5	San Gregorio Canal: From San Gregorio bridge to Voltabarozzo bridge	Roncajette Park, Fenice Park, Frassini Park, Il Giardino dei Giusti del Mondo, Iris Park. A rest and refreshment area at the Voltabarozzo.
Green Route	2.5	Scaricatore Canal: From Bassanello bridge to Voltabarozzo bridge	Parco dei Salici alla Guizza, Parco dei Faggi a Voltabarozzo, Roseto di S. Giustina.
Blue Route	-	Lungargine Boschetto: Along the Bacchiglione River and the Brentella Canal, from Brentelle di Sotto bridge in Tencarola to Isonzo bridge in the Bassanello area	Villa Zambelli-Folco-Pesavento farm, "Peoceto" beach, Parco del Basso Isonzo

Here is a map of the project:

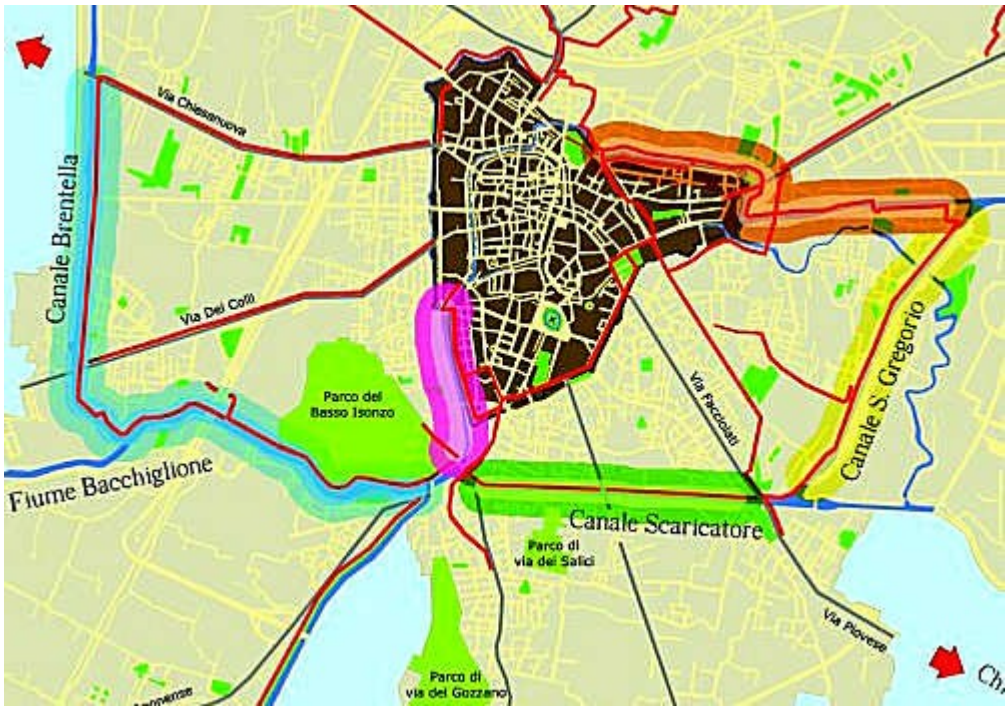


Figure 15 The map of the project Source: ("Padova: anello fluviale ciclabile di Padova percorsi nordic walking e ciclo-pedonali, nw mtb run canoa jogging gps passeggiate itinerari parchi piste ciclabili sugli argini anello fluviale in bicicletta, parco naturale)

This project considers the city's characteristics, being surrounded by rivers and canals, and presents a system that encourages cycling, pedestrian, and river mobility.

5.2 Other Shared Micromobility Options

Padova also has the option of renting micro-mobility solutions, such as scooters, in the city. The free flow scooter sharing services are available in Padova with two companies: Bit Mobility and Ride Dott. The municipality states that scooters are introduced gradually to adapt to users' needs (Comune di Padova 2022).

Ride Dott

It is one of the companies that has service e-scooters in Padova. They advertise their scooters as very easy to use and to go anywhere safely, thanks to the larger wheels that are excellent at holding the road and a triple braking system ("Ride Dott" 2019). Like other free-floating sharing systems, users

can download the Dott app, free of charge, and choose which subscription fits their needs and can start to use the scooters. Their website and the app present the rules of driving and parking the scooter and advise users to be always careful of themselves and the environment while using the scooter.

Bit Mobility

Similar to Dott, Bit Mobility is another company offering e-scooter services in Padova. By downloading the BitMobility app, users can choose among the offers, pay-per-use or monthly or more subscriptions, to use in the city. They advertise their services in Padova as:

"Choosing BIT means choosing environmentally sustainable mobility, but also safe and fun. No more long car lines and parking problems. BIT takes you to your destination by also pointing you to dedicated parking lots where you can leave your scooter. Download the app and contribute to the development of electric mobility in Padova, for a smart city with less traffic and pollution." (Bit Mobility, n.d.)

Both companies have equipped the geo-referenced scooters with restricted or reduced speed zones with a specific operating area. To rent the vehicles, the procedure is the same for both companies: download the app and register. All scooters are equipped with GPS to prevent theft, slow the vehicle's speed in pedestrian areas, and prevent parking in prohibited areas ("Padova, il servizio monopattini in sharing di Bit Mobility e Dott" 2021).

The rules for using the scooters in the city are the same for both companies, including the speed limit of 50 km/h on urban roads, which also cover the bike lanes. Driving the scooters along the suburban main and secondary roads is prohibited. Riding under arcades and on sidewalks is not allowed, and in other exclusively pedestrian areas where bicycles are allowed, the scooter may not exceed a speed of 6 km/h.

Together with the Padova Municipality, incentivized parking spots have also been identified, marked in both apps, which provide access to dedicated discounts. Below is a picture of both services in the dedicated parking area in front of the train station in Padova.

Figure 16 Sharing mobility services in the train station square Source: (https://www.alamy.it/14-febbraio-2022-padova-italia-scooter-elettrici-bit-e-dott-a-noleggio-nella-citta-di-padova-come-mezzo-di-trasporto-popolare-image460484551.html)

Car sharing

Car sharing is the concept of the chance to use a car when it is needed from dedicated parking places assigned. It is a transportation model where the users can use the vehicles on a short-term basis by simply reserving a car when needed through a mobile app or a website. The car is usually parked in a designated area, where users can access it easily by following the instructions provided by the company they are using the service. After using the car and when their need for the vehicle is finished, they must return to it in the same parking spot. Services of car sharing offer some benefits by eliminating the costs of personal car ownership.

Car Sharing Padova is an urban mobility service that allows users to use vehicles on a reservation basis, paying only for the actual use time. The company, Car Sharing Padova, is a division of APS

Holding S.p.A. The service is under the control of the City of Padova. It is stated that APS Holding S.p.A, through a variety of operating divisions, manages the services (""Chi Siamo"", n.d.).

In Padova, the car-sharing service started in 2011. Two years later, in 2013, the first electric car was added to their fleet. In 2015, they started to include stations outside the city quarters in addition to the ones in the city center. 2020 marked the 1 million kilometers of driving done by users of car sharing service in Padova. After its first ten years of operation, data from recent years point in a direction of growth. The number of drivers per month increased between 2020 and 2021, from 308 annually (in 2020) to 510 (in 2021). The number of rides also increased, reaching 616 in April 2022 (APS Holding 2023).

Car sharing is aimed at the concept of sustainable mobility for Padova. The car fleet of Car Sharing Padova consists of electric and gasoline hybrid vehicles, aiming at less car ownership, which should result in less congestion and pollution. In January 2020, they introduced hybrid vehicles; in October 2021, they added vans and electric vehicles to their fleet.

Car sharing Padova service allows free parking in the city's blue stripes and access to the restricted traffic zone, as well as circulation on days when traffic is blocked or vehicles are restricted. This move seeks to achieve an interest in this service by providing ease in car sharing.

To utilize the service, it is necessary to register via the Car Sharing Padua app; then, users can choose one of the subscription plans provided. The system will then assign a pin code to reserve and use the cars, picking them up at one of the street parking lots specifically reserved for Car sharing Padova cars. The car reservation must be made through either the app or the website. At the end of use, the car must be returned to the same parking lot where it was picked up. The payment is calculated using the chosen vehicle, adding up mileage and hourly rates. Below is a picture of a vehicle of the Car Sharing Padova service.

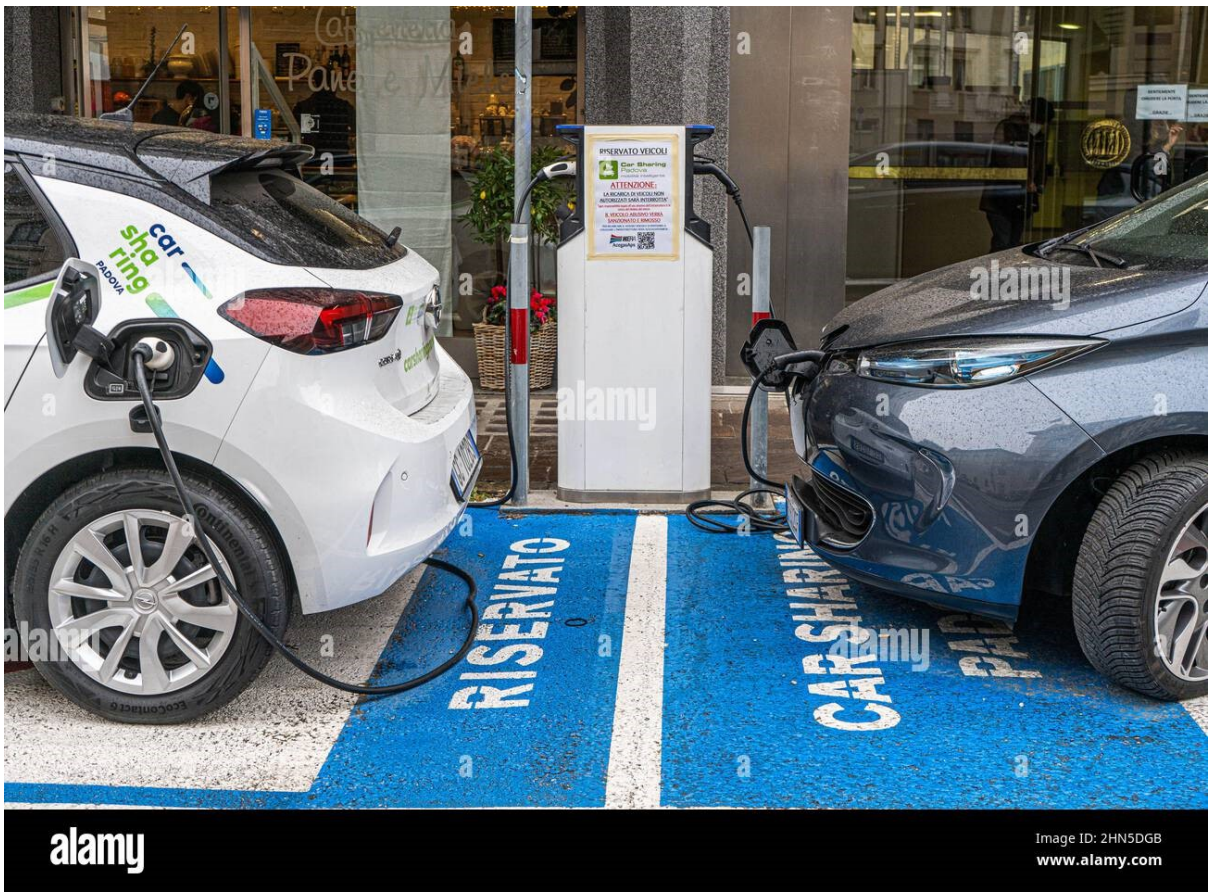


Figure 17 Car sharing service in Padova Source: (https://www.alamy.it/padova-italia-14-febbraio-2022-auto-condivise-in-un-punto-di-ricarica-elettrica-a-padova-italia-credit-amer-ghazzal-alamy-live-news-image460497755.html)

5.3 Initiatives of Sustainable Mobility in Padova

Padova has implemented various sustainable mobility initiatives to encourage a shift from private car use to environmentally friendly transportation options. These measures encompass various aspects of urban mobility, including, but not limited to, improving the public transport options and enhancing the cycling facilities by introducing new bike lanes, network systems that connect the different parts of the city, and free-floating sharing systems that are making it an easier experience for the users (European Mobility Week 2019). As these measures are explained above, other solutions are proposed by the Municipality of Padova for a more sustainable transportation system in the city. One of them is the traffic management system. Under the introduction of " La Zona a traffico limitato (Ztl) - The Restricted Traffic Zone," which was established in 1989, is defined as a 'blue zone' where the entry and exit to an area in the historic center are allowed only to particular users and vehicles, at predetermined hours (Comune di Padova 2023). Free access is allowed, unless otherwise specified and in accordance with the signs, only to bicycles, scooters, mopeds, motorcycles, and vehicles with

exclusively electric traction (Comune di Padova 2023). The circulation of vehicles in this zone is detected through an electronic system, with cameras where the entry and exit of vehicles are surveyed. In Padova, Ztl areas are divided into two zones: Zone A and Zone B. While in Zone A, there is a traffic limitation on weekdays from 8:00 a.m. to 11:30 pm and on holidays from 2:00 pm to 11:30 pm, on Zone B, traffic is not allowed 24 hours every day. Access to the Ztl area is entitled to the users of vehicles who have the badge for persons with disabilities in their vehicles, taxis with licenses issued by the municipality. In addition, a speed limit of 30 km/h inside the area of the Ztl.

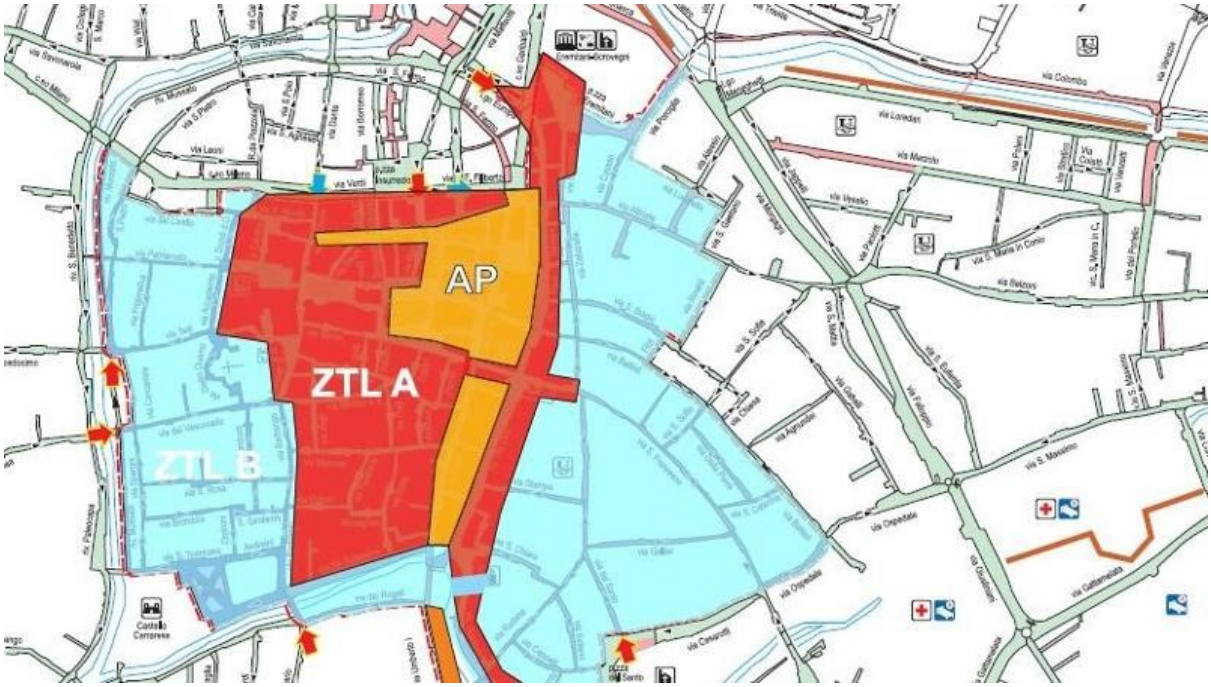


Figure 18 Map of ZTL Zone A and B in Padova city center Source: (Malfitano and Rafanelli 2019)

Here is a map of Ztl Zone A and Zone B in the city center of Padova. AP signifies Area Pedonale - Pedestrian Zone where no vehicles are allowed at any time.

Figure 19 ZTL sign in city center Source: (Rodighiero 2023)

An example of a Ztl sign in the city center of Padova.

In addition to the limited traffic zones, Padova Municipality limits which cars can be used in the city. According to the ordinance, the vehicles allowed to drive are:
"Vehicles with electric or hybrid engines, vehicles powered by LPG or methane gas, and vehicles powered by gasoline or diesel converted to LPG or methane gas…" (Comune di Padova, n.d.).
The vehicles outside this list are subject to limitations or not allowed to drive in the city center. By these rules, the city aims to encourage the use of clean vehicles and electric or hybrid vehicles throughout the city.

All these initiatives collectively reflect the city's commitment to promoting sustainable and accessible urban mobility and low reliance on private cars.

5.4 Incentives on walking

Padova has implemented several incentives to promote walking as a sustainable mode of mobility and to encourage its citizens to embrace walking as a means of transportation. Some of these initiatives include the ones explained above, such as traffic calming, limitations in some areas, and

the creation of cycling and walking trails along the rivers. Apart from these, the city has zones dedicated to pedestrians where safe and pleasant spaces for walking are created. An example is the area pedonale - pedestrian zone in the historic city center.

According to a newspaper article in 2021, it is stated that the road system in the city center is changing to expand the pedestrian area, with a goal of helping the business owners who were hit hard economically during the pandemic. With this aim, there were decisions to change the layout of the streets, in particular Via del Santo and Via Zabarella, which both are significant streets in the city center (Cozza 2019). Although the initial aim is not to encourage walking as a transportation mode but rather depend on economic reasons, the outcome will be increasing walking activity in the mentioned areas.

People who want to explore the different mobility solutions in Padova can check these applications on their mobile phones. The image below shows all the available options for mobility in Padova with digital applications. There are the apps of the bike sharing services, Ridemovi and Weelo for GoodBike Padova, the application for the bus, whether one can buy tickets or simply check the routes and available ticketing options in Padova, BusItalia Veneto, the apps of scooter sharing services BitMobility and Dott, and Car Sharing Padova, AppTaxi to call a taxi, and finally the Trenitalia app for any movement from the train station.

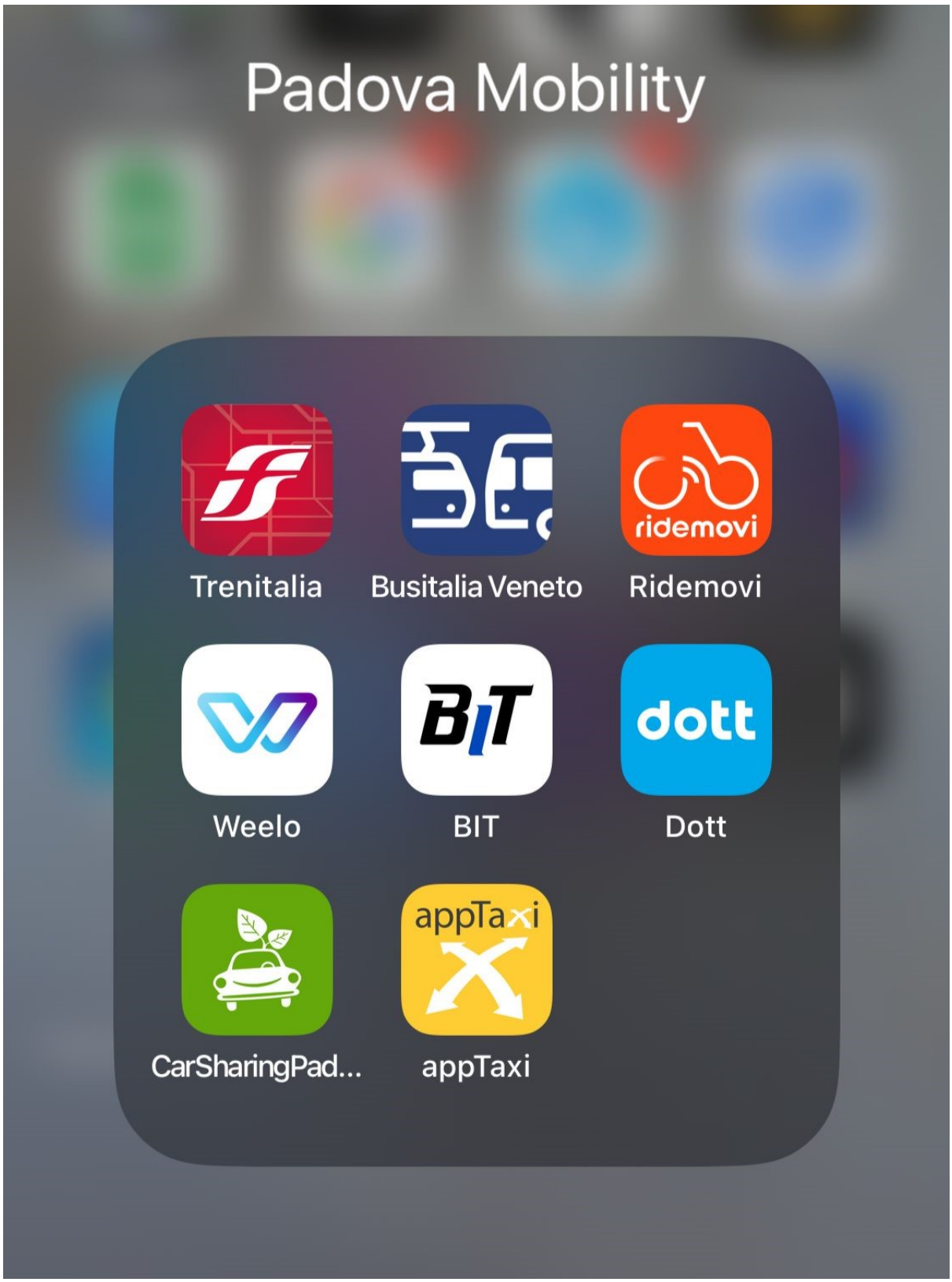


Figure 20 Padova mobility apps shown on screen. Screenshot by the author.

5.5 Who are the users of different transportation methods in Padova, and which methods do they choose?

The statistical report published in 2018 defines the territory of the central Venetian plain (said as Pianura Veneta) as the urbanization characteristics of a diffused city (cittá diffusa). The meaning of the diffused city is explained as a widespread settlement, as Veneto is considered one of the largest areas of settlement in Italy (Viale et al. 2018). Therefore, sustainable mobility in this region is a noteworthy topic since this type of urbanization also affects the transportation system, with a reliance on private car ownership. The report states that throughout the region, mobility for work and study takes place using motorized means in the majority of the cases, and among these, 85% by private means, while the use of public transportation remains very little compared to private transport, by 5.9%. They explained the initiatives on creating smart cities with sustainable mobilities relying on this fact of the region.

Figure 21 Statistics of movement in Veneto 2016 Source: (Viale, Cinzia, Diego Gasparini, Lorenzo Mengotti, and Antonella Trabuio. 2018. "Capitolo 7 - Il Veneto e la mobilità sostenibile - Rapporto Statistico del Veneto 2018." Rapporto Statistico del Veneto 2018)

The figure above presents some data regarding transportation and mobility in the Veneto region in 2016. According to the figure, the daily commuter number in 2016 was 2.4 million, while users numbered 460 million in public transport. The movement by motorized vehicles reached 80%, while the amount of cycling roads increased by 43%.

Venice and Padova stand out within the region as cities that attach importance to sustainable mobility and environmentally friendly transportation. Padova also stands out as the most attractive city in Veneto, considering that most people come to the city from outside the municipality. It is stated that 2.4 million people move every day within the region. Padova has over 120,000 arrivals every day from outside of their municipality.

The figure below shows the distribution of the individuals who moved habitually in 2015 in the region. According to this figure, the majority of the movement comes from people who move for

work with 76%, followed by students, excluding the number of university students, with 20% and 4% being for university reasons.

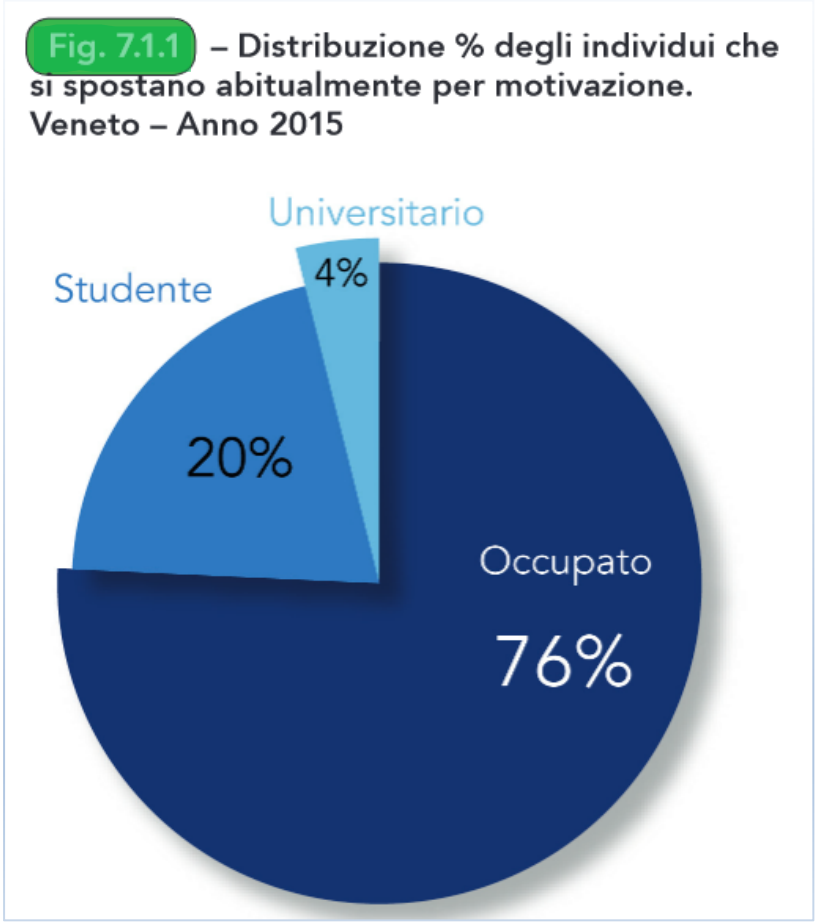


Figure 22 Distribution of people who move frequently with reason Source: (Viale, Cinzia, Diego Gasparini, Lorenzo Mengotti, and Antonella Trabuio. 2018. "Capitolo 7 - Il Veneto e la mobilità sostenibile - Rapporto Statistico del Veneto 2018.")

The transportation choice in the region remains mostly in favor of motorized vehicles, and among this, private cars are seen as the most used option. According to the figure below, where the movement for mobility utilized in 2016 has shown, motorized vehicles are at 78,7%, while cycling and walking together are at 21,3%. Inside the motorized vehicles, the private car has reached 85% while other options remain less significant than the private car.

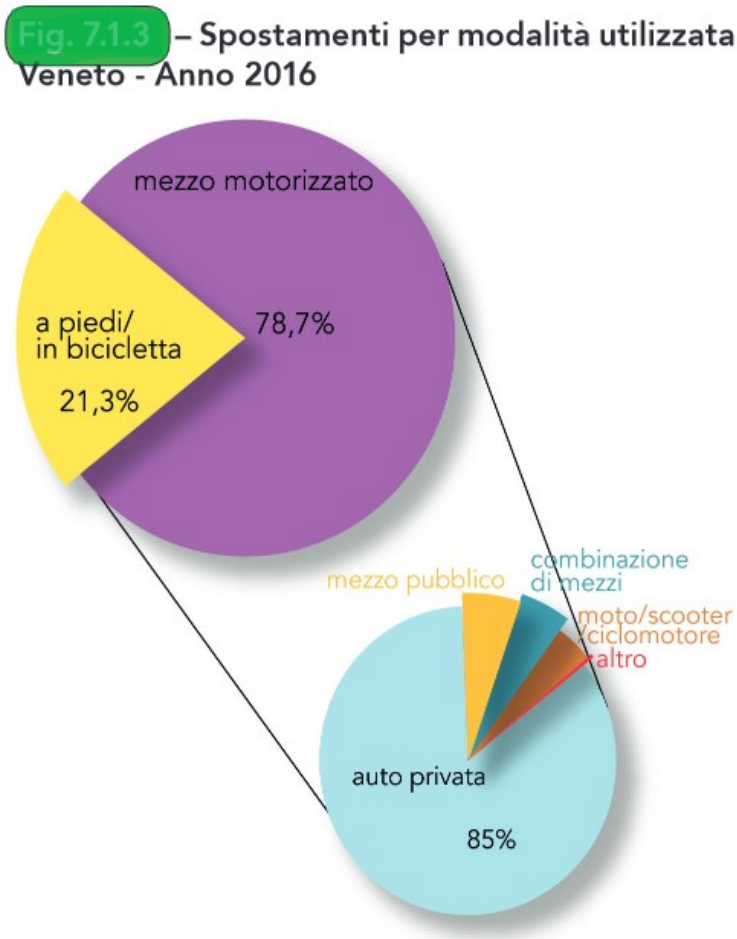


Figure 23 Movements by mode of travel Source: (Viale, Cinzia, Diego Gasparini, Lorenzo Mengotti, and Antonella Trabuio. 2018. "Capitolo 7 - Il Veneto e la mobilità sostenibile - Rapporto Statistico del Veneto 2018." Rapporto Statistico del Veneto 2018.)

In addition to the traditional understanding of mobility, new and sustainable ways of moving around the region are becoming increasingly popular. Padova stands out as an important example, being counted among the bicycle-friendly cities. With incentives mentioned previously from the city and changes in individual behavior that go against the traditional ways and established habits, cycling, walking, and relying more on public transportation rather than the private car have resulted in Padova. According to this table that indicates the cyclability of the cities, by looking at the equivalent meters per inhabitant, Padova is seen as the first of the region and the 9th at the national level. With 18.76 equivalent meters per 100 inhabitants, Padova is ambitious to promote an alternative mobility solution to the private car, although the outcome still needs improvement.

Tab. 7.3.2 - Indice di ciclabilità (metri equivalenti per abitante) nelle province venete e ranking su scala nazionale - Anno 2015

CITTÀ	Metri equivalenti/abitante	Rank nazionale
Reggio Emilia	41,06	1
Padova	18,76	9
Treviso	13,77	20
Venezia	12,82	22
Vicenza	12,79	23
Verona	12,05	24
Rovigo	9,34	33
Belluno	7,2	37

Figure 24 Statistic on cycling level of the provinces Source: (Viale, Cinzia, Diego Gasparini, Lorenzo Mengotti, and Antonella Trabuio. 2018. "Capitolo 7 - Il Veneto e la mobilità sostenibile - Rapporto Statistico del Veneto 2018.")

On the other hand, Padova stands out in the number of pedestrian zones, Ztl, and 30 km/h areas in a city. In the case of pedestrian roads, Venice stands as the first, thanks to its exceptional historical center, and Padova remains the region's second city.

Fig. 7.3.1 - Disponibilità di aree pedonali (m2 per 100 abitanti) e di stalli di sosta in parcheggi di scambio (stalli per 1.000 autovetture circolanti) nei comuni capoluogo di provincia - Anno 2015

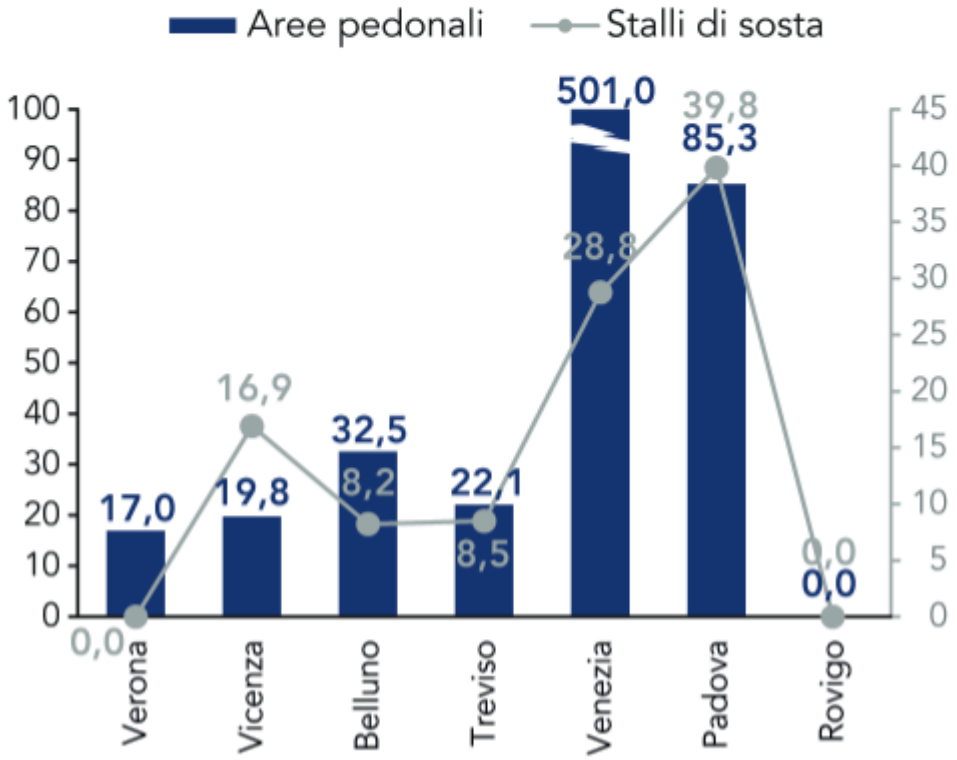


Figure 25 Availability of pedestrian areas and parking stalls Source: (Statistic on cycling level of the provinces Source: (Viale, Cinzia, Diego Gasparini, Lorenzo Mengotti, and Antonella Trabuio. 2018. "Capitolo 7 - Il Veneto e la mobilità sostenibile)

Lastly, Padova is also at significant levels in the use of sustainable modes of transportation compared to other Veneto cities. The figure below shows the availability of sustainable mobility services in Veneto's capital municipalities. Padova, together with Venice, has all the services of sustainable mobility, including car sharing, bike sharing, interchange parking lots, a 30 km/h zone, and a limited traffic zone (Ztl).

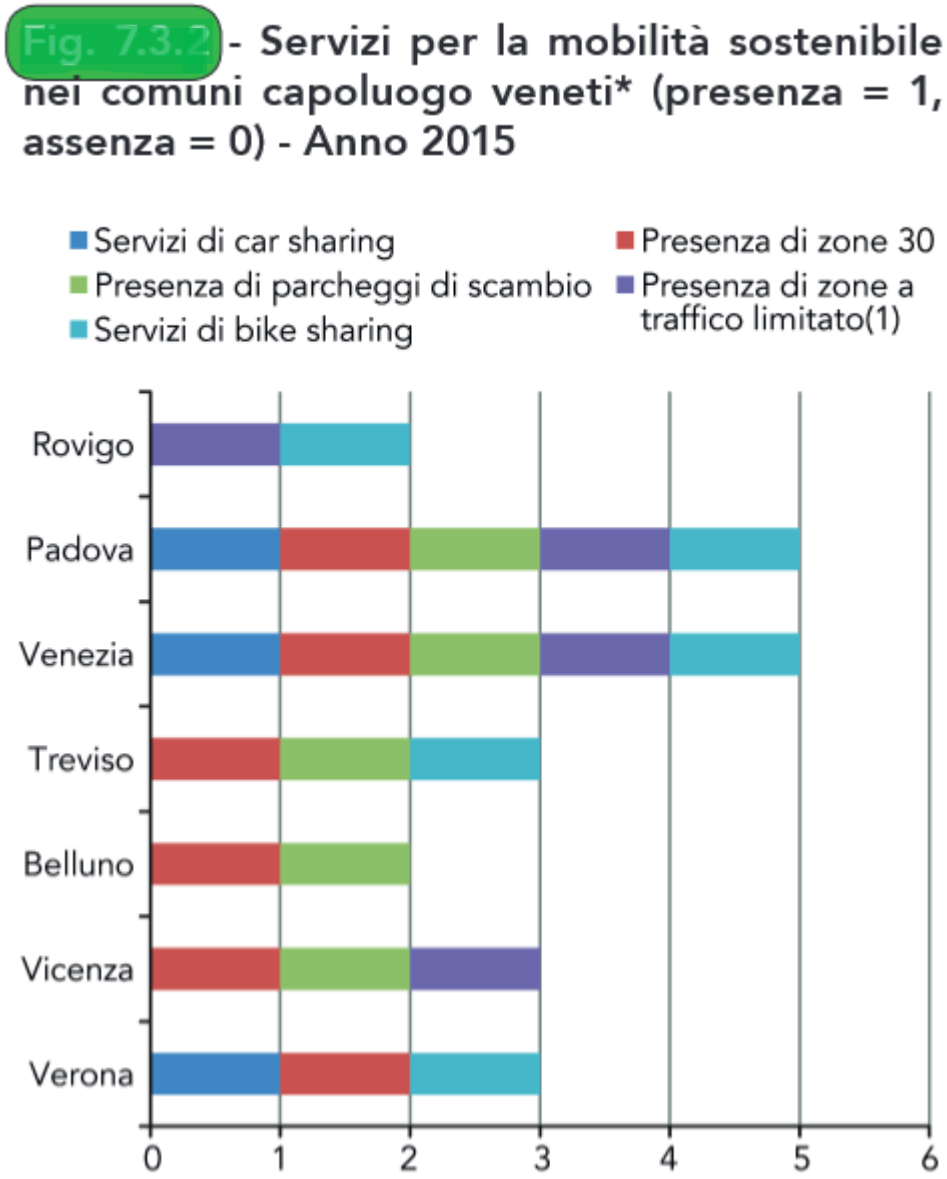


Figure 26 Sustainable mobility services in capital municipalities of Veneto Source: (Statistic on cycling level of the provinces Source: (Viale, Cinzia, Diego Gasparini, Lorenzo Mengotti, and Antonella Trabuio. 2018. "Capitolo 7 - Il Veneto e la mobilità sostenibile)

Padova's diverse sustainable transport modes are supported by the city's implementation of Sustainable Urban Mobility Plans and related supporting initiatives. The following chapter will delve into an analysis of Padova's SUMPs.

Who moves in Veneto, and specifically in Padova, with which means, depends on a lot of different factors and motivations. The type of settlement seen in the region, the widespread habitation and expansion, followed by individual mobilities, results in interesting outcomes when it comes to transportation. Understanding why and how people move requires an understanding of a complex

interplay of various factors, including people's behaviors, demands, and social status. These diverse dimensions of mobilities cannot be explained only by looking at the act of moving for work, school, or out of necessity. There is a lot more to why people are moving around, and there are numerous reasons behind it, which the scope of this thesis is not wide enough to explain.

CHAPTER 6 Sustainable Urban Mobility Plans in Padova

In the urban context of Padova, there is a growing incentive to adopt sustainable urban mobility solutions to address the challenges of daily urban life. With an agglomeration of 420,269 people and a core city population of 208,732, Padova accommodates its residents in an area covering 93.03 square kilometers (Osservatorio PUMS, n.d.). Notably, the city has a high population density of 2,244 people per square kilometer (Osservatorio PUMS, n.d.). In this chapter, we will explore the process of adopting sustainable urban mobility plans in Padova. Analyses of the plan will be presented, which aims to make mobility more sustainable and accessible, contributing to a greener and more inclusive urban future in a city like Padova, with many students and home to an established university.

6.1 The history and the legal background of the Sustainable Urban Mobility Plans in Padova

Before moving forward with the analysis of SUMPs in Padova, it is essential to explain what Conferenza Metropolitana Padova (Co.Me.Pa) is. It is a voluntary territorial agreement signed in 2003 between the municipality of Padova and its neighboring municipalities for a more comprehensive and coherent land and mobility management.

In the last three decades, Padova has undergone an evolution that has profoundly affected the neighboring municipalities and the territory. For the integration of Padova to its neighboring municipalities in 2003, it was considered necessary to create this consortium in order to put in the same line, in terms of social, cultural, and economic relations, Padova and the municipalities in the vicinity. It was also an important assembly for the citizens. Traditionally, citizens have a predominance of identification with their own little town. Now, according to the Municipality of Padova, people do not feel a sense of identification only with their town per se, as was traditionally the case, but rather with the public services and facilities of the city. They now have a broader and more interconnected view of citizenship that goes beyond their own local community (Comune di Padova 2015). The feeling of closeness to the network of services and resources provided by the different levels of administration, which come together in a wider system, increases the sense of belonging to the city.

With this consortium, Padova has a more comprehensive territorial dimension. The municipalities involved in this consortium are Abano Terme, Albignasego, Cadoneghe, Casalserugo, Legnaro, Limena, Maserà di Padova, Mestrino, Montegrotto Terme, Noventa Padovana, Ponte San Nicolò, Rubano, Saccolongo, Saonara, Selvazzano Dentro, Vigonza, Villafranca Padovana and the municipality of Vigonovo (Metropolitan City of Venice) for its proximity to the area. Here is a map of the explained territory:

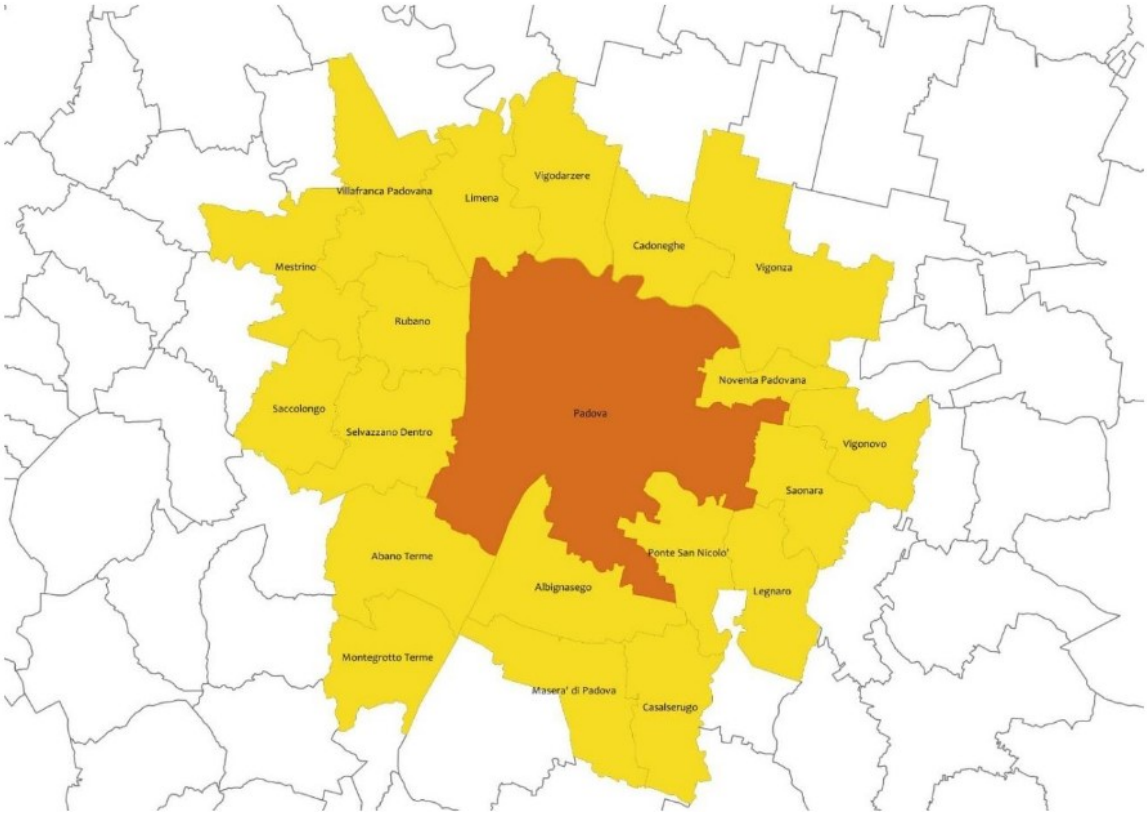


Figure 27Map of CoMePa territory Source: (https://www.padovanet.it/sites/default/files/attachment/Rapporto%20Ambientale_VAS_PUMS.pdf)

The main concern of this pact is to develop a trans-municipal governance system in which all municipalities have the know-how to deal with the challenges of urban mobility. In this network, the city of Padova plays a central role. The University of Padova also participates in this consortium by establishing a workgroup of professors from different departments to cover the necessary skills and conduct research on the metropolitan area (Comune di Padova 2015).

6.2 Start of the SUMP in Padova

The SUMP in Padova takes into account the territorial borders that go beyond the city of Padova, including the 18 municipalities counted in CoMePa. Therefore, it is also referred to as the CoMePa PUMS.

The SUMP in Padova was developed in alignment with the Sustainable Urban Mobility Plan guidelines set forth by the MIT (Ministry of Infrastructure and Transport) Decree of August 4, 2017, pursuant to Article 3(7) of Legislative Decree No. 2571 of December 16, 2016 (https://www.padovanet.it/sites/default/files/attachment/PUMS-Padova-Report%20TerzaFase_DEF-4%20-%20firmato.pdf).
This plan serves as a significant reference document to steer sustainable mobility strategies for the near future. The plan covers a wide geographical area, as explained in the metropolitan area of Padova. These municipalities in the area are actively collaborating to promote and realize a common vision for sustainable transportation policies at a regional level, transcending individual municipal boundaries.

The drafting of the plan was developed in three phases. The first phase consists of analyzing the status quo of mobility in the area with the help of surveys, simulations, and scenarios (Comune di Padova 2020). The first phase is also mentioned as the phase of building the cognitive framework. This part reported an understanding of the situation and identified critical issues on the mobility system, environmental impacts, and incidents in the CoMePa area (TRT Trasporti e Territorio et al. 2019, 16). The economic dimensions of the mobility system, the area's demographic structure, and the urban area's mobility attraction points are carefully considered and analyzed. Intensive research of the transportation networks and services, including the road network, the automotive network and rail services, the bicycle network, the car sharing and parking system, was conducted. The impact of the mobility network was examined from the environmental point of view, including trends in the environmental pollutants over the years, climate-altering gas emissions, and noise pollution, and the social point of view, including the incident and casualty rates and mortality rates.
The second phase consisted of the elaboration of the proposal of the plan and presentation of the plan to the political and technical entities of the City of Padova and the CoMePa assembly. The proposal underwent a detailed examination, and its technicalities and characteristics were discussed and reviewed on June 29, 2018 (TRT Trasporti e Territorio et al. 2019, 3). The review process took place through several meetings of the interest groups of the city and the CoMePa municipalities. After the

proposal was shared and discussed with the stakeholders over the course of several months. The plan proposal's continuing review and verification process has served as a base for the activities of the third phase. The third phase included the evaluation of the proposed interventions within the plan (Comune di Padova 2020). The planning scenarios and their assessments were shared with the CoMePa in two meetings on February 7 and March 14, 2019 (TRT Trasporti e Territorio et al. 2019, 4). The results of these meetings led to the decision of measures in the SUMP scenario for 2030. These measures aim to facilitate the transition to low-carbon mobility. They include modal shifts (from cars to walking, cycling, and public transport), the introduction of a Low Emission Zone (LEZ) in the city of Padova to regulate vehicle access, and measures to promote the increased use of clean electric vehicles at the local level during the transition phase, until 2030 (TRT Trasporti e Territorio et al. 2019, 4). Consecutively, a final document for the SUMP has been drafted. As stated by the Observatory of SUMP, the drafting of the SUMP of the Padova CoMePa was completed in 2019, and the document was adopted in February 2020 (Osservatorio PUMS, n.d.).

In addition to the MIT's August 4, 2017 decree, the SUMP was considered in light of various other Italian and European regulations and guidelines. The report of the third phase mentions that the Ministerial Guidelines followed in the creation of the abovementioned decree are a result of a broader initiative at both the national and European levels (TRT Trasporti e Territorio et al. 2019). It references Directive 2014/94/EU of the European Parliament and the European Council, which focuses on creating infrastructure for alternative fuels. Italy transposed this directive into law through Legislative Decree No. 257 of December 16, 2016. This decree states that the Minister of Infrastructure and Transport needs to prepare guidelines for creating plans that promote sustainable mobility in urban areas. These guidelines should follow the principles mentioned in the decree. The report also highlights the Law No. 340 of November 24, 2000, particularly the Article 22. This law establishes special Urban Mobility Plans intending to meet the population's mobility needs while addressing issues such as air and noise pollution reduction, energy consumption reduction, improved road safety, minimized private car usage, increased use of collective transportation systems (including car-pooling and car-sharing), and reduced urban congestion. Another reference has been made by the report that Law No. 244 of December 24, 2007, specifically the Article 1, establishes the National Observatory for Local Public Transport Policy, indicating the importance of monitoring and shaping policies related to local public transport (TRT Trasporti e Territorio et al. 2019). In summary, the creation of Sustainable Urban Mobility Plans has a background in both European and Italian legislation and guidelines, in like manner, both emphasizing the need to address various aspects of urban mobility, including environmental concerns and improved transportation infrastructure.

The significance of the SUMPs in the European Union, with various important policy documents as crucial tools for urban mobility planning, has already been explained in the previous chapters. These documents, such as The 2009 Action Plan and The 2011 White Paper, have been highlighted in the Third phase report as stressing the significance and specific requirements of SUMPs in the context of European urban mobility policies.

The case of Padova strikes as significant in the context of urban mobility policies. It is stated in the report that Padova and CoMePa place themselves in a pioneering role in Italy and Europe by deciding to adapt their mobility planning-programming tools with an approach attentive to the local context and the challenges that urban areas are facing and expected to face in the following years (TRT Trasporti e Territorio et al. 2019). The importance of the national context is that Padova and CoMePa are one of the first experiences of supra-local scale planning initiated voluntarily. This supralocal voluntary planning explains the planning efforts that go beyond the boundaries of a single local area and encompass a broader scope. Padova and the 18 participating municipalities in CoMePa represent a unifying force to overcome urban mobility challenges. The CoMePa SUMP includes diverse communities, from the city of Padova to industrial zones and communities in the outskirts of Padova, and towns on the skirts of hills with a touristic value, like Colli Euganei (TRT Trasporti e Territorio et al. 2019).

6.3 The Urban Mobility Challenges of Padova and CoMePa area

As stated earlier, during the preparation phase of the sustainable urban mobility plans in Padova and the CoMePa area, numerous activities were conducted to analyze the area's problems. Surveys, workshops, and roundtable discussions were held, engaging residents and stakeholders. Specifically, one survey was conducted, online and in person, to gain deeper insights into the local mobility characteristics and better understand the expectations of residents of Padova and the CoMePA or those who are frequently coming to the area (Twisse 2019). The survey was reachable through the Municipality portal and was also distributed as paper questionnaires at the Bicycle Festival, which took place in Padova on April 8, 2018. The total number of responses was approximately 2,500. It is stated that while the results were not statistically significant, the high number of responses clearly shows the understanding of mobility in the area (Twisse 2019). The survey's target population was residents, workers, and students in the CoMePa area and those who were commuting within the area.

The results of the participation of the survey were representative of 48% women and 52% men, almost all represented by Italian citizens, with 61% citizens of Padova and 39% citizens of the CoMePa area (TRT Trasporti e Territorio et al. 2019, 22).

The survey was helpful in understanding the aspects that best describe the priorities of the local community. The analysis of the responses has shown the way to the issues that are most significant to the population (TRT Trasporti e Territorio et al. 2019, 22). Regarding walking, the participants' concerns were the speed of cars, the coexistence of pedestrian and bicycle paths, and the lack of sidewalk maintenance. In the case of cycling, the most pressing concern is safety, while the speed of cars is mentioned once again. In the CoMePa municipalities other than Padova, there were concerns about insufficient parking facilities and bicycle racks with the absence of bike lanes and maintenance. The survey results on public transportation showed that the residents are unsatisfied with the low service frequency and the timetables. The public transport timetable, along with ticketing and subscription costs, is a higher concern in the other CoMePa municipalities. Punctuality and service regularity are among the issues regarding public transport. For private vehicle users, the main concern is the traffic congestion. For the case of Padova, finding parking for the vehicle is also stated as a pressing concern. Generally, outside the urban areas, the biggest mobility problems are the scheduling of the services, low service frequency for public transportation, and the coexistence of pedestrian and bicycle paths.

The survey includes a final question that asks for the respondent's preferences for allocating public resources on how to improve public transportation. The answers showed that residents are supporting the improvement of public transportation, and they also want more promotion of cycling. Another point of the answers was the residents' desire for increased road safety and improved public spaces. Here is a table of the results of the final question. The most highlighted responses concerned improving public transportation, promoting cycling, creating safe streets, and improving public spaces. Although less highlighted, other options are promoting mobility services such as bike and car sharing and electric cars and bikes.

- A suo parere in quale direzione dovrebbero essere concentrati gli investimenti per la mobilità?

principali problemi riscontrati	Maschi	Femmine	Padova	Altri Comuni	Totale
Migliorare i servizi di trasporto pubblico	4.3	4.4	4.3	4.5	4.3
Diffondere l'uso della bicicletta (ciclabili, servizi, ecc.)	4.3	4.3	4.2	4.1	4.3
Diffondere i servizi alla mobilità (bike/car sharing)	3.4	3.4	3.3	3.3	3.4
Incentivare l'uso di auto elettriche	3.3	3.4	3.4	3.4	3.3
Incentivare l'uso di bici elettriche	3.1	3.0	3.2	3.1	3.1
Innalzare la sicurezza stradale per pedoni, ciclisti, automobilisti	4.0	4.2	4.1	4.1	4.1
Dare qualità allo spazio pubblico (strade, piazze)	4.1	4.1	3.9	4.0	4.1

Figure 28 The survey on population's interest over investments of mobility Source: (TRT Trasporti e Territorio et al. 2019, 24)

The survey certainly gives an understanding of the population's interest in urban mobility and the challenges they face in their everyday lives. Given this frame, we can also look at the 'report cards' of mobility in Padova and the CoMePa area.

The first table concerns the area's mobility system, population, density, and employment. According to data in 2018 from ISTAT, the population shows 210.440 residents living in Padova. In the CoMePa area, this number reaches up to 252.738. The density of Padova is 2.266, while in the CoMePa region, it is 778. The number of students enrolled in the University of Padova is 57.272, showing a significant number regarding the population of the city. The number of workers in Padova is 98,135, while the number of production settlements is 26.543. In the CoMePa area, the number of workers is 80.541, and the number of production settlements is 26.055. This data excludes the number of workers and settlements in Vigonovo since it is under the rule of the Municipality of Venice. These numbers can be helpful to see that the city of Padova itself has almost the same population altogether as the whole population of the CoMePa area. The similarity is also shown again in the number of employees and the workplaces.

Tab. 3.1: Carta d'identità del sistema della mobilità di Padova e comuni CoMePa, Struttura territoriale

STRUTTURA TERRITORIALE		
PARAMETRO	VALORE	FONTE (ANNO)
Popolazione residente (abitanti) Padova	**210.440**	Istat (2018)
Popolazione residente (abitanti) CoMePa (escluso Padova)	**252.738**	Istat (2018)
Densità (abitanti/km^2) Padova	**2.266**	Istat (2018)
Densità (abitanti/km^2) CoMePa (escluso Padova)	**778**	Istat (2018)
Popolazione straniera residente (%) Padova	**15,9%**	Istat (2018)
Addetti (numero) Padova	**98.135**	Infocamere[8] (31.12.2017)
Addetti (numero) CoMePa (escluso Padova e Vigonovo)	**80.541**	Infocamere (31.12.2017)
Insediamenti produttivi (numero) Padova	**26.543**	Infocamere (31.12.2017)
Insediamenti produttivi (numero) CoMePa (escluso Padova e Vigonovo)	**26.055**	Infocamere (31.12.2017)
Popolazione scolastica Padova (Iscritti Università degli Studi di Padova)	**57.272**	Dati iscritti Unipd [9]

Figure 29 Padova and CoMePa area mobility statistics Source: (TRT Trasporti e Territorio et al. 2019, 17)

Another important report card is the one analyzing the transport in the area. The table below presents key mobility-related data for Padova and the neighboring municipalities within the CoMePa region. The data offers insights into various aspects of the mobility landscape. Within the region, there are 206,213 systematic daily movements, encompassing daily commutes and trips. Within Padova, there are 79,028 systematic daily movements, indicating the volume of local daily trips inside the city. The modal split within Padova shows that 43% of these movements involve cars, including both drivers and passengers. Of this, 29% are solo drivers, highlighting a significant reliance on private cars for local transportation. For other movements, which involve trips between Padova and surrounding areas, 60% of trips involve cars, with 53% being solo drivers. The motorization rate within Padova is 597.3 registered cars per 1,000 residents, indicating the predominance of automobiles in the city. The motorization rate in the broader Padova province is slightly higher at 636.4 registered cars per 1,000 residents.

The table also highlights the fundamental use of public transport services. Within the urban area, over 31.2 million passengers utilized public transport services, emphasizing the significance of these services for urban mobility. Approximately 12.5 million passengers were transported on extra-urban public transport routes for longer-distance travel.

In general, the table offers valuable insights into the mobility patterns in Padova and the CoMePa region, showcasing the importance of private cars, as well as the notable usage of public transport services for both urban and extra-urban travel. These statistics are proving to be crucial for sustainable urban mobility planning.

Tab. 3.3: Carta d'identità del sistema della mobilità di Padova e comuni CoMePa, Domanda di mobilità

DOMANDA DI MOBILITÀ		
PARAMETRO	VALORE	FONTE (ANNO)
Spostam. sistematici/giorno generati e attratti (numero)	**206.213**	Istat (2011)
Spostam. sistematici/giorno interni a Padova(numero)	**79.028**	Istat (2011)
Quota modale auto spost. sistematici - interni a Padova(%)	**43% (conducente+passeggero) (29% solo conducente)**	Istat (2011)
Quota modale auto spost. sistematici - di scambio (%)	**60% (conducente+passeggero) (53% solo conducente)**	Istat (2011)
Tasso di motorizzazione (autoveicoli/1000 abitanti) Padova	**597,3**	ACI (2017)
Tasso di motorizzazione (autoveicoli/1000 abitanti) Provincia di Padova	**636,4**	ACI (2017)
Passeggeri trasportati TPL rete urbana (numero)	**31.253.221**	Carta dei Servizi Busitalia Veneto (2017)
Passeggeri trasportati TPL rete extraurbana (numero)	**12.524.772**	Carta dei Servizi Busitalia Veneto (2017)

Figure 30 Statistics on mobility system of the area Source: (TRT Trasporti e Territorio et al. 2019, 18)

Another important table presents information on the offers of mobility. This table provides an overview of the mobility infrastructure and services in Padova and the neighboring CoMePa municipalities. Padova's urban public transport network covers approximately 239.6 kilometers, with the SIR network extending to 9.8 kilometers. For extra-urban travel, there is a network of 1,086 kilometers. The services offered within the urban area amount to 7.2 million bus kilometers annually; for extra-urban travel, it reaches around 14.6 million. There are 212 urban buses and 291 extra urban buses in the fleet.

Additionally, 18 trams are operating in the SIR network. The city of Padova is well-connected by rail, with its train station. There are 408 regional trains and 309 long-distance trains arriving daily. These services are vital for both local commuters and travelers.

Regarding cycling, the city has 168 kilometers of cycling lanes within Padova. The surrounding CoMePa municipalities, excluding Padova, have 329 kilometers of cycling lanes.

The data on parking facilities shows that Padova offers various parking options, with 2,936 parking spaces in the central urban area, 1,797 parking spaces in park-and-ride, and 4,949 spaces in structured parking. In addition, in terms of logistics, there is the intermodal terminal, Interporto Padova, which is designed to handle 275,000 TEUs (Twenty-foot Equivalent Units) and accommodate 5,500 trains annually. This facility plays a significant role in regional logistics and transportation.

The table below provides a comprehensive overview of the available mobility options, including public transport, cycling infrastructure, and parking facilities, showing the various ways to move in the city and the region. Additionally, the presence of Interporto Padova highlights the city's role as a transportation hub in the region.

Tab. 3.2: Carta d'identità del sistema della mobilità di Padova e comuni CoMePa, Offerta di trasporto

OFFERTA DI MOBILITÀ		
PARAMETRO	VALORE	FONTE (ANNO)
Rete TPL automobilistica (km) Urbano Padova	**239.6**	Carta dei Servizi Busitalia Veneto
Rete SIR (km)-estensione	**9.8**	Carta dei Servizi Busitalia Veneto
Rete TPL (Km) extraurbano	**1.086**	Carta dei Servizi Busitalia Veneto
Servizio TPL offerto (bus*km/anno) urbano	**7.193.978**	Carta dei Servizi Busitalia Veneto
Servizio TPL offerto (bus*km/anno) extraurbano	**14.635.107**	Carta dei Servizi Busitalia Veneto
Flotta TPL (autobus) urbano	**212**	Carta dei Servizi Busitalia Veneto
Flotta tram SIR	**18**	Carta dei Servizi Busitalia Veneto
Flotta TPL (autobus) extraurbano	**291**	Carta dei Servizi Busitalia Veneto
Treni/giorno a Padova - Regionali (numero)	**408**	Fonte Trenitalia
Treni/giorno a Padova FS – Lunga Percorrenza (numero)	**309**	Fonte Trenitalia
Rete ciclabile (km) Padova	**168**	Fonte Bici Masterplan
Rete ciclabile (km) CoMePa (escluso Padova)	**329**	Stime PUMS
Posti auto - Area urbana centrale (numero) Padova	**2.936**	Elaborazione dati APS
Posti auto - Parcheggi scambiatori (numero) Padova	**1.797**	Elaborazione dati APS
Posti auto - Parcheggi in struttura (numero) Padova	**4.949**	Elaborazione dati APS
Interporto Padova dimensionamento	**275.000 TEU** **5.500 treni/anno**	Fonte Interporto Padova

Figure 31 Statistics on mobility system of the area, transport options Source: (TRT Trasporti e Territorio et al. 2019, 18)

In light of the information provided in the survey regarding the challenges faced by residents and the data presented on the existing condition of mobility offers and users in the area, we can now proceed to answer the following question. What are the strategies of the SUMP in Padova and the CoMePa area?

6.4 The Strategies of CoMePa SUMP and the Planned Actions

In sustainable urban mobility plans, creating mobility strategies for the determined future is important. In the guidelines of CoMePa SUMP, there are seven strategies outlined. These strategies are tailored to the specific characteristics of the region. The strategies are determined by several factors, such as the analysis of strengths and weaknesses, which were acquired during the knowledge reconstruction in phase one. Another was the input from the participatory processes, such as the above survey and other workshops and roundtable discussions held in Padova and the CoMePa municipalities. Along with discussions with technical experts and feedback from stakeholders and political decision-makers, the strategies for the SUMP have been set for the next decade. These discussions took place in all the phases of the SUMP development in the first phase, during the knowledge gathering, in the second phase, during the identification of the macro themes of this plan, and finally, at the beginning of the third phase, during the creation of the scenarios of the plan - SR - Scenario di Riferimento (Reference Scenario) and SP - Scenario di Piano (Plan Scenario).

According to the report, the strategies are as follows:

1. Integration of transportation systems
2. Development of collective mobility
3. Focus on pedestrian and cycling mobility systems
4. Focus on shared motorized mobility systems
5. Renewal of fleet, introduction of low-impact and highly energy-efficient vehicles
6. Optimizing urban logistics
7. Promoting a culture of mobility safety - reducing risk and exposure to risk

The table below shows the strategies of the SUMP and which type of actions follow those planned strategies.

Table 6 Strategy and Actions of the SUMP. Table by the author.

Strategy	What actions to focus on?
1. Integration between transport systems	Promote the seamless connection of various transportation modes.
2. Development of collective mobility	Focus on enhancing public transportation systems.
3. Pedestrian and cycling mobility systems	Improve infrastructure and facilities for pedestrians and cyclists.
4. Shared motorized mobility systems	Encourage shared and eco-friendly modes of motorized transport.
5. Fleet renewal and low-impact vehicles	Transition to low-impact, energy-efficient vehicles and alternative fuels.
6. Urban logistics optimization	Streamline urban logistics to reduce congestion and emissions.
7. Promote mobility safety culture.	Raise awareness about safety in mobility and reduce risks.

Having looked at the strategies of the SUMP in the CoMePa area, we can also check the fundamental decisions taken by municipalities, stakeholders, and policymakers. The fundamental decisions of the SUMP focus on three main concepts. These are explained as follows:

- Quality public space
- Accessibility for all
- Vision Zero Risk
- Infrastructure Quality
- Promotion of Environmentally Friendly Modes of Mobility
- Freight Transportation Optimization

This table shows the focus points and how they are explained in the report.

Table 7 Focus points of the SUMP. Table by the author.

Focus Points	**Explanation**
Quality of Public Space as a Mobility Policy Factor	SUMP emphasizes the importance of public space quality as a guiding factor in mobility policies. It shifts from the traditional approach that views urban space primarily as roads and parking for private cars to a new perspective that promotes public space for collective use.
Accessible City for All	A key principle of the SUMP is making the city accessible to everyone. This involves not only physical access to public transportation but also virtual access through information services.
Vision of a City with Zero Risk	The SUMP prioritizes road safety, particularly for vulnerable road users like pedestrians, cyclists, and motorcyclists. The increasing severity of road accidents is a significant concern for residents. The plan focuses on reducing speed limits, enhancing safety measures near schools, and promoting responsible road behavior through educational programs.
Quality of Road Infrastructure	The need to refurbish major road networks, especially along key urban connection routes, and integrate them into the broader urban context is an important step of the plan. This involves rethinking these routes as part of a holistic urban space that connects various functions and mobility modes, including vehicular, active modes, and public transit.
Promoting Environmentally Friendly Transport Modes	The SUMP strongly supports active mobility modes (walking and cycling) and public transit. It aims to reduce the dependence on private cars for short-distance travel by promoting shared mobility services like car sharing and car-pooling. This approach seeks to reduce the motorization rates.
Attention to Freight Transport	The plan acknowledges the significance of effective freight transportation, focusing on both long-distance logistics and urban distribution. It highlights the need for efficient solutions that consider the environmental, social, and economic impacts of transporting goods within the city.

Within these fundamental choices of the implementation of the plan, we would like to take a deeper look at the two points, respectively, accessible city for all and the promotion of active mobility modes, as these points complement the previously explained theoretical foundation of the sustainable mobility, in the earlier chapters.

6.4.1 Accessible city for all

The concept of an accessible city for all parallels the idea of mobility justice, as explained previously. In the plan, this concept is adopted as a guiding factor in the planning and design of public spaces and access to mobility services. The administrative decision prioritized the quality and accessibility of the public space and transportation services. The emphasis on the quality of public space was explained in the first focus point of the SUMP. However, since Padova and the CoMePa area are medium-sized urban areas, the amount and size of the green areas and public spaces are not infinite. If not planned well, ensuring accessibility for all becomes a challenging task.
For this reason, the SUMP aims to create a well-planned urban design, focusing on the quality of public spaces and making them appealing and useful for the community while also creating enough land allocation for mobility management. The trade-off of this point is to create better public space for everyone while allocating less space to private cars but maintaining sustainable modes of mobility.
Another important aspect of the plan is ensuring the city is accessible to all. This includes both physical and virtual access to mobility services. Physical accessibility explains that no matter the physical condition of the users, they can safely access public transportation stops. People with disabilities or mobility challenges should be able to reach the public transportation stops safely. The virtual accessibility points to being able to access the information related to mobility services. This focus involves making transportation information easily available and understandable to the users. According to SUMP, this could be achieved through SMART City initiatives and Intelligent Transport Systems (ITS).

The cases of ITS, SMART city, and the MaaS are also explained in the report. The emphasis on these concepts is mostly made in the case of logistics. In the report, the use of ITS, which refers to the application of various technologies to enhance mobilities, including software for geolocation, communication, and information systems before, during, and after travel, remote payment systems, and integrated pricing for mobility services are explained in the case of enhancing the accessibility of mobility to all. The SUMP has acknowledged the benefits of using technological advancements for urban mobility. MaaS is also mentioned in the report, in the case of the adaption of services to

demand, with better insights into the mobility needs of users and what people actually demand. The report generally emphasizes the importance of technology and innovation to enhance urban mobility.

ITS, in the city of Padova, has been implemented in the parking management system. For instance, for the development of the parking plan, the aim of the SUMP is to integrate parking management policies with those related to mobility services through the development of the concept of MaaS. In addition, the implementation of ITS allows for a significant collection of data. This data can be used to formulate better mobility options for the city. In the parking case, the data gathered are on the usage of individual parking spaces during different times of the day and days of the week, the duration of parking, turnover, profitability, and more. All of this information is crucial for the city administration to formulate an effective parking policy.

These aspects have been addressed in the Infomobility System, called under Smart Mobility for the city of Padova, and are referenced in the SUMP to identify the functional characteristics of the technological equipment required to implement the necessary measures.

Another point in reaching a city accessible to all relies on acknowledging the diverse populations and cultural differences. Social diversity and cultural factors can influence how people perceive and use public spaces and transportation services. Therefore, the plan must consider these factors to create a truly accessible and inclusive urban environment.

In sum, the SUMP seeks to improve the quality of public spaces while ensuring that the city's mobility services are accessible to everyone, both physically and virtually, and it recognizes the importance of addressing cultural and social diversity in the planning process.

6.4.2 Promotion of Active Mobility Modes

Another significant focus point we will delve into is the promotion of environmentally friendly modes of transportation. When this definition is used, it implies modes such as walking, cycling, and public transport, as much as possible within available public resources and broader regional decisions.

The report of the plan points out the positive effects of active mobility highlighted by the WHO in 2018. It is stated how promoting active mobility contributes to reducing health issues caused by

sedentary living. For this reason, the SUMP of Padova and the CoMePa area gives importance to promoting a culture of awareness to the significance of active mobility. It is stated in the report that benefits are significant for both individuals and the community in terms of reducing the negative environmental impacts and energy consumption related to transportation activities.

One of Padova's initiatives to promote healthy and active mobility practices is the Bici Master Plan. The plan covers 2018-2022 and includes actions such as promotion of cycling, signage planning, and designing. This plan is an updated version of the 2010-2015 one. The Bici Master plan is based on the concept of network, safety, and improving the infrastructure for cycling. This plan aims to increase the role of cycling in urban transportation (Comune di Padova 2021). It is stated that 17% of urban trips were made by bicycle, which has positioned Padova as one of the leading cycling cities in Italy (Comune di Padova 2021). Padova has 168 kilometers of cycling road, and the goal set for 2030 is to reach 300 kilometers of cycling infrastructure with a 25% share of daily commute made by cycling (Comune di Padova 2021). The plan also suggests that the CoMePa municipalities offer similar promotions on cycling to increase the very low number of 6% cycling traffic to Padova from these municipalities. The Bici Master Plan is linked highly to the SUMP and its objectives.

Apart from the Bici Master Plan, there are other incentives to promote active mobility. One is to link better the public transport services. Integrating public transport services such as bus and train to connect better for commuters who use cycling or walking as another means of transport.

Another critical aspect is to create safe environments to cycle and walk. It was also stated in the survey explained above that one of the main concerns of residents is safety when it comes to cycling and walking. The speed of cars and motorized vehicles and the fact that cycling roads are not separated are among the reasons why it is considered not safe for the users. It is also stated that as the use of e-bikes increases and the average age of cyclists rises, potential challenges arise. An additional concern is the increasing number of micro-mobility vehicles. If these vehicles are not used properly or parked according to the rules, it can create problems for both cyclists and pedestrians. The SUMP proposes to develop a campaign to educate on road safety presented by public administration, NGOs, and other private entities. It is stated in SUMP that based on a road safety action plan, educational, communicative, and awareness campaigns will be launched annually, targeting various population segments, each with its own specific needs addressed through tailored language and tools.

Additionally, for the encouragement of pedestrian mobility, the Municipality of Padova presented a project called MetroMinuto. This project involves a map aimed at people moving in the city, whether

residents or tourists, that shows the distances of significant places in the city. It is a schematic map, similar to a metro route map, to present the walkable urban area in a clear and understandable way. The presentation by the Municipality of Padova shows the main routes, inside and outside of the Limited Traffic Zone (ZTL), and significant attractions of the city, such as cultural sites, museums, and squares. This project was already in operation before the preparation of the SUMP; however, it is also mentioned in the report since it is an important project part of sustainable mobility initiatives in the area.

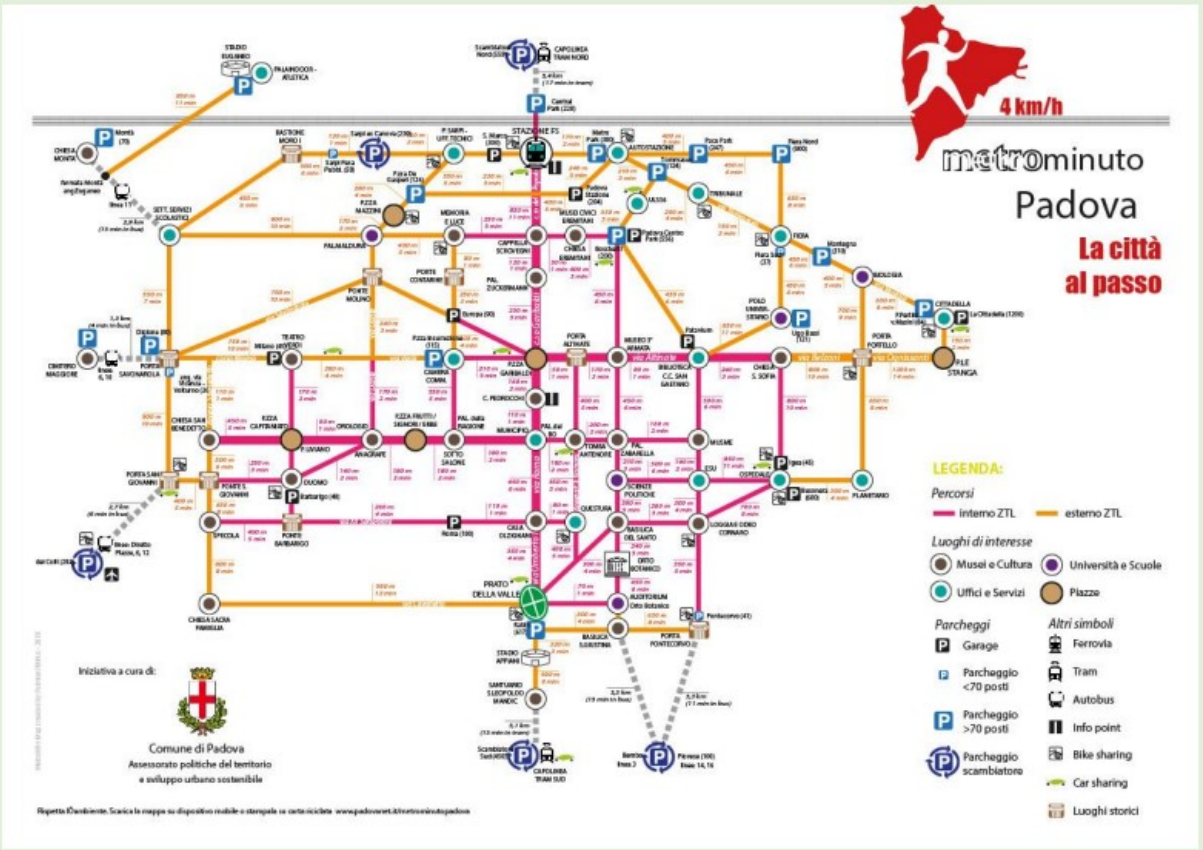


Figure 32 Metrominuto Map Source: (TRT Trasporti e Territorio et al. 2019, 54)

For pedestrian mobility, other incentives in the area can be listed as measures for traffic calming, protecting, and securing routes near schools in the CoMePa area. A mobility manager position is created to be active in schools and firms to increase education and awareness. This mobility manager concept is intended to increase awareness of the benefits of active mobility and create an educated society of users.

In summary, the SUMP in the CoMePA area aims to transform the mobility scene in Padova and the neighboring municipalities by prioritizing public space quality, accessibility for all, road safety,

infrastructure improvements, environmentally friendly modes of transportation, and efficient freight logistics. These fundamental decisions are crucial for creating a more sustainable and accessible urban environment.

6.5 Environmental Sustainability and the SUMP of Padova

Environmental sustainability is significant in the planning of urban mobility. The importance of integrating mobility, environmental, and territorial policies with a focus on environmental sustainability and efficient transportation is a vital point in creating a SUMP. It recognizes that environmental sustainability, such as reducing energy consumption, greenhouse gas emissions, air pollutants, and traffic noise, is closely linked to efficient mobility. The plan highlights that urban development choices should align with sustainable mobility models. In this context, SUMP CoMePA sets ambitious goals for the near future to pursue its environmental objectives, which will require a shift away from the current car-centric mobility model.

To this end, the plan places one of its strategic focuses on promoting active modes of mobility with lower environmental impact. The importance given to walking, cycling, and using public transport in a wide spectrum is evident in the SUMP and its commitment to creating sustainable transportation choices.

Apart from promoting active mobility, the municipality of Padova also gives importance to promoting electric mobility. Seen as a tool to reduce environmental impacts and fuel consumption, electric mobility has been identified as one of the measures for the urban mobility system. This promotion can be seen already in the renewal of the bus fleet with electric vehicles and the implementation of recharging stations around the city.
To this end, major players in the automotive sector, as well as energy providers, have defined medium-term investment plans, offering a wide range of vehicles to cater to different segments of demand. The municipality of Padova, together with the ApS Holding, gives incentives to promote electric mobility.

To calculate the environmental indicators, the parameters for air quality and greenhouse gases are considered. It is expected that the actions and interventions implemented by SUMP will lead to a reduction in greenhouse gas emissions and pollutants caused by traffic. It is essential to mention that SP includes actions that support the adoption of vehicles with lower environmental impact. It is stated in the report that this support extends to increasing the market share of electric and hybrid vehicles for both private and public transportation, aligning with estimates from various research centers and proposals outlined in the National Energy Climate Plan of 2018 (TRT Trasporti e Territorio et al. 2019, 147).

6.6 Other projects for reinforcing the promotion of sustainable mobility

There are two important initiatives to reinforce sustainability in transportation and residents' daily movements. These initiatives, which will be explained below, serve not only the focus of environmental sustainability of the plan but also beneficial for the promotion of active mobility and environmentally sustainable modes of transportation.

6.6.1 The concept of "Città 30"

The SUMP also addresses the adjustment of speed moderation in the city, which is crucial for improving safety. There are two different but complementary approaches in this manner. The first approach involves adopting the concept of a "*Città 30,*" - City 30 - which means widespread implementation of a maximum speed limit of 30 km/h on the urban road network, as opposed to the standard 50 km/h limit within urban areas according to the highway code. Implementing the Città 30 brings significant advantages, such as enhanced safety, reduced severity of accidents, and decreased traffic-generated noise. This implementation can also serve as a benefit for promoting active mobility by creating safer roads. With just an adjustment of the speed limit in the city, many outcomes can be achieved, such as safer and more livable cities with less noise pollution. The transformation from Zona 30 - the 30 km/h zones - into that of a Città 30 entails the idea that all roads have a strategic role in the city to organize the traffic and transportation better for all. This concept leads to the creation of environmental islands, areas tailored to road users more vulnerable to accidents, such as cyclists and pedestrians. Special policies, such as lower speed limits, prohibitions, one-way traffic, parking regulations, improved public transport, and urban development projects, are implemented in these areas. The design of these areas should consider various factors, including clear entry points to signal

the nature of the zone to passing motorists, the reduction of through traffic, and the identification of central public spaces to be reorganized as meeting and socialization areas, therefore creating better public spaces. The implementation of *Città 30* was determined based on a comprehensive analysis of the entire urban territory of the Co.Me.Pa. Municipalities considering factors like population density, the presence of schools, traffic density, accident locations, and their density. These priorities aim to create safer and more active mobility-friendly areas within the city, promoting sustainable mobility and community well-being.

6.6.2 Development of ZTL areas and the introduction of LEZ

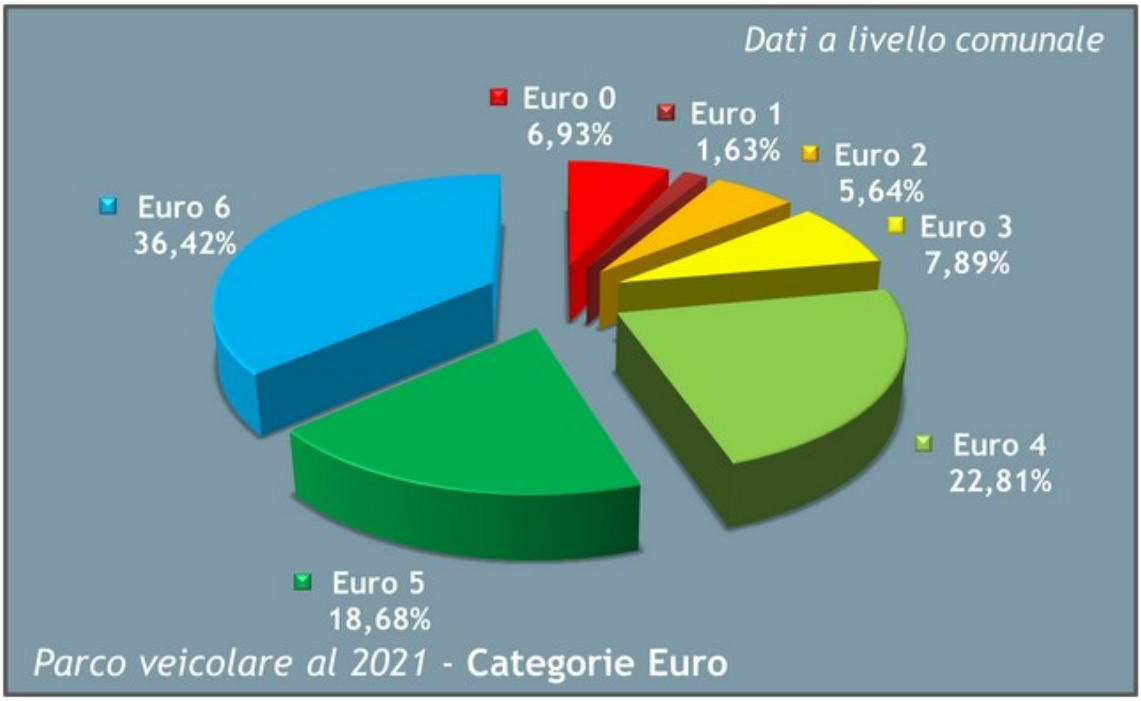
The second approach to creating a safer urban environment and supporting sustainable modes of transportation passes from the revisiting of the ZTL and the introduction of a new concept, the Low Emission Zone (LEZ). LEZ creates access rules according to the vehicle used in the certain areas. The ZTL has a history dating back to the 1980s and has evolved to address environmental and social concerns; however, no significant changes to the original idea have been made. In the SUMP of Padova, the ZTL scheme is part of the broader transition toward the Low Emission Zone, which stresses the need to consider the environmental burden of vehicles, such as their size, fuel type, and emissions standards. The municipality expressed its intention to reimagine the ZTL concept by using innovative information technology. Additionally, the Padova Administration and local businesses in the historic city center have agreed to reconfigure the ZTL area and establish a schedule for access regulation, which can be adapted based on traffic flow patterns. Special attention will be given to areas exposed to evening activities, known as nightlife zones (TRT Trasporti e Territorio et al. 2019, 93).

The introduction of the LEZ concept demonstrates Padova's commitment to improving urban mobility and environmental quality. The proposed approach is aligned with modern urban planning practices and reflects the city's emphasis on the well-being of its residents and the environment. The LEZ was already introduced by the European Commission's White Paper on Transport in 2011 as a means to reduce atmospheric pollution emissions (TRT Trasporti e Territorio et al. 2019, 95). This measure is also seen as suited to the context of Padova. The justification lies in a broader context related to the Agreement of the Padano Basin (Accordo di Programma del Bacino Padano 2017), which was established in 2017 (TRT Trasporti e Territorio et al. 2019, 95). This agreement has imposed certain

limitations on vehicular traffic in response to environmental concerns. Specifically, it requires the imposition of traffic restrictions in areas where the concentration of PM10, a type of particulate matter and air pollutant, exceeds established limits. Traffic restrictions are mandated when such limits are exceeded in urban and metropolitan areas.

Milano was the first city in Italy to introduce the LEZ in 2019. This served other cities as a practical example to implement LEZ in their own concept regarding improving their urban environment.

Other investments in the city, which are explained in this chapter, such as creating easy parking facilities, improving public transportation, and promoting active mobility, help to strengthen the grand scheme, this strategy of implementing LEZ concept. The LEZ aims to restrict the circulation of highly polluting vehicles within the city, aligning with European guidelines and environmental targets. Therefore, it is an important intervention outlined in the SUMP of Padova and the CoMePa area.
If we analyze the graphics below provided by the SUMP Observatory, we can see that they reveal several key insights into the current state of vehicle ownership within the area. Firstly, the motorization rate stands at 60.6 cars per 100 inhabitants, indicating a relatively high level of car ownership. The total number of cars in circulation is 126,553, which shows the significance of this mode of transportation in the region. The graph shows a considerable percentage of vehicles adhering to more recent Euro emission standards regarding emissions and fuel types. Euro 6 vehicles comprise the majority at 36.42%, signaling a commitment to lower emissions and the effect of the already implemented interventions. Gasoline and diesel remain the dominant fuel choices, with 41.95% and 40.94% of the market share, respectively. Notably, 3.63% of vehicles are hybrid or electric, reflecting a growing trend towards cleaner energy sources. The observatory also provides information about the average emission factors for pollutants such as NOx and PM1, which seem relatively moderate. The CO2 emission factor, at 236.8 grams per kilometer, indicates the carbon footprint associated with local transportation. Understanding this composition of the amount and the type of vehicle ownership is crucial for assessing its environmental impact and the reason for implementing the aforementioned sustainability measures.



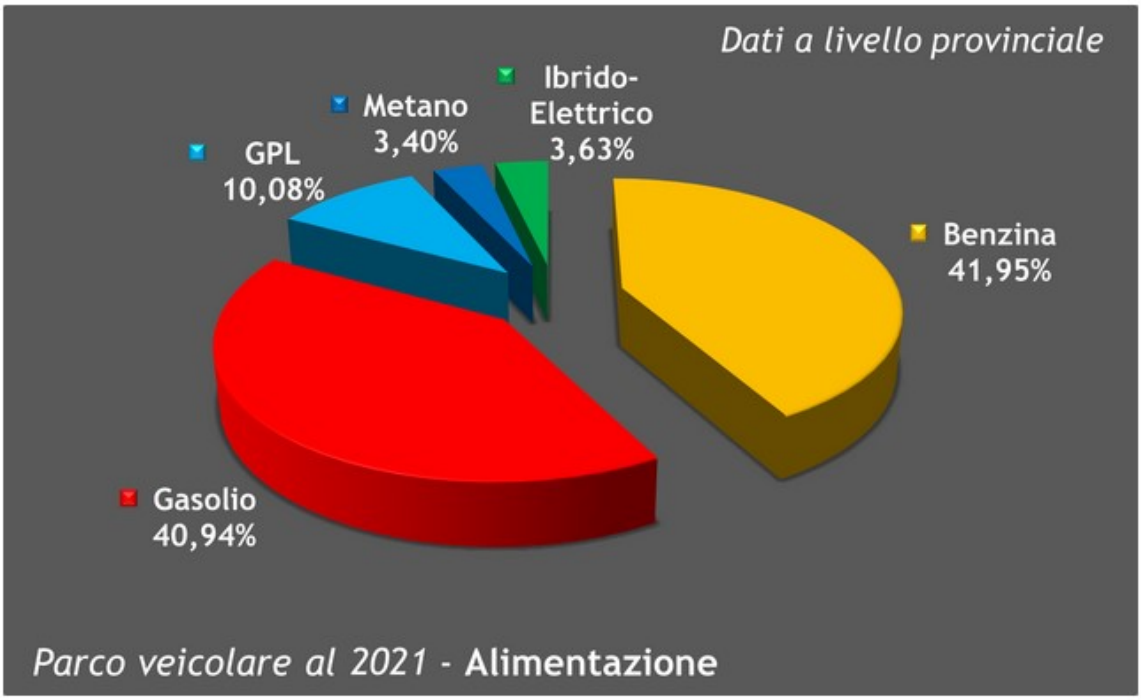


Figure 33 Vehicle types on provincial level, 2021 Source: (Osservatorio PUMS, n.d.)

6.7 Temporality of the SUMP

The SUMP of Padova and the CoMePA area envisions the realization of the plan in two temporal terms. Short to medium-term and medium-to-long-term allow the plan's organization to be clearer. The actions aimed to be completed in the short to medium term include the extension of the cycling road indicated in the Bici Master Plan or the interventions on vehicle speed in the 30 km/h zones in the central areas. For the medium to long term, many issues and enhancements are planned to happen. For instance, the plan includes 27 interventions to complete a tangential ring road and integrated cycling network, connecting the outermost municipalities in the CoMePa area. This type of intervention requires a dedicated building of infrastructure. Another example is the development of the A4 motorway lane between Padova Est and Mestre. Even though this project is mentioned in the plan, it is still less certain if the long-term planning will be enough to realize this development since uncertainty around this project is not solved yet (TRT Trasporti e Territorio et al. 2019, 48).

The plan is diverse in temporality and is not restricted to addressing only short-term or long-term issues. Instead, this approach of taking a long-term look helps for better planning of the urban areas. The plan does not just focus on immediate concerns but is intended to be applicable over a longer period, possibly spanning several years or even a decade. While the plan has a long-term perspective, it also recognizes the necessity and urgency of defining actions that can have an impact in the short to medium term. In other words, it acknowledges that there are pressing issues and challenges that need to be addressed as soon as possible, even if the plan considers longer-term goals and solutions. Therefore, the plan aims to balance addressing immediate concerns and laying the foundation for future developments (TRT Trasporti e Territorio et al. 2019, 25).

6.8 Composition of Alternative Scenarios in the SUMP

As mentioned earlier, two types of scenarios are explained in the report. These are the Reference Scenario (SR) and the Plan Scenario (SP).

SR represents a set of interventions that can be both infrastructure-related and non-infrastructure-related, have gone through the design and approval process, have the necessary financial resources for implementation, and would be realized even in the absence of the SUMP for 2030.

The Reference Scenario for the urban area's transportation network includes diverse projects. As an example, there is the implementation of the SIR 3 Line, along with an associated park-and-ride (P&R) facility. The inclusion of the P&R facility encourages people to use public transit more and reduce car use in the city center.

The interventions of the Reference Scenario must meet some conditions. First is the already mentioned realization, even without the SUMP. They must be invariant to be carried out even without the SUMP. Adding, the SR will eventually be added to the Plan Scenario. Finally, SR interventions serve as a basis for the SP's technical, environmental, social, and economic evaluation. The SR is important for evaluating the effect and impact of the interventions proposed in the SP. In this way, a comparison can be made to assess the outcomes and positive impacts of the SUMP's strategies.

Investment costs are also calculated in the report, with reference to the SP. These costs represent additional resources required compared to the Reference Scenario. The provided estimates offer insights into the overall size of investments needed for plan implementation, the distribution of expenses by the type of measures, and the time frame for spending, which can be short, medium, and long-term predictions. The temporal description is decided to be completed within 5 to 6 years for the medium term and within a decade for the long term. The interventions explained in the SP require a financial commitment for the next decade.

A summary of the investment costs categorized by the type of intervention is explained in the report of the SUMP. The intervention categories vary from road and cycling infrastructure to public transport, parking, logistics, and investments in technology. The SUMP of Padova and the CoMePa area is stated to envisage an investment of approximately 600 million euros to be allocated over the ten-year validity period of the plan (TRT Trasporti e Territorio et al. 2019, 150).

The table below shows the estimated investment calculated by the Municipality of Padova. This table breaks down the investment costs for different types of interventions, categorizing them into short-medium and long periods and providing the total cost and percentage distribution.

Table 8 Investment types and total costs Source: (TRT Trasporti e Territorio et al. 2019, 150)

Tipologia interventi	Breve-Medio Periodo (mln Euro)	Lungo Periodo (mln Euro)	Totale (mln Euro)	V.%
ITS: indirizzamento ai parcheggi, infomobilità, aggiornamento centrale della mobilità, istituzione della LEZ - Sviluppo controllo ZTL - Sharing Mobility	2,5	2,5	5,0	1,6%
Nuovi interventi viari – Padova-Albignasego	2,6		2,6	0,8%
Parcheggi scambiatori - Linee TRAM	4,6	2,3	6,9	2,2%
Parcheggi scambiatori – Fermate (San Lazzaro)		2,3	2,3	0,8%
Parcheggi scambiatori con linee forza TPL (Colli-Brusegana e Limena-Altichiero)	4,6		4,6	1,5%
Parcheggio attestamento (Via Sarpi)	16,5		16,5	5,3%
Ciclabilità (Tutti gli interventi del BiciMasterPlan)	20,0		20,0	6,4%
Potenziamenti della rete viaria: terza corsia tangenziale est,		39,4	39,4	12,7%
Trasporto ferroviario: nodi e binari	10,0	10,0	20,0	6,4%
Trasporto ferroviario: potenziamento servizio (per 5 anni)		2,5	2,5	0,8%
Trasporto Pubblico Locale: SIR 2	38,2	89,0	127,2	41%
Zone 30 (moderazione velocità)	5,7	57,3	63,0	20,3%
Attività di comunicazione-informazione anche a supporto della sicurezza stradale e monitoraggio PUMS	0,3	0,3	0,60	0,2%
Totale complessivo	**149,7**	**160,9**	**310,6**	100,0%
	48%	**52%**	**100%**	

Table 9 Translation of the above table

Intervention Type	**Short-Medium Period (million euros)**	**Long Period (million euros)**	**Total (million euros)**	**Percentage (%)**
ITS: parking direction, infomobility, mobility central update, LEZ establishment - ZTL control development - Sharing Mobility	2.5	2.5	5.0	1.6%
New road	2.6		2.6	0.8%

interventions – Padova-Albignasego				
Park-and-ride - TRAM lines	4.6	2.3	6.9	2.2%
Park-and-ride stops (San Lazzaro)		2.3	2.3	0.8%
Park-and-ride with TPL lines (Colli-Brusegana and Limena-Altichiero)	4.6		4.6	1.5%
Stopover parking (Via Sarpi)	16.5		16.5	5.3%
Cyclability (All BiciMasterPlan interventions)	20.0		20.0	6.4%
Road network upgrades: third lane eastern ring road	39.4		39.4	12.7%
Railway transport: nodes and tracks	10.0	10.0	20.0	6.4%
Railway transport: service	2.5		2.5	0.8%

enhancement (for five years)				
Local Public Transport: SIR 2	38.2	89.0	127.2	41%
30 Zones (speed moderation)	5.7	57.3	63.0	20.3%
Communication -information activities, also in support of road safety and SUMP monitoring	0.3	0.3	0.6	0.2%
Total Overall	149.7	160.9	310.6	100.0%
Share (Short-Medium Period)	48%	52%	100%	

6.9 The Evaluation of the SUMP

To evaluate the success of the implementation of the SUMP actions, four scenarios have been provided. These four scenarios are:

1. Year 2025 - Reference Scenario (referred to as 2025-SR): In this scenario, there is an expected increase of 6% in mobility demand within the CoMePa area. The transport supply, which reflects the modifications resulting from interventions that are already in progress or planned by the year 2025, is also included in this scenario.

2. Year 2025 - Plan Scenario (referred to as 2025-SP): In this scenario, the mobility demand remains the same as in the Reference Scenario for the year 2025. However, the transport supply is altered to incorporate the interventions outlined in the SUMP specifically designed for 2025. This scenario assesses the impact of implementing these SUMP measures.

3. Year 2030 - Reference Scenario (referred to as 2030-SR): In this scenario, mobility demand within the CoMePa area is projected to increase by approximately 10%. The transport supply accounts for changes stemming from interventions already in progress or planned by 2030.

4. Year 2030 - Plan Scenario (referred to as 2030-SP or SUMP Scenario): Mobility demand remains the same as in the Reference Scenario for the year 2030, but the transport supply is altered to incorporate the interventions outlined in the SUMP designed for 2030. This scenario assesses the impact of implementing the full range of SUMP measures for 2030.

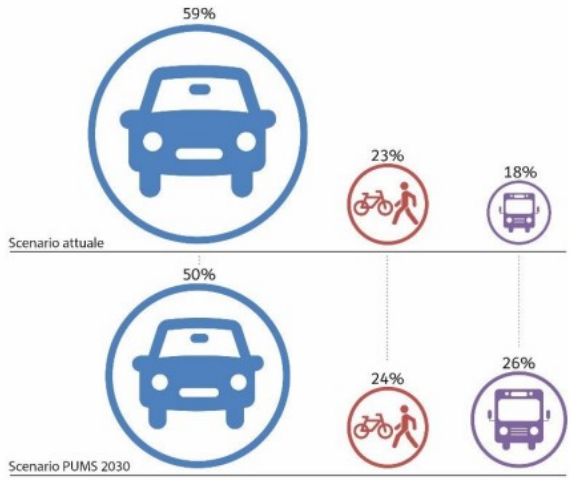


Fig. 9.2: La ripartizione modale dello Scenario PUMS: spostamenti generati dai Comuni Comepa (ora di punta del mattino)

Figure 34 Actual scenario and 2030 scenario of the SUMP Source: (TRT Trasporti e Territorio et al. 2019, 129)

The modal split of the SUMP Scenario: trips generated by CoMePa municipalities (peak hour in the morning). The present scenario above and the SUMP 2030 Scenario below are presented.

The images provided above indicate that it is foreseen that the mobility patterns in the CoMePa area are expected to indicate a positive shift away from private car use toward public transportation and

active modes like cycling by 2030. Despite an increase in mobility demand, the proposed SUMP interventions are expected to reduce car usage, with an impressive calculation of a 10% reduction in private car mobility compared to the Reference Scenario. This demonstrates the success expected by SUMP's actions in encouraging more sustainable and environmentally friendly transportation methods. This modal shift is crucial for reducing the environmental impacts and the unwanted congestion associated with private car use, thus promoting a more efficient and eco-conscious urban mobility system.

In essence, these four scenarios allow for the comparison of two key elements: mobility demand (the amount of travel needed) and transport supply (the available transportation options). Analyzing these scenarios makes it possible to evaluate how the SUMP measures will affect mobility in the area and assess whether they help meet the plan's objectives.

There are additional indicators that are also compared with the SR, which helps the monitoring of the SUMP. The indicators fall into two main categories: Mobility and Transport and Environmental Indicators. Mobility and Transport Indicators include a modal split of trips, kilometers traveled by mode, average travel distances, travel hours, and average speeds. On the other hand, Environmental Indicators include the emissions of greenhouse gases such as CO2 and the emission of air pollutants including NOx (nitrogen oxides), CO (carbon monoxide), and Volatile Organic Compounds (VOCs).

These indicators provide a comprehensive view of the plan's impacts on transportation choices and environmental factors, helping evaluate the plan's effectiveness in promoting sustainable mobility and reducing environmental impacts.

The construction of the SUMP CoMePa is a comprehensive task that involves many actors in its creation. Certain objectives are vital to the plan, the stress on sustainability criteria, the goals indicated in the guidelines presented in the drafting of the plan, and the needs of the local community and the urban area. These three pillars are essential and at the core of the SUMP CoMePa. In summary, the objectives of the SUMP are essential to connect the strategies with the plan's measures and future scenarios. They are based on sustainability criteria, official guidelines, and the input of the local community to create a mobility plan that is both ambitious and responsive to the specific needs of Padova while promoting sustainability in various dimensions: environmental, social, economic, and within the mobility sector itself. These objectives help define the direction and timeframe for the plan's implementation and assessment.

CHAPTER 7 A Critical Analysis of the Padova SUMP

Thus far, a thorough analysis of sustainable urban mobility methods with a keen emphasis on Europe has been carried out. In the world of today, it is essential to rethink the way we approach mobility. The primary objective in the forthcoming years should be to achieve sustainability in transport. Accordingly, countries worldwide are implementing diverse strategies to encourage sustainable urban mobility. We have additionally analyzed cases from across the globe to acquire knowledge into various sustainable urban mobility strategies and projects.

Our study encompassed various initiatives, including national policies and urbanization challenges. We looked closely at the European context, where Sustainable Urban Mobility Plans (SUMPs) have gained prominence. Many countries have adopted these plans as an integral part of their national sustainable mobility strategies. They have also resonated at the local level, where city governments are actively engaged in improving the daily lives of their residents.

As discussed earlier, the global trend of urbanization has brought both opportunities and challenges. Cities offer improved living conditions, greater access to employment, educational opportunities, cultural enrichment, innovative solutions, and modern infrastructure. However, rapid urbanization has also brought negative impacts, including resource depletion, excessive waste generation, environmental degradation, traffic congestion, health problems, and permanent changes to urban landscapes. As a result, the concept of transforming cities and urban areas into "smart" and sustainable entities has gained prominence.

To address the complex challenges of urbanization, cities have set ambitious goals to achieve sustainable urban mobility. These efforts encompass various aspects of urban mobility, and a critical facet is the integration of reliable transportation systems. Throughout our study, we have identified the importance of this integration in promoting sustainable and efficient transportation in urban areas.

In the previous chapters, we looked at the specific case of Padova and we have closely analyzed the steps taken in the development and implementation of Padova's SUMP, along with the key stakeholders involved in this process.

Our primary objective in this chapter is to evaluate the feasibility and suitability of the actions specified in the Padova SUMP. We aim to explore crucial issues, such as the true sustainability of

these actions and their perception by the public. Therefore, we will analyze the planned actions of SUMP of Padova by considering the three concepts presented by Holden et al. We will clarify each concept and its components, evaluate them against the sustainability plans of Padova, and determine their relevance and proximity towards achieving sustainable mobility. Through this evaluation, we will identify areas of improvement for the actions of SUMP Padova.

7.1 Achieving sustainable mobility: The Fundamental Concepts

Holden et al. state that to achieve sustainable mobility, it is essential to address three interrelated elements simultaneously: the "what," the "who," and the "how" (Holden et al. 2020). The "what" element is primarily concerned with the strategic aspects, while the "who" element is concerned with the key actors responsible for taking the lead in implementing these strategies. Bringing these two critical elements together, according to Holden et al., creates a matrix of different narratives that illustrate the pathways to sustainable mobility. The two elements combined, creates the narratives outlining the pathways to achieving sustainable mobility, and this constitutes the third element.
In practice, the strategies, actors, and narratives often overlap and influence each other. Nevertheless, each strategy, actor, and narrative serve as a distinct focal point in the contemporary discourse on sustainable mobility.

Holden et al. claim that:

"Logically, mobility can become sustainable if we travel more efficiently, travel differently, and/or travel less. From this, the three main strategies for sustainable mobility can be distinguished as efficiency, alteration, and reduction." (Holden et al., 2020)

From this statement, we can take a look at the sustainable mobility solutions of the Padova SUMP. Following, we will examine the SUMP of Padova regarding the elements stated by Holden et al.

7.2 Efficiency Strategy

If we try to observe sustainable mobility strategies from the efficiency strategy point, we can look at some policies of the Padova SUMP. The efficiency strategy is an approach aimed at enhancing both environmental performance and accessibility within the realm of transportation. It centers around the idea of improving efficiency through the adoption of innovative technologies. In this context, technology encompasses a wide range of tools and methods, encompassing what is often referred to as "hard technology" and "soft technology" (Holden et al. 2020). Hard technology is this facet of efficiency technology that involves innovations in the hardware and physical aspects of transportation. It includes advancements in vehicle technology, such as the development of more energy-efficient and eco-friendly vehicles, such as electric cars.

Additionally, it encompasses shifts in fuel sources, such as transitioning from fossil fuels to cleaner and renewable energy sources, like electricity or hydrogen. These hard technology solutions directly impact the vehicles that are used and the infrastructure that supports them, like charging stations for electric vehicles. In contrast, soft technology encompasses the use of information, digital tools, and logistics to optimize the transportation system. It involves digital platforms, mobile apps, and intelligent systems facilitating trip planning, booking, and coordination. For example, ride-sharing apps, route optimization software, and public transportation tracking systems fall under the category of soft technology. These technologies enable more efficient use of existing transportation resources, reduce congestion, and enhance the overall travel experience.

Efficiency technologies can be applied throughout the entire transportation system. They can be integrated into motorized transport vehicles, such as making cars more fuel-efficient or developing electric vehicles. They can also be implemented in the transport infrastructure by establishing charging stations or constructing eco-friendly transportation hubs. Moreover, the energy system can be transformed by adopting renewable energy resources to power transportation, reducing the carbon footprint associated with energy consumption in the sector.

The efficiency strategy is about leveraging technological innovations, both in the hardware and software realms, to make transportation more environmentally friendly and accessible. This strategy recognizes the importance of optimizing the use of resources, reducing emissions, and enhancing the overall quality of transportation services by applying advanced technologies.

7.2.1 Efficiency strategy and the SUMP of Padova

In the case of Padova, we can observe the efficiency strategy in both hard and soft technologies realms.

Padova's public urban transport system, managed by APS–Azienda Padova Servizi – Holding Spa, as explained in the previous chapters. The company has gradually replaced diesel buses over the years with Compressed Natural Gas -CNG- fueled buses, which aims to reduce emissions. However, if we look at the operational costs per kilometer for CNG buses, they can sometimes be higher than diesel buses due to maintenance, fuel conditioning, and service factors.

Professors Andriollo and Tortella from the Department of Industrial Engineering at the University of Padova conducted a study on the sustainability of the electric bus fleet in Padova. The study highlights the challenges and opportunities for improving the environmental performance of the public bus transportation system in Padova, with a particular focus on the transition to more sustainable and less polluting technologies (Andriollo and Tortella 2022). They discuss the issues related to public bus transportation and its environmental impact in Padova. The authors point out the challenges in the conventional bus fleet of Padova. In 2011, the public bus fleet in Padova included a mix of older buses (Euro 0) and some newer ones (Euro 2 and 3). While there have been some improvements, there are still significant challenges. Conventional buses, especially older ones, tend to have higher emissions and lower fuel efficiency, contributing to air pollution and higher operational costs.

To address these challenges and reduce the environmental impact of public transportation, the city of Padova has started transitioning into electric buses, as it also takes its part in the SUMP. Electric buses are considered a cleaner and more sustainable option as they produce zero tailpipe emissions, reducing air pollution.

Some key points from the study of Andriollo and Tortella are regarding the air quality. Despite some measures to reduce air pollution, Padova's public bus transportation still falls short of European regulations, as stated in their study. In 2011, Euro 0 buses, less environmentally friendly, represented about 9% of the total fleet. While there has been an increase in Enhanced Environmental Vehicles (EEVs), compressed natural gas (CNG) buses, and electric vehicles, there are still challenges that Padova urban transport needs to overcome. Another point is on the emissions. Heavy-duty vehicles, including urban buses, significantly contributed to emissions in the Padova urban area in 2008,

accounting for 18% of total emissions, with a significant portion being nitrogen oxide (NOx) pollutants. The authors point out that the tram network showed an improvisation in the accessibility of public transport and reduced private car usage since 2007. However, it did not contribute to a change in the emissions, with Padova still exceeding daily limits for particulate matter (PM10) and nitrogen dioxide (NO2) in 2013 (Andriollo and Tortella 2022).

Another challenge of the electric bus fleet is its management strategy. The stations for battery recharging and fast battery swapping are necessary for the optimized working of the bus fleet. These stations would ensure that electric buses can operate efficiently throughout the day without returning to the depot for charging. Authors suggest that adopting less polluting technologies like electric or hybrid buses is essential for the sustainability of Padova's transportation system. They also point out another positive point of these vehicles, that they can offer greater route flexibility and can be more compatible with the historical part of the city. Electric buses are seen as more flexible regarding routes and capacity adjustment, making them well-suited for urban environments. They can adapt to variations in passenger demand and are often quieter, which can be beneficial for the historic and scenic downtown areas in cities like Padova.

While electric buses offer environmental benefits, there are pressing challenges to consider. These challenges include limitations in battery capacity, operating range, and battery lifetime. Another one for the case of Padova is that these electric buses offer less passenger capacity. Addressing these limitations is essential for successfully deploying electric buses in public transportation, in the case of Padova.

The authors conduct an assessment comparing two different types of buses in Padova. This examination discusses emissions evaluation in the context of electric battery-supplied buses (EBB) and internal combustion engine (ICE) buses. The study evaluates emissions based on the driving cycles of two specific routes in Padova. Different equivalent buses are considered, including 8 m and 11 m long buses. The evaluation spans over a 10-year reference time for EBB, unlike ICE buses. The assessment aims to compare the specific energy consumption (measured in tonne of oil equivalent) and gas emissions between different bus lengths and fuels, including both EBBs and ICE buses.

In the study, it is stated that not all emission types in ICE and EB buses can be directly compared except for NOx (nitrogen oxides) and PM (particulate matter) emissions. The results of the evaluation show that EBBs exhibit nearly half the primary energy consumption compared to ICE buses. Another finding is that among ICE buses, those fueled by compressed natural gas (CNG) have a 12% lower

energy consumption than their diesel counterparts. EBBs result in a one-third reduction in both hydrocarbon (HC) and NOx emissions. However, these emissions are sensitive to bus length (Andriollo and Tortella 2022).

In summary, the evaluation and comparison of the energy consumption and emissions of electric buses (EBB) and internal combustion engine (ICE) buses under various conditions highlights differences in emissions, energy consumption, and the environmental impact of different bus types and fuels, particularly emphasizing the potential benefits of EBBs in reducing energy consumption and emissions.

Overall, we can emphasize the need for transitioning to electric buses as a more sustainable and environmentally friendly option for public bus transportation in Padova. The benefits, such as reduced emissions and increased route flexibility, explained above, and the challenges related to electric bus technology and infrastructure show how to better this transition. The battery management strategy, suggested by the engineers, aims to make the operation of electric buses more efficient and practical. The transition to electric buses need not be only environmentally friendly but also economically viable to be approved and implemented by the authorities. For now, we can state that the number of electric buses is insufficient to replace all the bus fleet of Padova, and they should be increased in the number and the capacity of passengers.

For the soft technologies, we can present the example of intelligent displays at bus and tram stops in Padova. Intelligent displays -called plain intelligence- are the latest services BusItalia offers to experiment with the digitization of transportation services in the city. This service promises to offer real-time service, showing all the bus and tram stops. The service aims to provide users with real-time information about the actual arrival times, schedules, and delays of public transportation and aims to make public transport more reliable.

This project started in the spring of 2023 and continues to date. It is stated that regarding trams, the service will be available at all stops -except for Trieste- ("Paline intelligenti alle fermate di bus e tram, segnaleranno orari live e ritardi" 2023). Real-time coverage will then be extended to all 45 electronic displays on the bus lines involved, as well as the 273 displays equipped with e-ink technology. The real-time service will dynamically provide users with updated information about the arrival times of public transportation on electronic displays, allowing passengers to plan their trips better and have a clearer understanding of waiting times at stops.

This project is under the digitalization goals of Busitalia Veneto and an attempt to adopt innovative solutions for making public transportation more reliable, comfortable, and environmentally friendly, as aligned with the SUMP. The introduction of this experimental information mobility service at stops represents an important step toward offering a more modern and cutting-edge public transportation network, according to Busitalia Veneto.

From personal observation, it can be concluded that the displays, especially in the first months of installation, were constantly not working or not providing correct information. Still, to date, the timing for the bus displays does not always show the correct time; depending on the traffic congestion and weather conditions, users can see incorrect information. On the other hand, the tram displays most of the time to show correct timing since the tram has its track and works on a more definite schedule compared to the bus. For the enhancement of the digitization of the informatics of transportation, the technology should be bettered and should provide on-time information.

7.3 The Alteration Strategy for Sustainable Mobility

The second strategy, the alteration strategy, aims to transform existing transportation patterns by encouraging a shift from current dominant modes of transportation, such as private cars and airplanes, to more collective forms of transport. This strategy is built on the idea that by promoting a modal shift, we can achieve several important goals, including improving energy efficiency, reducing environmental impact, and enhancing accessibility for various groups.

The key components of the alteration strategy are modal shift, affordable and efficient public transport, energy efficiency, accessibility and shared mobility, and active mobility.

The primary focus of the modal shift is to induce a change in the way people choose to travel. It encourages a shift away from private car use towards more collective modes of transportation. This shift involves replacing individualized modes of transport with shared options, such as buses, trains, trams, and other forms of public transportation.

7.3.1 Modal Shift and SUMP of Padova

In the case of Padova, we can see that the SUMP is trying to create a modal shift in the urban area. The proposed Park&Ride facilities, the promotion of shared mobility options such as car-sharing, and the building of tram routes imply the focus of the SUMP on modal shifts in Padova.

With its positive and negative points, the development of the tramway system in Padova can be thoroughly discussed. The tramway has been seen as a sustainable and effective solution for urban mobility and the transformation of public space in the SUMP of Padova. It has been recognized as an integral aspect of urban revitalization and transportation and is a crucial component of sustainable mobility in the SUMP of Padova. Trams are promoted as a safe and reliable means of transport, and their integration into the city is expected to revitalize urban spaces. Trams are regarded as the future of urban mobility for several reasons, such as reliability, speed, passenger capacity, accessibility, safety and comfort, and environmental sustainability. The SUMP details the tram as a convenient way for individuals to move around the city. Trams are a popular option for tourists, providing a distinctive view of the city. Additionally, trams have earned a place in urban mobility planning by local governments, not only in Padova but also more generally ("Tramway: a sustainable solution for the transformation of public space" 2022).

Savchuk and Nahornyi delve into the significance of tram systems in urban development and the transition to smart cities (Savchuk and Nahornyi 2020). They underscore the potential of trams in bolstering sustainable and smart urban transportation. The authors propose tramways as one of the most suitable modes of transport for sustainable urban development. They call the renaissance of tram systems, the latest revival of trams, especially in the European cities, an essential step for improving urban spaces. The disregard for trams during the rise of motorization and private car use as the primary means of transportation is now being overturned, with a focus on the reintroduction of trams, especially technologically advanced ones, in urban areas.

The authors identify trams as the most environmentally friendly public transport option, generating minimal waste and surpassing buses in terms of emissions, electricity consumption, and safety. Trams are also noted for their energy efficiency compared to metro systems. The authors argue that tram corridors foster inclusive and democratic cities (Savchuk and Nahornyi 2020).

Trams can also be categorized today as advanced intermediate rubber-tired transport systems with guided running modes. These systems aim to be cost-effective, efficient, environmentally friendly, and flexible. The translohr is considered one of them, and it is also used in the tram plan of Padova.

It is an advanced transport system with dual-mode guidance and dual-mode supply. In guided mode, it follows a central rail using a roller system, while in unguided mode, it operates like a regular articulated bus. Padova has chosen the translohr for its urban mobility plan (Andriollo et al. 2002).

Although the municipality and the stakeholders are presenting the tram as a solution for creating sustainable urban mobility for Padova, there is also strong opposition from the public to the inclusion of the tram in the transportation scene of the city.

Associazione No Rotaie Padova -No Rail Association Padova is a merged association in opposition to the creation of tram lines in the city. The association presents itself as an apolitical, solution-oriented commission willing to engage with authorities and competent representatives ("L'Associazione | Associazione No Rotaie Padova", n.d.). Their focus includes environmental and mobility issues, intending to find solutions for traffic-related problems. The committee focused on safeguarding the area's social and economic interests, discussing topics related to the environment, mobility, and traffic solutions. They gathered signatures to oppose projects of SIR2 and SIR3 in favor of non-invasive, eco-friendly transportation systems. Their objective is to provide modern, eco-friendly, cost-effective, and quickly implementable transportation solutions, and they encouraged neighboring municipalities to adopt such systems. The committee is also active in various neighborhoods in Padova and surrounding municipalities.

The association argues that this tram system is not as environmentally friendly and efficient as claimed and states that it consumes more energy compared to traditional trams. The association insists that labeling this system as a tram is incorrect because it essentially functions like a rubber-tired bus with only a single steel rail for guidance ("Tram, l'associazione No rotaie: «Anche Shangai ha rinunciato a quel tipo di mezzo»" 2023).

The Associazione No Rotaie Padova criticizes the use of single-rail tram systems and is skeptical about their environmental claims. They consider trams a form of prehistoric local transportation technology that can be replaced with more ecologically friendly, less invasive, cheaper, and almost immediately deployable alternatives ("Padova, blitz dei «No Rotaie» con sagome del tram a grandezza naturale: «Mezzo preistorico»" 2022).

The association aims to highlight the intrusiveness and economic burden of trams, which they believe will lead to the decline of many businesses, potentially causing commercial and craft services to disappear. In change of trams, they suggest wider use of electric buses as a solution for the city's traffic problems and for a more sustainable urban environment.

As previously stated, although there are benefits of it, integrating electric buses presents new challenges in developing a sustainable urban environment. Implementing tram systems in cities also poses significant challenges, including technical malfunctions, accidents, and inadequate infrastructure support. These obstacles emphasize the importance of supplementary transportation modes, such as buses and non-motorized transport, complementing tram systems. Although bi-directional trams in use in Padova offer sustainability and efficiency, there are challenges that must be overcome, with specific challenges related to their long-term implementation in Padova leading to problems in daily life. Overcoming these challenges will require efficient planning, management, and allocation of resources. The process of implementing a tram route takes a significant amount of time and generates a significant amount of noise pollution, causing short-term discomfort in the city. The municipality should improve this to make it more comfortable and safer for all users. However, the slow bureaucratic processes may cause delays depending on the nature of the work.

In terms of implementing a tram system within the broader transportation network of the city, it appears that cycling has not been adequately considered. Specifically, the Padova tram network currently prohibits users from bringing bikes onboard, which I argue represents a lack of integration with other modes of transportation in the city. If a person rides a bicycle to a certain point within the city and then plans to continue their journey using the tram, they are not permitted to bring their bicycle on board. This circumstance can compel the individual to select between the modes of transportation or forego them entirely. It should be possible to carry bicycles and micro-mobility devices with you to your destination on the tram network just as it is on the railway network. To facilitate this, designated bike racks inside the vehicle could be installed. This feature for the tram can encourage more users to combine different modes of transportation during their daily commute or movement to optimize their mobility.
The concept of door-to-door mobility should receive greater consideration in the planning of sustainable urban mobility in Padova. The importance of active mobility modes in the door-to-door transportation experience should not be disregarded.

Overall, trams are discussed as a reliable choice for sustainable urban transport due to their efficiency, capacity, and sustainability. Bi-directional trams have the potential to positively impact city development and contribute to smart and sustainable urban planning, as they are planned for implementation in Padova. However, there are pressing challenges to address. Another significant aspect is to communicate the decisions made regarding sustainable urban areas to the public clearly

and address their critiques. As stated in the SUMP Guidelines, obtaining public consent and providing transparent explanations of the plans leads to better outcomes.

Furthermore, a central element of the alteration strategy is establishing a cost-effective and well-functioning public transport system. This entails creating an accessible and efficient network of buses, trains, and trams that can be viable alternatives to private cars. An affordable and reliable public transport system can push people to opt for shared transportation options. The alteration strategy acknowledges that public transportation is more energy-efficient than private cars. Buses, trains, and trams can transport a larger number of passengers using less energy per capita compared to individualized motorized travel. This increased energy efficiency contributes to reducing the environmental impact of transportation. By promoting collective transportation and making it affordable and efficient, the alteration strategy also seeks to enhance accessibility for individuals with limited mobility or those who face challenges in using private vehicles. This includes making public transportation more inclusive for low-mobility groups, such as the older population or people with disabilities.

7.3.2 Public transportation of Padova as an alteration strategy element

Establishing an effective public transportation system is one of the goals of the SUMP of Padova as stated previously. In this case, we can discuss the pricing of public transportation and how accessible it is economically. The latest increase in the price of tickets for buses and trams was made in June 2023. The urban ticket for buses and trams has risen from 1.30 euros to 1.70 euros, while the extra-urban ticket has increased from 1.50 to 2 euros ("Aumenta il prezzo del biglietto di tram e bus, Raduzzi: «C'è una cresta del 15%. Grazie Giordani»" 2023).

The ticket prices have remained the same, 1.30 euros, since 2013. With the increase of this year, the cost increased as well as the validity. The urban ticket validity increased from 75 to 90 minutes, and the extra-urban ticket extended from 90 to 100 minutes. According to the price increase, all the subscriptions will also increase by 10%.

The Mayor of Padova, Sergio Giordani, stated about this increase that:

"This is an intervention foreseen in the contract and comes after more than a decade of unchanged fares in a very difficult economic period, which everyone unfortunately knows. We all tend to pay close attention to the cost of some decisions, but as an administrator, I also need to be concerned about the cost of not making them. This will make us stronger and more determined to request that the operator continues rapidly, as agreed upon in the contract, on the path of structural investments and service improvement." ("Aumento dei biglietti bus e tram, Giordani: «Ora possiamo pretendere di più da BusItalia»" 2023)

Contrary to the mayor's statement, we can look at the statement by CGIL, CISL, and UIL representatives. They declare that:

“We can only express strong perplexity at the decision, authorized by the local governing body, namely the Municipality and the Province, at the request of the company, namely Busitalia, to increase the ticket prices for urban and suburban rides of public local transport. Our position is dictated by both the significant increase in ticket costs – over 30% for city rides – and the particular timing of this decision, with inflation heading towards 9%, driven by the rise in essential goods, raw materials, energy, and general services, while the wages that workers use to support their families have been dramatically stagnant, according to OECD data, for over 30 years. Furthermore, we see in this decision a repetition of the usual pattern where the company's errors, lack of planning, and short-sightedness are remedied by calling on the usual suspects, the citizens who use these services, to pay for the crisis. This, considering the low quality of the services received, results in an additional and bitter irony.” (Marturano, Scavazzin, and Zanetti, n.d.)

The increase in ticket prices surely affected many people who cannot afford to pay this price. This results in the discouragement of the use of public transportation and creates injustices in reaching the means of transportation. Especially in these times of crisis and emergency, public transport should be more reachable and affordable; however, in the case of Padova, this is not the situation. The discouragement that is resented from the increased prices and low-quality service fundamentally affects the quality of daily life of citizens and their right to move.

Another problem with public transport, regarding the buses in Padova, is the shortage of drivers. BusItalia is having difficulty maintaining its services due to a shortage of drivers. Many drivers have left the company, primarily for economic reasons and because of the demanding and often long shifts. The shortage is affecting urban, suburban, and tram services, causing disruptions for passengers. This shortage results in trips canceled in the city and creates inconvenience for the users. This shortage

problem is directed to the Busitalia company since it is the provider of bus transport in Padova. Unions are considering legal action due to drivers leaving, and the company is struggling to maintain its services. Many shifts are described as being too heavy for the drivers. Many drivers have to work extended hours, sometimes up to thirteen hours a day. It is also highlighted by the unions the pay disparities between drivers at BusItalia and other transportation workers. Specifically, they point to why bus and tram drivers are paid significantly less than railway workers despite both being part of the same state-owned group, with 79% of BusItalia Veneto owned by the State Railways (Ferrovie dello Stato) ("Caos BusItalia, stipendi bassi e carenza di autisti: rischiano di saltare almeno 50 corse al giorno" 2023).

The rise in ticket prices, coupled with a shortage of drivers, has led to an unsatisfactory public transportation system in Padova. Some routes in the city remain unserviced due to the insufficient number of drivers. This situation affects the quality of public transport and creates a bad image in the eyes of the public and a refrainment when it comes to choosing public transport to move.

To proceed with the alteration strategy, we can adopt the concept of shared mobility, which involves encouraging individuals to share transportation resources, such as carpooling, ride-sharing services, or shared bike and scooter programs. The alteration strategy prioritizes shared mobility as a means of resource allocation, encouraging people to share transportation resources, whether through carpooling, ride-sharing services, or shared bike and scooter programs. By reducing the number of individual cars on the road, shared mobility initiatives contribute to less traffic congestion and a reduced environmental impact. Another facet of this strategy involves promoting walking and cycling as sustainable alternatives to individual motorized travel. By investing in pedestrian-friendly infrastructure and cycling lanes, this approach aims to encourage more people to choose these eco-friendly modes of transportation for short trips. The concept of shared mobility and the micro-mobility solutions are widely accepted in the SUMP of Padova and examples were given on how it is planned to be implemented.

In summary, the alteration strategy seeks to reshape transportation patterns by emphasizing collective and sustainable modes of travel while discouraging excessive reliance on private cars and airplanes. It prioritizes affordability, energy efficiency, and accessibility, aiming to create a more sustainable and environmentally friendly transportation system.

7.4 Reduction Strategy for Sustainable Mobility

The last strategy that we will explain is the reduction strategy. It focuses on achieving sustainable mobility by actively reducing the overall need for motorized travel, particularly for individualized modes of transportation like private cars. While efficiency and alteration strategies play essential roles, the reduction strategy recognizes that additional measures are required to reduce energy consumption and emissions associated with transportation significantly. This strategy seeks to address the ongoing growth in transport demand that can offset the gains made through technological advancements and modal shifts.

The central aim of the reduction strategy is to decrease the demand for motorized travel, especially for single-occupancy vehicles. This can be achieved by encouraging people to use alternative transportation modes or to travel less frequently and for shorter distances. In this regard, encouraging telecommuting, or working from home or remotely, can significantly reduce the necessity for daily commuting. Advances in technology have made it increasingly feasible for people to work from locations other than traditional offices.

7.4.1 Teleworking as an element of reduction strategy and the case study of Padova

For the case of Padova, Baldassa et al. published an article that discusses the increasing trend in teleworking and its potential impact on MaaS adoption, especially in the context of the COVID-19 pandemic (Baldassa, Orsini, and Ceccato 2023). Teleworking has gained popularity in recent years, but it has experienced an increased popularity thanks to the Covid-19 pandemic. In this article, the authors tried to explore the relationship between teleworking and the use of MaaS since they saw a gap in the academic literature in this regard. The paper's primary objectives are to identify the factors influencing teleworking adoption in a post-pandemic scenario and to examine how the willingness to telework relates to joining a MaaS system. The study uses data collected from questionnaires distributed to employees of the Padova Municipality between October 2020 and January 2021, which was a time when teleworking saw significant growth in Italy due to the pandemic. The authors assumed that since the pandemic has significantly changed travel habits, the sudden adoption of teleworking may have long-lasting effects on people's travel choices, which, in turn, could impact MaaS adoption. Their analysis reveals that individuals inclined toward teleworking usually seek more

flexibility and may not have access to private transportation. However, those who anticipate teleworking more in the future are less likely to adopt MaaS, indicating a potential negative impact on MaaS adoption due to the increased popularity of teleworking caused by the pandemic. The study also mentions that people with higher household incomes are more interested in teleworking, possibly because they seek greater work flexibility with higher incomes.

The findings of this study are interesting in regard to creating low mobility and applying the reduction strategy in Padova because findings suggest that telework may not necessarily reduce travel and could even lead to a shift from public transportation to less environmentally friendly means. The analysis suggests that MaaS services, as surveyed, may not seamlessly integrate with teleworking, especially for those who telework frequently and have short trip lengths. To address this, policy planners should conduct preliminary studies to assess the number of people working from home in a specific area when designing MaaS systems. In the long term, it is essential to manage and plan mobility services and telework policies together to maximize societal benefits.

It is also found in the study that certain MaaS services may be perceived as unnecessary by specific user groups (e.g., car sharing for municipal employees). Therefore, it is crucial to design MaaS offerings that are tailored to the characteristics and preferences of end users. Customizing MaaS options can enhance their attractiveness and usability. Therefore, the city needs to understand the preferences of citizens concerning MaaS options and develop and enhance the ones that are most needed.

The research emphasizes the importance of avoiding modal shifts from zero-emission travel, such as cycling or walking, to non-zero emission modes when adopting MaaS. For example, suppose people use active modes of transportation when going to work but change this habit to private car ownership when they transition to teleworking. In that case, this result is not desired by the policymakers. The data indicates that such shifts are unlikely in the study area, highlighting the need for flexible MaaS system planning considering site-specific factors.

Although teleworking has been tried in Padova, due to COVID-19 circumstances, I believe that it is not the preferred method of working yet. For example, in the report published after the Intelligent Cities Challenge (ICC) on Padova, ICC review, a solution of creating a Smart District was expressed (*Padova: Intelligent City Transformation Overview*, n.d.). This solution is for addressing economic challenges and youth unemployment in the city, with a focus on creating a Smart District that fosters innovation and modernization. It is suggested that the development of this strict, with a strong urban

and architectural identity, a type of "Silicon Valley" area in Padova. This area should be located between the Fiera area and the train station with university and small enterprises. This plan includes various initiatives such as improving public transport, expanding car parking, enhancing safety through surveillance cameras, and focusing on health infrastructure. It also mentions transforming Padova into a smart city with innovative services and sustainable logistics.

If we consider this plan, it is more desirable to establish workplaces in the city center rather than promoting teleworking. Such a plan is contrary to the reduction strategy because it creates a mobility flow to a certain area of the city. However, if the necessary conditions are provided, such as improved public transportation and increased options for active mobility within and around the area, this could be perceived as a valuable business and economic opportunity for both the city and its young residents.

All in all, the reduction strategy also involves changing established travel preferences, such as a mindset shift where individuals become more open to using public transportation, carpooling, walking, or cycling rather than automatically resorting to private cars for their daily travel needs.

By implementing the reduction strategy, there is a greater likelihood of achieving more substantial reductions in energy consumption and emissions associated with transportation. This strategy recognizes that even the most energy-efficient vehicles and advanced public transportation systems may not be sufficient if the overall demand for travel continues to rise. Therefore, it places a strong emphasis on reducing the need for travel, particularly by making it easier for people to fulfill their daily needs in a more sustainable and energy-efficient manner.

7.4.2 Comfort and safety issues regarding cycling in Padova

To promote active mobility in a city like Padova, the SUMP suggested the increased kilometers of cycling routes and initiatives to encourage people to cycle and walk. However, the significant point, in this case, should be the creation of easiness and safety in providing sustainable and energy-efficient manners of mobility. According to the Bicycle Master Plan of Padova, there are between 155,000 and 160,000 bicycle trips per day in the city (Vergnani 2019). This estimated number of bicycle trips amounts to nearly 20% of the total daily urban trips in Padova. This shows that bicycles already play a significant role in the city's transportation system. Padova's goal in the SUMP regarding cycling is

to increase the total of bicycle trips to 25%. This means that one-quarter of all daily urban trips should be made by bicycle. This is an ambitious target and reflects the city's commitment to promoting cycling as a sustainable and environmentally friendly mode of transportation.

However, I believe that this commitment lacks an important point, which is the safety of the cycling routes. Currently, Padova has 168 kilometers of cycle routes, which are designated paths for bicycles. This infrastructure forms the basis for promoting cycling as a mode of transportation. The goal is to extend the infrastructure for cycling to 300 kilometers. A study that was conducted in 12 cities in the USA to examine the safety effects of protected and separated bike lanes in urban areas revealed that cities with protected and separated bike lanes experienced a significant reduction in road fatalities ("Tramway: a sustainable solution for the transformation of public space" 2022). This finding also indicates that infrastructure designed to protect cyclists had a positive impact on road safety for all road users. So, not only cyclists benefit from the separated lanes but also pedestrians and micro-mobility vehicle users. This suggests that when cities prioritize creating safer environments for cyclists, it benefits the overall safety of the city.

The study found that the presence of physical barriers that separate bicycles from fast-moving cars, as opposed to shared or painted lanes, played a crucial role in reducing fatalities. In areas with separated bike lanes, researchers estimated a 44% reduction in deaths and a 50% reduction in serious injuries compared to an average city. The study found that painted bike lanes offered no significant improvement in road safety. In some cases, they even provided a false sense of security to cyclists (“Tramway: a sustainable solution for the transformation of public space” 2022).

In Padova, separated bike lanes with physical barriers do not exist. In the SUMP, there are plans to increase the number of bike lanes, but they will be similar to the pre-existing ones. Thus, it is not possible to observe the improvements mentioned in the plan for enhancing cycling safety. Besides, the case of Padova shows that pedestrian and cycling lanes are generally next to each other, separated only by paint. This situation poses a safety risk for both cyclists and pedestrians. With the rising prevalence of micro-mobility vehicles, it is evident that safety levels are decreasing.

Overall, the Bicycle Master Plan and proposed actions in the SUMP provide insights into Padova's efforts to promote cycling as a major urban transport mode. However, the city's goal to increase bicycle usage by 2030 does not align with the insufficient safety conditions of the cycling infrastructure. Expanding the cycle network and developing connections with neighboring municipalities are important goals that aim to encourage more individuals to use bicycles for their

daily trips. However, a more important objective is to alter individuals' mindsets to perceive cycling in and out of the city as a secure and accessible option.

Regarding the safety of cycling, another downfall observed in the case of Padova is the increased theft of bicycles. In Padova, the safety of cycling is compromised by bike theft. This issue persists despite efforts to prevent theft, including marking the bicycles. In response, Bici Rubate a Padova - Avvistamenti - Stolen Bikes in Padova - Spotted, an online Facebook community with 3.6k members, has formed to share and seek help in recovering stolen bikes. Users can post pictures of their stolen bikes and ask for help. Alternatively, if they come across stolen bikes abandoned in public, they can post pictures and inform the members. To foster a secure environment for cycling, the municipality must take stronger measures to combat bike theft. One solution is to increase the number of bike locking stations throughout the city. For instance, in front of the train station in Padova, there is a free parking lot that is usually full, and it is not safe to leave a bike for a long time. Alternatively, a paid bicycle facility is available near the bus terminal. The parking area has a capacity of 830 spaces and is supervised. To use it, one can choose between paying 1.50 euros per day or subscribing for 16 euros per month ("Bici Park in Piazzale Stazione | Mobility Center", n.d.). If the city of Padova aims to increase the use of cycling for transportation, safe and free parking facilities should be provided to all citizens. This aligns with the belief that public transport should be equally accessible to everyone.

1.7.4 Low mobility societies as an element of the reduction strategy

Another important concept of reduction strategy is creating low-mobility societies. The concept of low-mobility societies signifies a significant change in our sustainable mobility outlook. It disputes the predominant and increasing reliance on cars and airplanes for transportation. Instead of solely concentrating on altering transportation modes, as observed in strategies such as electromobility and shared mobility, low-mobility societies propose changing how we live by reducing or even eliminating the use of cars.

In the context of Padova, a medium-sized city with high density, the concept of low-mobility societies may apply in certain circumstances. One potential strategy is to implement a car-free city. The central idea behind such a city is to create an environment that favors sustainable transportation alternatives rather than individual private cars. This initiative aims to solve issues linked with areas in the city

dominated by cars, such as an abundance of automobiles leading to traffic congestion, high noise levels, pollution, and inadequate public spaces. The primary objective is to improve the city's quality of life by transforming urban landscapes into clean, green, and comfortable communities.

Additionally, the concept of low mobility seeks to prepare the city for the future by transforming streets into public areas that prioritize the well-being and convenience of its inhabitants rather than just cars. In many instances of car-free cities today, there is a significant emphasis on micro-mobility solutions, consisting of small and lightweight modes of transportation. These solutions encompass traditional bicycles as well as schemes for e-bikes and electric scooters.

This concept aligns with the proposed measures of SUMP Padova, which include prohibiting cars from significant areas like the historic city center and facilitating access for residents, emergency vehicles, and low-emission delivery services. However, it is important to note that low-emission zones do not equate to a comprehensive car-free urban planning strategy. SUMP Padova should, therefore, develop more specific steps to achieve this goal. Currently, the implementation of low-emission and zero-emission zones can serve as a stepping stone toward establishing a car-free city that prioritizes both safety and environmental sustainability.

Venice is a noteworthy example of a car-free city located very close to Padova. Venice's unique city layout and historic core have made it the largest pedestrian-only urban expanse in Europe (Collings 2023). The dominant transportation mode in Venice is the iconic gondola boats, and the city has 438 bridges, 183 canals, and very narrow streets for pedestrians. The historic center of Venice is exclusively reserved for pedestrians, and cycling in any form is strictly forbidden. However, bicycles can be carried by hand along a specific short route that starts at Venice-Piazzale Roma, crosses the Costituzione Bridge, continues along Santa Lucia Street, and ends at the Scalzi Bridge ("Venice by bicycle," n.d.). The car-free nature of Venice is a result of its unique geography rather than intentional urban planning. Nevertheless, Venice can be seen as supporting sustainable urban areas due to the availability of bike parking stations in main areas and the protection of numerous green spaces.

Another remarkable and well-known example is Pontevedra, a city located in the northwest of Spain. The city is widely recognized as an exceptional case of successful pedestrianization and a car-free city. This transition towards a car-free city began back in 1999 and has garnered attention ever since for its achievements in this area. According to Eltis, the latest vehicle-related death in Pontevedra occurred in 2011 and was an isolated case involving a delivery truck (Collings 2023). With this impressive safety record, Pontevedra emerges as one of Spain's safest communities designed for

pedestrians. Pontevedra can serve as a model for other municipalities seeking to create green and walkable urban areas.

Another advantage of creating a low-mobility area in Padova is the higher population density and shorter distances between key destinations. To promote alternatives to car usage, medium-sized cities like Padova can enhance their infrastructure by implementing walking, cycling, and efficient public transport systems. Investing in pedestrian-friendly areas, bike lanes, and reliable public transportation can encourage residents to choose sustainable modes of travel.

The same category of investment applies to the promotion of active mobility in Padua, which can be seen in the SUMP's initiatives to promote environmentally friendly transport and reduce private car use. One of the initiatives to be highlighted is the planned expansion of cycling paths in and around the city.

The Padova Municipality also promotes community engagement by promoting active travel modes and public transportation. One way to achieve this is by involving local businesses and organizations in planning for low-mobility initiatives. The municipality endorses modes of commuting to work, such as cycling to work or using micro-mobility solutions. Additionally, business growth is facilitated by engaging with local businesses by converting streets into no-car zones. For example, according to the SUMP of Padova, the pedestrianization of Via del Santo between Via Gaspara Stampa and Via Galilei, as well as Via Zabarella between Via Cesare Battisti and Via San Biagio, has had a positive impact on local businesses in the area (Cozza 2021). This change was intended to provide refreshment to the area after the struggling times of COVID-19, and it was successful in supporting businesses. The alterations in traffic and modifications to the area enabled businesses to establish tables and offer outdoor services. The transformation into a pedestrian zone also permits safe bike crossings and generates a lively local space for residents to enjoy.

We can conclude that medium-sized cities like Padova have a great advantage when implementing sustainable actions in the urban area. Smaller cities often have more direct and responsive governance structures. Local politicians can play a crucial role in launching and supporting low-mobility initiatives. Policies that prioritize the reduction of car use, the creation of car-free zones, and the promotion of alternative modes of transport can be implemented more swiftly in smaller cities.

However, the success of the transition to a low-mobility society with high sustainable urban mobility values depends on the support and decisions of the local population. In democratic societies, it is the citizens who legitimize and influence government actions. Therefore, public awareness, understanding, and acceptance of the benefits of sustainability initiatives are crucial for their success.

To envision car-free, low-mobility, sustainable societies to combat the increasing negative consequences of car use, such as congestion and pollution, requires reevaluating our current way of life. Smaller cities such as Padova can lead the way in experimenting with low-mobility initiatives and setting an example for more sustainable and livable urban environments. This transition, while challenging, is essential to achieving sustainable mobility and improving the overall quality of life for city inhabitants.

CONCLUSION

Padova as a pioneer in sustainable urban mobility planning

At the outset of this work, we embarked on a quest to address the complex challenges of urban mobility, taking a glance at the global context and then observing the city of Padova. Additionally, our objective was to evaluate the sustainability and distinctiveness of the SUMP of Padova in the context of Italy and Europe. The research question centered on the efficacy of Padova's SUMP in attaining sustainable urban mobility goals.

Our investigation into Padova's SUMP and its positioning within the wider urban mobility context showed several noteworthy findings. First and foremost, the plan establishes a strong foundation for sustainable urban mobility, placing significant emphasis on environmental sustainability, especially through initiatives that target emission reduction and improvement of public transportation services. Secondly, the SUMP shows dedication towards promoting active mobility by executing action plans to enhance residents' accessibility to active mobility solutions. In line with global best practices, this initiative aims to change residents' perceptions of traditional transportation.

However, our analysis also revealed room for improvement for SUMP of Padova. The economic sustainability of public transportation within the SUMP requires further examination. Furthermore, the plan overlooks safety issues and solutions for active mobility, indicating a need for continuous development and adaptation.

The implications of this research can extend beyond the boundaries of Padova. By evaluating the city's efforts in sustainable urban mobility, we make a contribution to the wider field of urban planning and transportation. The lessons and experiences from Padova can inspire and inform other cities striving to pioneer sustainable urban mobility. Furthermore, Padova can also draw upon the best practices of other cities to enhance the sustainability of its mobility system.

Our research methodology, grounded in content analysis and literature review, enabled us to extract information from various sources and produce a comprehensive evaluation of Padova's SUMP.

The study began by highlighting the global challenges of urban mobility, drawing attention to Padova's position in the battle against the challenges of urbanization. As we conclude this exploration, we find that our research has advanced our understanding of sustainable urban mobility in both local and global contexts. The statement supports the notion that cities such as Padova serve as a space for solutions and as a pioneer in tackling the challenges of urbanization.

Recommendations

Our findings suggest that Padova's SUMP should continue developing with a greater emphasis on economic viability, improving road safety for cyclists and pedestrians, and maintaining a balance among the environmental, social, and economic aspects of sustainability. Regular evaluations and adjustments should be made to micromobility and shared mobility solutions to ensure that the plan remains aligned with evolving urban dynamics and sustainability principles.

Although this research offers valuable insights, it cannot fully answer certain questions. Urban mobility is an ever-changing and dynamic field, and more exploration is necessary to comprehend the long-term impact of the SUMP and address any potential challenges that may arise. To better understand all aspects of urban mobility, future research can benefit from further collection of data on user habits and their comprehension of the transportation network. A comprehensive dataset on public opinion should also be gathered to understand the position of residents in urban planning.

As we conclude our exploration of Padova's urban mobility landscape, let us remember that the city is not only a setting for our daily lives, but also a representation of our aspirations. While this chapter of exploration comes to a close, the narrative of sustainable urban mobility in Padova remains an ongoing one.

The journey toward establishing sustainable urban mobility continues, and Padova's story is just one chapter in this global narrative. May it become a story of inspiration and innovation that resonates far beyond its ancient walls.

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