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Smart Mobility in the Italian and European Context: Analysis of the Current Developments and Future Perspective

TESI DI LAUREA MAGISTRALE IN
MANAGEMENT ENGINEERING – INGEGNERIA GESTIONALE

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Abstract in English

In a context of increasing urbanization, where cities are becoming more populated and congested, one of the main challenges today concerns mobility. Numerous factors, taken together, have contributed to and continue to influence the development of what is now referred to as "Smart Mobility". The emergence of digital technologies, such as Internet of Things (IoT), Artificial Intelligence (AI), and Big Data Analytics algorithms, has enabled the creation of smarter and more integrated transportation systems that can adapt to real-time conditions and user needs. Furthermore, the urgent need to address climate change, urban pollution, and promote sustainable practices has led legislators and businesses to invest in more environmentally friendly transportation alternatives.

This thesis aims to analyse the development of Smart Mobility first in Italy and then in Europe, seeking to identify the analogies and differences between these two contexts and to envision how it may evolve in the near future. To provide a comprehensive and coherent analysis, the discussion will be organized to address three key questions that will be presented in a dedicated chapter.

The tools used for writing this thesis were primarily three. Regarding the introductory part, a literature review was conducted to gain an overview of the topic (the European and national context, the application areas of Smart Mobility and the key technologies that have enabled its development were analysed). In particular, many scientific articles from platforms such as Scopus, Google Scholar, and ResearchGate were consulted. For the section dedicated to Smart Mobility in Italy, a survey provided by the Connected Car and Mobility Observatory of the Politecnico di Milano was utilized, which directly surveyed several Italian municipalities on the subject. Finally, to analyse the European context, a database (also provided by the Connected Car and Mobility Observatory of the Politecnico di Milano) containing numerous projects related to this theme from around the world was used. The initial task was to update the database with new projects and then filter all those in Europe from 2020 to 2024 in order to use them for a specific analysis.

Key-words: Smart Mobility, application areas, regulations, sustainability, efficiency.

Abstract in Italian

In un contesto di crescente urbanizzazione, in cui le città stanno diventando sempre più popolate e congestionate, una delle sfide principali ad oggi riguarda la mobilità. Numerosi fattori, nel loro complesso, hanno contribuito e continuano a contribuire allo sviluppo di quella che oggi viene definita "Smart Mobility". L'emergere di tecnologie digitali, come l'Intenet of Things (IoT), l'Intelligenza Artificiale (IA) e gli algoritmi di Big Data Analytics, ha reso possibile la creazione di sistemi di trasporto più intelligenti e integrati, capaci di adattarsi alle condizioni in tempo reale e alle esigenze degli utenti. Inoltre, la necessità urgente di affrontare il cambiamento climatico, l'inquinamento delle città e di promuovere pratiche sostenibili ha indotto i legislatori e le imprese a investire in alternative di trasporto più ecologiche.

In questo lavoro di tesi si cercherà dunque di analizzare lo sviluppo della Smart Mobility prima in Italia e poi in Europa, cercando di cogliere le analogie e le differenze tra questi due contesti per poi provare a immagine come questa potrebbe evolversi in un prossimo futuro. Per cercare di avere un'analisi completa e coerente, il discorso verrà organizzato in modo tale da rispondere a tre domande chiave che verranno esposte in un capitolo dedicato.

Gli strumenti che sono stati utilizzati per la scrittura di questa tesi sono stati principalmente tre. Per quanto riguarda la parte introduttiva, è stata compiuta un'analisi della letteratura in modo tale da avere una visione generale sul tema (si è analizzato il contesto europeo e nazionale, le aree applicative della Smart Mobility e le tecnologie principali che ne hanno permesso lo sviluppo). In particolare, sono stati consultati molti articoli scientifici provenienti da piattaforme come Scopus, Google Scholar e ResearchGate. Per quanto riguarda la sezione dedicata alla Smart Mobility in Italia, è stata utilizzata una survey, messa a disposizione dall' l'Osservatorio Connected Car and Mobility del Politecnico di Milano, con cui sono stati interrogati sul tema direttamente alcuni comuni italiani. Infine, per analizzare il contesto europeo, è stato utilizzato un database (sempre messo a disposizione dell'Osservatorio Connected Car and Mobility del Politecnico di Milano) contenente numerosi progetti riguardanti questo tema dispersi in tutto il mondo. Il lavoro è stato inizialmente quello di aggiornare il database con nuovi progetti e poi filtrare tutti quelli in Europa dal 2020 al 2024, in modo tale da usarli per condurre un'analisi specifica.

Parole chiave: Smart Mobility, aree applicative, regolamentazioni, sostenibilità, efficienza.

Executive Summary

Smart Mobility in the Italian and European Context: Analysis of the Current Developments and Future Perspectives

TESI MAGISTRALE IN MANAGEMENT ENGINEERING – INGEGNERIA GESTIONALE

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1. Introduction

The first chapter of this thesis provides a general introduction to the Smart Mobility topic. It explains all the essential concepts needed to fully understand the analysis presented in the following chapters.

1.1 Policy regulation in Europe

The first paragraph is dedicated to the current regulatory framework and it is divided into two subsections: the first focuses on the European context, while the second one addresses the Italian one. The first subsection outlines the main strategies, reforms and regulations implemented by the European Union in recent years that are shaping mobility. The EU's goal of becoming the first carbon-neutral continent is significantly transforming the way mobility is conceived, driving the transition toward a sustainable, connected, safe, and accessible transportation system, in other words toward, "Smart Mobility". This section covers key initiatives such as the Green Deal, the Sustainable and Smart Mobility Strategy, the Fit for 55 Package and other more. The subsection dedicated to the Italian context primarily discusses the National Recovery and Resilience Plan (PNRR), highlighting how Italy's approach aligns with the broader European vision.

1.2 Application areas

The second section focuses on the application areas into which Smart Mobility has been divided. Each of these areas is explored in a dedicated subsection,

followed by an example of a project, company, or startup to provide a concrete and practical understanding of the topic. The first area discussed is Mobility-as-a-Service (MaaS), an innovative approach to integrating different modes of transportation into a single digital platform. The section also details the various levels of integration within MaaS. The second area is Sharing Mobility, where the four different models of shared mobility services are presented. The third area covers Electric Mobility, a key pillar in the ongoing effort to decarbonize the transportation sector. The fourth area is Smart Roads, which refers to new connected road infrastructures capable of communicating with vehicles through sensors and advanced technologies. Following this, the discussion moves to Smart Parking and Traffic Management, two areas addressing increasingly critical urban challenges. The section then explores more innovative application areas, such as Air Mobility and Autonomous Driving, with an in-depth explanation of the different levels of automation. Finally, the paragraph presents Support Services, Public Transportation, and, as the last application area, Last Mile Delivery (LMD): the final stage of logistics, which is often the most inefficient and costly part of the supply chain.

1.3 Technologies

The third and final section of the introduction outlines the key technologies that have enabled the emergence of Smart Mobility and continue to be essential for its development. The first of these is the Internet of Things (IoT), a foundational technology for this kind of mobility. IoT refers to physical devices (often called "things") that have the ability to sense real-world environments, collect data, and communicate with other devices. The second crucial technology is 5G, which is essential for unlocking the full potential of IoT by providing high-speed and low-latency connectivity. Next, the analysis moves to Vehicle-to-Everything (V2X) communication and its various applications. This technology leverages IoT sensors and 5G networks to enable real-time communication between vehicles and different road actors, improving safety and efficiency. The fourth key technology is Big Data Analytics, which plays a vital role in processing and extracting insights from the vast amounts of data collected by IoT sensors. This is particularly useful for applications such as traffic flow optimization and predictive maintenance.

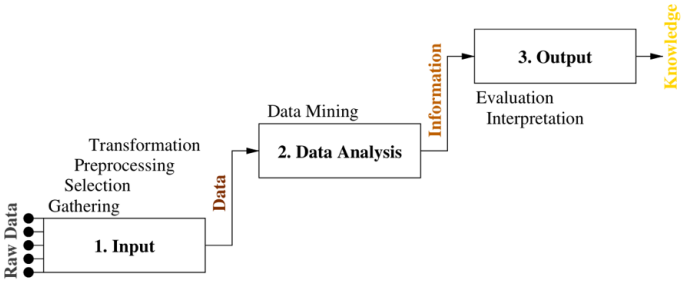

Figure 11. The process of knowledge discovery in databases

Finally, the section discusses Artificial Intelligence, a highly relevant and widely debated technology today, and Digital Twin, which can be defined as "*a virtual representation of a physical system (and its associated environment and processes) that is updated through the exchange of information between the physical and virtual systems*". These technologies are expected to further enhance the efficiency, automation, and decision-making capabilities of Smart Mobility solutions.

2. Objectives and Methodologies

This concise yet crucial chapter is divided into two parts. The first section is intended to present the key research questions that form the foundation of this thesis. The second one outlines the methodologies used to identify and evaluate the sources.

2.1 Objectives

To ensure a structured and comprehensive examination, three key questions have been formulated, which will be addressed throughout the discussion. The first question (Q1) focuses on the Italian context and is stated as follows: "*What is the current state of Smart Mobility in Italy*?". The second question (Q2) expands the perspective beyond Italy to consider the broader European framework: *"How is smart mobility developing in Europe? Do the trends of innovation and development coincide with what happens in our Country?"*. Finally, the third and final question (Q3) aims to conclude the discussion by looking at future expectations

and potential developments: *"How will smart mobility change in the coming years? Which areas are expected to be more prosperous?"*.

1.1 Methodologies

Subsequently, the second part of the chapter outlines the three types of sources used to conduct the analysis. The first one is the literature review, which was particularly essential in the initial phase to establish a comprehensive understanding of the topic and to develop the entire Introduction chapter. The second methodology is the analysis of a survey, conducted by the Connected Car & Mobility Observatory of the Politecnico di Milano, which was sent to various Italian municipalities. This survey was crucial in addressing the first research question (Q1) as it provided direct insights from those actively involved in the field of Smart Mobility in Italy. The third and final source is a database (also provided by the Connected Car & Mobility Observatory), which contains a large collection of Smart Mobility projects all over the world. This database was instrumental in answering the second research question (Q2) by offering a broader perspective on international trends and developments. Specifically, the work carried out on this database initially involved updating it by adding new projects from around the world. Subsequently, all European projects from 2020 onwards were filtered to structure a specific analysis based on these.

3. Analysis and Discussion of Results

This chapter describes the main work carried out to answer the first two questions presented in the previous chapter, which represent the final objective of this thesis. To achieve this, the chapter is divided into two parts: the first focusing on the Italian context and the second on the European context. For both, the structure will be as follows: first, the section's objective and the methodology used (starting with the survey and then the database) will be described, followed by the analysis. The main results will then be revisited in the final chapter "*Conclusion*".

3.1 The Italian Scenario

The objective of this section is to address Q1. Given its broad and complex nature, the question has been divided into five sub-questions (S1, S2, etc.) to structure the analysis more effectively. The section is organized as follows: first, the survey is introduced, along with an overview of the responses provided by Italian municipalities to establish the context. Subsequently, each of the five sub-questions is analyzed individually, using the most relevant survey questions to support the discussion. Additionally, the answers are examined through two clustering approaches: the first categorizes municipalities by size (small, medium-small, medium-large, or large), while the second groups them based on geographical location (North, Center, and South).

The first sub-question (S1) aims to determine whether Smart Mobility is truly a relevant topic in Italy. To address this, Italian municipalities were first asked how they perceive this topic. The results indicate that the majority (53%) consider Smart Mobility "very important," while nearly a quarter (24%) even regard it as "fundamental." Next, the survey investigates whether municipalities have a dedicated figure responsible for Smart Mobility. The result is that 59% of respondents confirmed the presence of such a role within their administration. Finally, municipalities were asked whether they had ever initiated Smart Mobility projects and in which year. The findings reveal that 65% of respondents had launched at least one Smart Mobility initiative. Overall, these results are quite encouraging. However, when analyzing different clusters, a clear disparity emerges between smaller and larger municipalities, with the latter reporting significantly more positive outcomes.

The second sub-question aims to understand how and why a Smart Mobility project is initiated. First, municipalities were asked about the origin of the need to start such projects. The results indicate that in 75% of cases projects are driven by public authorities' initiatives. The second most selected reason was the availability of funding opportunities.

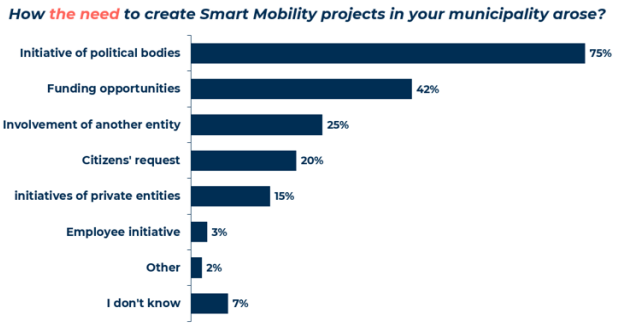

Figure 17. The actors that initiate a Smart Mobility project (60 respondents, 113 answers)

Next, the survey examined the financial impact of Smart Mobility projects on municipal budgets. For 62% of respondents, these projects accounted for less than 5% of the total budget, highlighting their relatively small financial footprint. To address the "why" behind Smart Mobility initiatives, municipalities were asked about the main objectives of these projects. The most common response (59%) was "mobility optimization," underscoring a focus on efficiency and infrastructure improvement. Lastly, the survey included a brief analysis of sustainability. Municipalities were asked how they aim to achieve the ecological transition, and among the various responses, the most selected approach was "human-scale cities," emphasizing a shift toward more livable and people-centric urban environments.

The third sub-question focuses on the strategies adopted for Smart Mobility projects. The most frequently chosen approach, selected by 41% of respondents, was the "bottom-up strategy" (where the municipality has a strategy, but it acts in watertight compartments), which also has increased by 12% compared to last year. Similarly, the "planned strategy" (which involves a medium-to long-term plan for the start-up of Smart Mobility projects) was implemented in 22% of municipalities, showing a growing trend in structured Smart Mobility planning. Naturally, long-term strategic planning requires specific skills within municipalities. The survey revealed that 49% of respondents rely on "on-demand skills" (meaning that competent figures within the municipality work individually based on the needs of the moment) while, unfortunately, no municipality reported using a "long-oriented skills" approach (which would involve a well-organized team of experts dedicated to the topic, and there is also a plan oriented towards the creation and enhancement of widespread internal competences). However, there is a positive trend: the percentage of municipalities reporting a lack of skills has significantly decreased, from 38% last year to 20% this year. Once again, the worst results in terms of missing strategies and inadequate skills were reported by smaller municipalities, highlighting a gap in expertise and resources based on city size.

The penultimate sub-question aimed at gathering predictions on various Smart Mobility areas. An analysis of the maturity levels of different application areas revealed that half are still in the exploration phase, indicating that many Smart Mobility solutions remain in their early stages of development. Municipalities were then asked to identify the most interesting Smart Mobility solutions for the next three years in three key areas: electric mobility, traffic management, and smart parking. The results showed that in electric mobility, the most preferred solution is smart charging points, while in traffic management, municipalities favored intelligent traffic light systems. For smart parking, the most selected option was parking with integrated charging points. These insights provide a clear indication of where municipalities are focusing their attention and investments for the near future.

The final sub-question (S5) examined the barriers that municipalities face in achieving a Smart Mobility future and how these obstacles can be overcome. The two main challenges, identified by Italian municipalities, were: "scarce availability of economic resources" and "lack of knowledge". To address the second part of the question (how to overcome these barriers) alternative data points were analyzed. One effective approach for municipalities to compensate for limited funds and knowledge is to form strategic partnerships, which can create significant synergies and competitive advantages. Survey results revealed that most current partnerships are with municipal companies, but in the future, many municipalities aim to collaborate with innovative startups. Another crucial strategy for overcoming these barriers is the efficient utilization of the vast amount of data generated by Smart Mobility projects. The final set of survey questions focused on understanding how municipalities manage,

utilize, and safeguard this data, with findings highlighting significant room for improvement.

3.2 The European Context

This section shifts the focus to Europe to answer question Q2. It begins by describing the database used for this analysis: initially, it contained 518 projects, but after filtering to include only European projects from 2020 onward, the number was reduced to 313. A geographical map of Europe is first presented, highlighting the countries with the highest representation in the database. The results show that the majority of projects are in Italy (36%), which reflects an inevitable bias in this kind of analysis due to the ease of accessing information about Italian projects. It is followed by Germany (8%), Sweden (7%), and France (6%). Subsequently, a bar chart is introduced to determine which years had the highest number of projects, with 2021 leading at 25% of the total.

The second paragraph of this section analyzes specific aspects of the projects. First, it is noted that the majority (72%) take place in an urban context. The focus then shifts to the role of public actors, revealing that they are involved in 75% of the projects and fully fund 50% of them. Finally, the analysis examines the beneficiaries and the benefits of these initiatives. The primary beneficiary is the citizen, while the main advantages identified are sustainability, efficiency, traffic flow, and safety.

Figure 37. On the left, the main beneficiaries of the database projects, on the right, the main benefits (313 projects)

The third paragraph highlights key differences that emerge when comparing the database analysis with the survey responses. The first notable difference concerns an application area: autonomous driving. In the database, it is the second most common application area, yet when Italian municipalities were asked which areas they intend to focus on in the near future, very few of them selected autonomous driving. The second difference relates to artificial intelligence. When municipalities were asked whether they currently use or plan to use AI to improve the efficiency and quality of their services, only 6% responded affirmatively. Furthermore, the database analysis also reveals a significant disparity between Italy and the rest of Europe in AI adoption. It is used in 29% of the projects in the database, but when separating Italy from the rest of Europe, the contrast is stark: AI is present in 47% of European projects outside Italy, whereas for Italian projects, the percentage drops to just 12%.

The final paragraph presents a financial analysis. Initially, all the projects for which the funding is known are used to conduct cluster analysis. The result shows that the most significant cluster (containing 31% of the projects) includes projects with a budget ranging from 1 to 5 million euros. Following this, a table is presented that shows the mean, the standard deviation, and the median values for each year, from 2020 to 2024. In order to calculate these values, bias values are removed to reduce the standard deviation as much as possible. Finally, three matrices are presented. These matrices are created using all possible pairings of the following axes: average funding, level of maturity, and the percentage of public funds relative to the total funding. Within the matrices, the application areas are placed as elements, with different colors and sizes used to represent them: the larger and darker the element, the more projects in the database are related to that specific application area. The first matrix uses funding as the horizontal axis and the level of maturity as the vertical axis: the elements are fairly dispersed, filling most of the matrix. The second matrix replaces the level of maturity with the percentage of public funds, and here the elements are positioned much closer to the diagonal. This suggests that public funds primarily support application areas where greater economic effort is needed, while private investments are more focused on areas requiring less funding (such as LMD and shared mobility).

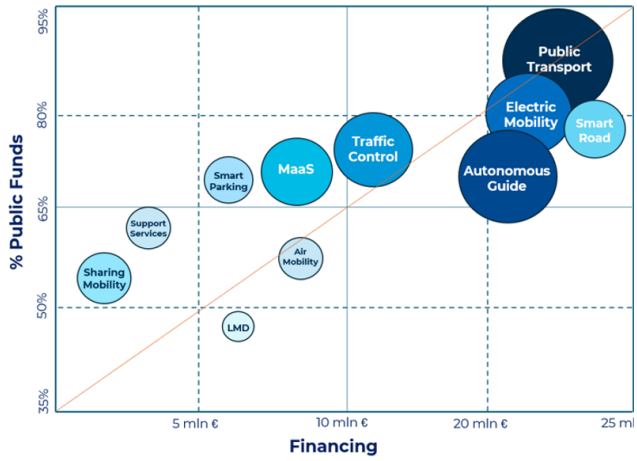

Figure 44. Second matrix (118 projects)

The third and final matrix, which combines the level of maturity and the percentage of funding, can be used to understand whether public funds are essential to achieve a high level of maturity. The answer is that while public funds are important, they are not necessarily essential. This is exemplified by shared mobility, which has a high level of maturity but a relatively low percentage of public funds compared to total funding.

4. Conclusion

The concluding chapter of the thesis serves to summarize all the points covered so far, in order to provide more direct answers to the three questions. To address the first question (Q1), the analysis presented in section 3.1 "*The Italian Scenario*" is revisited, with a focus on the insights drawn from various survey responses. This section re-examines the current state of Smart Mobility in Italy, highlighting key findings and trends. Next, attention shifts to the second research question (Q2), which explores the development of Smart Mobility across Europe. Here, section 3.2 "*The European Context"* is revisited, drawing connections between the Italian scenario and the broader European one. To further illuminate the differences between the trends observed in Italy and those in other European countries, the discussion expands on specific areas such as electric mobility and autonomous driving. In this section, additional data not previously covered in the earlier analysis are introduced to provide a more precise comparison of innovation trends. Finally, to conclude the thesis, a brief yet insightful overview of a potential future scenario for Smart Mobility is presented, offering answers to the third and final question (Q3). This section outlines possible developments in Smart Mobility in the coming years, considering technological advancements, policy shifts, and societal trends that could shape the evolution of mobility systems.

1 Introduction

In this introductory chapter all the elements, that are necessary to better understand this work of thesis regarding Smart Mobility, will be explained. The first section will be dedicated to explaining the current European context and the direction we're going to, by analysing the objectives and regulations concerning mobility and transport sector in Europe and Italy. In the second paragraph, it will be better explained what is meant by the word "Smart Mobility", so the different declinations of this topic that are the areas of application according to the Connected Car & Mobility Observatory of the Politecnico di Milano. Finally, in the third and last paragraph, the main technologies about this topic, and that will be mentioned afterwards in the analysis, will be descripted in detail. Where necessary, specific cases (like projects, companies or startups) will be described and used as examples to better understand the topic of the discussion.

1.1. Policy regulation in Europe

To get a complete overview of Smart Mobility, let's now analyse the European context we have been experiencing in recent years and how it is influencing this topic.

In recent years, the European Union has strongly pushed for decarbonization and environmental sustainability; this vision, that our continent has for the future, is described and officialised within the European Green Deal. Presented on 11th December 2019 by the European Commission, it is the European Union's strategy to achieve climate neutrality by 2050, aiming to transform the economy in a sustainable way and significantly cut greenhouse gas emissions, making our Continent the first one in the world to be carbon neutral (this does not mean that GHG emissions will be completely eliminated, but that they will be offset in order to be reabsorbed and therefore have a zero final balance). This strategy is the European Union's contribution to the 2015 Paris Agreement, which set the goal of keeping global warming within +1.5°C compared to pre-industrial levels.

On 9th December 2020, the European Commission presented the Sustainable and Smart Mobility Strategy, a strategy, long-term oriented (with targets in 2050), which concerns the mobility sector. The need for a dedicated mobility strategy arises from

the fact that the transport sector in Europe is responsible for more than a quarter of CO_2 emissions, with road transport alone accounting for over 70% of these emissions (Karadag et al., 2025). Beyond the issue of pollutant emissions (Which, it is important to note, poses less of a threat to the planet itself and more to the human beings who inhabit it), mobility presents additional challenges. Traffic congestion in urban areas leads to economic losses, increased emissions (resulting in a lower quality of life), and energy dependency. The transport sector relies heavily on fossil fuels, making it vulnerable to economic instability caused by oil price fluctuations and supply uncertainties (Gkoumas et al., 2021). The Sustainable and Smart Mobility Strategy is built on three core principles: Sustainability, aimed at cutting greenhouse gas emissions and promoting the use of renewable energy in transportation, Intelligent Mobility, leveraging advanced digital technologies to enhance efficiency and safety, and Resilience, ensuring a more robust transport system capable of withstanding future crises. Within this strategy the EU Sustainable and Smart Mobility Strategy Action Plan is contained (Campisi et al., 2021), which provides an operational roadmap with concrete measures, goals and deadlines in the short, medium and long term. The plan includes 82 initiatives to be implemented by 2050, with intermediate goals set for 2030 and 2040. Key measures involve improving public transport, expanding infrastructure for zero-emission vehicles, and fostering integrated and multimodal mobility solutions, and this will enable a 90% reduction in greenhouse gas emissions from transport by 2050, as defined in the European Green Deal.

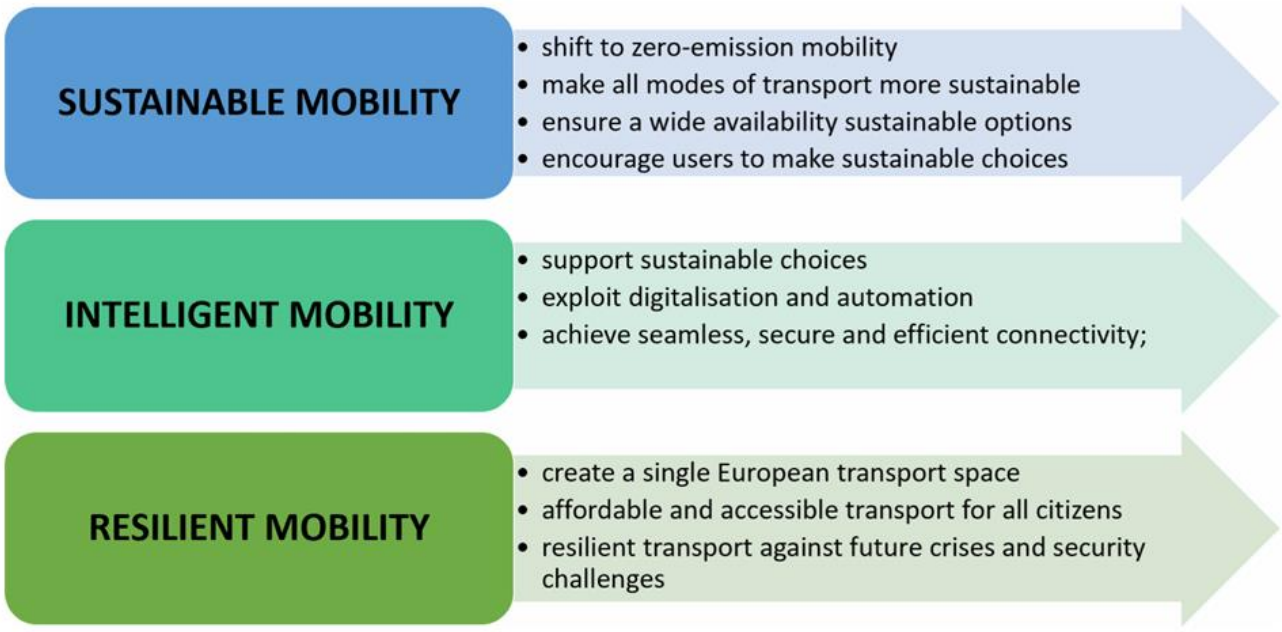

Figure 1. The three pillars on which the Sustainable and Smart Mobility Strategy is based

With these strategies in mind, and in order to achieve the objectives proposed by the Green Deal, the European Commission presented on 14th July 2021 the Fit for 55

Package, a legislative framework designed to reduce CO_2 emissions by 55% by 2030 compared to 1990 levels. While the Green Deal outlines a long-term vision for carbon neutrality, the Fit for 55 Package translates part of this vision into concrete action by 2030. It introduces binding regulations across sectors such as transportation, energy, construction, and industry.

Focussing on the mobility and transport sector, it is possible to find different initiatives to enhance sustainability (Werland, 2020) within this package of legislative proposals. The automotive sector is strongly impacted by these regulations with the obligation to stop selling new petrol and diesel cars from 2035 (average emissions of new cars will have to come down by 55% by 2030), forcing car manufacturers to switch completely to zero-emission vehicles (electric cars, hydrogen cars, etc.). To allow this, the European commission has created some initiatives that support this radical change, such as the Alternative Fuel Infrastructure Regulation (adopted in 2023) and the Efficient and Green Mobility Package (adopted in 2021). The first one is a legislative proposal to promote the development and deployment of adequate infrastructure for alternative fuels, such as electricity, hydrogen, synthetic fuels (e-fuels) and liquefied natural gas (LNG) for the transport sectors. The second one, the Green Mobility Package includes several legislative proposals that aim to promote green mobility, improve transport efficiency and reduce greenhouse gas emissions in the transport sector. Within this Green Mobility Package it is inserted the New Urban Mobility Framework (NUMF), which promote a smart, sustainable and connected urban mobility (quoting this framework: "*We want people and goods to move more sustainably in our cities, to make life easier for the rural and suburban commuters travelling to school or work, and to support cities in their role as essential transport hubs within the single market*").

The road-transport is not the only transportation sector impacted by these regulations For what concerns the air and marine transport, The RefuelEU Aviation and FuelEU Maritime Regulations (officially adopted in July 2023 and October 2023) aimed at stepping up the supply and demand of sustainable aviation and maritime fuels; in addition, the ETS[1] is also extended to these sectors by requiring airlines and shipping companies to reduce their emissions through the purchase of emission allowances, incentivising the use of low-emission fuels and technological improvements for SAF[2] and marine fuels. As regards the rail transport sector, The European Commission has proposed measures to make freight transport more efficient and sustainable, improving cross-border coordination, increase punctuality and reliability and, attract more freight companies to rail transport.

[1] The Emission Trading System is an environmental policy tool according to which to emit CO2 you must buy permits; the total amount of CO2 that can be emitted is determined by the European Union.
[2] Acronym for "Sustainable Aviation Fuels".

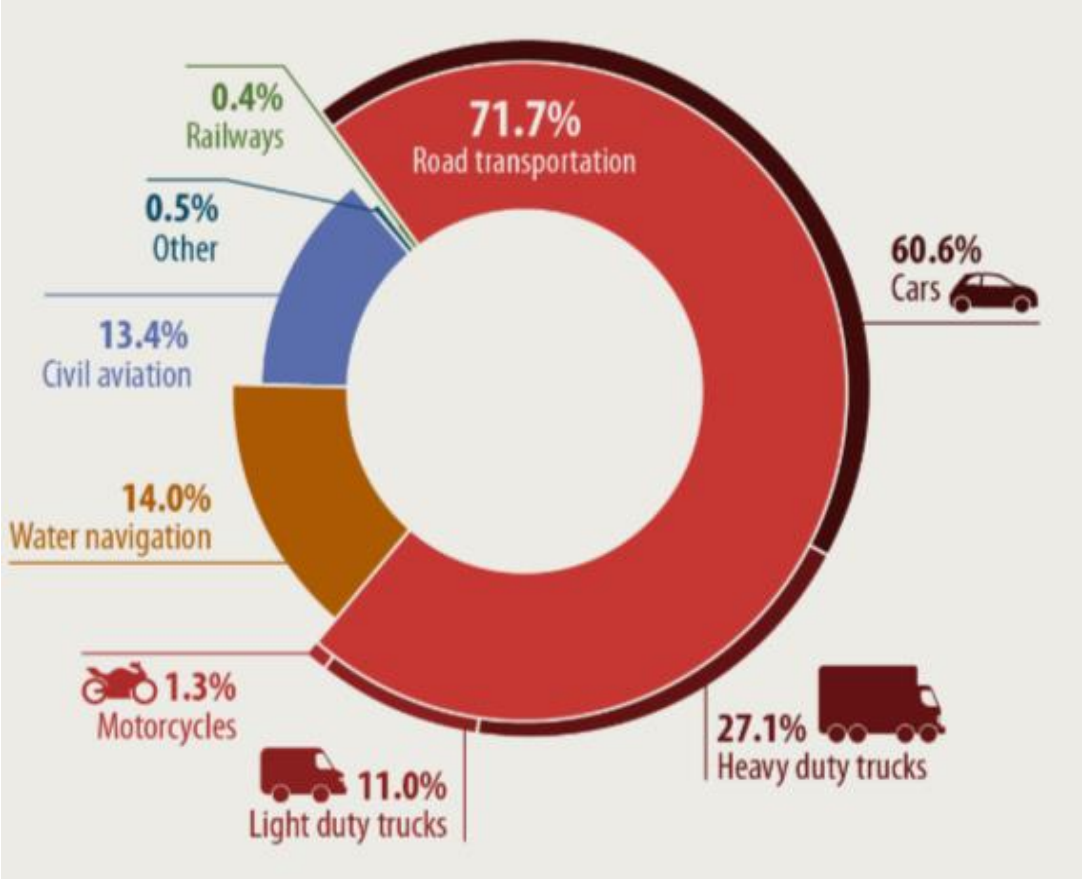

Figure 2. GHG emissions breakdown by transport mode in 2019

Of course, setting objectives and regulations is not enough to carry out strategies: economic funds are necessary to implement such a radical change. To finance these strategies, in fact, the European Union has made available various investment funds, some of the most important are Next Generation EU (2020), the Horizon Europe program (2021), and the Just Transition Fund (2020). Next Generation EU allocates crucial resources for post-pandemic economic recovery, with a strong focus on sustainable mobility by funding the development of low-emission public transport, charging infrastructure for electric vehicles, and smart city projects. Horizon Europe supports research and innovation in fields such as autonomous vehicles, connected transportation, mobility digitalization, and green logistics. In particular, Cluster 5[3] ("Climate, Energy, and Mobility") is dedicated to developing new technologies for more efficient and sustainable transportation. Finally, the Just Transition Fund helps regions heavily reliant on fossil fuels diversify their economies by providing resources for low-emission mobility projects, railway infrastructure, and shared transportation

[3] The part of the Horizon Europe program dedicated to "*Global Challenges and European Industrial Competitiveness*" is divided into six clusters, the fifth of which is focused on mobility.

solutions, ensuring a fair and inclusive transition. (European Environment Agency, 2022).

1.1.1. Italian Regulations

Italy has developed a comprehensive strategy to promote sustainable and smart mobility through various initiatives and funding mechanisms, aligning with the broader European goals for decarbonization and green transition. Our country's approach involves a mix of incentives, policies, and investments, aimed at encouraging the adoption of electric vehicles (EVs), enhancing public transport, and modernizing transport infrastructure. A very important element for the green transition is the PNRR fund ("Piano Nazionale di Ripresa e Resilienza"), the recovery plan, presented in April 2021, with which Italy aims at overcoming the crisis caused by the Covid-19 pandemic, thanks to a fund of 191.5 billion euros[4] that is part of the extraordinary European fund Next Generation EU. It is structured to support different areas in six key missions. Since the third one is dedicated to "Infrastructure and Sustainable Mobility", it allocates substantial funds for green mobility projects, the expansion of the electric car fleet, the expansion of EV charging networks, the electrification of public transport, and the promotion of smart mobility solutions. The *Eco-bonuses* (whose fund was allocated by the Government for the purchase of low-emission vehicles, of which 200 million euros have been allocated to electric vehicles) and the *bonus-colonnina* (a contribution up to 80% for the purchase and installation of charging infrastructure), partly funded by this recovery fund, helped slightly to push electric and more sustainable mobility.

Mission 3 of the PNRR is therefore aligned with other strategic mobility plans, such as the National Sustainable Mobility Plan (PNMS), the Plan for Smart Mobility and the Digitization of Transport and the MaaS 4 Italy project. The first one is focused on promoting low-emission transportation, investing in electric public transport, and enhancing cycling and pedestrian infrastructure. In addition, the Plan for Smart Mobility and the Digitization of Transport aims to integrate new digital technologies, such as AI, IoT, and V2X, to optimize traffic flow, improve safety, and enable real-time mobility management. Within this framework, MaaS 4 Italy, launched in 2021 and funded through Next Generation EU via the PNRR, plays a crucial role in advancing mobility-as-a-service solutions.

[4] These €191.5 billion must then be supplemented by additional funding from other national and European funds, bringing the total amount to €261 billion by 2032.

1.2. Application areas

In these sub-paragraphs, all the application areas into which Smart Mobility is divided will be described, and, additionally, an example for each of them will be presented. They will be described one by one even if, in reality, these areas often overlap[5]. Besides, being a necessary parenthesis to better understand the complexity of this topic, it will be essential for fully grasping the continuation of this thesis work: all these areas will appear again later in the following chapters.

1.2.1. MaaS

MaaS, the acronym for "Mobility-as-a-Service", is an innovative way of thinking about mobility based on the integration of various transportation modes (including buses, trains, taxis, car-sharing, bike-sharing, and micro-mobility options) into a cohesive ecosystem where various modes of transportation converge within a unified digital platform (Kamargianni & Matyas, 2017). There are several definitions that can be given to this concept, one of these define MaaS like a "*user-centric, intelligent mobility distribution model in which all mobility service providers' offerings are aggregated by a sole mobility provider, the MaaS provider, and supplied to users through a single digital platform*" (Liimatainen & Mladenović, 2021). This definition presumes that MaaS adds value by providing not just information to help plan a trip, but the convenience of one single payment that covers all segments of the trip by different transport modes, regardless of whether these are provided by a private or a public operator.

[5] Just think of public mobility or shared mobility that are mixed with electric mobility, air mobility that mixes in the sphere of Last Mile Delivery due to the drone technology, or autonomous mobility that could not exist without smart roads.

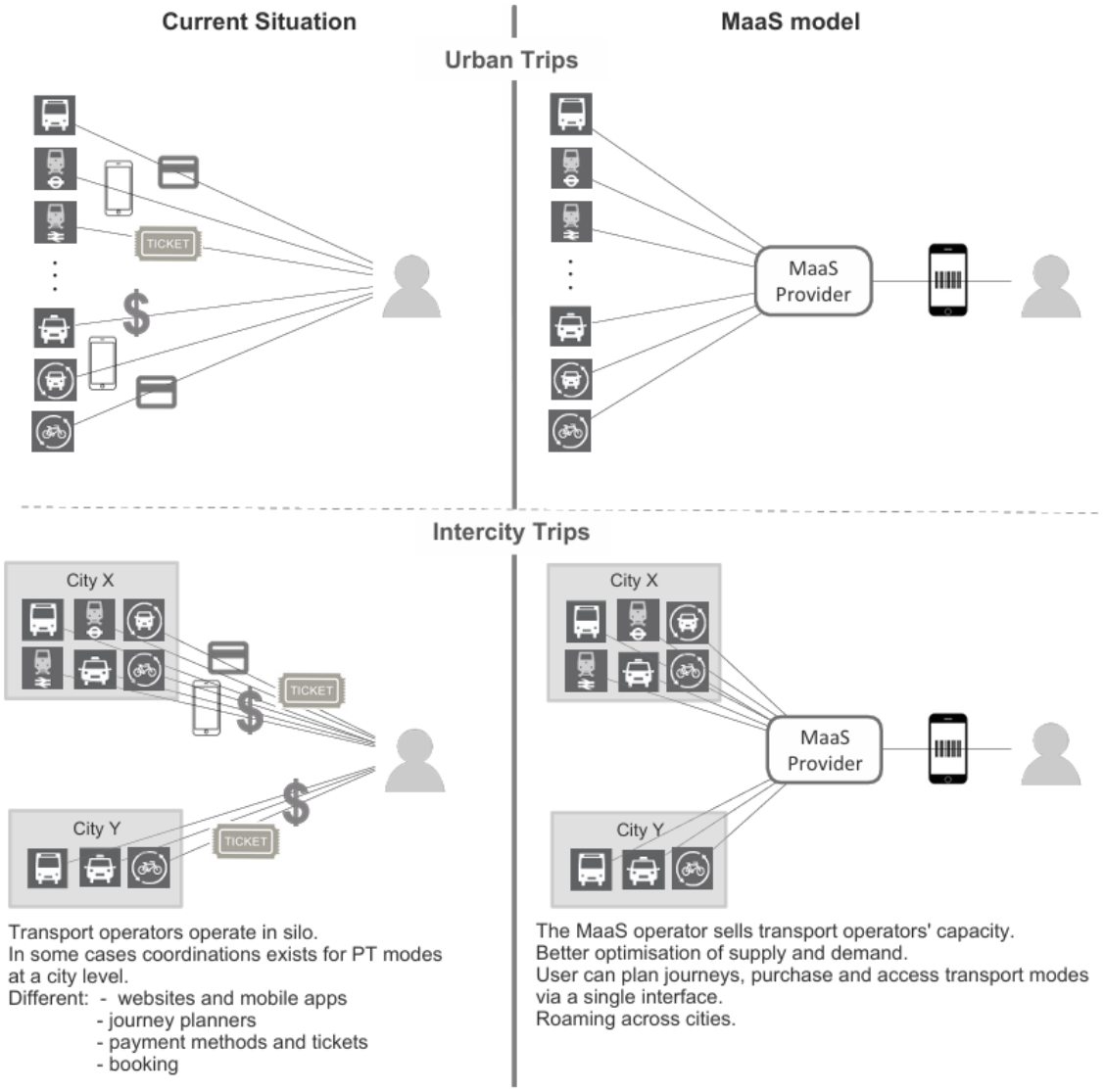

Figure 3. Some advantages of the MaaS paradigm

In this way, this new vision of mobility, would make the concept of owning a private car obsolete. Nevertheless, it should be emphasized that there are different levels of integration among the different players that can populate the MaaS platform (Santos & Nikolaev, 2021):

- *No integration*: There is no integration of information, payment/ticketing/ interchanges. Different modes of transport need to be booked and paid for separately.
- *Basic integration*: Travel information is available in a journey planning format which include some or potentially all possible modes of transport.

- *Limited integration*: Multimodal booking and ticketing may be possible, directly or indirectly, and/or there may be co-ordination between different transport modes.
- *Partial integration*: Journeys using more than one mode of transport can be booked and paid for using one platform or application without having to navigate away from it.
- *Full integration under certain conditions*: Some but not all available mode combination offer a fully integrated experience. There is full integration of information and payment/ticketing, but full operational integration, understood as quick and seamless interchanges, may not be available across all modes.
- *Full integration under all conditions*: MaaS provides mobility services that are competitive with private car.

Case 1: Jelbi, 2023 (Berlin, Germany)

Jelbi is a prime example of Mobility as a Service, it is a concept that integrates various forms of transportation into a single digital platform. Developed by BVG, the public transport operator in Germany's capital, Jelbi allows users in Berlin to access public transport, e-scooters, bikes, car-sharing, and ride-hailing services (e.g. Uber) all within one app, simplifying urban mobility for residents, tourists and whoever want a flexible and cashless way to travel.

1.2.2. Sharing mobility

Sharing mobility is a transport model based on the sharing of different means of transport so that they can be used only when needed without having to own them: carpooling, bike/bicycle sharing, and automobile sharing are the principal declination of sharing mobility (bike sharing, particularly, is the most diffused in Italy). There are several positive results in adopting this transportation mode, due to the reduction of the number of the owned vehicles: reducing noise and air pollution, easing traffic congestion, and enhancing the overall quality of life and accessibility in urban areas (Bergantino et al., 2024). By sharing an asset such as a means of transport (which generally has a very low level of use) it is possible to exploit it as much as possible, avoiding leaving it unused for a long period of time.

It's possible to define 4 different models of car sharing mobility (Santos, 2018):

- Model 1 (*Peer-to-peer car rental*): Peer-to-peer service facilitated by a company acting as an intermediary. Private individuals can rent out their personal vehicles when they are not in use. Unlike traditional rental companies, this model involves consumers offering their own cars to others. Supply and demand are connected through a broker that provides an online platform, such as a website or app, managing transactions and taking a commission from the total earnings.
- Model 2 (*Modern car club*): Short-term vehicle rentals managed and owned by a service provider. The company maintains a fleet of vehicles strategically distributed across specific urban areas. Users can locate a nearby vehicle, drive it to their destination, and then park it in another public parking space (differently from the old car club in which the user must return the vehicle to the same location from which it had been accessed).
- Model 3 (*Uber-like service*): The companies sign up ordinary car owners who act as drivers. The service relies on an app, provided by the company, which also collects payment, taking a percentage of the total income.
- Model 4 (*New public transport on demand*): On demand private cars, vans, or buses, shared by passengers going in the same direction. It is essentially a user-oriented form of public transport. Options could include users specifying pick-up and drop-off locations and required departure and/or arrival times, which would essentially be shared taxi services, and taxi-bus services using pre-defined stops and requiring a reservation in advance.

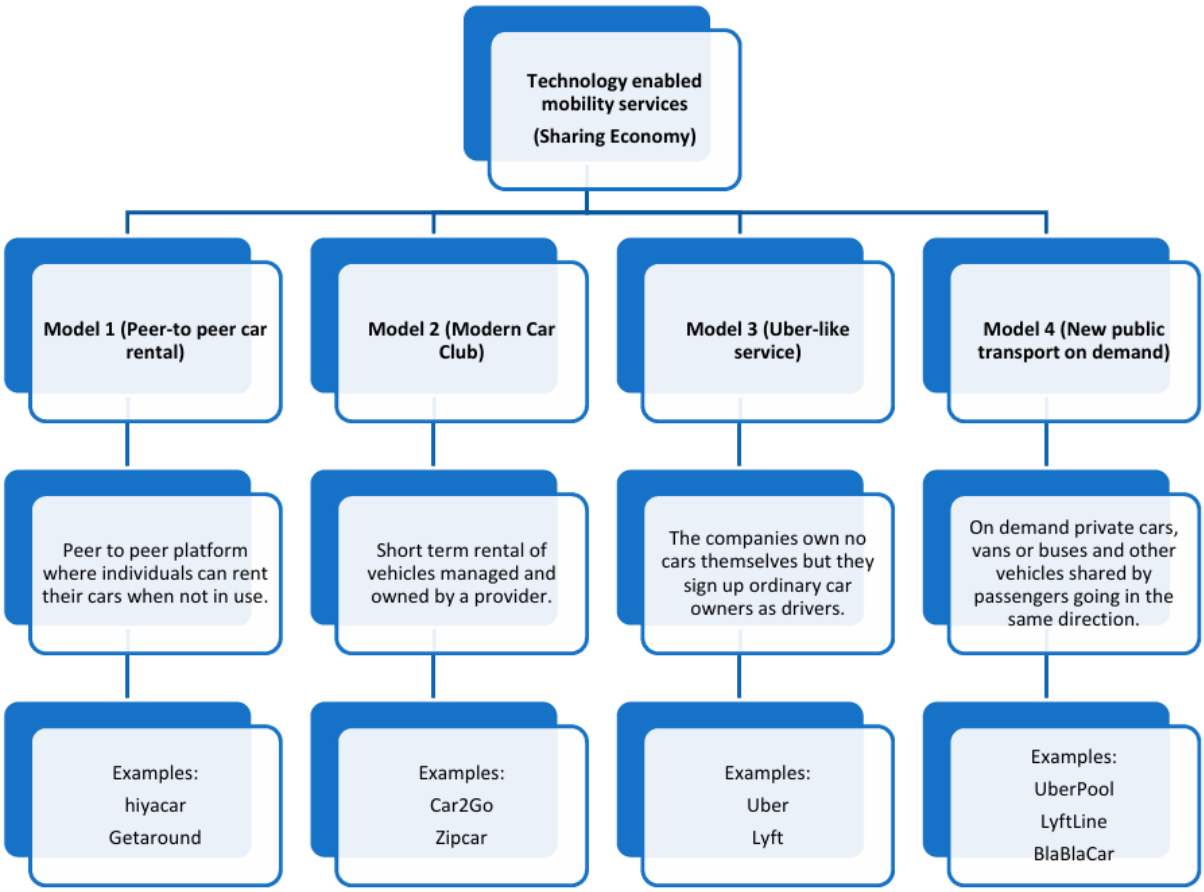

Figure 4. Different models of car sharing

Case 2: Wayla, 2021 (Milan, Italy)

Wayla is a transport service that improves urban mobility by offering flexible, shared rides based on real-time passenger requests and it is part of model 4, being a new public transport on-demand. Unlike conventional buses with fixed schedules, it allows users to book trips through an app, dynamically adjusting routes to match demand and reduce waiting times. By complementing existing public transportation, it helps to solve first-mile and last-mile challenges, making travel more efficient, accessible, and environmentally friendly. Wayla promotes smarter, more connected, and sustainable urban transit, encouraging shared mobility and reducing dependence on private cars.

1.2.3. Electric mobility

Electric mobility aims to replace traditional fossil fuel-powered vehicles with electric and hydrogen alternatives, which can be resumed in four different types (Hossain et al., 2022): BEV[6] (Battery Electric Vehicles), PHEV[7] (Plug-in Hybrid Electric Vehicles), HEV[8] (Hybrid Electric Vehicles) and FCEV[9] (Fuel Cell Electric Vehicles).

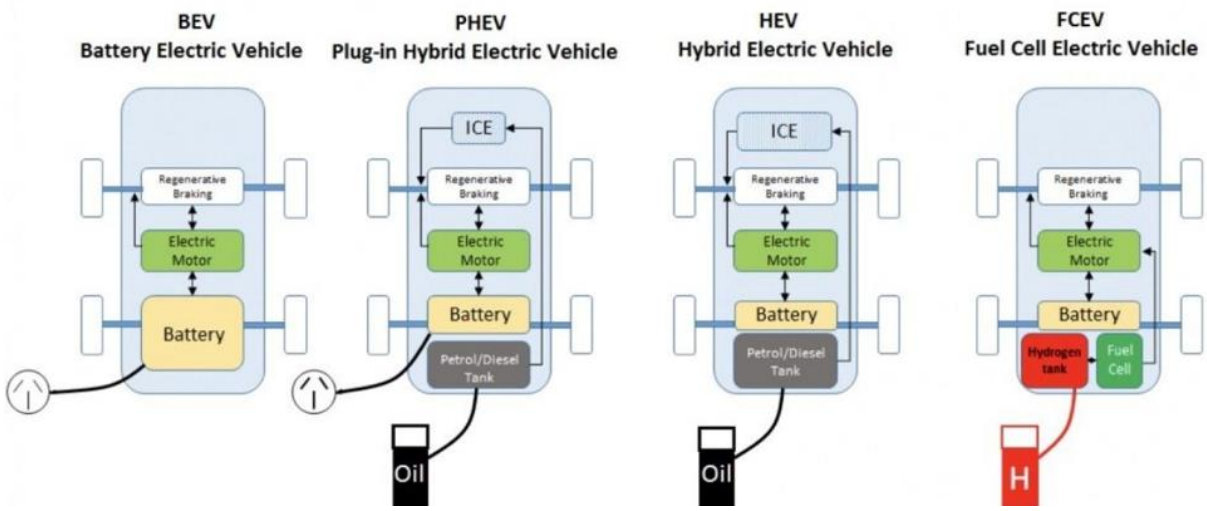

Figure 5. types of electric vehicles

This transition towards the use of electric vehicles instead of internal combustion engine cars is considered essential to achieving the sustainability goals we have set. In addition to reducing emissions, especially when the electricity used to power them comes from clean energy sources, electric vehicles also have much higher energy efficiency compared to traditional cars. It is important to highlight that when considering emissions over the entire life cycle of a car (from raw material extraction, production/assembly, vehicle use, to final disposal and potential component recycling) an electric vehicle is always less polluting than an internal combustion engine car, regardless of the energy mix of the location where the vehicle is produced and used. However, there are still several barriers preventing electric mobility from becoming truly dominant over conventional transportation. The main obstacles include high purchase costs, battery range limitations (which creates range anxiety for those who need to travel long distances), long charging times and issues related to the production and disposal of batteries. To reduce issues related to batteries, proper recycling is

[6] BEV vehicles are equipped with a single battery-powered electric motor.
[7] PHEV vehicles are equipped with an endothermic engine and an electric engine, whose battery is rechargeable from external columns, and that can work separately.
[8] HEV vehicles (or MHEV, Mild Hybrid Electric Vehicle) are equipped, in addition to the endothermic engine, with a small electric motor to support the main one in some actions, such as departure.
[9] FCEV vehicles exploit the chemical reaction of reverse electrolysis of hydrogen, which is used as fuel, to produce clean energy, powering the electric motor.

extremely important, as it allows for the recovery and reuse of rare materials such as cobalt, lithium, and nickel found within them (efficiently recycling an electric vehicle battery means recovering over 95% of its components). To support the widespread adoption of it, national and local coordinated initiatives are essential. These could include tax incentives, reductions or exemptions from road tolls and parking fees, the expansion of public charging infrastructure, and increased funding for research, development, and pilot project (Gulc & Budna, 2024).

Case 3: Reefilla, 2021 (Italy)

Reefilla is an innovative company dedicated to improving electric vehicle infrastructure across Italy, with the goal of supporting the transition to a more sustainable transport system. Through its Smart Ricarica initiative, Reefilla provides smart charging solutions that optimize energy management, making charging more efficient and accessible. Reefilla provides a unique, flexible, and customized on-demand service, eliminating infrastructure and installation work while delivering energy generated from 100% renewable sources. The system operates with a cloud platform and an app: when there is a need to recharge the car, a van carrying a battery pack reaches the vehicle, which is then connected to the car. The platform recognizes it, and the charging process begins. In addition to this on-demand charging service, Reefilla also focuses on giving a second life to electric car batteries to minimize their environmental impact as much as possible.

1.2.4. Smart road

Smart road can be defined as a *"road infrastructure that is integrated with advanced network and communication technologies"* (Chen et al., 2023). The main object of this kind of infrastructure is to create an ecosystem in which different actors can communicate among them. There are various technologies that can be used to make a road a "Smart Road". At the core of smart roads there are advanced systems that facilitate communication between equipped vehicles and infrastructure. These systems utilize a network of intelligent antennas and sensors strategically positioned along the roadway, enabling the reception of vehicle data, such as position and speed, while transmitting critical information back to drivers. This allows for real-time alerts regarding unusual traffic conditions, adverse weather, stationary vehicles, or ongoing roadworks. Additionally, smart roads incorporate various other innovative features. Adaptive lighting systems adjust to prevailing road conditions and provide warnings through specific light configurations in case of potential hazards. Dynamic lane management enables the roadway to be reconfigured based on traffic demands. Furthermore, certain smart roads are equipped with embedded metal coils beneath the surface, allowing for wireless charging of electric vehicles as they travel.

This type of road is also fundamental when talking about autonomous driving. The integration of self-driving cars with digitized highways could be the key to achieving significant advancements in safety and environmental sustainability. By utilizing road sensors to monitor traffic flow and speeds, these systems can communicate directly with autonomous vehicles, leading to smoother traffic and a reduction in accidents by eliminating human error (Kussl & Wald, 2022).

Case 4: KEHV project, 2023, Italy

The KEHV (Kinetic Energy Harvesting from Vehicles) project, launched by Autostrade per l'Italia, represents an innovative step towards sustainable energy solutions in transportation. The initiative, developed in collaboration with Movyon and 20energy srl, utilizes a groundbreaking technology that converts the kinetic energy of decelerating vehicles into electricity. This energy can then be used to power infrastructure such as service stations, toll booths, and other highway facilities, promoting a more sustainable and energy-efficient road network. KEHV is the first large-scale experiment of its kind in the highway sector, aiming to integrate renewable energy generation into daily transportation operations.

1.2.5. Smart parking

Parking challenges are becoming an increasingly prominent issue, particularly in large urban centres where high motorization rates and ongoing urbanization have made the competition for available parking spaces unsustainable. This struggle contributes to traffic congestion, increased pollution, and wasted time, especially during peak hours in certain parts of the city. When the demand for curb side parking exceeds the available supply, drivers are often forced to search for spaces farther from their destinations, a behaviour known as “cruising” for parking. Traditionally, cities have attempted to reduce cruising and related traffic by implementing road and parking pricing policies (Abirami et a l., 2024). In the smart cities of the future, parking problems are being tackled through innovative solutions known as Smart Parking Systems. These systems leverage technology to provide real-time information on parking availability, helping drivers make more informed decisions about where to park. By addressing the root cause of cruising, lack of information about curb side availability, smart parking can significantly reduce unnecessary driving, alleviate congestion, and improve urban mobility efficiency.

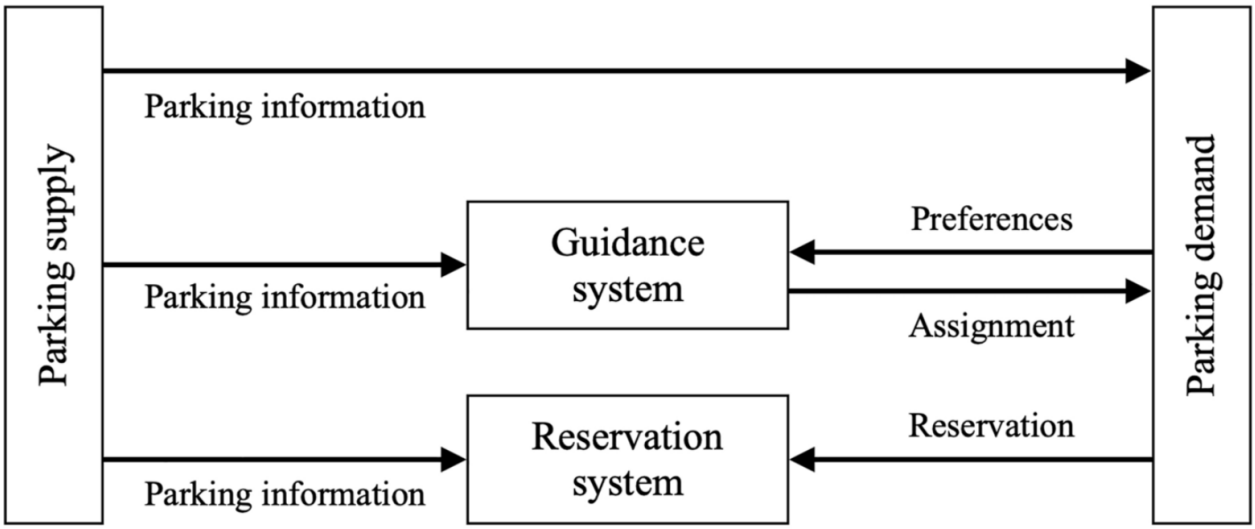

Figure 6. Different use of information in smart parking systems

There are various methods for delivering parking information to drivers (Ismael & Holguín-Veras, 2025). One approach, explored in several studies, involves a centralized guidance system that collects data on curb availability, travel destinations, and driver parking preferences to calculate the optimal parking assignment. Another model is the reservation system, where drivers can directly book a parking space for a specific time window. A more straightforward form of smart parking systems simply provides real-time information on available parking spaces, allowing drivers to make their own decisions based on this data.

Case 5: EasyPark, 2001 (Stockholm, Sweden)

EasyPark is an app that allows users to find, book, and pay for parking spaces. By integrating real-time data, it reduces the time drivers spend searching for parking, helping to minimize traffic congestion and lower emissions. Its smart features, such as the "Find" function, guide users to available spots, while remote session management enables them to extend or stop their parking time via their smartphones. Additionally, EasyPark collaborates with municipalities and private operators to optimize parking infrastructure, showcasing how smart parking solutions contribute to more efficient and sustainable urban mobility.

1.2.6. Traffic management

As previously discussed, traffic congestion remains a significant challenge for modern cities and large urban areas. With advancements in sensor technology, a vast array of them is now integrated into transportation systems (traffic flow sensors, environmental sensors, vehicle detection sensor etc.), continuously collecting extensive data. By processing and analysing this information on big data platforms, valuable insights can be uncovered regarding traffic flow and congestion patterns, allowing for the development of intelligent and data-driven strategies (Abirami et al., 2024). These platforms facilitate real-time traffic analysis, enabling smarter decision-making and more effective congestion management. Furthermore, Big Data Analytics support real-time monitoring, predictive maintenance, and system optimization, ultimately enhancing the safety, efficiency, and sustainability of urban transportation networks (Babar & Arif, 2019).

Case 6: Movyon, 2019 (Italy)

Movyon, a company within the "Autostrade per l'Italia" Group, plays a crucial role in traffic management by leveraging advanced technology to enhance the efficiency, safety, and sustainability of transportation networks. The company develops and implements smart systems that enable real-time monitoring and control of traffic flow. By utilizing smart sensors, data analytics, and automated systems, Movyon helps optimize traffic signals, reduce congestion, and improve the overall travel experience for travellers.

1.2.7. Air mobility

Air mobility (the newest application area that will be discussed in this work of thesis) is increasingly recognized as a potential solution to alleviate ground traffic congestion in major metropolitan areas. Even if helicopters have been utilized for various applications (like police missions, emergency transport, firefighting etc.), their use in urban mobility poses significant challenges, such as excessive noise, high operational costs and safety risks, largely due to the dependence on large, single-engine combustion systems (Preis et al., 2025). Recent advancements in technology have addressed many of these issues. Distributed electric propulsion systems, featuring smaller rotors than traditional helicopters, now enable quieter, more efficient, and safer flights. Electric propulsion greatly reduces noise, while the use of multiple distributed motors adds stability, enhancing safety in case of mechanical failure; additionally, rapid progress in battery technology, coupled with the widespread adoption of electric vehicles, has resulted in lighter and more affordable batteries with higher energy density. All this elements have allowed urban air mobility aircraft,

called eVTOLs[10], to represent a highly promising future for air travel and smart mobility in general (Shon & Lee, 2025). In addition to eVTOLs used for human transportation, other typologies of aircraft, drones, can be used for the merch transportation (drones will be better descripted in the "*last Mile Delivery*" sub-paragraph).

Figure 7. Prominent examples of different eVTOL configurations: VoloCity (left), Beta ALIA-250 (centre) and Joby S4 (right)

Case 7: Volocopter, 2011 (Germany)

Volocopter is a pioneering company in the field of urban air mobility, focusing on the development of electric vertical take-off and landing (eVTOL) aircraft. It aims to revolutionize urban transportation by introducing air taxis that can alleviate traffic congestion and provide efficient, eco-friendly alternatives for short-distance travel. The company's flagship model, the Volocopter 2X, is a two-seater aircraft designed with multiple rotors, providing exceptional stability and safety. It is fully electric, producing zero emissions and operating quietly, which is crucial for urban environments. Volocopter envisions a future where people can book air taxi rides via an app, enjoying a seamless travel experience above city traffic.

1.2.8. Autonomous drive

Autonomous driving is perhaps the first thing that comes to mind when talking about Smart Mobility and the mobility of the future. Although, there are many projects that aim to develop a fully autonomous, efficient vehicle, which can circulate on our roads in complete safety, much still needs to be done for this to happen (such a vehicle must be able to communicate perfectly with all the other vehicles and the obstacles on the road and with the entire infrastructure on which it travels). This type of fully autonomous vehicle is only the last possible level of autonomous driving; the SAE International[11], in fact, has defined six different levels of autonomous driving (Rizopoulos et al., 2022).

[10] Acronym for "electric Vertical Take-Off and Landing".

[11] Acronym for "Society of Automotive Engineers". It is a standardization body in the field of aerospace, automotive and vehicle industry.

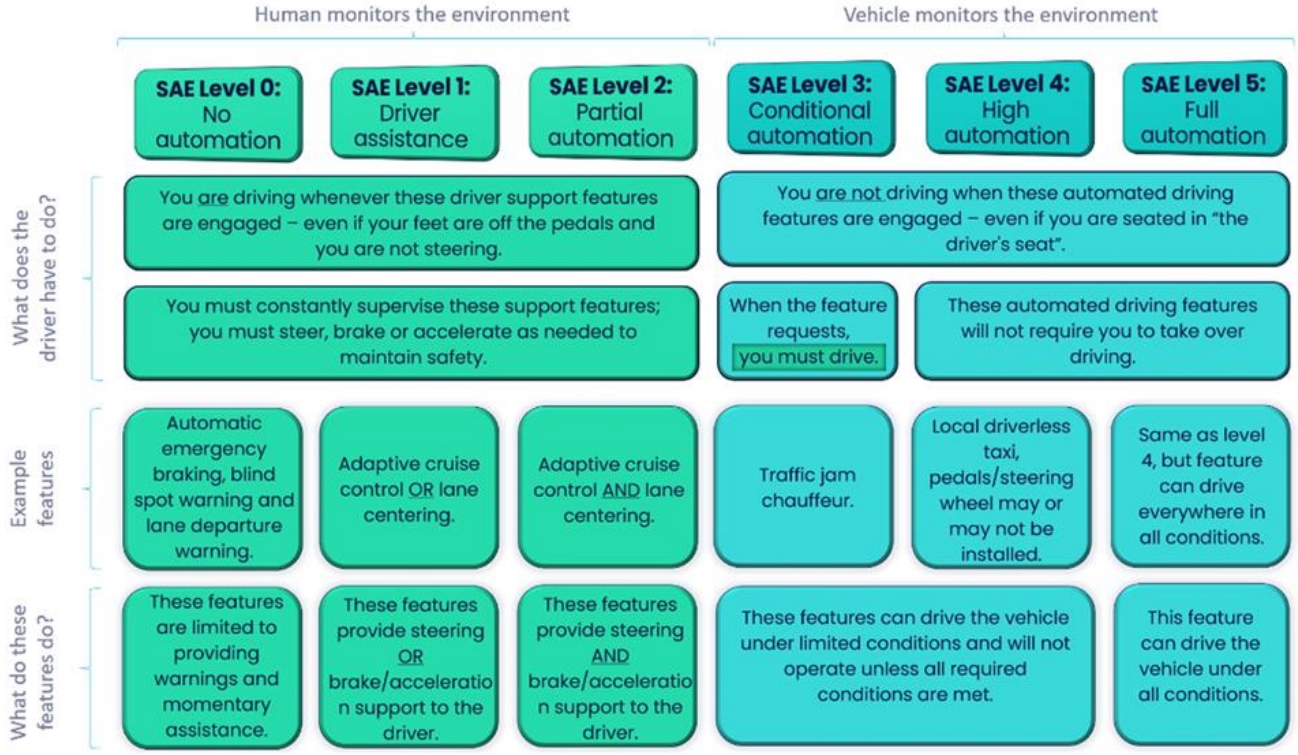

Figure 8. The levels of Driving Automation from the perspective of the driver of the vehicle

Case 8: Mille Miglia Autonomous Drive, 2023 (Milan, Italy)

The 1000-MAD (1000 Miglia Autonomous Drive) project is an innovative initiative designed to test autonomous driving technology in real-world conditions. Developed by the Politecnico di Milano in collaboration with 1000 Miglia S.r.l. and supported by the Italian Ministry of Infrastructure and Transport, the project aims to refine autonomous driving algorithms, prioritizing safety and seamless interaction with other road users. In the 2023 edition of the race, specific sections of the route were driven autonomously, representing a key milestone in the advancement of self-driving technology.

1.2.9. Support services

Support services are a crucial application area for the security and accessibility of a mobility system that aims to be defined as "smart". By leveraging advanced technologies such as artificial intelligence (AI), machine learning, and the Internet of Things (IoT), smart mobility solutions offer real-time assistance to travellers, ensuring smooth navigation and enhancing the overall user experience (Badii et al., 2022). An example of this typology of systems are the Advanced Driver Assistance Systems (ADAS): these are innovative technologies aimed at improving vehicle safety and

enhancing the driving experience. By employing sensors, cameras, radar, and artificial intelligence, these systems monitor the vehicle's environment and assist drivers in various tasks. Key features include lane departure warnings, adaptive cruise control, automatic emergency braking, and parking assistance. ADAS not only helps reduce accident risks but also adds convenience and comfort by alleviating the driver's workload. With continuous technological advancements, ADAS capabilities are expected to grow, further promoting safer and more efficient transportation.

Case 9: BMW Driving Assistant Professional, 2019 (Germany)

The BMW Driving Assistant Professional integrates several advanced features to enhance driving safety and convenience. Active Cruise Control with Stop & Go adjusts the vehicle's speed and can bring it to a full stop in traffic, resuming movement automatically. The Lane Change Assistant helps drivers safely change lanes by monitoring surrounding traffic and alerting the driver if it is not safe. Evasion Assistant assists in avoiding sudden obstacles by suggesting or executing steering manoeuvres to prevent collisions. The Traffic Jam Assistant manages acceleration, braking, and steering in slow-moving traffic, reducing driver stress. Finally, Remote Control Parking allows the driver to park the car remotely, for example using a smartphone. Together, these systems make driving safer, more efficient, and more comfortable.

1.2.10. Public transport

The public transport sector, comprehending subways, buses, trains, trams, bicycles etc. is a key element in the smart city ecosystem. By integrating cutting-edge technologies such as real-time data, artificial intelligence (AI), and Internet of Things (IoT), public transport systems can enhance route efficiency, minimize congestion, and improve passenger convenience. Having efficient and connected public transport is also fundamental in the Mobility as a Service paradigm to be able to combine different means of urban and suburban public transport. The shift toward electric public vehicles is also helping to reduce emissions and promote cleaner air (Gkiotsalitis et al., 2025) in the city. Furthermore, smart bus stops and intelligent traffic management enhance service reliability, reducing waiting times and optimizing transit flows. As cities continue to expand, embracing innovative public transportation strategies will be essential for fostering more connected, sustainable, and resilient urban environments.

Case 10: NGE-BUS project, 2022 (Spain)

The NGE-BUS project is focused on developing a new generation of highly efficient electric urban buses in the Basque Autonomous Community of Spain. This initiative is supported by the Basque government and the European Regional Development Fund, reflecting a strong commitment to sustainable mobility solutions. The project aims to enhance the electrification of public transport in major urban centres such as Bilbao and San Sebastián. By fostering innovation in electric bus technology, including improved battery systems and energy management, the NGE-BUS project plays a crucial role in the broader effort to reduce CO_2 emissions and promote cleaner air in the region's cities.

1.2.11. Last Mile Delivery

Last-mile delivery (LMD) refers to the final stage of transportation in a supply chain, moving a shipment from the dispatch point to the consignee's location. The rapid growth of e-commerce has intensified the challenges associated with LMD, which is often the most complex and expensive segment of the supply chain. A recent study found that 80% of consumers now expect same-day or next-day delivery, emphasizing the urgent need for innovative solutions to meet these evolving demands (Patro et al., 2024). Unfortunately, the last-mile delivery process remains one of the most polluting and inefficient stages due to its heavy reliance on fossil-fuelled vehicles. The majority of urban logistics operations, in fact, rely on the use of trucks. However, utilizing trucks in last-mile delivery has limitations, such as being unable to provide deliveries to some rural regions that are hard to reach by truck, consuming gasoline that leads to air pollution, being unable to deliver parcels in a timely manner due to traffic jams, etc. These challenges have driven the search for sustainable alternatives, with electric vehicles gaining popularity for their lower emissions and operational efficiency. Especially in inner urban areas, where population density and traffic levels are higher, cargo bikes (powered manually, electrically, or by a combination of both) are widely used. These well-established delivery vehicles have the main advantage of being able to reach customers in areas with access restrictions (such as pedestrian zones) and in locations where parking is scarce (Mogire et al., 2025). Looking ahead, drone technology is emerging as a potential game-changer in last-mile logistics, offering a faster, more efficient, and eco-friendly alternative. However, successfully integrating drones into existing logistics networks requires addressing key factors such as technological advancements, regulatory frameworks, strategic implications and public perception (Lauenstein & Schank, 2022).

Case 11: Amazon Prime Air, 2013 (USA)

Amazon Prime Air is an innovative last-mile delivery service that employs autonomous drones for rapid package delivery. Designed to boost efficiency and sustainability, it aims to alleviate urban congestion and lessen dependence on conventional delivery vehicles. These electric-powered drones can transport small packages while safely navigating their surroundings using AI-powered obstacle detection. By incorporating e-VTOL drone technology into last-mile logistics, Amazon aims to transform e-commerce deliveries by lowering costs, enhancing speed, and minimizing environmental impact.

1.3. Technologies

In this paragraph, the most important technologies that are the basis of Smart Mobility, without which this new vision of mobility could not have been born, will be explained. Also in this case, as well as the previous paragraph, this one is important to understand the complexity of the topic and all these technologies will be mentioned in all the work of thesis.

Once more, it should be emphasized that these technologies will be presented one by one but in the reality they can work in a high-performance way only if used together: IoT is at the basis of these technologies, the data extracted from IoT devices, which are transmitted in a very short time thanks to 5G technology, are processed by Big Data Analytics and AI platforms, then, thanks to this processing, it is possible to create Digital Twins and to develop V2X technologies.

1.3.1. Internet of Things (IoT)

In recent years, the number of connected smart devices has grown significantly, expanding the digital world exponentially. This growth is driven by the affordability of internet services and advancements in efficiency, which have led to a decline in the cost of smart devices (Dorsemaine et al., 2015). These smart objects, often referred to as "things" or physical devices, have the capability to sense real-world environments, collect data, and communicate with other devices. Moreover, due to the concept of "smartness," these devices exhibit a certain level of intelligence, enabling them to establish connections and interact with other systems based on predefined protocols. The devices involved in such environments are connected through the internet, which crafts the terminology of “Internet of Things (IoT)” (Babar & Arif, 2019). IoT would require advanced wireless technology to achieve its full potential. Previous wireless

technologies are not optimized to fully support the potential of IoT models. Over time, there has been a shift from 1G to 5G. Unlike earlier networks, 5G is designed to overcome the challenges of previous generations, offering benefits such as lower costs, higher data speeds, larger bandwidth, intelligent services, low latency, massive connectivity, and more consistent quality of service.

The advancements in the IoT technology have presented significant advantages for Smart Mobility. Smart parking systems, for example, utilize sensors and IoT platforms to detect the departure and arrival of cars helping drivers to save time and gas by reserving parking spaces. By making decisions based on the availability of parking spaces and time, the congestion condition in parking areas and pollution can be improved (Nazim et al., 2022). Another branch of smart mobility influenced by IoT is smart lighting systems. It introduces smart and monitoring systems by using a diverse range of sensor technology, cameras and photocells; some of the common features of this systems are: movement-based lighting control, energy consumption, pedestrian safety by continuous surveillance of the area, increased life span of the lights used and decreased maintenance expense. Smart payment system, due to IoT technologies, will create a hassle-free movement at toll for the drivers going long distances by automatically deducting payment through different means, without the need to wait in line to pay individually at the toll gates. IoT and 5G are also important technologies for sharing mobility and autonomous drive: in the first case they provide users real-time information about their locations, distance, time needed to reach their destination and they can also simplify payment methods through online alternatives (Alam et al., 2024); in the second case, IoT and 5G allows self-driving cars to gather vast amounts of data about road conditions, traffic patterns, weather, and nearby vehicles.

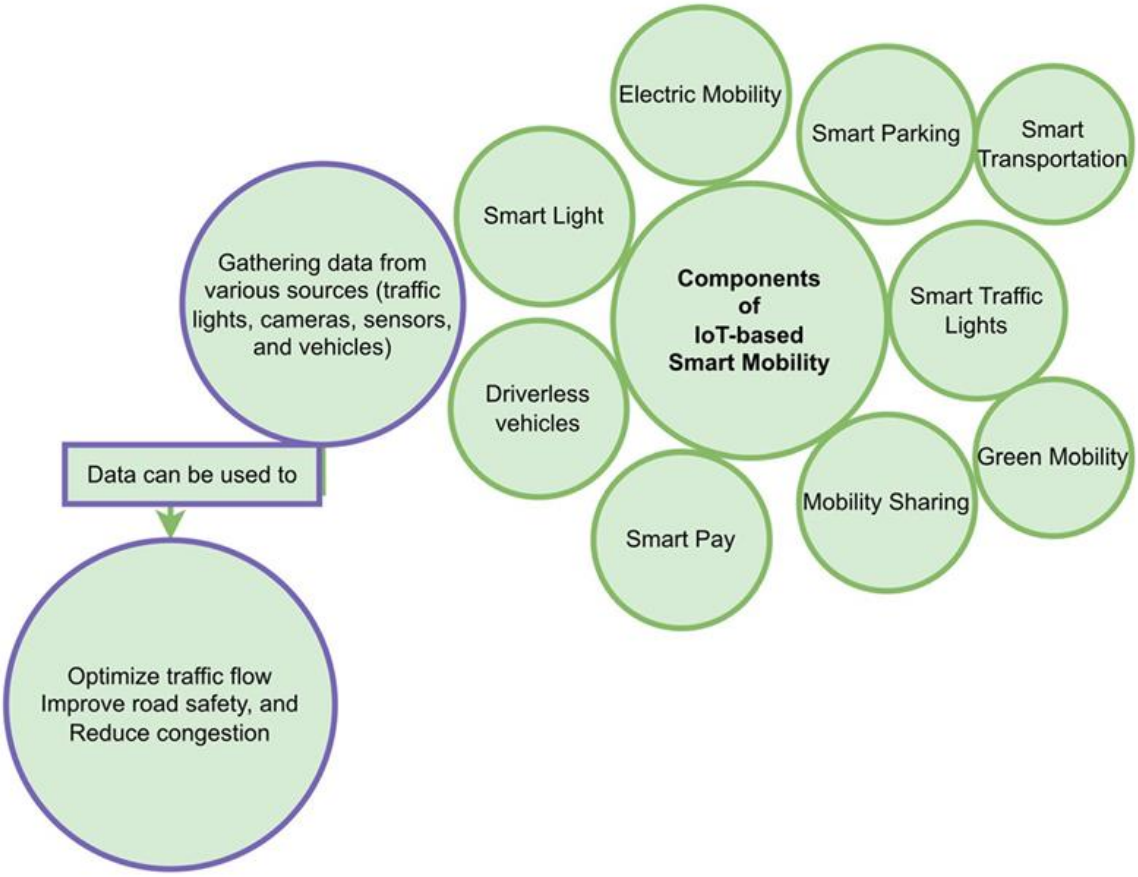

Figure 9. IoT technologies in Smart Mobility application areas

1.3.2. 5G

The 5G technology, or fifth-generation mobile network, has been proclaimed as all-in-one communications solution for a wide range of application scenarios with stringent requirements for reliable real-time delivery of data packets. With its high-speed connectivity, it offers enhanced mobile broadband, massive machine type communication, and ultra reliable low latency communication. 5G is developed for not only supporting the existing applications but also to support and leverage the upcoming novel applications that require communication at a very low latency. This technology provides building blocks for supporting the existing traditional platforms like 2G, 3G, 4G, and Wi-Fi. Apart from this, it also leverages greater connectivity and coverage for handling higher network density (Aljeri & Boukerche, 2022).

With potential download speeds of up to 10 Gbps and latency as low as 1 millisecond, 5G is set to transform numerous sectors, one of these is certainly that of the of Smart Mobility. In increasingly congested urban areas, 5G's capability to connect a massive number of devices enables the total integration of Internet of Things (IoT) technologies.

This connectivity allows for real-time interaction between vehicles, infrastructure, and pedestrians, enhancing traffic management and boosting road safety. For instance, autonomous vehicles can leverage 5G networks to access instantaneous data about their environment, facilitating faster decision-making and decreasing the risk of accidents (5G's low latency feature makes self-driving more real as every millisecond is essential for autonomous vehicles, decision-making is done in microseconds to avoid accidents). Moreover, 5G supports innovative applications such as adaptive traffic signals that respond to live traffic conditions, optimizing vehicle flow and reducing waiting times. Public transportation systems can also take advantage of improved connectivity, for example leading to more efficient routing and scheduling through data analysis and real-time notifications (Rizopoulos et al., 2022). Additionally, the introduction of 5G in Smart Mobility is also important to improve electric vehicle charging networks: with smart charging stations that communicate with the power grid to better manage energy consumption.

1.3.3. V2X

The technology that allows communication between vehicles and other elements, collectively known as V2X (Vehicle-to-Everything), can be classified into four main types: Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Vehicle-to-Pedestrian (V2P), and Vehicle-to-Network (V2N).

- V2V (Vehicle-to-Vehicle) enables direct communication between vehicles, allowing them to exchange sensory data such as speed, position, and direction to enhance road safety and traffic management.
- V2P (Vehicle-to-Pedestrian) facilitates the exchange of information between vehicles and pedestrians, helping to prevent accidents by alerting both sides about their locations and movements.
- V2I (Vehicle-to-Infrastructure) connects vehicles with surrounding infrastructures, which act as intermediaries to extend the communication range and improve traffic flow.
- V2N (Vehicle-to-Network) establishes communication between vehicles and cloud-based network services, enabling features like route optimization, media streaming, and real-time traffic updates.

The core components of a V2X system are the On-Board Unit (OBU) and the Roadside Unit (RSU), two elements that fall under IoT technology. The OBU is a device installed in a vehicle that enables communication with both other vehicles and infrastructure elements. It gathers and transmits critical data to enhance road safety, assist drivers, and support applications such as navigation and collision warning systems. The RSU,

on the other hand, is a stationary unit placed along roads or integrated into infrastructure elements. It facilitates communication with OBUs and with other RSUs (I2I – Infrastructure-to-Infrastructure). The RSU's primary role is to collect, process, and relay data from vehicles while also providing essential information to optimize the performance of transportation applications and improve overall traffic management (Vladyko et al., 2024).

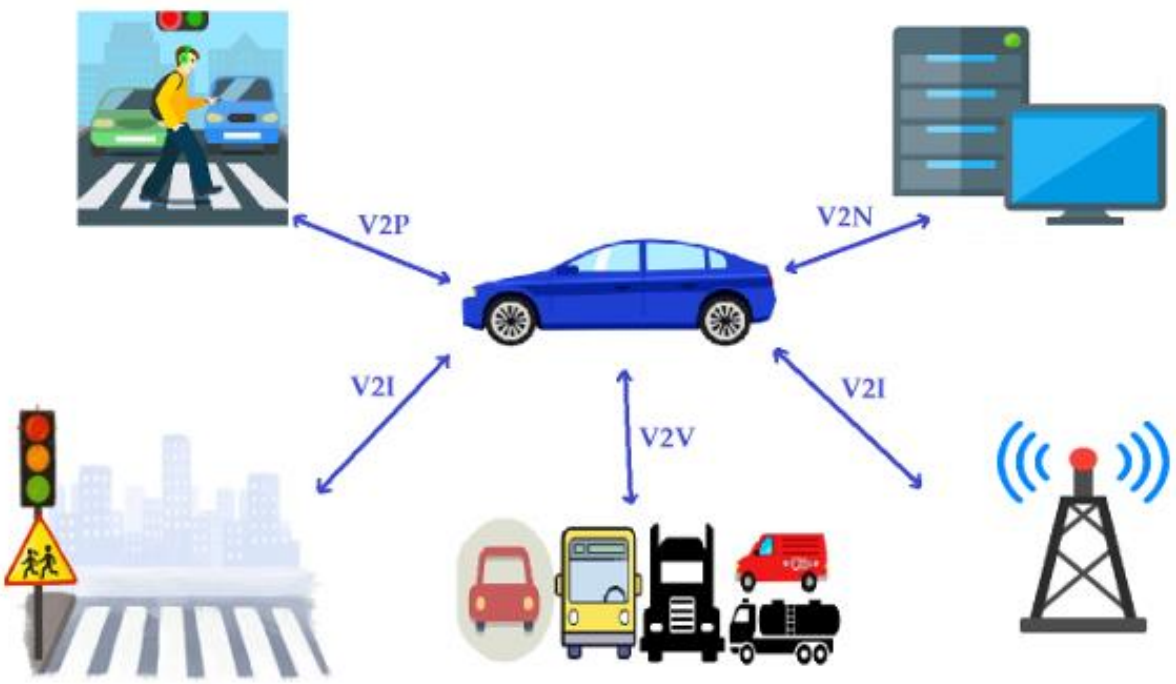

Figure 10. Different types of communication with vehicles

Case 12: Truck Platooning, 2021 (Autostrada del Brennero, Italy)

The truck platooning experiment on the Autostrada del Brennero (A22) is a significant step toward the future of smart and sustainable freight transport. Conducted as part of the C-Roads Italy project, and co-financed by the European Union, the project involved a fleet of Iveco trucks traveling in coordinated convoys using V2X (Vehicle-to-Everything) communication, so that only the first truck is driven by a human operator and the others, which are driven autonomously, depend on the first. The system enables trucks to maintain a safe and optimized distance, reducing fuel consumption and CO_2 emissions. Along the route, 82 Roadside Units (RSUs) were installed to facilitate real-time information exchange between vehicles and infrastructure. Over 300.000 kilometres were covered during the testing phase, demonstrating the potential of truck platooning to improve logistics, to reduce congestion, and to lower environmental impact.

1.3.4. Big data Analytics

In the IoT model, sensors continuously collect and transmit data worldwide, generating vast and ever-growing quantity of data known as "Big Data"; these data are highly heterogeneous, as IoT gathers information in various formats from multiple sources (Lawson-Body et al., 2024). A key aspect of IoT is the possibility to analyse information about connected devices, enabling real-time insights and decision-making. Big Data Analytics plays a vital role in processing this vast amount of data, being able to immediately extract knowledgeable information by using data mining techniques. Data Mining is a key concept in Big Data Analytics and consists in applying data science techniques to analyse and explore large datasets to find meaningful and useful patterns in those data. It involves complex statistical models and algorithms, mainly to perform two categories of analytics: Descriptive analytics and Predictive analytics. The aim of the descriptive analytics is to find interpretable patterns that describe the data, for example through Clustering[12] or Association Rules[13], for reporting, monitoring and visualization purposes. Predictive analytics, on the other hand, allow to make predictions about the future basically for decision

[12] Machine learning technique used in data mining to group a set of data points into distinct clusters (groups of elements) based on their similarities.

[13] Machine learning technique used to discover relationships, correlations, or patterns between variables in large datasets.

support, using other data mining techniques like Regression[14] or Time Series Analysis[15] (Borgi et al., 2017).

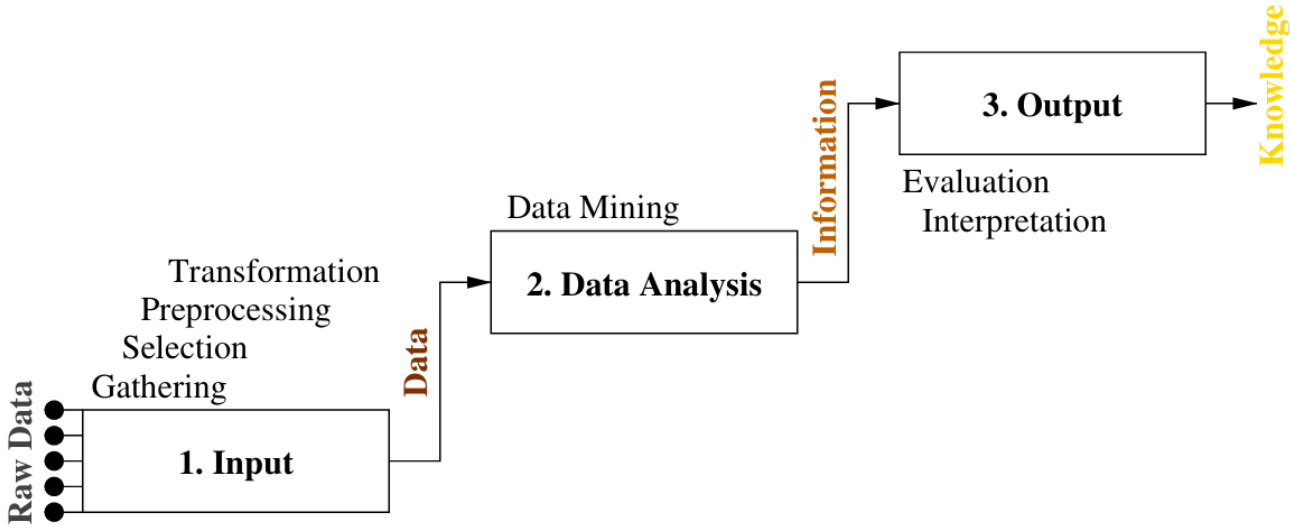

Figure 11. The process of knowledge discovery in databases

In the field of Smart Mobility, Big Data Analytics platforms are essential. This type of mobility relies on the development of cutting-edge technologies and sensors capable of quickly generating an immense amount of diverse data. These extremely large and complex datasets, known as Big Data, cannot be effectively processed using traditional data processing methods. Analysing and extracting information from this large amount of data is crucial for the decision-making process and for understanding patterns or trends. Through the processing and analysis of this data on Big Data platforms, it is possible to gain valuable insights into traffic flow and congestion patterns, enabling the development of strategic and intelligent solutions. Beyond traffic control, cities can develop real-time solutions for parking congestion, accident prevention, and route optimization by analysing this data. Autonomous vehicles also generate an enormous amount of data (such as speed, location, route, etc.), that must be communicated instantly to other vehicles and infrastructures, which in turn must send data back to the vehicles to be processed immediately for making instantaneous decisions.

[14] Machine learning technique used to map data into a specific function.
[15] Machine learning technique used to analyse data over time.

1.3.5. Artificial Intelligent (AI)

Artificial intelligence (AI), which can be defined "*the field of computer science dedicated to creating machines capable of performing tasks that typically require human intelligence, such as learning, reasoning, and problem-solving*" (Tariq, 2024), is a prominent technology which is also becoming increasingly important in the mobility sector (Hussain & Badi, 2025). Through technologies like machine learning, computer vision, and real-time data processing, AI enables cities to analyse vast amounts of traffic data from IoT sensors, cameras, and connected infrastructure (Anthony Jnr, 2024). This data-driven approach allows AI to predict congestion, identify anomalies, and dynamically adjust traffic signals, optimizing vehicle and pedestrian movement. Beyond traffic management, AI is helping to integrate more sustainable solutions, such as electric vehicles, shared mobility platforms, and autonomous vehicles, into urban transportation ecosystems (Danish Mirza & Brouwer, 2025).

Since artificial intelligence is a very powerful tool, and, therefore, potentially dangerous if used badly, it is regulated in Europe by the AI Act. This document, published by the European Commission in May 2024 and coming into force in February 2025, follows a risk-based approach, categorizing AI systems according to their potential impact on safety and fundamental rights (Kim et al., n.d.):

- Unacceptable Risk: AI applications that pose a clear threat to individuals (e.g. AI systems that exploit people's vulnerabilities due to age, disability, or social or economic situations) are banned.
- High Risk: AI applications that could significantly impact health, safety, or fundamental rights (e.g. Biometric identification and categorization) must meet strict compliance requirements.
- Limited Risk: AI applications subject to transparency requirements (e.g. chatbots or deepfake generators) must disclose their artificial nature to users but are subject to fewer regulations compared to high-risk AI systems.
- Minimal Risk: AI applications with negligible impact (e.g. spam filters or recommendation algorithms) are largely unregulated.

One of the main concerns regarding the AI Act is that it could hinder Europe's ability to compete with other leading countries, such as the USA and China, in the rapidly evolving field of artificial intelligence. While the Act aims to regulate AI for safety and ethical purposes, its strict regulations might slow down innovation and deployment, putting European companies at a disadvantage. In contrast, the USA and China have more flexible approaches to AI development, which allows their industries to advance more quickly and at a larger scale.

Even if the term "autonomous driving" is not explicitly mentioned, it is inherently classified within the high-risk category due to the significant implications for public safety. This classification imposes strict regulatory requirements, including rigorous safety protocols, enhanced transparency measures, and the necessity for continuous human oversight to ensure responsible deployment and operation.

1.3.6. Digital twin

Digital Twin concept is based on the idea that a digital informational construct about a physical system could be created as an entity on its own. This digital information would be a "twin" of the information that was embedded within the physical system itself and be linked with that physical system through the entire lifecycle of the system (Grieves, 2016). It can be defined as a *"a virtual representation of a physical system (and its associated environment and processes) that is updated through the exchange of information between the physical and virtual systems"*. Using this generalized definition the digital twin can be characterized by three primary components: A physical reality, a virtual representation, and interconnections that exchange information between the physical reality and virtual representation (VanDerHorn & Mahadevan, 2021).

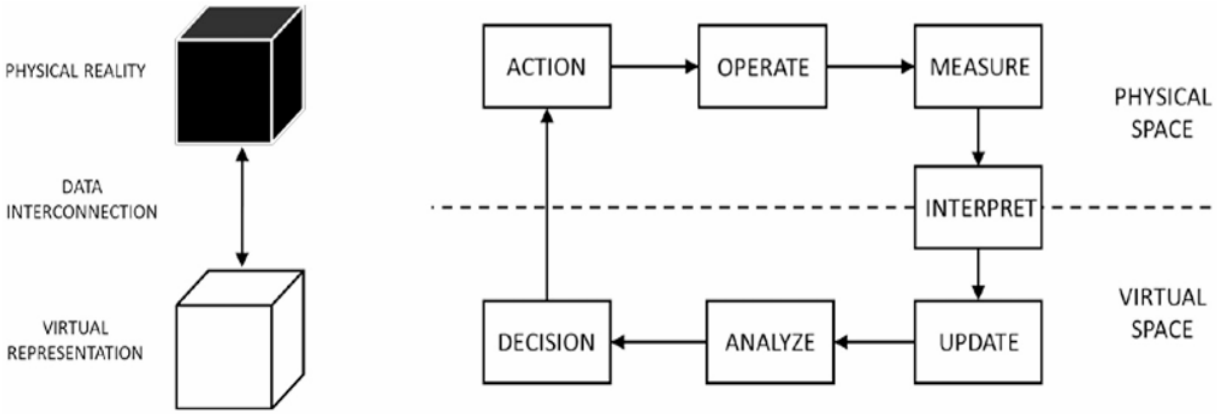

Figure 12. Digital Twin components and high-level processes

The advent of digital twin technology is revolutionizing various sectors, and the transportation industry and smart cities are no exception. Digital twins leverage advancements in IoT, cloud computing, artificial intelligence, and big data to create dynamic, real-time replicas of physical systems, facilitating their monitoring, control, and optimization. This technology holds significant promise in enhancing battery management systems, contributing to the development of smart electric vehicles, revolutionizing urban planning, and addressing traffic management issues in cities (Hananto et al., 2024). From simulating complex traffic scenarios to creating interactive

3D city models, digital twins are setting new benchmarks in transportation and urban governance.

Case 13: DUET project, 2021 (different cities in Europe)

DUET (Digital Urban Environment Twins) is a cutting-edge initiative aimed at developing a digital twin for cities to improve urban planning and promote sustainability. This project seeks to create a virtual model of urban areas, facilitating sophisticated data analysis and scenario modelling to enhance decision-making in urban management and policy development. DUET consolidates data from multiple sources, including IoT sensors, transportation networks, and demographic statistics, providing a comprehensive perspective on urban dynamics. Moreover, DUET promotes active participation from citizens by allowing them to engage with the digital twin and share their feedback on urban initiatives, thus encouraging a more inclusive approach to planning.

2 Objectives and methodologies

This concise yet crucial chapter aims to present the objectives and methodologies of this thesis. In the first section, the key research questions that form the foundation of this thesis will be presented and explained in detail. Following this, the second section will outline the approach taken to identify and evaluate the most relevant sources.

2.1. Objectives

The primary objective is to address specific key questions that will serve as a unifying thread throughout the study. Each question will be analysed in detail in the following chapter, while the final chapter "*Conclusion*" will summarize the findings and provide clear and conclusive answers.

As analysed in the previous chapter, the Smart Mobility topic was born a few decades ago and, hand in hand with an increasingly connected, populated and sustainability-oriented world, it is steadily increasing in importance all over the world. However, given the vastness and complexity of the world, it would be impossible to explore how this topic is developing in every country, so, the first question this thesis will try to answer is:

Q1 "What is the current state of Smart Mobility in Italy?"

Since this question is quite vague, it will be divided into few several sub-questions to be able to analyse more aspects without confusion. After understanding the situation of our country today, the interest will focus on the context in which it is inserted: Europe. We know that our continent, in the last years, is focusing heavily on environmental sustainability and carbon neutrality (section 1.1), question number two is therefore:

Q2 "How is smart mobility developing in Europe? Do the trends of innovation and development coincide with what happens in our Country?"

This question wants to consider the European context in which Italy is inserted to make a comparison between them. After answering these questions, the point of view will change further, this time towards future. The third and last question can be formulated in this way:

Q3 *"How will smart mobility change in the coming years? Which areas are expected to be more prosperous?"*

Finally, this thesis will conclude by reflecting on what the future of smart mobility might be and what can be reasonably expected in the coming years. Since there are no concrete and reliable data available that can be used to predict a possible future, this question will be answered in an open manner, using the knowledge gained while writing this thesis.

2.2. Methodologies

The focus is now on the sources that have been used to answer the questions exposed in the previous section. In this work of thesis three main sources will be used, and now they will be described and explained.

2.2.1. Literature review

The literature review is used as the foundation for building a strong knowledge base around the Smart Mobility topic and everything about it. To develop the introduction chapter, many scientific papers were consulted, sourced from platforms such as Scopus, Google Scholar, and ResearchGate, using keywords related to the different topics. These papers provided the most pertinent information for the thesis. Additionally, for the introductory section, non-academic articles were referenced, sourced from secondary outlets such as online blogs, search engines, and company websites. all the papers and websites used in this thesis are cited in the final sections "Bibliography" and "Citography".

2.2.2. Italian survey

The second source utilized in this study is a survey conducted last year by the Connected Car & Mobility Observatory of the Politecnico di Milano. This survey was sent to various Italian municipalities across northern, central, and southern Italy, encompassing different city sizes to ensure a heterogeneous sample. This diversity enhances the representation of the country as a whole. This survey was of fundamental importance to understand the role of smart mobility in the Italian context, and to answer to Q1 and all the sub-questions in which it will be divided. It will be analysed in detail in the next section 3.1 "*The Italian Scenario*", in which different answers of the Italian municipalities to the different survey's questions will be presented and discussed, using also a cluster analysis to give more information to the data. The entire survey will be attached at the end of the work in section "*Appendix A*".

2.2.3. Global database

The last source that will be used in this analysis is an Excel database, still made available by the Connected Car & Mobility Observatory of the Politecnico di Milano, in which 518 projects, that concern Smart Mobility projects worldwide from 2015 to 2024, are surveyed. This database is composed of many information boxes (excel columns) in which the main project's characteristics are detailed:

- Name of the projects and name of the use case.
- Actors involved in the project (companies, municipalities, startups etc.).
- A concise description of the project and its objectives.
- Geographical information like the continent, the nation and the region/city.
- The year the project was launched.
- Which public actor is involved, if there is one.
- The progress state (Preliminary Analysis, Pilot and Executive Project or Concluded projects).
- The application area and the main project's functionality.
- The context (urban, extra-urban or both).
- The benefits (in this case there are three columns to mark them all).
- The main beneficiary and other beneficiaries if there are any.
- Information related to funding, including its monetary value, whether it comes from public or private funds, whether it is regional, national, or European funding, and finally, the source of the funding.
- The main technologies on which the project is based (also in this case there are three different columns).
- The channel used (display of the car, GPS, App, etc.).
- How the data are used (for internal purposes, to offer services to citizens, shared with other companies etc.).
- At the end, there are links, any notes, and any phone contacts.

Unfortunately, not all the cells are always filled, this is because it is not always possible to find all the information on the projects (especially information related to the financial part such as the value of the project budget and the source of funding). The first step was to enter new projects in the database to keep it updated; to do this, different types of web sources have been used (in particular the official websites of the projects itself, of the companies and of the institutional bodies involved, and also online newspapers). The result was an increase of just over fifty projects, from Europe, America and Asia. As will be reiterated in the following section dedicated to the analysis of this database, most of the projects contained in it are Italian; this bias is unfortunately unavoidable due to the greater ease of finding national projects when searching online. After this work, in order to make a precise analysis of the European Country, the data has been filtered keeping the projects present on this continent from

2020 to 2024. This database will be analysed in detail in section 3.2 "*The European Context*", in which Q2 will be answered.

3 Analysis and Discussion of Results

This chapter will be divided into two main sections: the first one will analyse the Italian context, while the second one will focus on the European one. In the initial sections 3.1 and 3.2, a detailed explanation will be provided on how the analysis was conducted, how the different sub-sections will be organized, and which questions should be kept in mind while reading to better understand the flow of the discussion.

3.1. The Italian Scenario

In this paragraph the work will be focused on analysing and understanding the current state of Smart Mobility in Italy in order to answer question Q1 *"What is the current state of Smart Mobility in Italy?"*. There are many possible ways to develop an analysis about this topic, but thanks to the use of a survey made available by the Connected Car and Mobility Observatory of Politecnico di Milano (*Appendix A*), this work will use the point of view directly of Italian municipalities to develop the reasoning. This approach is particularly important as it enhances the relevance of the analysis by relying on responses from those who are directly involved in the topic within the country. Specifically, the survey will first be described, and then the responses to its questions will be analysed. These responses will be examined based on a different logical structure rather than their original order. The primary objective of this chapter is to address question Q1. To ensure a smoother and better-organized discussion, Q1 will be broken down into five sub-questions (referred to as S1, S2, etc.). The relevant survey responses will be selected to answer each sub-question, which will also serve as the titles for the subsequent sub-sections (from section 3.1.2 to 3.1.6).

3.1.1. Survey description

This survey, which was sent to many Italian municipalities, has collected 98 respondents all over Italy during last year. Unfortunately, not all of them responded to all the 22 questions, so the response rate varies during the survey (the minimum one is in question 12, which collected responses only from 40 municipalities).

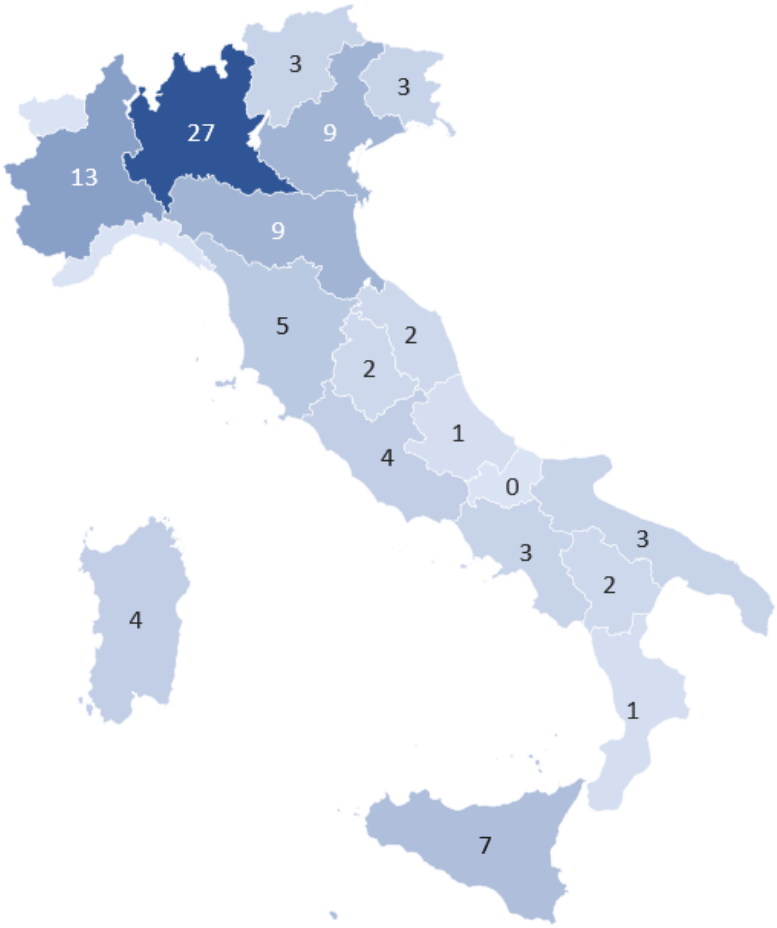

Figure 13. Number of municipalities per region (98 respondents)

The region that provided the largest number of responses is Lombardia (27), followed by Piemonte (13) and then Emilia-Romagna and Veneto (both 9); these regions are not too different from the ones of last year, in which the first one was Lombardia (31), the second one was Emilia-Romagna (19), and the third one was Piemonte (12). During the analysis of this survey two typologies of clustering will be used to give more information to the speech: the first one is done according to the geographical location and the second one according to the number of inhabitants; not all the questions will be analysed by using these clusters, but only the ones that are interesting in this regard.

Geographically speaking it's possible to divide Italy into 3 "macro areas": North (*Piemonte, Valle d'Aosta, Liguria, Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia* and *Emilia-Romagna)*, Centre (*Umbria, Toscana, Marche* and *Lazio)* and South (*Abruzzo, Molise, Puglia, Campania, Basilicata, Calabria, Sicilia* and *Sardegna*). According to this definition, the most representative area is the North with 64 respondents, whereas the Centre and the South are equally represented by 17 respondents each. The main change, from the 2023 survey, is the decrease in the number of respondents in the Centre of Italy, which were 33; at the same time, the number of respondents in the

North and in the South has not change that much, being respectively 60 and 16 last year.

Area	Number of respondents	%
North	*64*	*65,30%*
Center	*17*	*17,35%*
South	*17*	*17,35%*

Table 1. Number of municipalities per geographical cluster (98 respondents)

The other division, that takes into consideration the number of people living in a certain municipality, is done by dividing them into 4 categories: large-size urban centres (more than 80.000 inhabitants), medium-large-size urban centres (with a population between 40.000 and 80.000 inhabitants), medium-small-size urban centres (with a population between 25.000 and 40.000 inhabitants) and then small-size urban centres (less than 25.000 inhabitants). According to this classification, the most representative urban size is the small one (31 respondents) followed by the medium-small size (25), the large size (24) and then, the less representative one, that is the medium-large size (only 18). In this case, the main difference between the last year survey and the one of this year is in the number of small-size urban centres, which were still the most representative cluster but with 42 respondents; the medium-large-size centres had 22 of them, the medium-small-size centres 20 and the large-size centres 25.

Population [thousands of inhabitants]	Number of respondents	%
15-25	*31*	*31,63%*
25-40	*25*	*25,51%*
40-80	*18*	*18,37%*
80+	*24*	*24,49%*

Table 2. Number of municipalities per cluster of inhabitants (98 respondents)

3.1.2. Is Smart Mobility really a concreate issue in Italy?

After introducing and explaining the survey, we now move on to analysing its responses. As previously mentioned, Q1 will be divided into five sub-questions. Let's begin with the first one. To answer S1 (which reads *"Is Smart Mobility really a concreate issue in Italy?"*), let's start by asking how Smart mobility is seen from the Italian municipalities' perspective and so, quoting the survey: *"How relevant is the Smart Mobility topic for the municipality?"*. This question, that collected 98 responses, provided

4 different possible options ("fundamentals", "very relevant", "not so relevant" and "not relevant") and the possibility to choose only one of them.

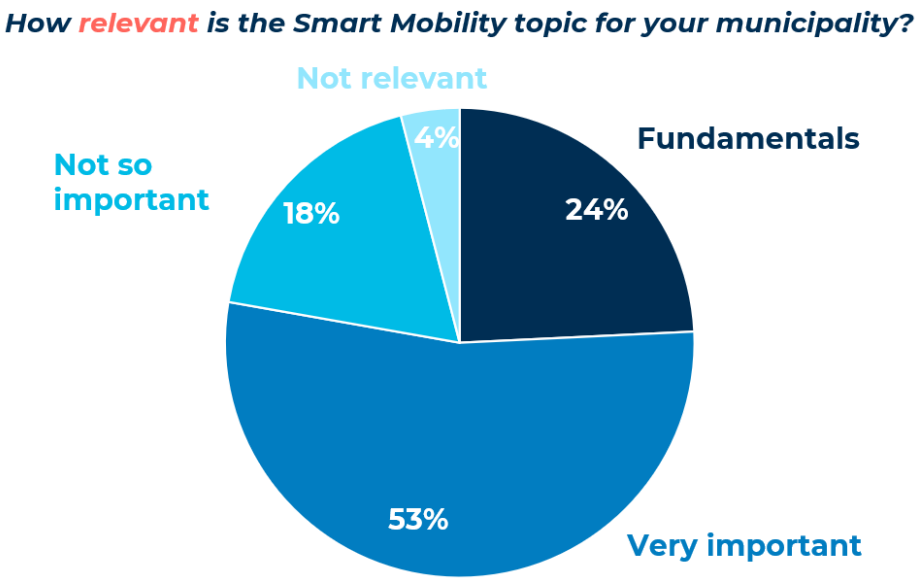

Figure 14. Municipalities' perception of Smart Mobility (98 respondents, 98 answers)

According to *Figure 14*, this topic is considered quite important because it is fundamental for 24% of the municipalities and very relevant for 53%; on the other hand, it is considered not so relevant for 18% of the respondents and not relevant only for 4%.

Options	15-25	25-40	40-80	80+	North	Center	South
Not relevant	*6%*	*4%*	*17%*	*4%*	*5%*	*6%*	*0%*
Not so relevant	*26%*	*24%*	*56%*	*4%*	*19%*	*18%*	*18%*
Very relevant	*55%*	*44%*	*28%*	*58%*	*52%*	*59%*	*53%*
Fundamental	*13%*	*28%*	*0%*	*33%*	*25%*	*18%*	*29%*

Table 3. Cluster distribution of *Figure 14* (98 respondents, 98 answers)

Looking at *Table 3*, it's possible to see the subdivision of the answers for all the different typologies of cluster, and it's interesting to note that one of them have responded quite differently respect to the majority (according to which the highest percentage of their municipalities considers Smart Mobility very relevant and fundamental). The most interesting cluster to analyse is the one composed by medium-large-size urban centres; according to them, the topic is for most of the municipalities "Not so relevant" (56%), it's "Fundamental" for no one and it is "Not relevant" for the 17% (highest percentage

among all the clusters), which is a very different vision compared to the other municipalities.

Of course, it is not enough for those who respond to this survey to think that Smart Mobility is a relevant issue to make it so. Therefore, let's analyse other more concrete parameters, such as the presence of a professional figure in charge of this topic, again quoting the survey: *"Is there a figure in charge of Smart Mobility within the municipality?"*. This question provided 7 possible options and each respondents had the possibility to select no more than 2 of them (in case there are more than one person in charge of Smart Mobility). 94 municipalities responded to this question and 9 of them selected multiple options. The result is that 59% of the municipalities, that is majority, have at least one dedicated figure, whereas the other 41% not.

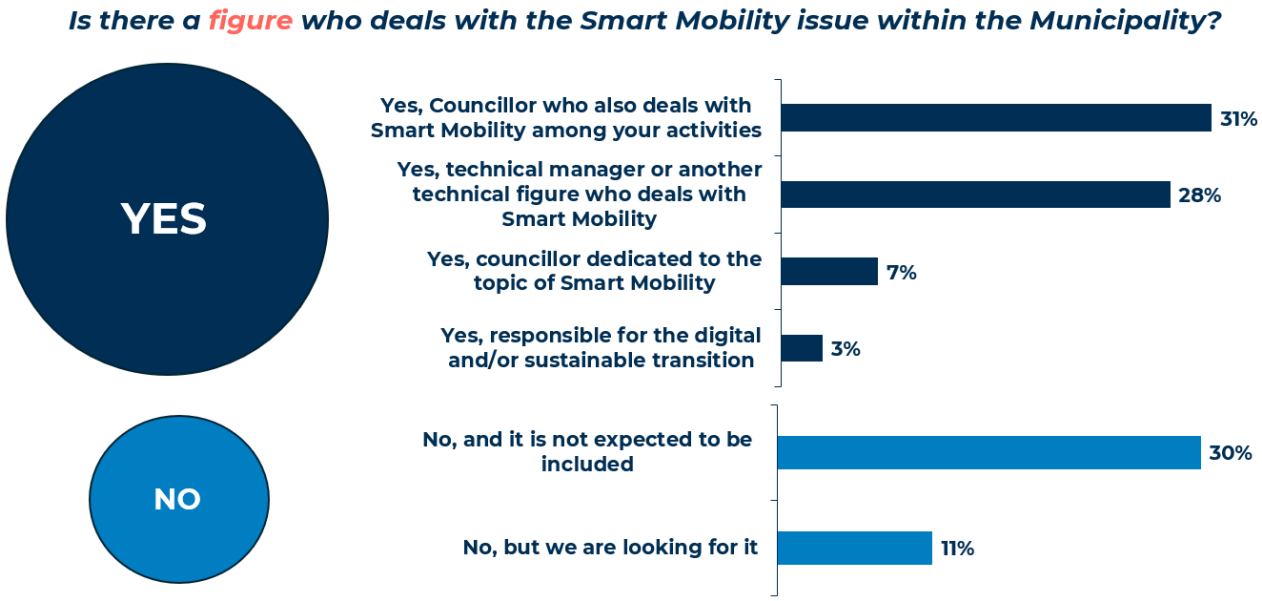

Figure 15. Figures in charge of Smart Mobility (94 respondents, 103 answers)

The most selected figure[16] is the Councillor who also deals with Smart Mobility (that works in the 31% of the municipalities), followed by the Technical Manager (28%); these are therefore resources that are not totally dedicated to Smart Mobility but which have various tasks including that of. For what concerns the negative responses, the majority of the municipalities does not have a dedicated figure and it is not interested in having one in future.

[16] To create this graph, the option "Other" has been removed.

Options	15-25	25-40	40-80	80+
Yes	*41%*	*50%*	*65%*	*93%*
No	*59%*	*50%*	*35%*	*7%*

Table 4. Cluster distribution of *Figure 15* (94 respondents, 103 answers)

In this case it is very interesting to look at the division by cluster, in particular the division by number of inhabitants (there is no significant difference between the municipalities of Northern, Central and Southern Italy in this answer). As it can be seen from *Table 4*, the percentage of municipalities with a figure dedicated to this topic is constantly increasing, passing from the smallest municipalities, in which only 41% have this kind of figure, to the largest ones, in which the percentage increases up to 93%.

The presence of a figure dedicated to Smart Mobility is an important condition to understand if this is a concrete issue in our country, but we must then look at the actual projects initiated by the municipalities and whether there are growth trends or not. The question of the survey that is now being analysed is: *"Has the municipality started Smart Mobility projects in the years 2022-24?"*. This question has 5 possible answers and the possibility, for the respondents, to select more than one option; 95 municipalities responded and 128 responses were totally collected.

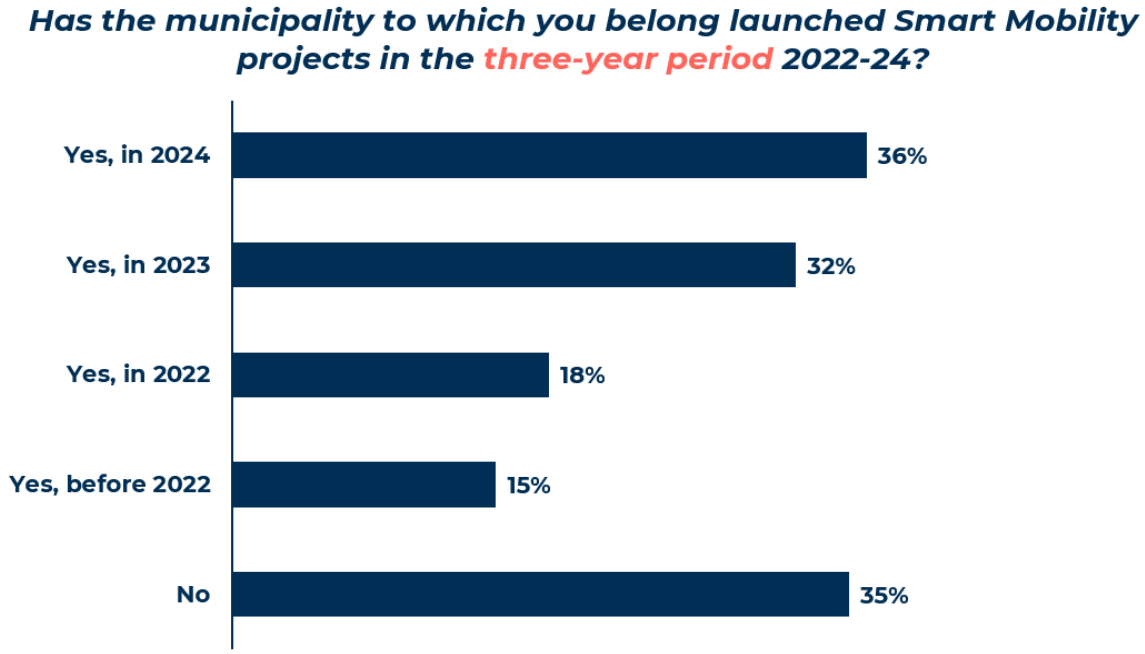

Figure 16. Projects started in the last years (95 respondents, 128 answers)

According to the graph, 35% of the municipalities have never started a Smart Mobility project, so this means that the 65% of the municipalities have at least started one. Another positive element is the growing trend that underline the interest in this topic, which is becoming more and more important year by year.

Options	15-25	25-40	40-80	80+	North	Center	South
Yes	*60%*	*59%*	*75%*	*95%*	*74%*	*85%*	*64%*
No	*40%*	*41%*	*25%*	*5%*	*26%*	*15%*	*36%*

Table 5. Cluster distribution of *Figure 16* (95 respondents, 128 answers)

Looking at *Table 5*, the most interesting cluster is the one including large-size centres, in which almost the totality of the municipalities has already started Smart Mobility projects. The situation is very similar to that of the previous question: the larger the municipalities, the more advanced the municipalities have been on this topic.

3.1.3. How and why does a Smart Mobility project begin?

After asking ourselves whether Smart Mobility is truly a relevant topic in our country and for our municipalities, it naturally follows to question the nature of a project related to this theme. Let's now analyse how these projects work concretely and start by asking ourselves where the need to develop one of these comes from. From the survey: *"How did the necessity to create Smart Mobility project come about?"*. The aim of this question was to investigate the reasons behind the decisions to start Smart Mobility projects; also in this case, there was not a limitation in the number of options that the respondents could select; 60 municipalities responded to the question with 113 answers in total.

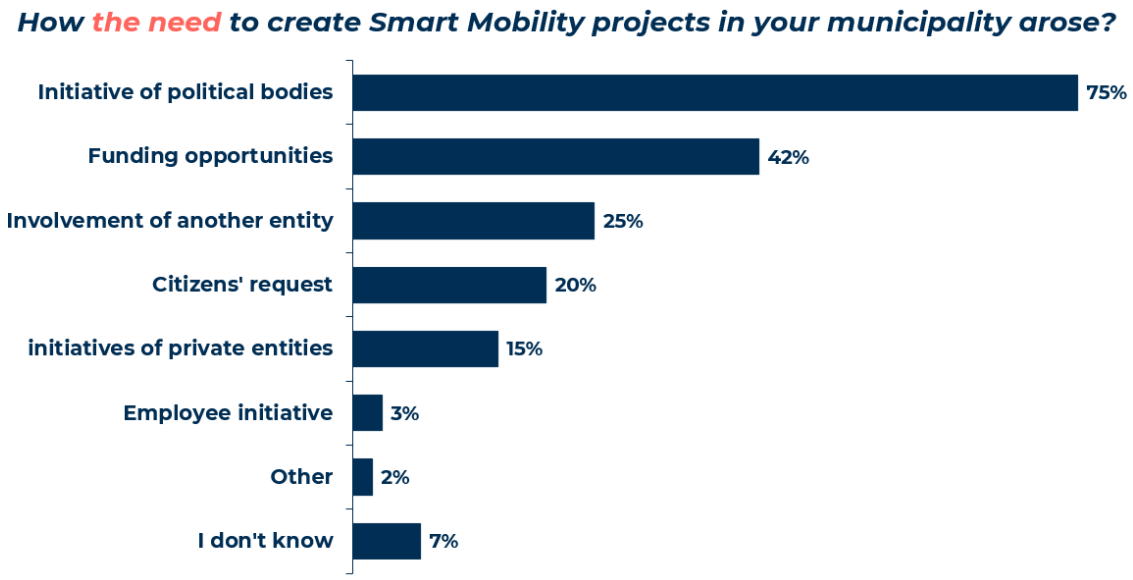

Figure 17. The actors that initiate a Smart Mobility project (60 respondents, 113 answers)

The result is clear and tells us that the main reason for a municipality to start this kind of project is a political initiative (75%) followed, but with far fewer votes, by a financing opportunity (42%).

Having said this, it is therefore important to understand how much these projects impact the budgets of Italian municipalities, the survey asks: *"Considering all the projects provided by the municipality for the year 2024, what is the percentage of the budget destinated to the Smart Mobility projects that have started during the year?"*. The question is perfectly right for us because it's about the budget that the municipalities have dedicated to the Smart Mobility topic, 60 municipalities responded and it was possible to select only one option.

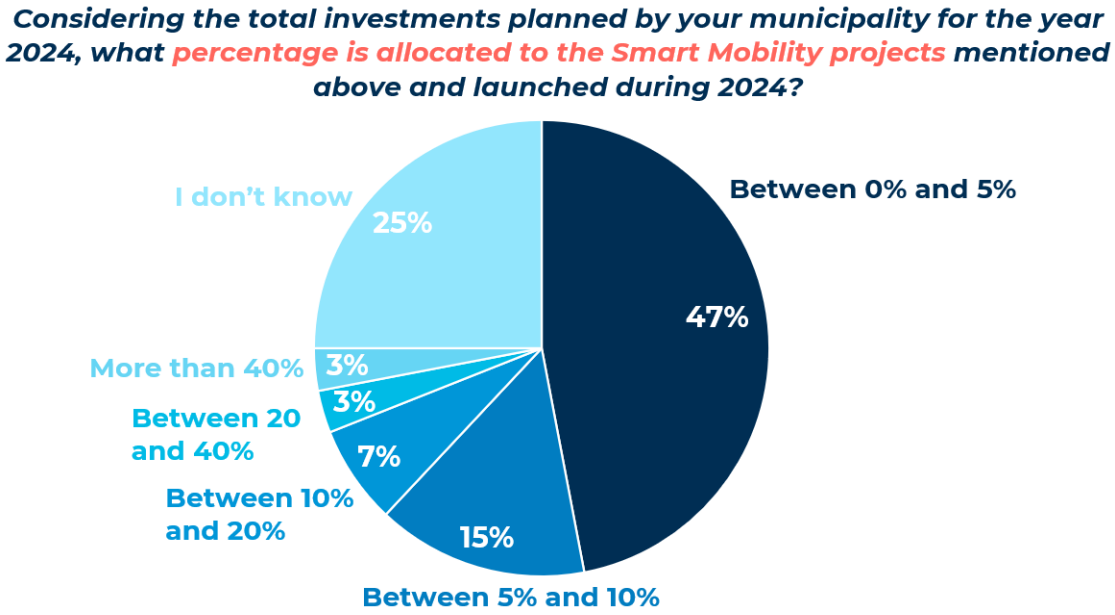

Figure 18. Percentage of the budget invested in Smart Mobility (60 respondents, 60 answers)

According to the graph, most of the municipalities invest less than 5% of their budget and the percentage that invests less than 10% is increased by 9% respect to 2023. The high percentage of "I don't know" is probably linked to the unavailability of this data for the respondents (especially in the large-scale municipalities due to the higher level of complexity regarding management in general).

The sub-question S2 also specifies "why", that means the ultimate goal behind these projects; the survey asks: *"What objectives would the Administration like to pursue through the (eventual) launch of the Smart Mobility project in the future?"*. In this case the interest is on the generic objectives that the municipalities have on Smart Mobility projects.

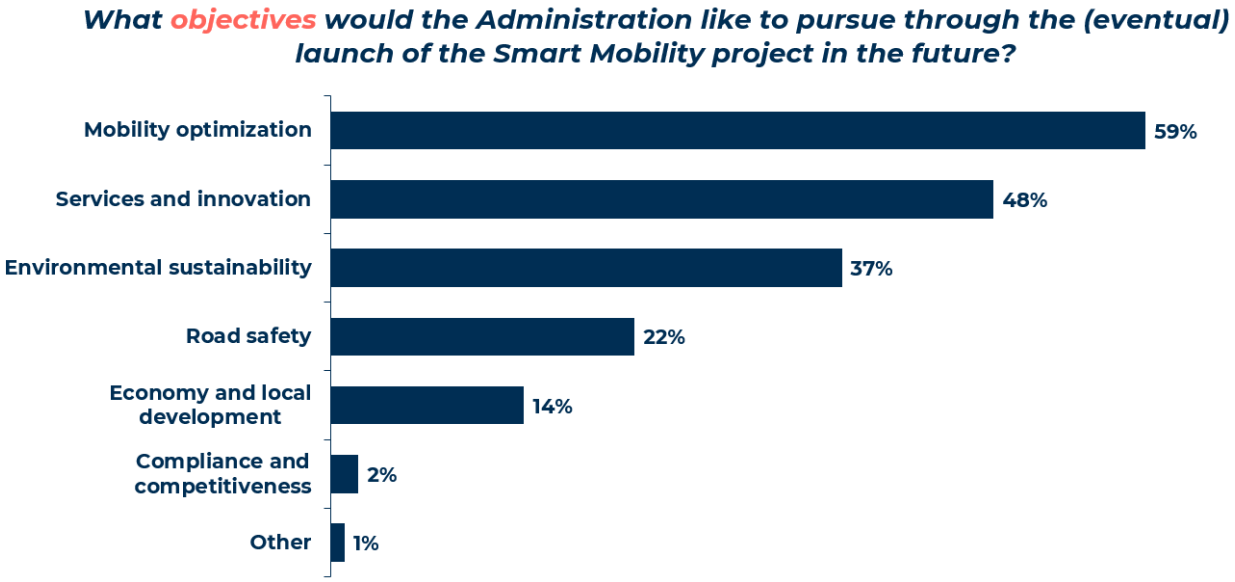

Figure 19. The objectives behind Smart Mobility (81 respondents, 149 answers)

This graph is done by using the responses of 81 municipalities (each could select no more than 2 options) and, watching at *Figure 19*, the main object is the "Mobility optimization" (59%), followed by "Services and innovation" (48%) and "Environmental sustainability" (37%).

Let's now open a brief parenthesis on the sustainability topic, which, as discussed before, is becoming increasingly relevant and widely debated, especially in Europe (sections 1.1 and 1.1.1 analysed the main strategies aimed at decarbonization at both the European and Italian levels). Looking at *Figure 19*, environmental sustainability has been selected as the objective of Smart Mobility projects by 37% of the responding municipalities, yet it remains an important factor driving the initiation of such projects. The need to start these kinds of projects, in fact, arises from political initiatives (*Figure 17*), which are often strongly focused on sustainability. Let's try to understand how Italian municipalities exploit Smart Mobility with a view to improving environmental sustainability, quoting the survey: *"What type of initiatives, in the Smart Mobility area, does the municipality consider fundamentals in order to support efficiently the sustainable transition indicated in the European objectives of the "Fit for 55" package?"*. As explained in the Introduction chapter, the Fit for 55 package is a set of reforms and regulations that were promulgated by European Union, in order to reduce by 55% the CO2 emissions by 2030 (respect to the 1990 level of emissions). This question wants to analyse how Italian municipalities intend to support the sustainable transition focussing on the Smart Mobility area; respondents could select no more than 3 answers and 85 municipalities responded to it.

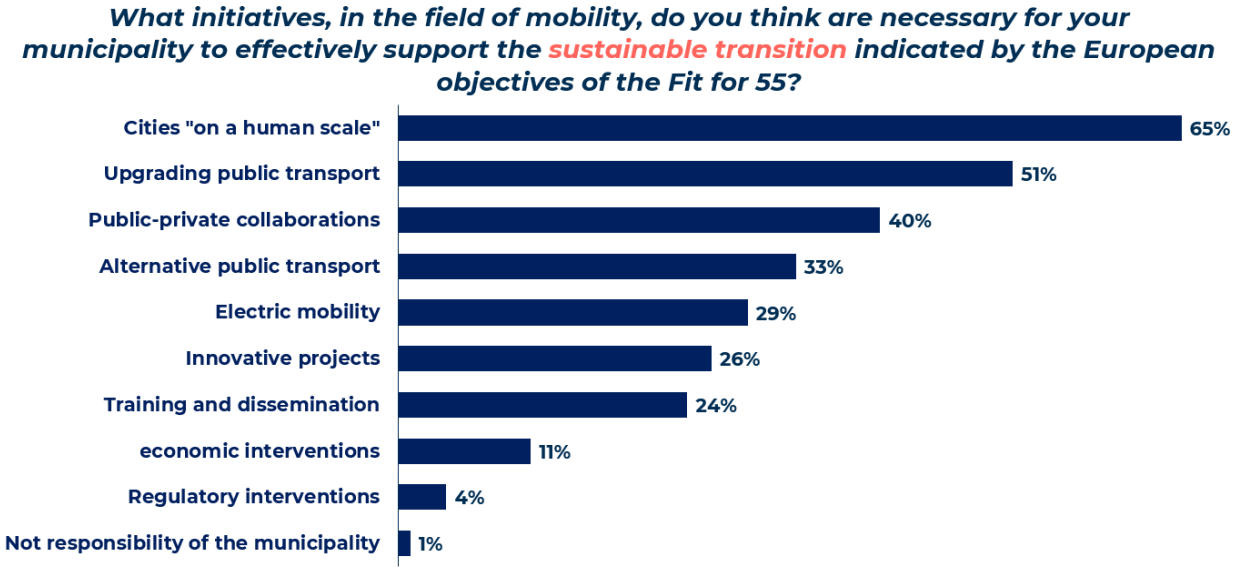

Figure 20. Initiatives to support the sustainable transition (85 responders, 240 answers)

The graph above, created with all the 240 answers, underlines that, according to the Italian municipalities, the best initiative to support the sustainable transition, is the creation of "human-scale" cities (cities based on the individual's needs: pedestrian areas, public transports, cycle paths, large green areas and public parks), followed by the upgrading of the public transport and the public-private collaborations (such as energy communities: groups of citizens, businesses or public bodies that come together to produce, share and consume renewable and clean energy). A positive aspect that emerges from the graph is also the very low percentage of municipalities according to which it is not their responsibility (1%), thus underlining the commitment that there is towards greater environmental sustainability.

3.1.4. What kind of strategy is used in this type of projects?

The fundamental thing for the success of any type of project is the strategy that is implemented; in the survey, in fact, the Observatory asked to Italian municipalities: *"What kind of strategy does the municipality adopt for Smart Mobility?"*. In this question, they had to select only one option among the 5 possible ones.

- *Absent*: there is not a particular strategy
- *Bottom-up*: the municipality has a strategy, but it acts in watertight compartments; innovative approaches are driven by the need of the few who have understood the benefits.
- *Tactical*: the benefits generated by Smart Mobility projects are known by everyone; guidelines are defined with an overview and are shared within the municipality.

- *Planned*: there is a medium- to long-term plan for the start-up of Smart Mobility projects, with allocated budget, shared KPIs and roadmap for the evolution of investments.
- *Mobility First*: in addition to being included in a medium- to long-term plan, the initiation of Smart Mobility projects is an essential part of the municipality's strategy.

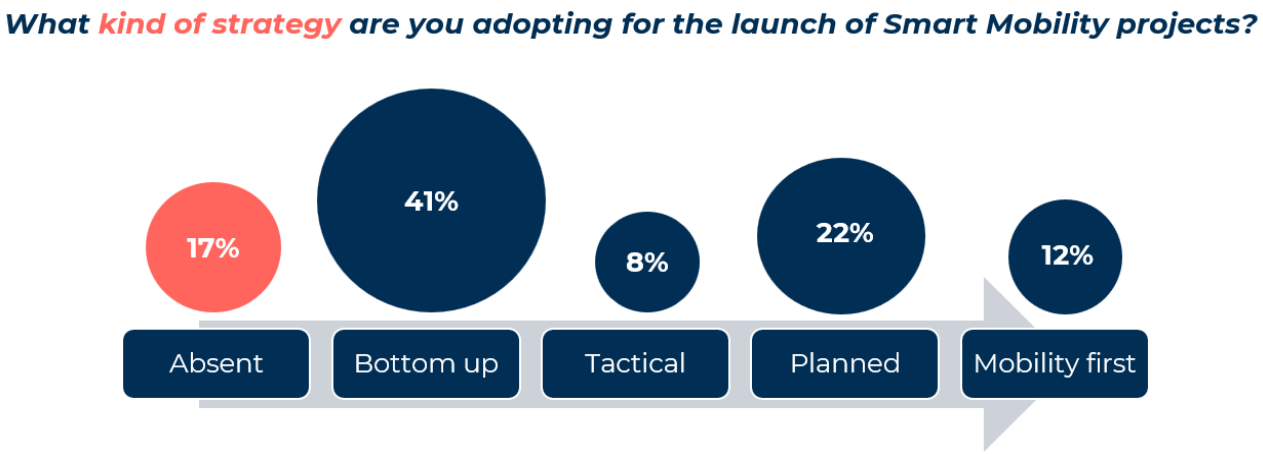

Figure 21. Strategies behind Smart Mobility projects (59 responders, 59 answers)

The responses are 59 and according to them the majority of the municipality adopt a Bottom-up strategy for this kind of projects; respect to the last year there is an increase in the percentage of Bottom-up strategies and Planned strategies (both +12%) to the detriment of Tactical strategies (-22%).

Strategy	15-25	25-40	40-80	80+
Absent	*29%*	*17%*	*10%*	*10%*
Bottom up	*47%*	*58%*	*30%*	*30%*
Tactic	*6%*	*8%*	*20%*	*5%*
Planned	*12%*	*8%*	*20%*	*40%*
Mobility First	*6%*	*8%*	*20%*	*15%*

Table 6. Cluster distribution of *Figure 21* (59 respondents, 59 answers)

Looking at *Table 6*, it is clear that the absence of strategy is mainly a problem of the small-size municipalities (29%), whereas the large-scale one is the only cluster in which the dominant strategy is not the Bottom-up but the planned strategy (40%).

Of course, in order to be able to organize a complex strategy, such as those previously defined as "Planned" and "Mobility First", there is a need for a considerable level of skills and competencies for the figures of the municipality who deal with these projects. The next question in fact reads: *"How do you judge the level of internal skills of your municipality for the management of Smart Mobility projects"*. The responses are still 59 and also in this case there is the possibility to select only one option among the 5 possible ones.

- *Missing*: the municipality has no skills and competent figures to manage Smart Mobility projects.
- *On-demand*: competent figures within the municipality work individually based on the needs of the moment and the necessary skills are concentrated on a few resources.
- *Shared*: competent figures within the municipality interact with each other based on a shared coordination plan for competence management.
- *Organized*: there is a team of experts dedicated to the topic that works based on the objectives the municipality has set for Smart Mobility and the resulting planning.
- *Long-term oriented*: there is a well-organised team of experts dedicated to the topic, and there is also a plan oriented towards the creation and enhancement of widespread internal competences.

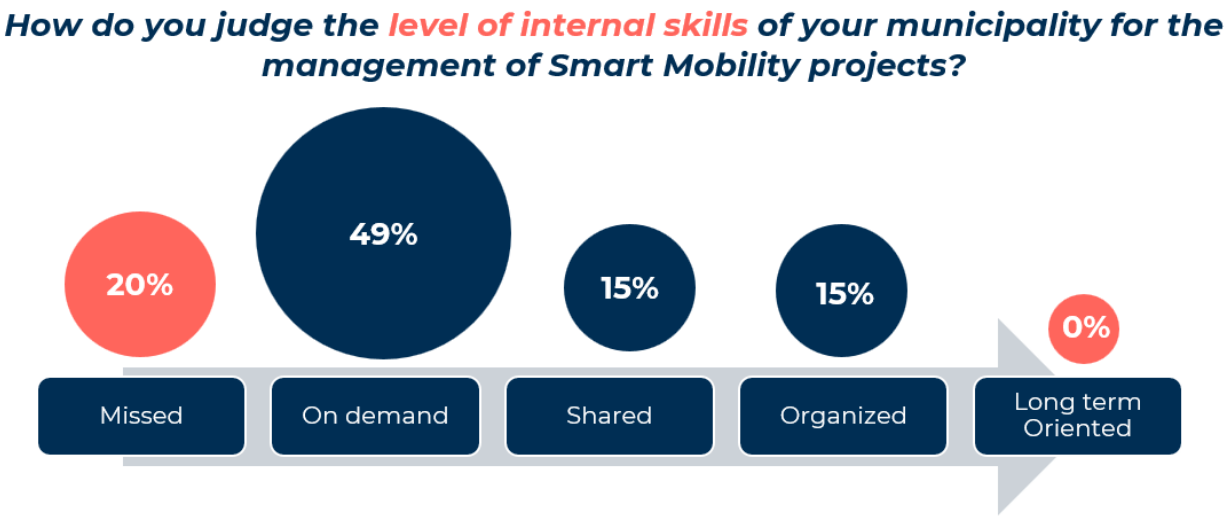

Figure 22. Skill level inside municipalities for those who deal with Smart Mobility (59 respondents, 59 answers)

As the graph shows, the majority of the municipalities selected on-demand competences (+21% respect to the last year), whereas, unfortunately, no one have selected long-term oriented competences; a positive change respect to 2023 is the reduction, from 38% to 20%, in the municipalities with missing competences.

Competences	15-25	25-40	40-80	80+	North	Centre	South
Missing	*35%*	*33%*	*10%*	*5%*	*26%*	*10%*	*0%*
On-demand	*41%*	*58%*	*50%*	*50%*	*50%*	*70%*	*14%*
Shared	*12%*	*0%*	*20%*	*25%*	*10%*	*20%*	*43%*
Organized	*12%*	*8%*	*20%*	*20%*	*14%*	*0%*	*43%*
Long term oriented	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*

Table 7. Cluster distribution of *Figure 22* (59 respondents, 59 answers)

Looking at the cluster table, it's interesting to note that the problem of the missing competences involves a larger number of small and medium-small municiplaities, whereas the biggest ones have more shared and organized competences (the on-demand competences are always dominant for all the clusters). As far as the geographical subdivision is conerned, the on-demand competences are very dominant only for the municipalities in the North and in the Centre of Italy, whereas the one in the South have an important percentage of shared and oganized competences.

3.1.5. What are the forecasts for the future of this topic?

Let's now try to understand how Italian municipalities perceive some key elements of Smart Mobility in the near future. The survey will ask for opinions on the development of some issues: electric mobility, smart parking and traffic management; first, however, let's try to understand the level of maturity of the different application areas to date, the survey asks: *"What is the maturity level for each kind of Smart Mobility project in the municipality?"*. This question wants to investigate the level of maturity of the projects, so, for each field of application, the responder could select one option among: "Exploration", "Experimentation", Adoption" and "Strategic distribution". The first phase is only a feasibility analysis of the project, the "Experimentation" phase starts when the municipality has done some concrete tests in a small-scale impact, whereas the "adoption" phase starts when the project is officially adopted in large-scale all over the municipality. For what concerns the last phase, it is a little bit different: a project can be classified in the "strategic distribution" phase only if it is crucial in terms of the municipality strategic plan.

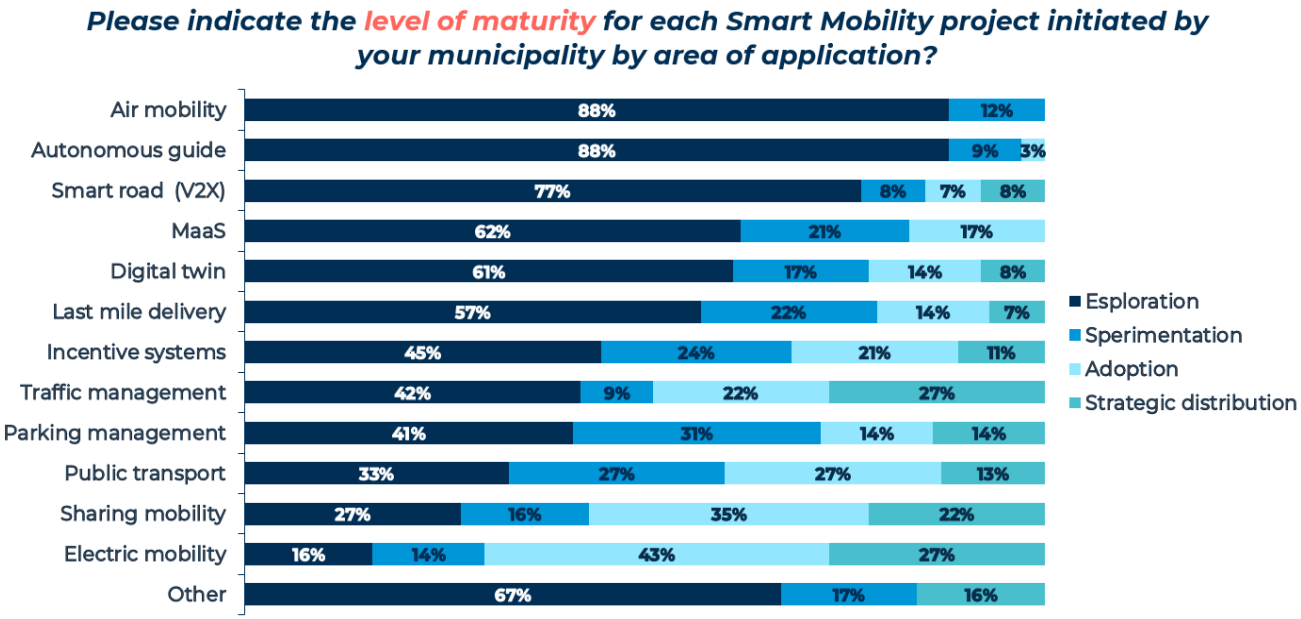

Figure 23. Maturity level for different application areas (60 responders, 456 answers)

The graph above is based on 60 municipalities and their 456 projects (219 are in the first phase, 81 in the second one, 94 in the third one and 62 in the last one). Looking at *Figure 23*, it's possible to note that projects like air mobility, autonomous guide and smart road are still mainly in an experimentation phase, whereas projects like electric mobility and sharing mobility are mainly in the adoption one. For what concerns the strategic distribution phase, the most relevant projects are those in the traffic management and electric mobility field; this one, in addiction, is the most described project category: 93% of the respondents have projects in it, a clear sign of how this is a very important issue in our country when it comes to mobility.

Therefore, let's start with the electric mobility and see how Italian municipalities forecast its future. Quoting the survey: *"What are the smart solutions, in the electric mobility field, that you think are more interesting for the municipality's projects in the next 3 years?"*. This question is about electric mobility solutions in the next three years; the respondents at this question are 80 municipalities that had to select no more than 3 answers, for a total of 191.

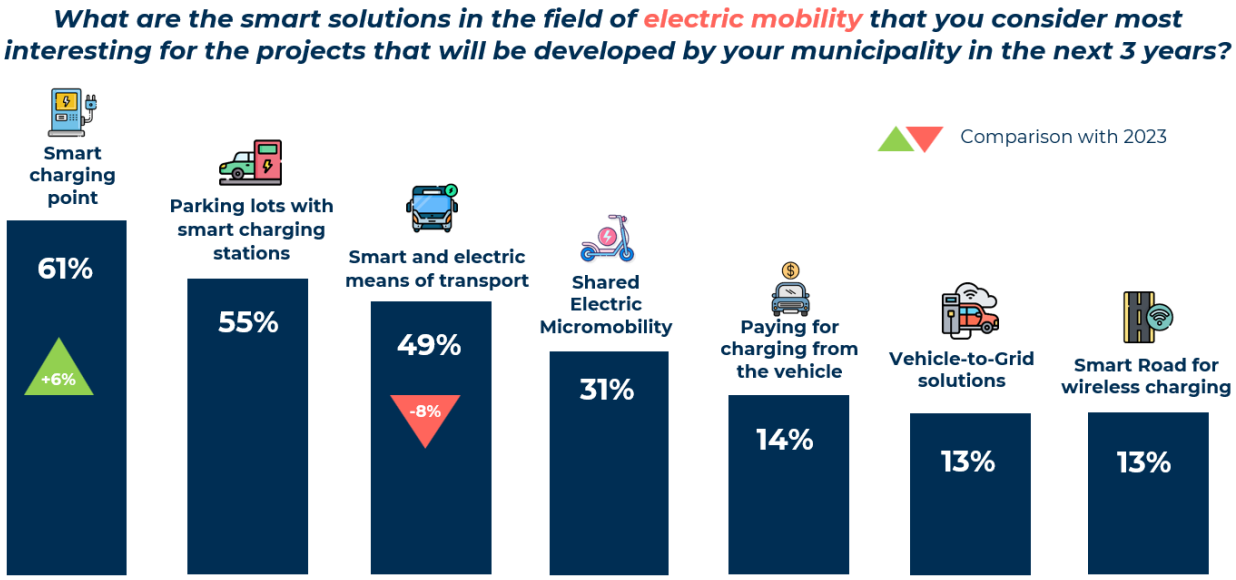

Figure 24. Forecast of electric mobility solutions for the future (80 respondents, 191 answers)

The main solution, that deals with electric mobility, is considered by 61% of the respondents "Smart charging point"[17], which is also grown from +6% respect to 2023, followed by "Parking lots with smart charging stations" (55%) and "Smart and electric mean of transport" (49%), which is also the option with the biggest change respect to last year (-8%), the least selected options are "Vehicle to grid solutions"[18] and "Smart road for wireless charging"[19], both with 13%.

Options	15-25	25-40	40-80	80+	North	Center	South
Smart charging point	27%	19%	29%	29%	24%	32%	29%
Parking lots with smart charging stations	29%	32%	16%	7%	24%	12%	29%
Smart and Electric mean of tranport	12%	23%	26%	27%	18%	32%	23%
Shared electric micromobility	9%	9%	19%	20%	14%	12%	11%
Vehicle-to-Grid solutions	6%	6%	0%	7%	6%	4%	3%
Smart road for wireless charging	9%	2%	3%	5%	6%	4%	3%
Automatic payment while charging	6%	9%	3%	2%	8%	4%	0%
Other	0%	0%	0%	2%	0%	0%	3%
None	2%	0%	3%	0%	2%	0%	0%

Table 8. Cluster distribution of *Figure 24* (80 respondents, 191 answers)

This table shows two differences: the first one between the smallest municipalities, which are more interested in parking lots with smart charging stations and then in

[17] Unlike traditional charging stations, these infrastructures leverage connectivity, AI, and IoT to optimize energy management, making it more efficient and sustainable.
[18] V2G solutions are intelligent energy management systems that enable EVs to both draw electricity from the grid and feed excess power back when required, to enhance grid stability and the overall efficiency.
[19] Smart roads equipped with solar panels capable of charging electric vehicles wirelessly and/or inductively.

smart charging points, and the biggest ones, that instead are more interested in smart charging points and then in smart and electric means of transport. The second difference is between the municipalities in the Centre of Italy, which are very interested in smart and electric mean of transport, and the others that are focussing more on parking lots with smart charging stations.

The second area that is asked to think about a possible change in the coming years is that of traffic management, the question is similar to the previous one: *"What are the smart solutions, in the traffic management field, that you think are more interesting for the municipality's projects in the next 3 years?"*. The respondents are 79 and the answers 178.

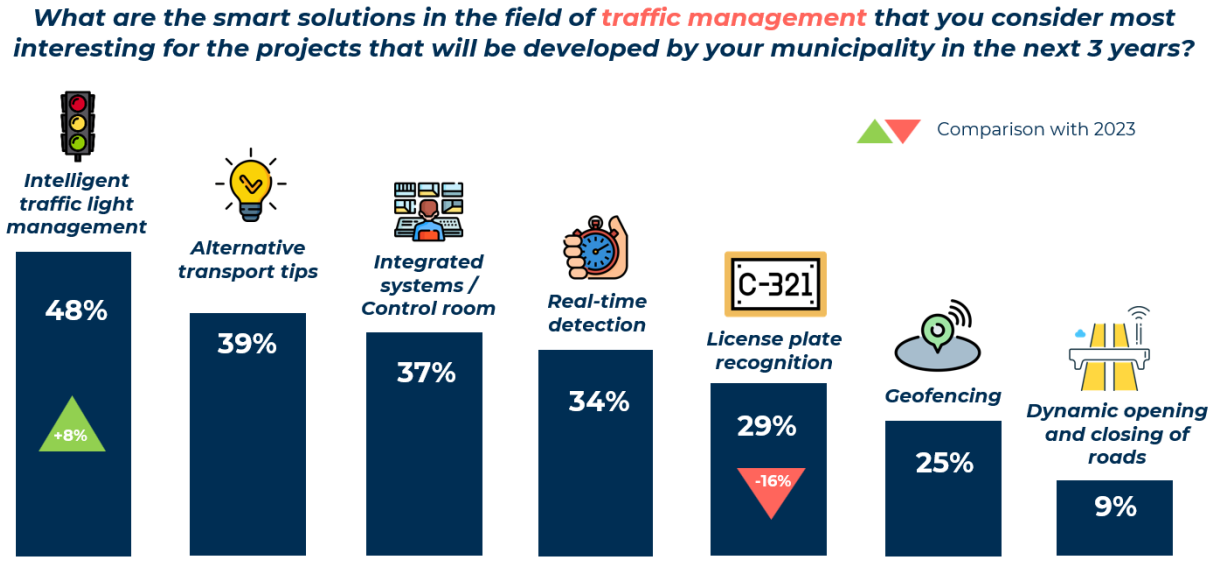

Figure 25. Forecast of traffic management solutions for the future (79 respondents, 178 answers)

The main solution, with 48% of the votes and an increase of 8% compared to 2023, is the "Intelligent traffic light management" (for example able to vary the green/red times to allow the passage of emergency vehicles or the "green wave"), followed by the "Alternative transportation tips"[20] and the "Integrated system/control room"[21]; noteworthy is the option "License plate recognition", which is positioned between the options "Real-time detection" (e.g. solutions that detect traffic problems in real time and also communicate alternative routes) and "Geofencing"[22]. It is in fact reduced by

[20] Solutions that adjust the charge for crossing lanes (e.g. emergency lanes) or traffic-calmed zones.
[21] A Control Room is a central hub designed for real-time monitoring, management, and coordination of a city, in particular traffic and the transport sector in general.
[22] Geofencing is a technology based on GPS or Wi-Fi localization that allows the creation of a virtual boundary; when a device, such as a smartphone or a vehicle, enters or exits this defined zone, the system automatically send a pre-set response, such as notifications or a security alerts.

16% respect to 2023, mainly due to three clusters: small-scale and medium-small-scale municipalities and the ones in the Centre of Italy.

Always similar to the previous two questions is the one concerning the parking management: *What are the smart solutions, in the parking management field, that you think are more interesting for the municipality's projects in the next 3 years?"*. Still 79 municipalities responded but this time with 183 answers.

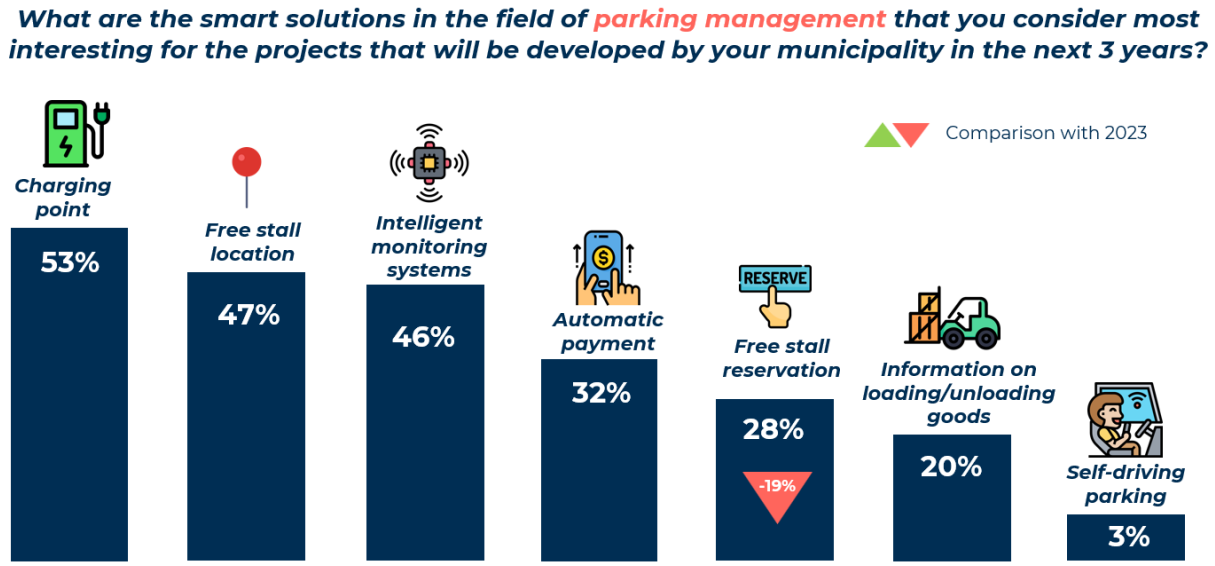

Figure 26. Forecast of parking management solutions for the future (79 respondents, 183 answers)

The most selected option is "Charging point" (53%, mainly voted by small-scale municipalities) followed by free "Stall location" (47%) and "Intelligent monitoring systems"[23] (46%), whereas the option "Self-driving parking"[24] is very little selected. In this case the biggest difference is faced by the option "Free stall reservation", that decreased by 19%; no one have faced an increase in the percentage of responses (they are just more balanced), except for "Intelligent monitoring systems" that is a new entry in the survey.

3.1.6. What are the barriers to the development of these projects? how can they be overcome?

After taking a look at the municipal forecasts regarding key areas of Smart Mobility, let's now ask ourselves what elements could actually avoid this development and

[23] Intelligent systems for monitoring parking areas using smart cameras.
[24] Self-driving parking systems through which it is possible to leave the car at the entrance of a parking lot and it parks itself.

therefore must be overcome: "*Which are, according to you, the main barriers that prevent or slow down Smart Mobility projects, or that do not allow the passage from experimentation to large scale production?*". This question wants to investigate all the possible barriers that municipalities may face when they decide to start this kind of projects; in this case they could select no more than 3 options and 83 of them responded with 209 answers in total.

Figure 27. Barriers to the development of Smart Mobility projects

The result, that emerges from the graph above, emphasizes the presence of two main barriers that prevail over all: "Resource availability" (64%, especially voted by the small-scale municipalities) and "Knowledge/ skills" (61%). As was highlighted in paragraph 3.2.2, the presence of funding in fact is a very important element to allow Smart Mobility projects to start. Even if this two are considered the most important ones, it is interesting to note that the option "Citizen understanding" is the one that has grown the most respect to 2023 (+11% especially voted by the municipalities in the South of Italy), whereas the main change is the "Perception of bureaucracy complexity" that is less relevant by -17%.

A tool that can be used to overcome some of these barriers is that of collaboration with other actors; a partnership, in fact, can be used to create synergies and important competitive advantages to counteract the lack of funds and/or resources. Quoting the survey: *"Which actors can be engaged (or are already engaged) by your municipality for the development of Smart Mobility's projects?"*. This is the last question of the survey and it wants to investigate the possible actors that can help the municipality with the Smart

Mobility topic; the respondents are 74 and there was not a maximum number of answers that could be selected.

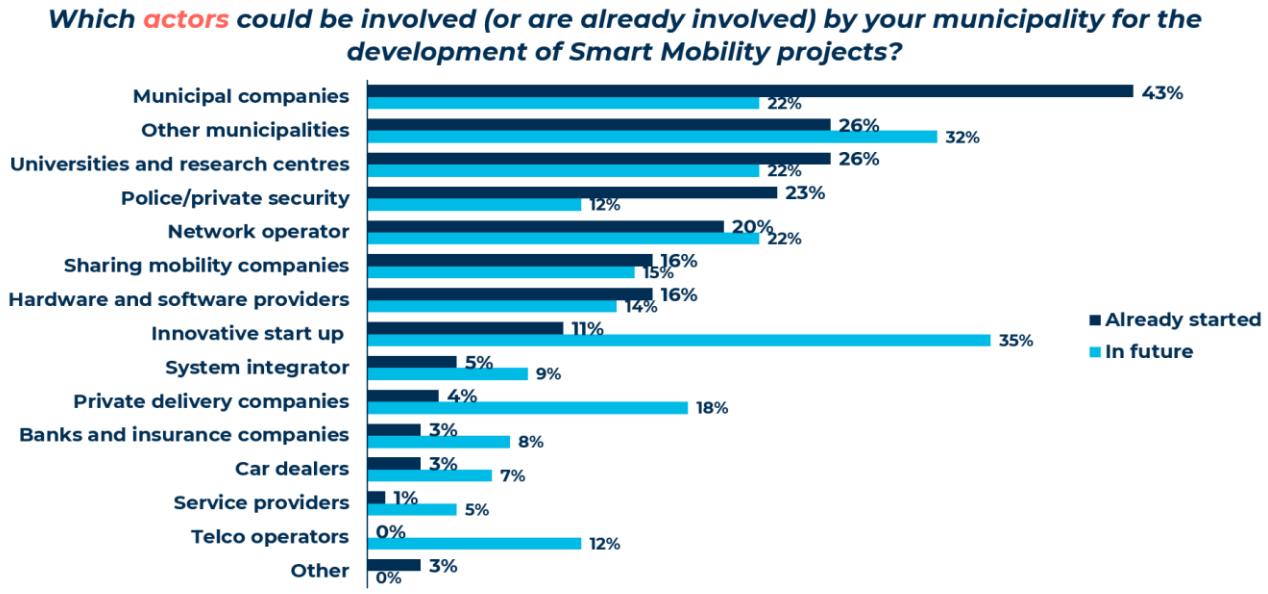

Figure 28. Actors engaged in Smart Mobility projects (74 respondent, 331 answers)

This graph, which is created by using the 331 responses at this question, shows us the main actors with which the municipalities are collaborating right now and with which they want to collaborate in the next future. For what concerns the actual situation, the main actors are municipal companies (43%), other municipalities (26%) and universities and other research centres (26%), whereas the situation is a bit different watching at the future: the focus is more on innovative starts up (35%) and still on other municipalities (32%).

Another way to obtain competitive advantages, in addition to partnerships, is to be able to exploit an element that is fundamental nowadays: Big Data (thus, the enormous amount of data generated throughout the lifespan of various projects). The last three questions that conclude this analysis serve precisely to understand how Italian municipalities exploit the data acquired from the projects, starting with the first which asks: *"How does the municipality manage the data collected by these initiatives?"*. This question is about the utilization of data collected by the municipalities, in this case they had to select only one option among 5 possibilities.

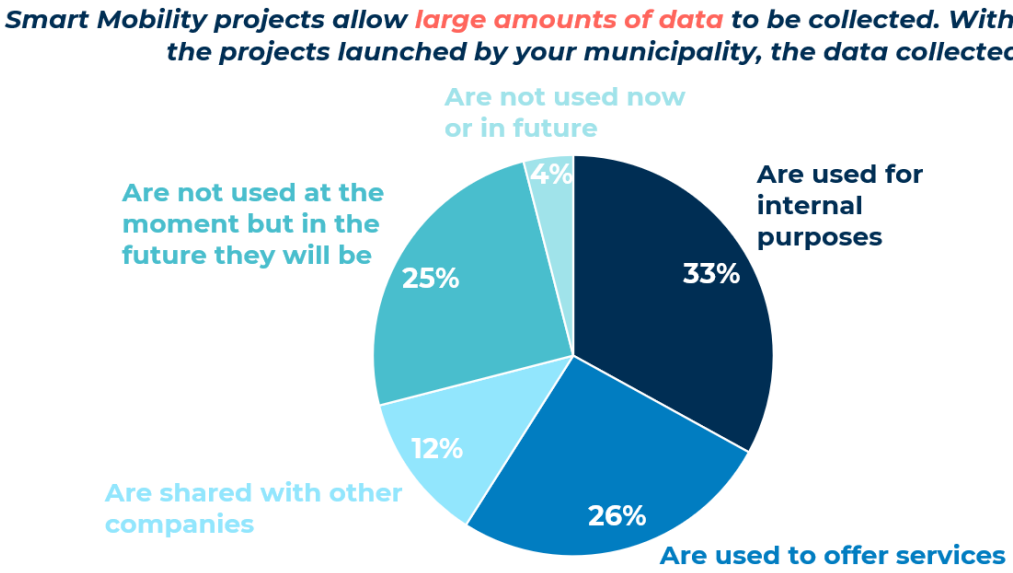

Figure 29. The use of data (57 respondents, 57 answers)

The graph is created by using the 57 responses of the Italian municipalities and it's clear that the majority of them, 71%, already use this data in some way (mostly for internal purpose), whereas, for what concerns the others 29%, the large majority (86%) is interested in exploiting this opportunity in the next future.

Let's continue entering in the detail of their usage: *"What is the main use you make of data collected?"*. This one requires selecting one option among the five possibilities; the possibilities are:

- *Descriptive*: data are used to analyse the current situation and nothing else.
- *Diagnostic*: data analysis is oriented on understanding the reason why something happened.
- *Predictive*: data are used to predict future and to make decisions.
- *Prescriptive*: data are used to optimize the AS-IS scenario contrasting it with other possible one.
- *Adaptive*: data and planification are more flexible and dynamic due to AI algorithms that allow a high automatization of decisions in real time.

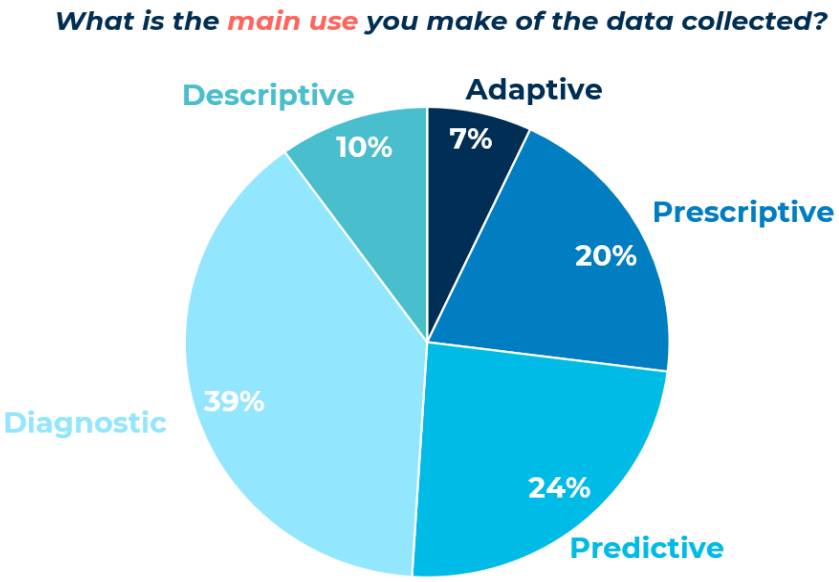

Figure 30. How the data collected are used (41 respondents, 41 answers)

This question has 41 responses and, as it is possible to see from *Figure 30*, the majority of the municipalities use data in a diagnostic way (in particular in the medium scale municipalities and in the one located in the South of Italy), whereas they are not so used in the adaptive and descriptive way.

The last analysed question asks: *"Has the municipality implemented, or intends to implement, cybersecurity measures to protect data from citizens and firms, used in the digital infrastructures of the Smart Mobility projects?"*. This question is important to understand if all the data collected by municipalities are safe, investigating not only the implementation of cybersecurity measures but also if the people that work in the municipality are updated and well informed about this topic.

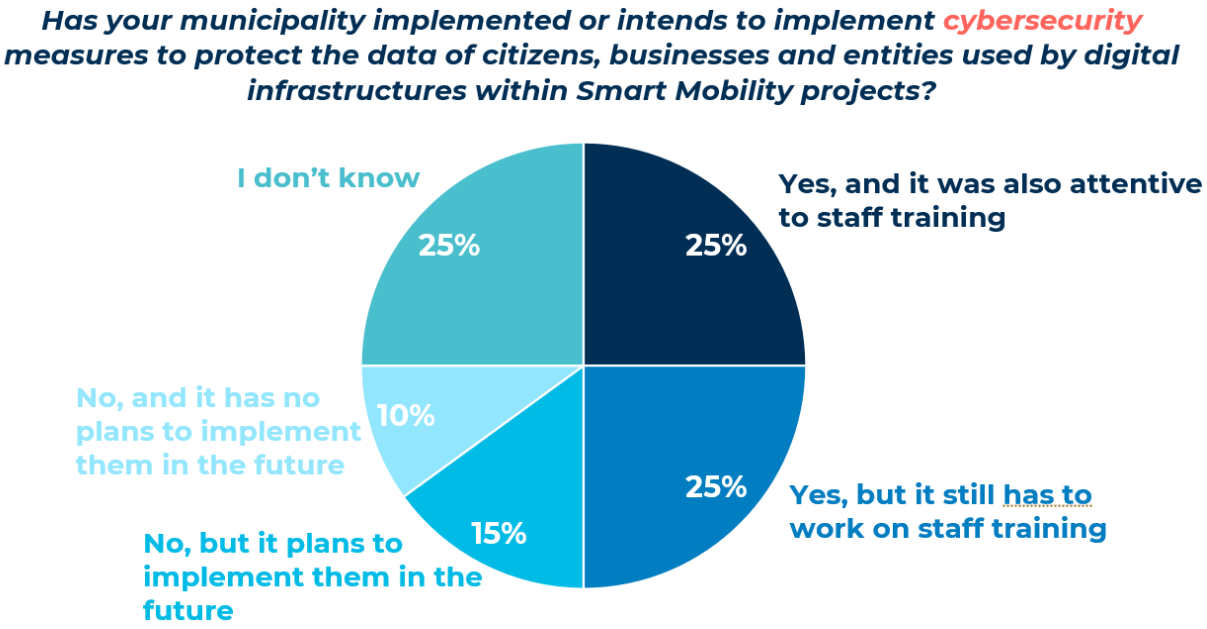

Figure 31. Cybersecurity measures to protect data collected (40 respondents, 40 answers)

An important fact is that today this theme is not very developed in the Italian municipalities; not only because this is the question with less responses (40) and 25% of the respondents do not even know the answer [25], but also because only 50% of them has given a positive response (only half of them is also engaged in training workers to the topic). For the future, there is still much room for improvement in cybersecurity measures.

[25] This is likely due to the respondents' inability to provide an answer to the survey question.

3.2. The European Context

After the analysis of the Italian scenario, let us take now a broader look at the European context thanks to a new database which will be shortly presented. The main goal of this paragraph is to expand the view to the European level to see how this topic is evolving, nevertheless always keeping the main focus on Italy. After answering question Q1 in the previous paragraph (through its subdivision S1, S2 etc.), let us now try to answer the next question, Q2: "*How is smart mobility developing in Europe? Do the trends of innovation and development coincide with what we see in our country?*". In order to do so, this section is structured in four parts, at the beginning the database will be described to contextualise its data and then a more generic analysis is presented to introduce some interesting aspects emerging from the database. After that, there will be a part in which two comparisons will be made among some elements that emerge in the database and in the Italian survey. The chapter ends with a financial analysis that will be done also through the explanation of three matrices.

3.2.1. Geographical and temporal distribution of database projects

The "Database 2015-2024" (provided by the Connected Car & Mobility Observatory of the Politecnico di Milano) includes 518 Smart Mobility projects all over the world, but in this analysis only data referring to European initiatives from 2020 to 2024 will be used, for a total of 313 projects. The analysis was conducted by working on these columns, particularly using pivot tables, used to group, organize, and filter the necessary data in order to find useful and interesting information.

From the image below it's possible to see how different European countries are present in the database, thus contributing to the evolution of smart mobility in our continent. As mentioned earlier, Italy is the country that is contributing more, with 36% of projects, due to an inevitable ease, compared to other countries, in finding information on it (an inevitable type of bias during this type of research). Other countries that contributed most to this analysis are the ones coloured with a darker shade of blue (for example Germany contributes with 8%, Sweden with 7%, France with 6% etc.).

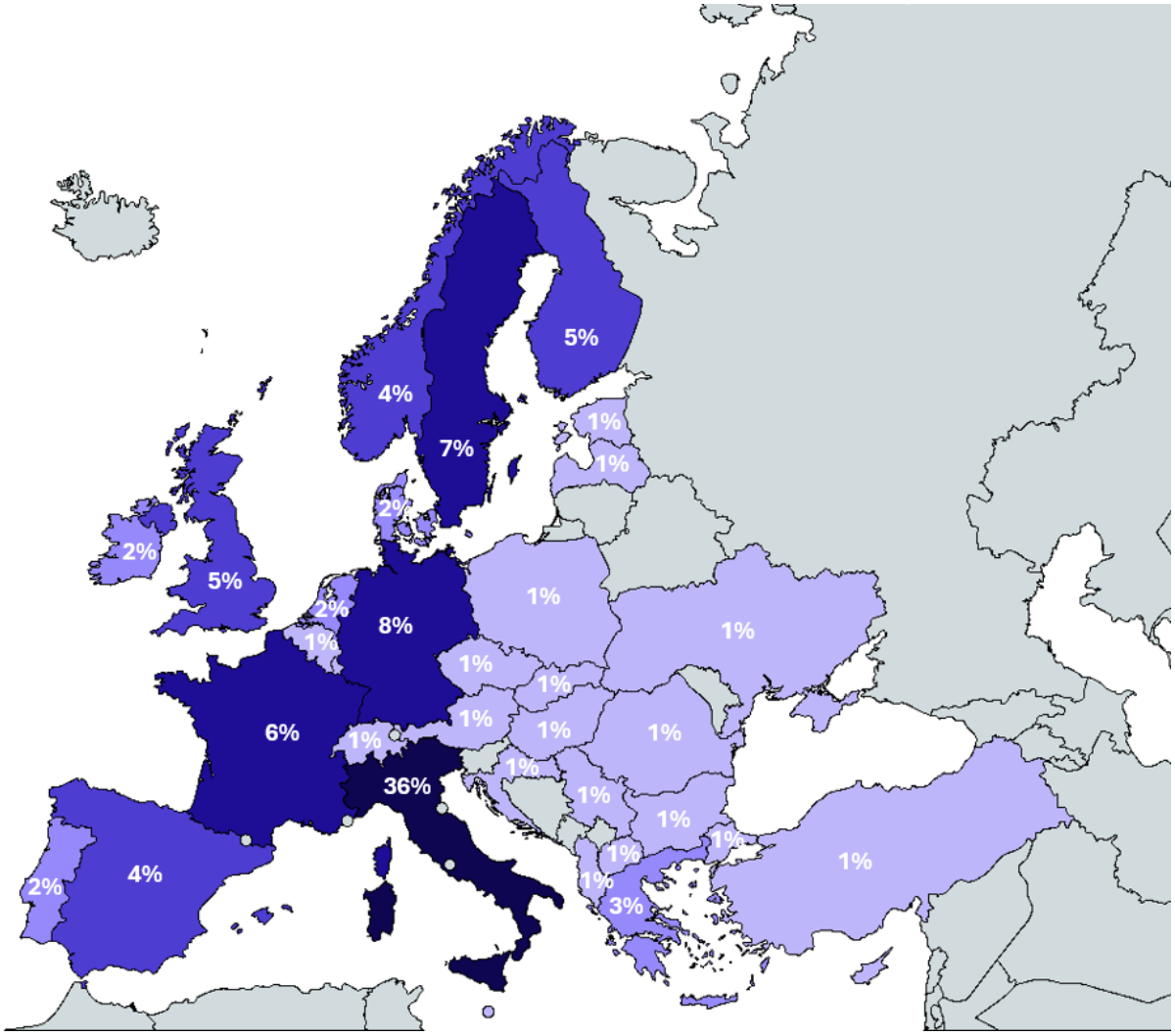

Figure 32. Geographic distribution of database projects[26] (313 projects)

As it is possible to see from the map, the analysis refers to countries that are part of geographical, and not political, Europe; states like England, Ireland, Scotland, Switzerland, Turkey, Ukraine and so on, are present in the database, even if they are not members of the EU.

Another aspect to consider regarding these data is the one concerning their temporal distribution. The year in which the highest number of projects has been found is 2021 (a quarter of the database projects refers to this year), followed by 2020. After 2021 it's possible to see a substantial decrease in the number of projects as it is possible to see in *Figure 33* the 2022 is represented by only 12%. This fact could be attributed to several factors: one reason may be the reduction of extraordinary post-COVID recovery funds, which initially boosted investments in sustainable transportation, another one can be

[26] The total of the percentages does not make 100% due to approximations on the percentages (especially in the 1%).

attributed to economic challenges[27], including inflation and rising energy costs. After this year, the number of projects face a constant increase until today, nevertheless without reaching the 2021 values.

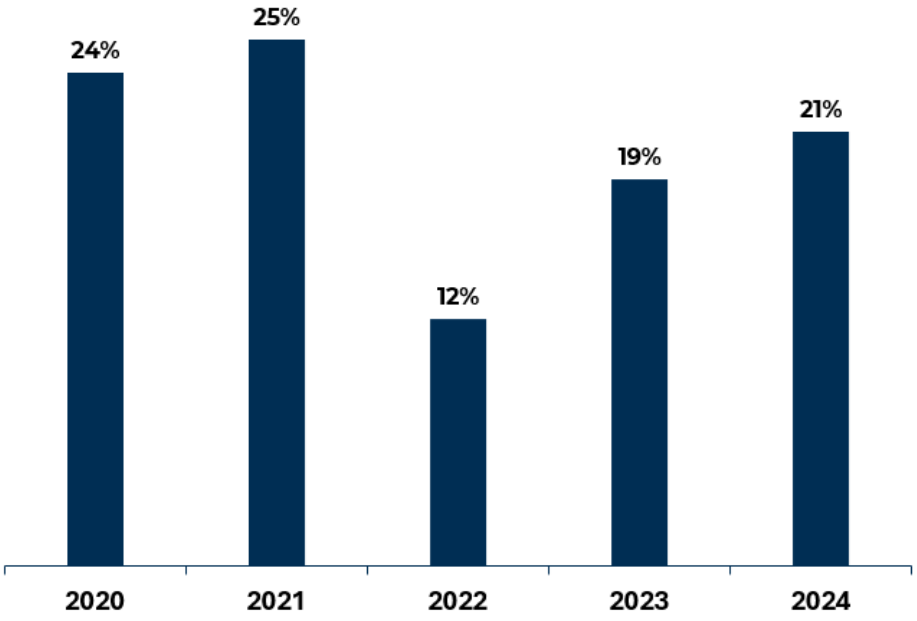

Figure 33. Temporal distribution of database projects (313 projects)

3.2.2. Database analysis

The first characteristic that is interesting to analyse, to better understand what is happening in Europe regarding Smart Mobility, is the context in which these projects are developed; in the database there is a column dedicated to this that can contain only 3 alternatives: "Urban", "Extra-urban" and "Urban and extra-urban". The expected result is a prevalence of urban projects, and this for different reasons Projects on a smaller scale, in this case urban, are easier to implement, require fewer stakeholders, and have a lower budget. Additionally, cities typically have a higher population density, so the benefits of this type of mobility are more evident.

[27] The energy crisis was driven by combination of more geopolitical, economic, and structural factors. The main factor was the Russian invasion of Ukraine in 2022, this triggered sanctions and supply disruptions, significantly affecting Europe's energy stability due to its heavy reliance on Russian gas.

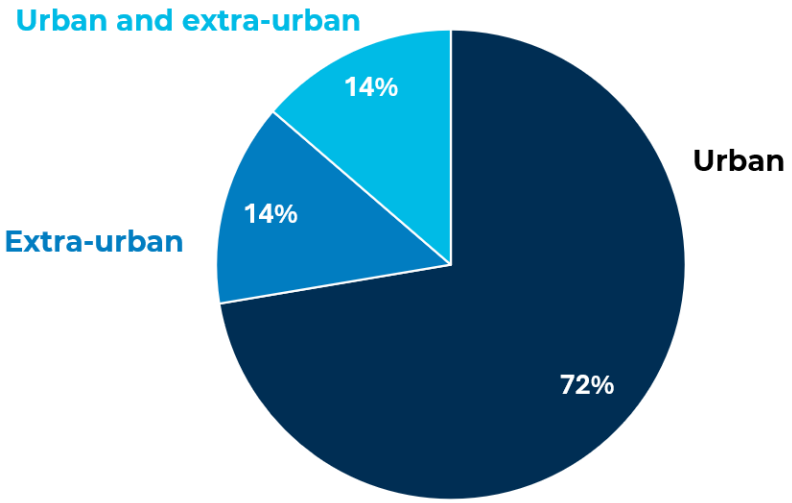

Figure 34. Context of database projects (313 projects)

Figure 34 confirms perfectly the assumption: 72% of the initiatives concern directly a urban context (without considering the projects that are linked both to a urban and extra-urban context); it is important to consider that, although urban-scale projects are usually smaller than extra-urban projects, they can vary greatly: from small local start-ups to large urban projects in big cities.

Another important element to understand is the involvement of the public actor: whether they are present only as an external stakeholder or if they directly fund the projects.

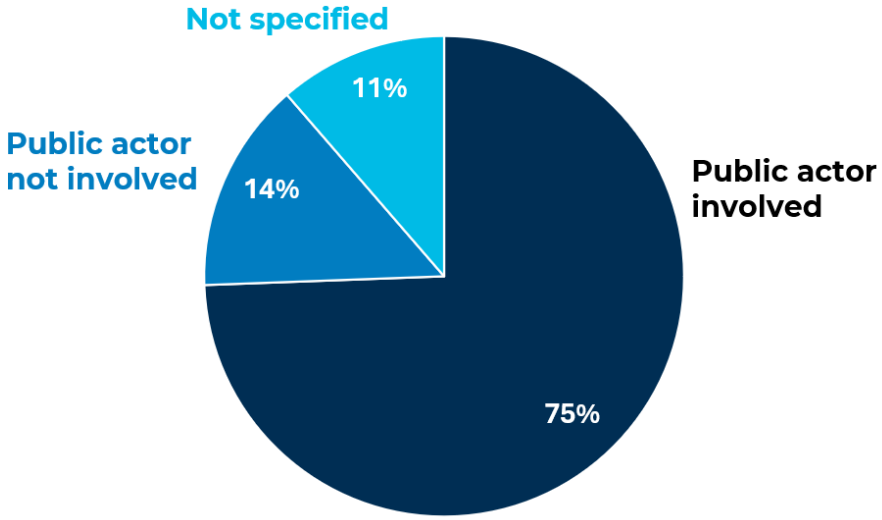

Figure 35. Presence of the public actor in database projects (313 projects)

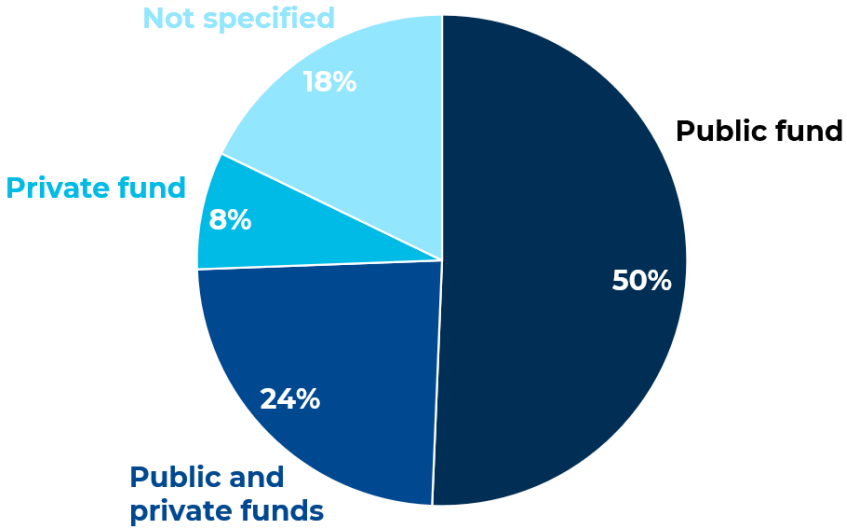

Figure 36. Types of funds for database projects (313 projects)

The situation is clear: the public actors (such as national governments, local authorities and European institutions), today, are involved in the large majority of the Smart Mobility projects in Europe and contribute significantly with the financing. This means that, to date, Smart Mobility, is considered to have a positive impact on the community, it responds to the needs of citizens and has the potential to stimulate the economy, otherwise this data could not be explained.

Having therefore understood the importance of this theme for the public actors, and so for the community of people they represent (remember that the "community" is a very complex and heterogeneous ecosystem that includes many different actors), let's try to understand which players benefit most from Smart Mobility and through what happens. The first question is analysed in the graph at the bottom left, while the second is analysed at the bottom right, both in *figure 37*.

Figure 37. On the left, the main beneficiaries of the database projects, on the right, the main benefits (313 projects)

For what concern the main beneficiaries the result is clear, the main player who gains from this typology of projects is the citizen. Despite an important role is played by the environment, which is the main beneficiary of 19% of the projects, the citizen, so the person who lives in the urban area, is the main beneficiary of 41% of the projects.

It's important to consider that we are talking about an urban environment and, as such, it is a complex ecosystem in which these beneficiaries are not disconnected from each other. Let's take as an example a project that aims to support electric vehicles in the city with new fast and smart charging stations, connected to renewable energy sources such as solar panels. In this case, it's difficult to think of a single main beneficiary: it can be the environment, but the environment necessarily also benefits the citizen due to a decreasing number of CO2 emissions, the driver, in this case all the electric car drivers, and the sector's company, in this case the ones that deal with the creation, implementation and maintenance of smart charging stations.

After seeing that the citizen is the main beneficiary of these type of projects let's now look at the second graph, in order to understand how this benefit occurs. Here the situation is different: the blue line is much wider, there is not just one striker but four: efficiency, viability, sustainability and safety are all considered very important benefits, to the detriment of connectivity, comfort and accessibility. It is therefore important to understand what we mean by these words. efficiency is a benefit which can concern several elements such as energy efficiency or efficiency in transport; the situation can be clarified by an example of a project whose main benefit is precisely efficiency.

Case 14: SWITCH – Street WITCHer, n.a. (Italy)

SWITCH is an initiative company supported by EIT Urban Mobility, an initiative of the European Institute of Innovation and Technology (a body of the European Union). Thanks to the use of algorithms of machine learning and AI technology, the company works to analyse and optimize the distribution of micromobility fleets, thus finding the most efficient solution for both those who use the vehicles of this fleet and those who own them. By integrating fleets in the best possible way into the urban context, SWITCH is a clear example of a project that has efficiency as its objective and therefore benefit.

Viability regards all the projects that aim to reduce traffic, which is a very important issue especially in large urban areas. Sustainability is a benefit that concerns environmental and energy sustainability, while safety is used, for example, for projects that study smart sensors to be implemented in cars to avoid accidents, projects that involve the use of cameras to promptly call for help in the event of accidents or the creation of cycle paths in which cyclists do not risk coming into contact with cars. The last three benefits are connectivity, such as all regarding the V2X technologies, comfort, like projects involving fast and smart payment methods for parking, and, last, accessibility, so a benefit that concerns, for example, the ease of access to public transport, infrastructure or digital platforms. Again, it is necessary to remember that these benefits very often are linked to each other and, in fact, for this reason, in the database there are 3 different columns in which it is possible to write the benefits resulting from just one project.

3.2.3. First comparison: the application areas

So far, in this chapter, we have always talked about smart mobility in a general way, but we know that, in this term, there are many types of projects and many ways of understanding mobility. Let's continue dividing the types of Smart Mobility projects that we observe most in Europe, in order to make a comparison with the Italian paradigm.

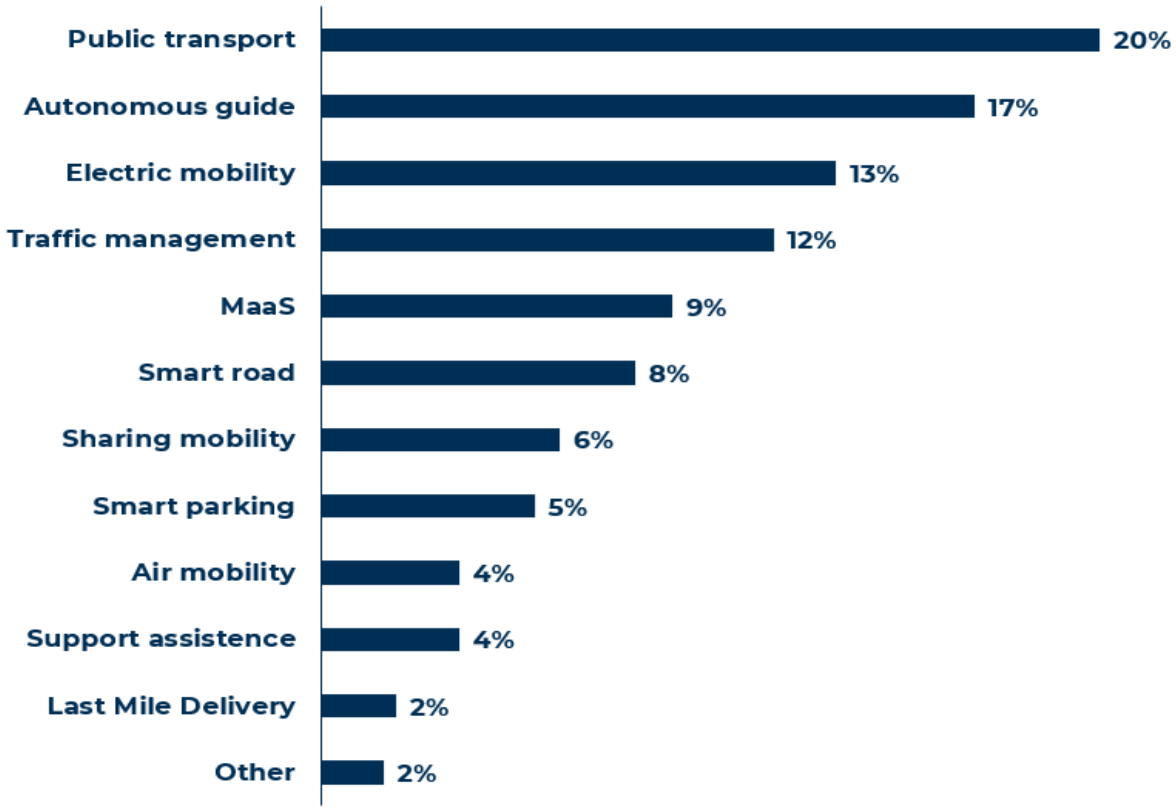

Figure 38. Breakdown of database projects by application area (313 projects)

Figure 38 is done clustering all the 313 projects in the categories that have been used also in the Italian survey. In this case the most representative application area is public transport, containing a fifth of all projects, followed by the autonomous guide (17%), the electric mobility (13%) and the traffic management (12%). The result found is fully consistent with what was found before: at least 75% of the projects in the database see a public actor involved and at least half involve it from a financial point of view, so it makes sense that public transport is the first application area. An interesting comparison can be made between this graph and the one created using the answers of the Italian municipalities to the question: *"Does the municipality intend to start Smart Mobility projects in future?"*.

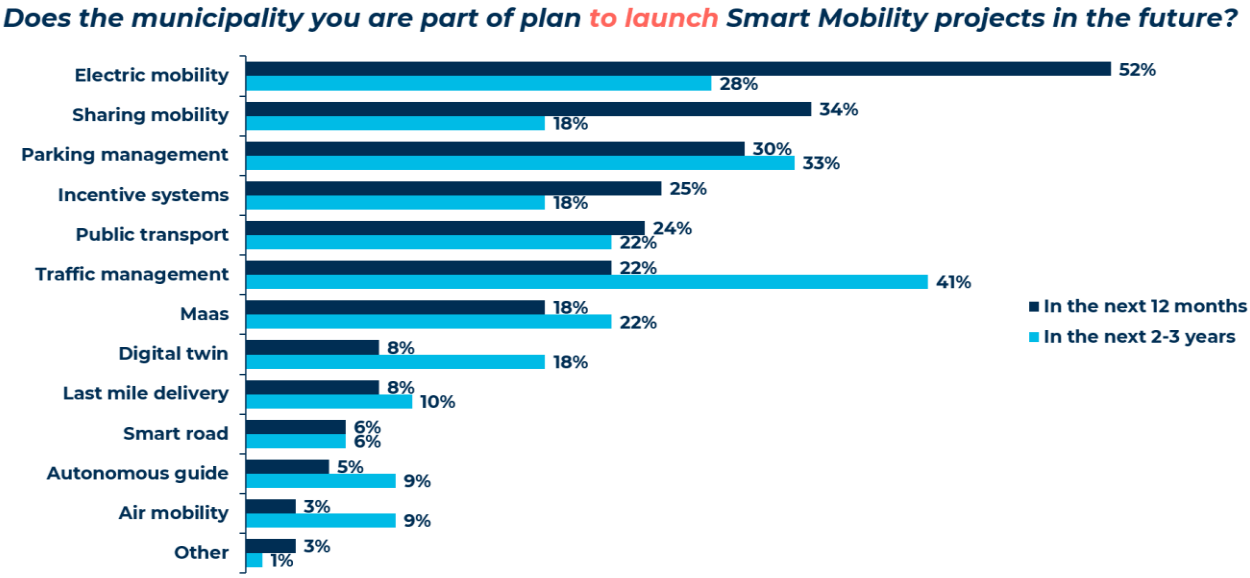

Figure 39. Application areas[28] on which Italian municipalities are looking for the future (85 respondents, 371 answers)

In this case the graph is composed by two lines, the dark blue represents the next future (12 months), whereas the light blue a more distant future (2-3 years); Italian municipalities had also the possibility to indicate one or more answers (so the sum of the percentages will not make 100% as in the case of *Figure 38*). According to the graph, in the next 12 months, the Italian municipalities intend to start projects regarding: electric mobility (52%), sharing mobility (34%) and parking management (30%). If we look forward in time, the focus shifts to traffic management (41%), parking management (33%) and electric mobility (28%). Making a comparison between these two graphs let's analyse the main element. The electric mobility is a very important topic in Italy, especially in the short term; it is important also in Europe, but, probably due to the fact that it is a type of mobility already widely used in Northern Europe, there are fewer projects concerning it in recent years. Whereas in Europe many projects concern public transport, the survey underlines the Italian interest in sharing mobility and smart parking, which are not very present in the Database. However, the main difference that this sub-paragraph wants to underline concerns autonomous guide: very present in recent years in Europe and very little selected by Italian municipalities for their future projects.

[28] This question is also asked about the "digital twins", which does not appear as an application area in the database.

3.2.4. Second comparison: the artificial intelligence

Another curiosity that emerges by comparing the database and the Italian survey concerns the artificial intelligence. Looking at the results of the survey it's possible to see that there are two questions regarding this topic, the first one reads: "*Does your municipality use or are you planning to use artificial intelligence (AI)-based solutions to improve the efficiency and quality of municipal services in the field of Smart Mobility?*". What can be deduced from *figure 40* is that in Italy AI is not yet a technology so exploited by our municipalities, and there is still some uncertainty.

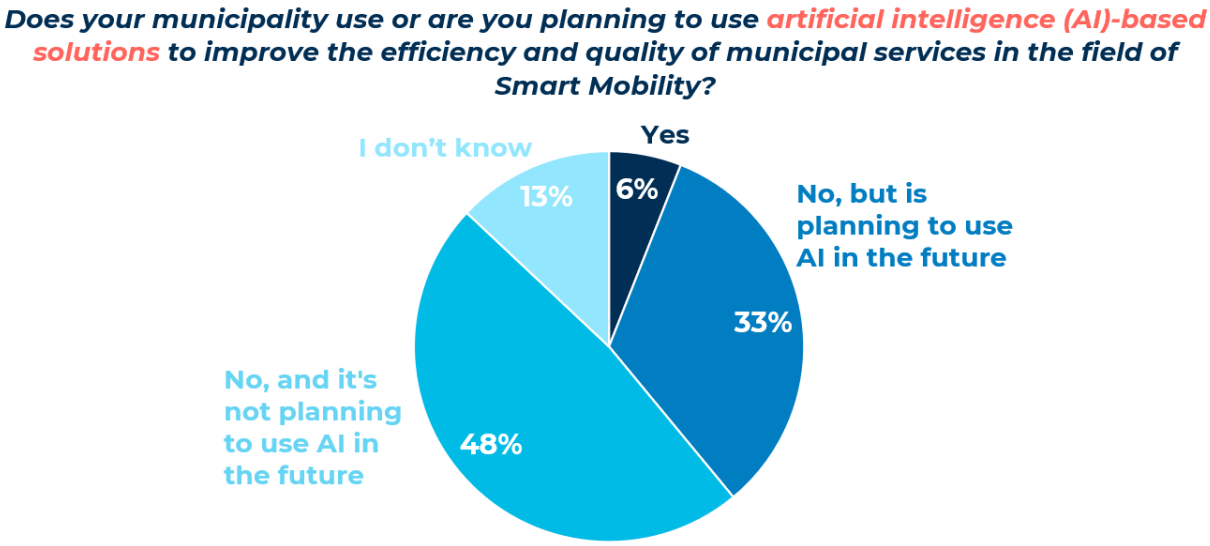

Figure 40. The use of AI in the Italian municipalities for smart mobility projects (84 respondents, 84 answers)

At this point let's see if it is also confirmed by the database. AI is used in 29% of the projects in the database but, if we divide Italy from the rest of Europe, it is possible to see how the situation is clearly different: as far as European projects outside Italy are concerned, AI is present in 47% of them, while, if we look at the Italian ones, the percentage drops to 12%. The answer, therefore, is affirmative: even when analysing the database, it becomes evident that AI is not a widely used technology in this field in Italy.

The second question regarding this topic, which is present in the survey, reads: "*What are the application areas where you foresee the greatest impact related to the use of artificial intelligence (AI) algorithms on urban mobility in the next 2-3 years?*".

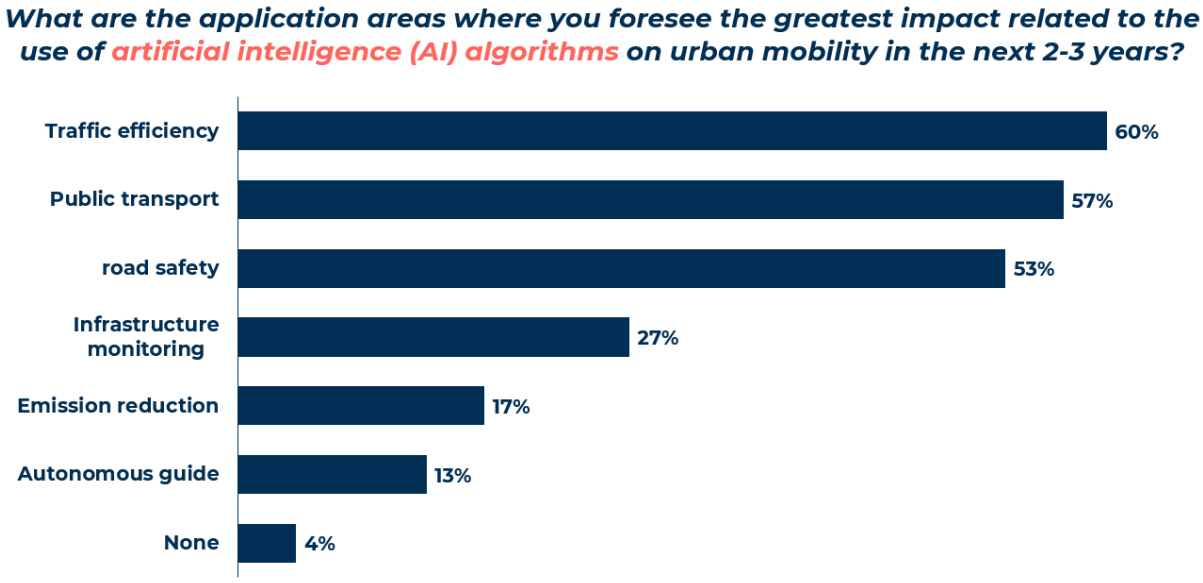

Figure 41. Forecasts regarding the use of AI in urban mobility (77 respondents, 179 answers)

Italian municipalities foresee a greater use of AI for traffic efficiency, public transport, and road safety, which is certainly a valid prediction. However, autonomous driving is significantly underestimated. According to the database, the application area where AI is most commonly used is autonomous driving, with 62% of projects in this category incorporating AI. Yet, only 13% of Italian municipalities have planned to adopt this technology in the coming years. In summary, AI plays a smaller role in Italy's smart mobility sector compared to the European paradigm, maybe because autonomous driving (where AI is most widely applied) receives less attention overall.

3.2.5. Financial analysis

Now, in this last part of this chapter, the focus is going to switch to a financial perspective in order to better understand the budgets for the different application areas and how these are evolving over time.

The first graph is created making a cluster analysis over 123 projects of the database (all those where it was possible to find the budget value, in Europe and after 2020), the 5 clusters were created based on the monetary budget of a project, without considering the origin of it, being it public, private or a mix of both.

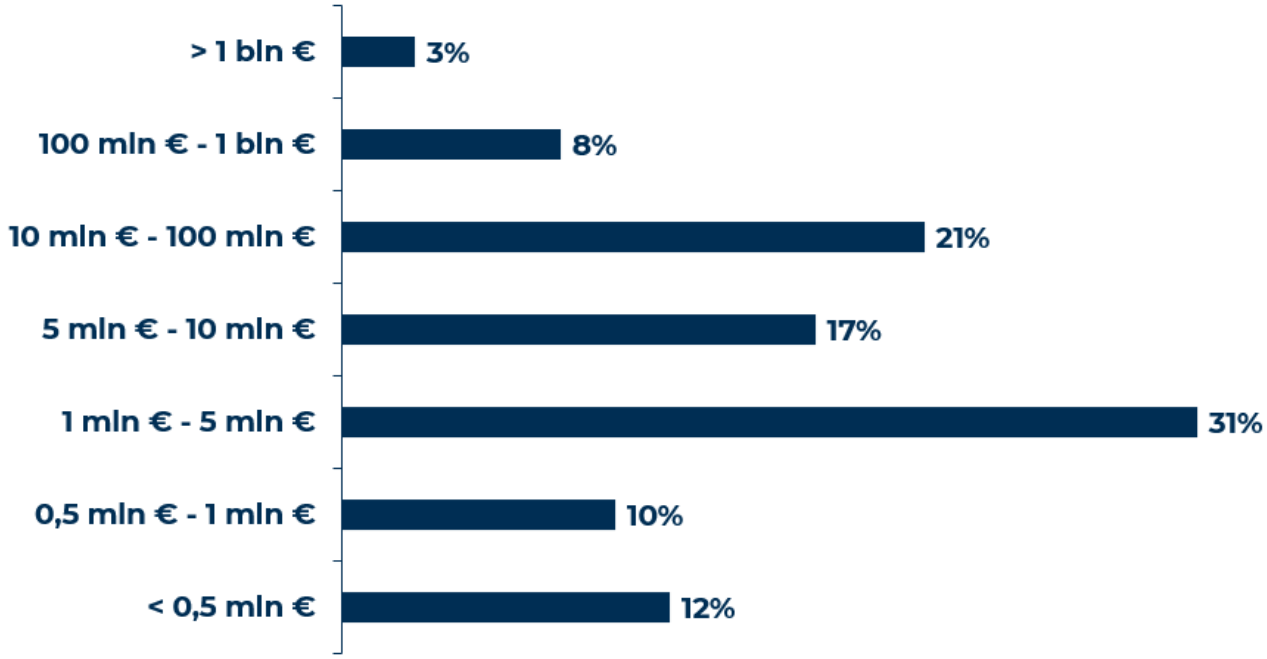

Figure 42. Different clusters of budgets for database projects (123 projects)

The most significant cluster is the one concerning a budget between 1 and 5 million euros, as 31% of all the projects whose budget is known, are characterized by this value. The second cluster is composed by projects with a budget between 10 and 100 million euros with 21% of projects, 4% more than the third cluster composed by a monetary value between 5 and 10 million euros. The smallest cluster is the one composed by projects with a very high budget, more than one billion euros, so projects that are very large and long term oriented. An example of a major project that falls into this last cluster is the one presented below in *Case 15*.

Case 15: Piano Industriale di Autostrade per l'Italia, 2022 (Italy)

This project, whose budget is estimated to be 21,500 billion euros (dedicated to both investments and maintenance, from 2022 to 2038), is an impressive, long-term oriented project that aims to modernize the Italian motorway network towards a more connected, safety and efficient one. Some concrete actions that Autostrade per l'Italia S.p.A. aims to implement through this project include: the installation of IoT sensors on bridges, viaducts, and tunnels for predictive maintenance, the creation of digital twins to simulate scenarios and prevent critical issues on the highway network, the deployment of electric vehicle charging areas every 50 km across the entire highway network and the implementation of smart rest areas with real-time monitoring of available parking spaces.

Another very interesting analysis can be done looking at how funding varies over the years. To do that, a clarification must be done: the data field had some bias values that were eliminated in order to have a more consistent analysis. This data cleaning was performed by analysing the standard deviation for the various yearly averages, ensuring that this value was not too high. In particular: 1 value has been eliminated for year 2020, 2 values has been eliminated for years 2021, 3 values for year 2022, 2 values for year 2023 and values for year 2024; in all these cases these values were too high (an example of a project considered "biased" is the one previously presented in *Case 15*; such a high budget deviates too much from the average values, exponentially increasing the standard deviation).

YEAR	2020	2021	2022	2023	2024
MEAN OF FUNDING [mln €]	*7,10*	*13,09*	*18,82*	*13,25*	*10,08*
STANDARD DEVIATION	*9,06*	*24,68*	*31,76*	*14,41*	*25,51*
NUMBER OF ELIMINATED VALUES	*1,00*	*2,00*	*3,00*	*2,00*	*3,00*
MEDIAN OF THE FUNDING [mln €]	*3,90*	*4,85*	*9,94*	*9,05*	*4,00*

Table 9. Mean, median and standard deviation of the database projects' budget (112 projects)

As can be seen in *Table 9*, unfortunately, we still have a standard deviation that is higher than the mean (even after removing the most extreme outliers). This is due to the fact that the values exhibit a high level of dispersion. Acknowledging this, it was decided to calculate also an indicator that, unlike the mean, is less affected by extreme values: the median. Looking at the table, we can observe two main things, the first one is that the median values are significantly lower than the mean values (as expected due to the significant dispersion of the data). This is not the case when referring to the median values, as 2022 and 2023 are very similar to each other.

3.2.6. First Matrix

In this last sub paragraphs three matrices will be presented to end the financial analysis. These 4X4 matrices were created by combining two of these dimensions at a time: average funding, maturity level and percentages of public investment.

To calculate the percentage of public funding, the database column "public, private, public and private funds" was used. In these matrices, a percentage around 40% is considered low, while a percentage close to 95% is considered high.

To determine the maturity level, the database column "progress status" was used, which includes the following stages: "Preliminary analysis", "Pilot project", "Executive project", and "Completed project". A weighted average of these elements was calculated, assigning a value from 0 to 1 to each application area: the higher the number, the higher the maturity level.

Finally, to determine the average funding of each application area, the mean value of financing was calculated[29]. The elements will be placed within the matrix using circles of different diameters, with the circle size proportional to the number of projects in that application area.

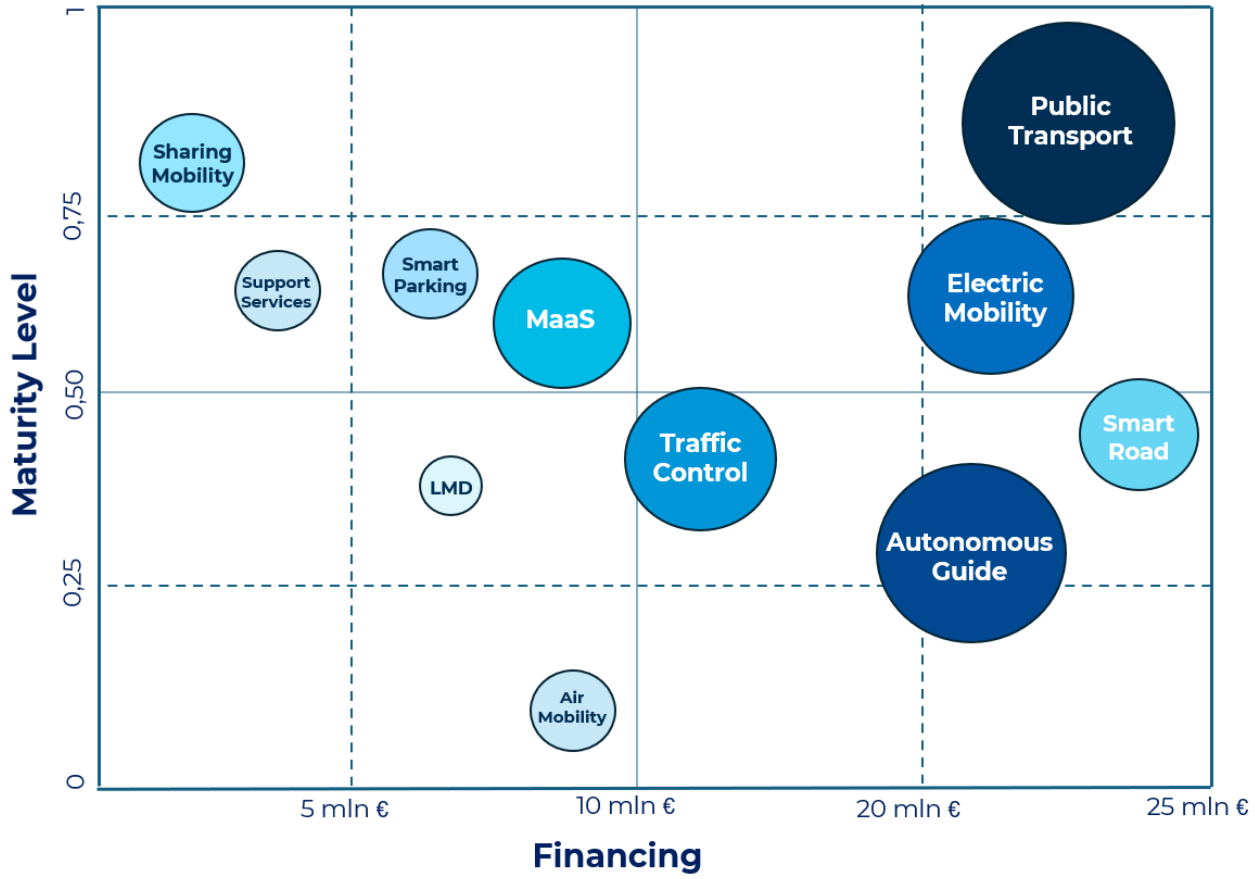

Figure 43. First Matrix (118 projects)

This first matrix uses funding as the horizontal axis and maturity level as the vertical axis. The elements are scattered across the matrix, covering almost all quadrants. In the far-right section, which includes the highest level of funding, there are four elements that differ in their maturity levels, in ascending order: Autonomous Driving, Smart Roads, Electric Mobility, and finally, Public Transport. In the upper-medium funding range, there is only one element, Traffic Control, with a medium-low maturity level. In the lower-medium funding range, there are four elements: Air Mobility (which is positioned the lowest, making it the least mature application area), LMD (with medium-low maturity), and finally, MaaS and Smart Parking, which share the same quadrant with a medium-high maturity level. As for the far-left section of the

[29] Bias values, which were different from those previously deleted due to a different grouping of data, have also been eliminated here.

matrix, Support Services are positioned with a medium-high maturity level, while Sharing Mobility stands out with a high maturity level.

3.2.7. Second matrix

Let's see the second matrix, in which the "Maturity level" axe is replaced with the "Percentage of public investment" axe: how many projects in percentage are financed with public money by public actors.

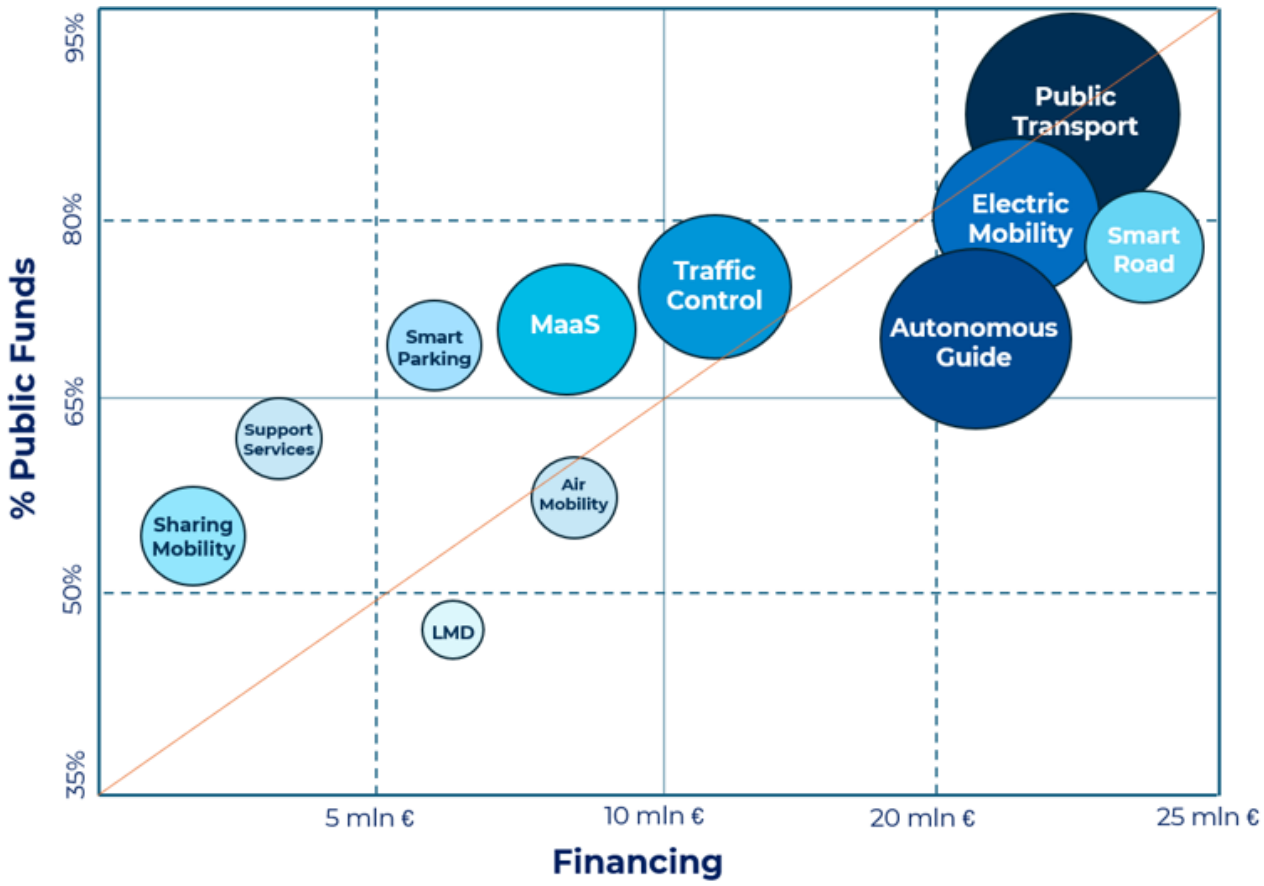

Figure 44. Second matrix (118 projects)

Looking at the matrix, the first thing that stands out is that, unlike before, the elements seem to roughly align with the diagonal, with some elements overlapping in the upper-right section; The six boxes furthest from the red line (three at the top left and three at the bottom right) are not occupied by any elements. Where funding is more substantial, there is also greater public commitment; conversely, the elements with lower funding are those where the proportion of public funds is lower. This suggests that public funds primarily support application areas where greater economic effort is needed (in addition to public transportation, for example, we find electric mobility and

smart roads), while private investments are more focused on areas requiring less funding (such as LMD and shared mobility).

3.2.8. Third matrix

This final matrix represents the combination of "Maturity Level" and "Percentage of Public Investment."

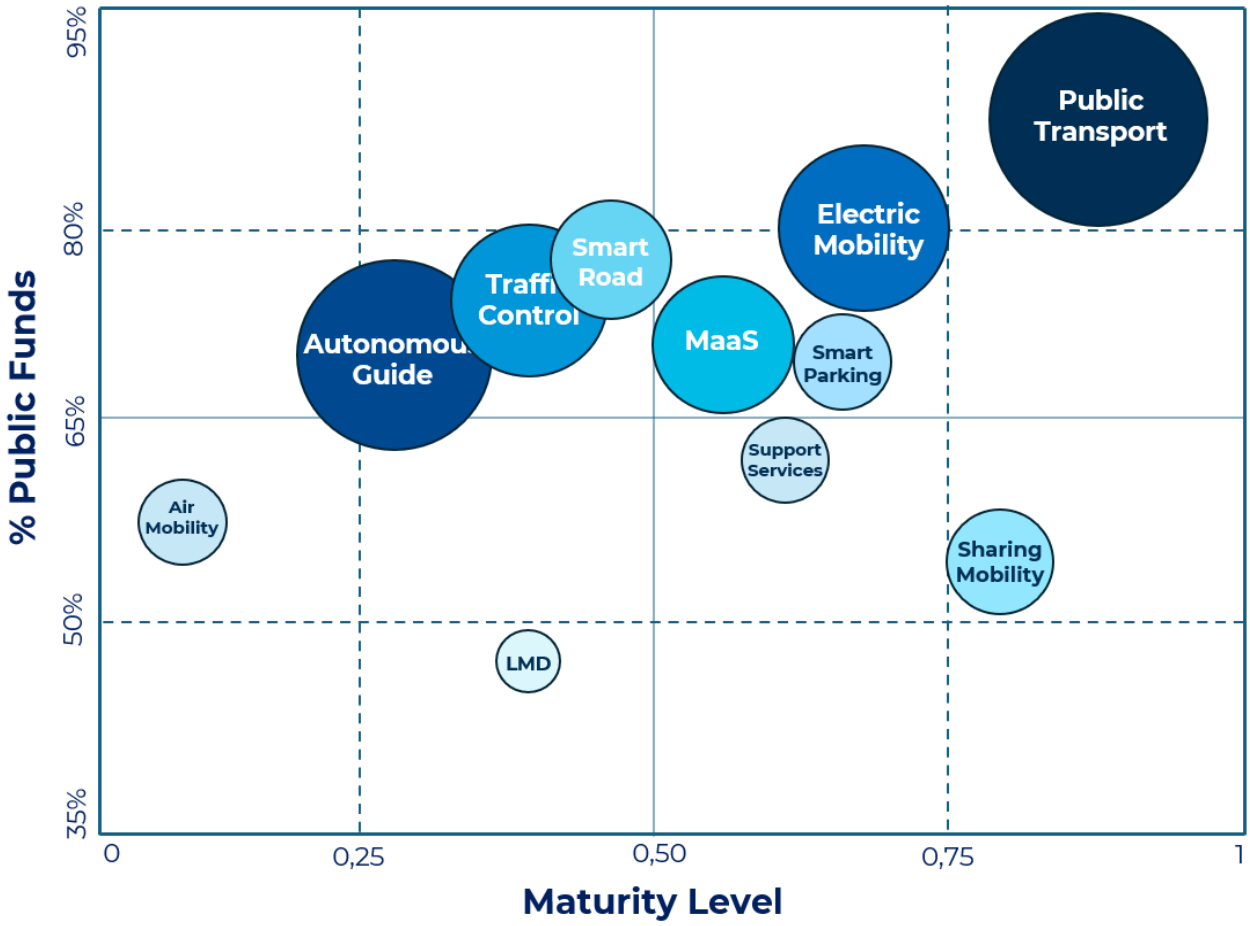

Figure 45. Third matrix (118 projects)

This matrix can be used to answer the question: *"Does the presence of public actors actually drive the development and growth of different application areas?"*. Analysing this matrix, the answer appears to be a partial "yes", as public funding plays a role, but it is not the only factor determining technological maturity.

The elements on the right side of the matrix (those with a medium-high or high maturity level) are not all positioned at the top, meaning they do not all receive a high percentage of public funds. In the upper right quadrant, we find public transport, electric mobility, smart parking, and MaaS, all benefiting from strong public investment. Conversely, in the lower section, support services and sharing mobility

have reached a mature technological stage despite receiving relatively little public funding. On the left side of the matrix, we see autonomous driving, smart roads, and traffic control, all characterized by a medium-high percentage of public funds. Given their reliance on public investment, it is reasonable to expect these technologies to continue evolving and increasing their maturity level over time. Finally, air mobility remains in an early development stage, with both low maturity and a medium-low percentage of public funding. Similarly, Last Mile Delivery has a low percentage of public funds and a medium-low maturity level. This matrix highlights that public funds are indeed very important for the development of many application areas, even though some applications, such as shared mobility and assistance services, can achieve significant levels of maturity primarily through private funding.

4 Conclusion

This final chapter will now be used to summarize all points covered so far, in order to provide more direct answers to the three questions presented in Chapter 2 "*Objectives and Methodologies*".

Let's now retrace the discussion we have conducted, starting by answering the first question: *"What is the current state of Smart Mobility in Italy?"*. Q1 was mainly addressed in the sub-section 1.1.1 "*Italian Regulations*" and in section 3.1 "*The Italian Scenario*", where it was divided into several sub-questions and analysed through a direct comparison with Italian municipalities. The first key takeaway from this analysis is that Smart Mobility is certainly a relevant topic in Italy: 77% of the municipalities under review consider it to be a very important or even fundamental issue (*Figure 14*). Additionally, we observed other positive results: 59% of municipalities have at least one dedicated Smart Mobility figure (*Figure 15*), and 65% have launched smart mobility projects since 2022, with a growing trend in recent years (*Figure 16*). However, through the cluster analysis, we found that these positive results primarily belong to larger municipalities. We then explored the origins of the need to initiate such projects and the driving factors behind them. The analysis revealed that, in most cases, the motivation stems from political bodies' initiatives (*Figure 17*), with the primary objective being mobility optimization. At this point, we aimed to understand the strategies and competencies of the municipalities and the actors dedicated to this topic. Once again, the analysis revealed that more complex strategies (*Figure 21*) and advanced competencies (*Figure 22*) are still somewhat lagging, particularly in smaller municipalities. We then examined the maturity level of key application areas (*Figure 22*), in order to understand the current state of Smart Mobility today and what we can expect in the near future. In half of these areas, the majority of projects are still in the exploration phase. The areas currently receiving the most focus in Italy appear to be electric mobility, traffic control, and shared mobility. After this, we analysed which solutions are of greatest interest to Italian municipalities in certain application areas, shifting the focus of the analysis to the next three years. Then the focus shifted to the barriers that Italian municipalities face in this field. Two main obstacles emerged: lack of knowledge and scarcity of resources (*Figure 27*). In this regard, as mentioned in the introduction, the funds provided by the European Union and the Italian government, such as the PNRR, represent a significant support in addressing these challenges. Finally, considering how these barriers can be overcome, we explored potential

collaborations for developing smart mobility projects and examined how municipalities utilize the data generated by these initiatives.

The second question we are now going to answer is the following: *"How is smart mobility developing in Europe? Do the trends of innovation and development coincide with what happens in our Country?"*. To answer this question, we need to look at section 1.1 "*Policy Regulation in Europe*" and section 3.2 "*The European Context*". In the latter, we analysed a database containing various Smart Mobility projects, filtering them to include only those from Europe and from 2022 onward. From this analysis, we identified similarities and differences between the Italian and European contexts. Definitely, the vision that both share regarding mobility is clear, unified, and future-oriented, driven by European regulations, above all the Green Deal and the Sustainable and Smart Mobility Strategy, which are also embraced by our country. However, differences emerge in the implementation and maturity of projects. Initially, we contextualized the database and its projects by analysing their distribution across European countries, determining whether they concern to urban or non-urban contexts, assessing the involvement of public actors, examining the sources of funding for the various projects and finally the beneficiaries and benefits. The result was that most of the projects concern an urban context in which the public actor is involved[30] and that also participates in the direct financing of the project. As far as the beneficiaries are concerned, the main one is certainly the citizen whereas for the benefits these are multiple: viability, efficiency, safety and sustainability. Subsequently, before conducting a financial analysis of these projects, we focused on some key differences that emerged from the database analysis. The previous analysis focused on application areas (particularly autonomous driving) and AI; however, in addition to these, it is also important to consider electric driving. Let us now open a brief parenthesis on autonomous driving and electric driving (also adding new data to expand the discussion):

- One of the most notable findings was that a significant number of European projects are related to autonomous driving (*Figure 38*), whereas very few Italian municipalities identified this as a priority area for future development (*Figure 39*). This discrepancy can be attributed to several factors, one of this is for sure Italy's more restrictive and fragmented regulatory framework. Currently, autonomous driving testing on public roads is only permitted with specific authorizations and must be conducted under human supervision. This regulatory constraint slows down development compared to other European countries, where large-scale testing is already in operation. Other factors can be linked to the infrastructure and Smart Roads, that are less common in our

[30] It must be remembered that for the research that has been conducted it is certainly easier to find projects funded by the public actor (this is another inevitable type of bias).

country respect to the ones leader in Europe, and maybe also to the underutilization of artificial intelligence in smart mobility projects.

- Another significant difference between Italy and the rest of Europe emerges in the field of electric mobility. Italy lags considerably behind in the electrification of its vehicle fleet compared to the European average. In 2024, 13.6% of new registered cars in Europe were electric, with Norway leading at 88.9%, whereas in Italy, this value remains significantly lower at 4.2%. Since 2017, electric vehicle sales in Italy experienced a steady increase, with nearly a doubling of registrations each year, driven by the introduction of more competitive models and the availability of state and regional incentives. However, this trend reversed in 2022, primarily due to the termination of incentives[31] at the end of 2021 and the Ukraine war, which led to a surge in electricity prices, making electric vehicles less economically advantageous than gasoline-powered cars, both in terms of purchase price and operating costs. The years 2022-2024 marked a stagnation in market growth, largely attributed to the absence of structured incentive programs or the implementation of ineffective policies that hindered progress. While most European countries are witnessing a progressive and steady adoption of electric vehicles, Italy may experience a prolonged slow growth, followed by a rapid acceleration as regulatory constraints intensify, particularly with the 2035 ban on internal combustion vehicle sales. Another noteworthy aspect is the steady growth of electric charging points across Italy, although this expansion is disproportionately concentrated in northern regions compared to the south. This misalignment between the increase in infrastructure and the decline in electric vehicle registrations highlights the urgent need for more effective policies aimed at incentivizing electric vehicle adoption.

Finally, the section dedicated to the European context concluded with a financial analysis. First, a cluster-based analysis was conducted, revealing that the most representative cluster included funding amounts between 1 and 5 million euros. Then, three matrices were presented, each illustrating different aspects of Smart Mobility applications. The first matrix demonstrated that high levels of maturity can be achieved even with relatively low funding, depending on the application area. The second matrix highlighted the crucial role of public actors in sectors where average project funding is high, showing that as funding increases, so does the involvement of public entities. Lastly, the third matrix illustrated that while public funding plays a significant role in reaching high maturity levels, it is not always essential. For instance,

[31] The incentives dedicated to the purchase of electric vehicles have not been renewed by the Italian government for 2025. Instead, they have been redirected towards investments in the automotive industry to support domestic production.

sharing mobility has achieved a high level of maturity despite relatively low project funding.

The last question we need to answer is Q3, which states: "*How will smart mobility change in the coming years? Which areas are expected to be more prosperous?"*. In the coming years, Smart Mobility is expected to undergo a profound transformation, driven by rapid technological advancements, increasing urbanization, and the global push for sustainability. The continued expansion of electric vehicles will remain a key trend, with significant investments in EV infrastructure, including fast-charging stations and the integration of renewable energy sources into transportation networks. Governments and private sectors are likely to collaborate in enhancing battery technology, reducing costs, and improving accessibility to accelerate the transition away from fossil-fuel-powered vehicles. Another pivotal development will be the rise of autonomous vehicles, which promise to revolutionize transportation by increasing efficiency, reducing human error, and optimizing traffic flow. However, while progress in automation is undeniable, the widespread adoption of fully autonomous systems may take longer than anticipated due to stringent regulatory requirements, ongoing safety concerns, and the need for extensive infrastructure adaptations. Despite these challenges, partially autonomous features, such as advanced driver assistance systems (ADAS) and self-parking technologies, are expected to become mainstream in the near future. At the same time, connected transportation systems will become more sophisticated, leveraging the power of the Internet of Things and 5G networks to enable seamless vehicle-to-vehicle and vehicle-to-infrastructure communication. This enhanced connectivity will lead to smarter traffic management, improved road safety, and greater efficiency in urban mobility, reducing congestion and emissions. Moreover, the expansion of shared mobility services (including car-sharing, bike-sharing, ride-hailing, and micro-mobility solutions) will play an increasingly vital role in urban environments. As cities aim to reduce traffic congestion and promote eco-friendly alternatives, these services will be supported by digital platforms that optimize route planning, pricing, and vehicle availability. The concept of Mobility-as-a-Service, which integrates various transportation options into a single, user-friendly platform, is expected to gain widespread adoption, offering seamless multimodal travel experiences. When considering the most prosperous areas in smart mobility, electric and autonomous transportation, as well as MaaS platforms, stand out as key growth sectors. Innovations in battery storage, artificial intelligence, data analytics, and sustainable transport solutions will continue to attract significant investments, shaping the future landscape of mobility. To conclude, the trajectory of Smart Mobility is clear: its importance will continue to grow in the years to come. However, the scale of its evolution will largely depend on governmental policies, public and private investments, regulatory frameworks, financial incentives, and public awareness. The extent to which societies embrace these advancements will

ultimately determine how quickly and effectively Smart Mobility can revolutionize our cities and transportation systems, making them more efficient, sustainable, and connected.

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Appendix A

Here it's attached the survey sent to the Italian municipalities by the Osservatorio Connected Car & Mobility of the Politecnico di Milano.

"OSSERVATORIO CONNECTED VEHICLE & MOBILITY"

SMART MOBILITY

SCHOOL OF MANAGEMENT DEL POLITECNICO DI MILANO

INDAGINE SUI PROGETTI SMART MOBILITY

SURVEY COMUNI ITALIANI

Obiettivo dell'indagine: **approfondire lo stato di diffusione in Italia dei progetti di Smart Mobility.**

L'espressione *Smart Mobility* racchiude in sé una concezione della mobilità urbana che integra molteplici modalità di trasporto al fine di garantire la massima efficienza di spostamento, flessibilità, sicurezza e convenienza. Alcuni esempi di funzionalità dell'offerta riferite all'ambito Smart Mobility sono: la gestione dei parcheggi e del traffico; last-mile delivery (gestione del trasporto merci con riferimento all'ultimo tratto della catena logistica); la mobilità elettrica; lo sharing e l'ottimizzazione del trasporto pubblico e privato. Tramite l'integrazione delle nuove tecnologie digitali con i trasporti pubblici, le infrastrutture urbane esistenti e le nuove modalità di sharing dei veicoli, le applicazioni di Smart Mobility mirano a ridurre il traffico e l'inquinamento, a creare flussi intelligenti e senza interruzioni, e a rafforzare le economie di scala per promuovere una mobilità accessibile a tutti. Inserita in un contesto più ampio di Smart City, la Smart Mobility contribuisce ad innalzare gli standard di sostenibilità, vivibilità e dinamismo economico delle città del futuro.

Guida alla compilazione del questionario: **la compilazione la impegnerà non più di 10 minuti. Non sono necessarie competenze tecnologiche specifiche per la compilazione del questionario.**

Se desidera interrompere momentaneamente la compilazione, al termine di ogni pagina potrà salvare le sue risposte cliccando su "Salva". Le sue risposte saranno conservate e le verrà inviata un'email con il link per ritornare al questionario e terminarlo.

Eventuali chiarimenti in merito alla compilazione del questionario possono essere richiesti ad Elisa Vannini (elisa.vannini@polimi.it – 3470035450). Qualora preferisse è possibile rispondere alle domande del questionario tramite intervista telefonica.

Cliccando su "inizia il questionario" esprime il consenso al trattamento dei suoi dati da parte degli Osservatori Digital Innovation e dichiara di aver preso visione dell'informativa privacy (link).

QUESTIONARIO

1) La preghiamo di inserire i suoi dati anagrafici:*

Comune	
Nome e Cognome	
Ruolo professionale	
e-mail	
Contatto telefonico	
Disponibilità a intervista telefonica di approfondimento	☐

2) Quanto è rilevante il tema Smart Mobility per il suo Comune?*

Le chiediamo di indicare il livello di rilevanza nella tabella sottostante, in cui:

- *1= il tema non è rilevante*
- *2= il tema è poco rilevante*
- *3= il tema è molto rilevante*
- *4= il tema è fondamentale Selezionare una sola risposta*

Livello di rilevanza	1 ☐	2 ☐	3 ☐	4 ☐

Note:

3) È presente una figura che si occupa del tema Smart Mobility all'interno del Comune?

Selezionare al massimo 2 risposte. Indicare se possibile nel campo Note il job title della persona che si occupa di tematiche Smart Mobility.

☐ Sì, è un Assessore dedicato al tema Smart Mobility

☐ Sì, è un Assessore che tra le sue attività si occupa anche di Smart Mobility

☐ Sì, è un Responsabile tecnico o un'altra figura tecnica che si occupa di queste tematiche

☐ Sì, è il Responsabile alla Transizione Digitale e/o Sostenibile

☐ No, ma la stiamo cercando

☐ No, e non è previsto il suo inserimento

☐ Altro (*specificare nel campo note*)

Note:

4) Il Comune di cui fa parte ha avviato progetti Smart Mobility nel triennio 2022-24?*

Selezionare una o più risposte

☐ Sì, abbiamo avviato almeno un progetto in ambito Smart Mobility nel 2024

☐ Sì, abbiamo avviato almeno un progetto in ambito Smart Mobility nel 2023

☐ Sì, abbiamo avviato almeno un progetto in ambito Smart Mobility nel 2022

☐ Sì, abbiamo avviato almeno un progetto in ambito Smart Mobility, ma prima del 2022 ☐ No Note:

Se è stato indicato almeno un progetto nella domanda 4, proseguire con la domanda 5 del questionario.

Se non è stato indicato alcun progetto nella domanda 4, proseguire con la domanda 13 del questionario.

SEZIONE DEDICATA A CHI HA AVVIATO PROGETTI SMART MOBILITY

A CHI HA RISPOSTO SI NELLA DOMANDA 4

5) Come nasce l'esigenza di creare progetti Smart Mobility nel suo Comune?

Selezionare una o più alternative

☐ Nasce dall'iniziativa degli organi politici

☐ Nasce dall'opportunità di accedere a un finanziamento

☐ Nasce da una richiesta dei cittadini

☐ Nasce dall'iniziativa dei dipendenti

☐ Nasce dall'iniziativa di società ed enti privati

☐ Nasce dal coinvolgimento di un altro ente (es. Comune, società di trasporto pubblico, Provincia, Regione)

☐ Non saprei

☐ Altro (*specificare nel campo note*)

Note:

6) Considerando gli investimenti complessivi previsti dal suo Comune per l'anno 2024, qual è la percentuale destinata ai progetti Smart Mobility prima citati e avviati nel corso del 2024?

Selezionare una sola risposta

☐ Tra lo 0% e il 5%

☐ Tra il 5% e il 10%

☐ Tra il 10% e il 20%

☐ Tra il 20% e il 40%

☐ Tra il 40% e il 60%

☐ Oltre il 60%

☐ Non saprei

Note:

7) La preghiamo di indicare, per ciascun progetto Smart Mobility avviato dal suo Comune, il livello di maturità raggiunto per ambito applicativo (esplorazione, sperimentazione, adozione, distribuzione strategica). N.B.

- Esplorazione: il Comune ha valutato la fattibilità di iniziative in questo ambito applicativo, e le opportunità associate, all'interno del territorio comunale;

- Sperimentazione: il Comune ha testato iniziative in questo ambito applicativo in modo controllato e su scala ridotta all'interno del Comune;

- Adozione: il Comune ha formalmente avviato iniziative in questo ambito applicativo in larga scala su tutto il territorio comunale;

- Distribuzione strategica: il Comune considera questo ambito applicativo centrale all'interno del proprio piano strategico in termini di impatto sull'intero territorio comunale.

Se possibile, le chiediamo di indicare nel campo note il nome dei progetti

Selezionare una sola risposta per ogni riga

AMBITI APPLICATIVI SMART MOBILITY	**LIVELLO DI MATURITÀ**			
	Esplorazione	**Sperimentazione**	**Adozione**	**Distribuzione strategica**
Gestione del Traffico (es. gestione da remoto di semafori, congestione stradale, infomobilità)	☐	☐	☐	☐
Gestione dei Parcheggi (es. monitoraggio dello stato di occupazione del parcheggio)	☐	☐	☐	☐
Trasporto Pubblico Locale (es. localizzazione mezzi pubblici, controllo accessi, ottimizzazione delle rotte grazie ad algoritmi di IA)	☐	☐	☐	☐

Mobilità Elettrica (es. installazione e gestione di stazioni di ricarica per veicoli elettrici)	☐	☐	☐	☐
Sharing Mobility (es. servizi di sharing dei veicoli, quali auto, scooter, monopattini e bici, carpooling offerti da terze parti tramite app o sito web)	☐	☐	☐	☐
Guida Autonoma (es. sperimentazioni di veicoli a guida autonoma in specifiche aree urbane, robotaxi)	☐	☐	☐	☐
Sistemi incentivanti per la mobilità sostenibile (es. app per monitorare mezzi di trasporto scelti dagli utenti e attivazione di scontistiche dedicate)	☐	☐	☐	☐
Last Mile Delivery (es. riders che consegnano ordini al domicilio del cliente previa inoltro richiesta tramite app)	☐	☐	☐	☐
Smart Road equipaggiate con tecnologie V2X (es. installazione di sensori e telecamere sulle strade per abilitare la comunicazione tra veicoli e tra veicoli e infrastrutture)	☐	☐	☐	☐
Mobility as a Service – MaaS (es. un'app che consenta di scegliere le alternative di mobilità in modo integrato, fornendo informazioni su tempi di percorrenza, costi e anche impatto ambientale)	☐	☐	☐	☐
Air Mobility (es. servizi di consegna merci e trasporto persone tramite droni/taxi volanti, gestiti da una centrale operativa o autonomi)	☐	☐	☐	☐

Digital Twin e **modelli di simulazione urbana** (es. modelli di simulazione creati con algoritmi di IA per testare virtualmente soluzioni di mobilità)	☐	☐	☐	☐
Altro (*specificare nel campo note*)	☐	☐	☐	☐

Note:

8) Che tipo di strategia state adottando per l'avvio di progetti Smart Mobility?*

Selezionare una sola risposta

☐ **Assente:** non c'è una strategia alla base delle scelte di avvio di progetti Smart Mobility all'interno del Comune

☐ **Bottom up:** una o qualche unità del Comune ha una strategia sul tema, ma si agisce a compartimenti stagni; gli approcci innovativi sono guidati dalla necessità di pochi che ne hanno compreso i vantaggi

☐ **Tattica:** i benefici generati dai progetti Smart Mobility sono noti a tutti; linee guida e priorità sono definite con una visione d'insieme e vengono condivise all'interno del Comune ☐ **Pianificata:** c'è un piano di medio-lungo termine per l'avvio di progetti Smart Mobility, con budget allocato, KPI condivisi e roadmap di evoluzione degli investimenti

☐ **Mobility First:** oltre ad essere inseriti in un piano di medio-lungo termine, l'avvio di progetti Smart Mobility è parte essenziale della strategia del Comune Note:

9) Come giudica il livello di competenze interne del suo Comune per la gestione dei progetti Smart Mobility?

Selezionare una sola risposta

☐ **Mancanti:** il Comune non competenze e figure dedicate per la gestione di progetti Smart Mobility

☐ **On demand:** le figure competenti all'interno del Comune lavorano singolarmente sulla base dell'esigenze del momento e le skill necessarie sono concentrate su poche risorse

☐ **Condivise:** le figure competenti all'interno del Comune interagiscono tra di loro sulla base di un piano di coordinamento condiviso per la gestione delle competenze

☐ **Organizzate:** c'è un team di esperti dedicato al tema che lavora sulla base degli obiettivi che il Comune si è posto per la Smart Mobility e sulla conseguente pianificazione

☐ **Orientate al lungo termine:** c'è un team di esperti ben organizzato dedicato al tema, ed è presente anche un piano orientato alla creazione e alla valorizzazione di competenze interne diffuse Note:

10) I progetti Smart Mobility consentono di raccogliere grandi quantità di dati. Con riferimento ai progetti avviati dal suo Comune:*

Selezionare una sola risposta

☐ I dati raccolti sono utilizzati dal Comune per finalità interne (es. per conoscere i flussi legati alla mobilità e prendere decisioni legate alla gestione del traffico)

☐ I dati raccolti sono utilizzati dal Comune per offrire servizi ai cittadini (es. per fornire indicazioni su quali aree della città presentano un miglior livello di qualità dell'aria, per rendere disponibili i dati in logica open data)

☐ I dati raccolti sono condivisi con società pubbliche o private, con l'obiettivo di erogare nuovi e più completi servizi

☐ I dati raccolti non sono attualmente utilizzati dal Comune ma è in programma un loro utilizzo nel prossimo futuro

☐ I dati raccolti non sono attualmente utilizzati dal Comune e difficilmente saranno sfruttati nel prossimo futuro

A CHI UTILIZZA I DATI NELLA DOMANDA 10

11) Qual è l'uso principale che fate dei dati raccolti? *

Selezionare una sola risposta

☐ **Descrittivo:** i dati vengono utilizzati per capire cosa succede, ma non vengono sfruttati per pianificare

☐ **Diagnostico:** l'analisi dei dati è orientata sul perché è successo, con un primo accenno al loro utilizzo per la pianificazione

☐ **Predittivo:** i dati servono a capire cosa succederà, e si attivano attività di pianificazione a supporto delle decisioni

☐ **Prescrittivo:** l'uso dei dati permette di capire come fare meglio, con una pianificazione che permette di ottimizzare le decisioni tra i diversi scenari

☐ **Adattivo:** i dati e la pianificazione diventano sempre più dinamici e flessibili in real time, anche attraverso l'utilizzo di algoritmi di Intelligenza Artificiale che permettono un'alta automatizzazione delle decisioni Note:

12) Il suo Comune ha implementato o ha intenzione di implementare misure di cybersecurity per proteggere i dati di cittadini, imprese ed enti utilizzati dalle infrastrutture digitali all'interno dei progetti Smart Mobility? (es. firewall, crittografia dei dati, formazione del personale, sistemi di rilevamento delle intrusioni, backup regolari ecc.) *Una sola risposta*

☐ No, il Comune non ha implementato e non ha intenzione di implementare misure di questo genere

☐ No, il Comune non ha implementato misure di cybersecurity, ma ha intenzione di farlo in futuro

☐ Sì, il Comune implementa misure di cybersecurity, ma deve ancora lavorare sulla formazione del personale

☐ Sì, il Comune non solo implementa misure di cybersecurity, ma è attento anche alla formazione del personale riguardo a questa tematica

☐ Non saprei

SEZIONE DEDICATA A TUTTI

13) Il Comune di cui fa parte ha in programma di avviare progetti Smart Mobility in futuro? Nel caso si intenda avviare progetti, specificare gli ambiti applicativi di interesse ed il periodo temporale nel quale saranno realizzati.

Selezionare una o più risposte

AMBITI APPLICATIVI SMART MOBILITY	NEI PROSSIMI 12 MESI	NEI PROSSIMI 2-3 ANNI
Non avvieremo progetti per la Smart Mobility in futuro	☐	
Gestione del Traffico (es. gestione da remoto di semafori, congestione stradale, infomobilità)	☐	☐
Gestione dei Parcheggi (es. monitoraggio dello stato di occupazione del parcheggio)	☐	☐
Trasporto Pubblico Locale (es. localizzazione mezzi pubblici, controllo accessi, ottimizzazione delle rotte grazie ad algoritmi di IA)	☐	☐
Mobilità Elettrica (es. installazione e gestione di stazioni di ricarica per veicoli elettrici)	☐	☐

Sharing Mobility (es. servizi di sharing dei veicoli, quali auto, scooter, monopattini e bici, carpooling offerti da terze parti tramite app o sito web)	☐	☐
Guida autonoma (es. sperimentazioni di veicoli a guida autonoma in specifiche aree urbane, robotaxi)	☐	☐
Sistemi incentivanti per la mobilità sostenibile (es. app per monitorare mezzi di trasporto scelti dagli utenti e attivazione di scontistiche dedicate)	☐	☐
Last Mile Delivery (es. riders che consegnano ordini al domicilio del cliente previa inoltro richiesta tramite app)	☐	☐
Smart Road equipaggiate con tecnologia V2X (es. installazione di sensori e telecamere sulle strade per abilitare la comunicazione tra veicoli e tra veicoli e infrastrutture)	☐	☐
Mobility as a Service – MaaS (es. un'app che consenta di scegliere le alternative di mobilità in modo integrato, fornendo informazioni su tempi di percorrenza, costi e anche impatto ambientale)	☐	☐
Air Mobility (es. servizi di consegna merci e trasporto persone tramite droni, gestiti da una centrale operativa o autonomi)	☐	☐
Digital Twin e **modelli di simulazione urbana** (es. modelli di simulazione creati con algoritmi di IA per testare virtualmente soluzioni di mobilità)	☐	☐
Altro (*specificare nel campo note*)	☐	☐

Note:

14) Quali iniziative, nell'ambito della mobilità, ritiene necessarie affinché il tuo Comune possa supportare efficacemente la transizione sostenibile indicata dagli obiettivi europei del Fit for 55?

Il Fit for 55 (in italiano: Pronti per il 55%) è un pacchetto di riforme e regolamenti economici e sociali promulgati dall'Unione Europea, incentrati sulla lotta al cambiamento climatico e alla riduzione delle emissioni di gas serra. Ad esempio, in ambito mobilità, la riduzione delle emissioni di CO_2 per autovetture nuove e furgoni del 100% entro il 2035 ed una riduzione delle emissioni di CO_2 del 55%, rispetto al livello del 2021, entro il 2030.

Selezionare al massimo 3 risposte

- ☐ Supportare l'adozione di **veicoli elettrici** (es. distribuzione capillare di colonnine di ricarica)
- ☐ Potenziare il **trasporto pubblico**
- ☐ Incentivare l'utilizzo di **mezzi di trasporto alternativi** all'auto (es. car sharing, micromobilità)
- ☐ Realizzare una città a "**misura d'uomo**" (es. zone pedonali, piste ciclabili, città di 15 minuti)
- ☐ Effettuare **interventi regolamentari** per limitare le emissioni e incentivare la sostenibilità
- ☐ Distribuire **incentivi economici** per promuovere comportamenti virtuosi
- ☐ Promuovere attività ed eventi di **formazione** e **divulgazione** sul tema della mobilità sostenibile
- ☐ Incentivare nuove forme di **collaborazione** Pubblico-Privato o Privato-Privato (es. comunità energetiche)
- ☐ Investire in **progetti innovativi** per individuare soluzioni più efficaci, efficienti e sostenibili
- ☐ **Non compete** al Comune attivare azioni per mitigare gli impatti del cambiamento climatico
- ☐ Altro (*specificare nel campo note*)

Note:

15) Il suo Comune utilizza o sta pianificando di utilizzare soluzioni basate sull'Intelligenza Artificiale (IA) per migliorare l'efficienza e la qualità dei servizi comunali nell'ambito della Mobilità Smart? (es. Monitoraggio e modellazione del traffico)

Selezionare una sola risposta

☐ No, il Comune non utilizza soluzioni di IA e non sta pianificando di farlo in futuro

☐ No, il Comune attualmente non utilizza soluzioni di IA ma sta pianificando di farlo in futuro

☐ Sì, il Comune attualmente utilizza l'IA soprattutto nei progetti di monitoraggio e modellazione del traffico

☐ Sì, il Comune attualmente utilizza l'IA non solo nei progetti di monitoraggio e modellazione del traffico ma anche per l'erogazione di servizi avanzati alla cittadinanza (specificare quale nel campo note)

☐ Non saprei

Note:

16) Quali sono le aree applicative dove prevedi maggiore impatto relativo all'utilizzo degli algoritmi di Intelligenza Artificiale (IA) sulla mobilità urbana nei prossimi 2-3 anni?

Selezionare al massimo 3 risposte

☐ Miglioramento dell'efficienza del traffico

☐ Riduzione delle emissioni

☐ Miglioramento della sicurezza stradale

☐ Ottimizzazione del trasporto pubblico

☐ Sviluppo dei veicoli a guida autonoma

☐ Monitoraggio e manutenzione predittiva delle infrastrutture

☐ Non ritengo che l'IA avrà un impatto significativo sulla mobilità ☐ Altro (*specificare nel campo note*) Note:

17) Quali obiettivi vorrebbe perseguire l'Amministrazione tramite (l'eventuale) avvio di progetti Smart Mobility in futuro?

Selezionare al massimo 2 risposte

- ☐ **Economia e sviluppo locale** (es. maggiori introiti per il Comune, riduzione dei costi per il Comune e/o gli altri operatori della mobilità, sviluppo delle imprese del territorio, beneficiare degli incentivi statali e/o europei)
- ☐ **Servizi e innovazione per i cittadini** (es. miglioramento dei servizi attualmente offerti ai cittadini, introduzione di nuovi servizi per i cittadini, maggiore inclusione sociale)
- ☐ **Ottimizzazione mobilità** (es. miglioramento dei flussi di traffico / riduzione congestioni stradali, creazione di un database ricco di informazioni rese disponibili dai progetti Smart Mobility)
- ☐ Maggiore **sicurezza stradale** (es. riduzione della probabilità di incidenti)
- ☐ **Sostenibilità ambientale** (es. riduzione CO_2, supporto transizione ai veicoli elettrici, efficienza energetica)
- ☐ **Conformità e competitività** (es. adeguamento rispetto a vincoli di legge e/o obblighi normativi, necessità di allineamento rispetto a quanto presente in altri Comuni, miglioramento dell'immagine del Comune)
- ☐ Altro (*specificare nel campo note*)

Note:

18) Quali sono le barriere (interne ed esterne) che secondo lei rallentano o impediscono l'avvio di progetti Smart Mobility, oppure che non consentono il passaggio da sperimentazioni a iniziative su larga scala?*

Selezionare al massimo 3 risposte

BARRIERE	MAX 3 RISPOSTE

Scarsa **conoscenza** delle tematiche relative alla Smart Mobility e/o mancanza di **competenze** interne in grado di gestire tali progetti	☐
Scarsa disponibilità di **risorse economiche**	☐
Difficoltà nell'**utilizzo** delle **risorse economiche** (es. difficoltà nell'accesso agli incentivi statali)	☐
Complessità legate alla **burocrazia**	☐
Mancanza di **comprensione da parte dei cittadini** del reale **valore** delle soluzioni che si intendono implementare	☐
Cambi frequenti della Giunta comunale, che impediscono di portare a termine i progetti avviati	☐
Difficoltà di **coordinamento dei diversi attori** (pubblici e/o privati) coinvolti nei progetti	☐
Problemi di **interoperabilità** tra diverse tecnologie e piattaforme	☐
Resistenze interne (es. da parte dei dipendenti comunali)	☐
Problematiche legate alle **privacy** e alla **cybersecurity** (es. cittadini restii al monitoraggio delle proprie attività, eccessiva vulnerabilità dei dati scambiati)	☐
Mancanza di **fornitori** adeguati	☐
Fenomeno del **lock-in** (es. vincoli legati all'utilizzo di tecnologie di un unico fornitore)	☐
Scarso interesse da parte degli **organi politici**	☐
Mancanza di **dati** accurati e strumenti di monitoraggio per valutare l'efficacia dei progetti Smart Mobility	☐
Altro (*specificare nel campo note*)	☐

Note:

19) Quali sono le soluzioni smart nell'ambito della mobilità elettrica che ritiene più interessanti per i progetti che saranno sviluppati dal suo Comune nei prossimi 3 anni?

Selezionare al massimo 3 risposte

- ☐ Punti di ricarica intelligente (es. soluzioni che permettano l'individuazione del punto di ricarica più vicino o con tempi di ricarica più rapidi o con tariffe più convenienti a seconda della fascia oraria)
- ☐ Parcheggi muniti di colonnine di ricarica individuabili tramite app
- ☐ Mezzi di trasporto smart ed elettrici (es. e-bus, e-taxi, ed e-truck dotati di tecnologie di connettività)
- ☐ Veicoli di micro-mobilità elettrici in sharing (es. e-bike, e-scooter)
- ☐ Soluzioni di Vehicle-to-Grid (es. punti dedicati in prossimità di luoghi pubblici per immagazzinare e restituire energia tramite i veicoli)
- ☐ Strade intelligenti dotate di pannelli solari in grado di ricaricare i veicoli elettrici in modalità wireless e/o a induzione
- ☐ Soluzioni di pagamento automatico tramite il veicolo connesso in fase di ricarica
- ☐ Altro (*specificare nel campo note*)
- ☐ Non ritengo nessuna di queste soluzioni interessanti

Note:

20) Quali sono le soluzioni smart nell'ambito della gestione del traffico che ritiene più interessanti per i progetti che saranno sviluppati dal suo Comune nei prossimi 3 anni?

Selezionare al massimo 3 risposte

- ☐ Gestione intelligente dei semafori (es. in grado di variare autonomamente i tempi di verde e rosso, per consentire la prioritizzazione dei veicoli di emergenza, l'onda verde o il passaggio di pedoni)
- ☐ Soluzioni per la rilevazione real-time di eventi pericolosi, quali incidenti, veicoli fermi, lavori in corso (es. tramite pannelli a messaggio variabile o app su smartphone) e la divulgazione di suggerimenti per percorsi alternativi
- ☐ Sistemi di riconoscimento delle targhe a supporto del pedaggio variabile, secondo sia la classe ambientale sia il numero di veicoli in transito
- ☐ Sistemi che gestiscono l'apertura e la chiusura dinamica di strade sulla base di diversi eventi (es. incidenti, veicoli fermi, lavori in corso, congestioni stradali)

☐ Soluzioni che forniscono informazioni relative al traffico e ti propongono diverse alternative di trasporto (es. Mobility as a Service)

☐ Soluzioni che adeguano il prezzo per il passaggio su corsie (es. quelle di emergenza in autostrada) o in zone a traffico limitato per snellire i flussi stradali negli orari di punta

☐ Sistemi integrati di controllo della città e del traffico (es. Smart Control Room)

☐ Sistemi di geofencing per il rilevamento targhe e la gestione degli accessi nelle zone a traffico limitato (ZTL)

☐ Altro (*specificare nel campo note*)

☐ Non ritengo nessuna di queste soluzioni interessanti

Note:

21) Quali sono le soluzioni smart nell'ambito della gestione dei parcheggi che ritiene più interessanti per i progetti che saranno sviluppati dal suo Comune nei prossimi 3 anni? *Selezionare al massimo 3 risposte*

☐ Parcheggi muniti di colonnine di ricarica individuabili tramite app

☐ Sistemi che consentono l'individuazione dello stallo libero e forniscono le indicazioni stradali all'utente della strada

☐ Sistemi che consentono non solo l'individuazione dello stallo libero ma anche la sua prenotazione

☐ Soluzioni di pagamento automatico tramite il veicolo connesso, al termine dell'utilizzo dello stallo

☐ Soluzioni di condivisione delle informazioni relative alle zone di scarico-carico delle merci più sicure e vicine al corriere e al destinatario

☐ Sistemi di parcheggio a guida autonoma tramite cui è possibile lasciare il veicolo all'ingresso del parcheggio e impartirgli il comando di parcheggiarsi da solo

☐ Sistemi intelligenti di monitoraggio delle aree di sosta tramite telecamere smart

☐ Altro (*specificare nel campo note*)

☐ Non ritengo nessuna di queste soluzioni interessanti

Note:

22) Quali attori potrebbero essere coinvolti (o sono già stati coinvolti) dal suo Comune per lo sviluppo dei progetti Smart Mobility?

Selezionare una o più risposte

ATTORI SMART MOBILITY	COLLABORAZIONE GIA' AVVIATA	VORREI COLLABORARE IN FUTURO
Aziende municipalizzate	☐	☐
Altri Comuni	☐	☐
Utility	☐	☐
Operatori di infrastrutture / operatori stradali	☐	☐
Operatori Telco		
Tower company / operatori di rete	☐	☐
Aziende private che consegnano prodotti di vario tipo a casa dei cittadini (es. Amazon, Glovo, Cortilia)	☐	☐
Aziende private che offrono servizi di trasporto condiviso (es. Car2Go, Enjoy, Dott)	☐	☐
Concessionari auto	☐	☐
Polizia / Carabinieri / Aziende private che offrono servizi di sicurezza	☐	☐
Produttori di hardware / software	☐	☐
System Integrator	☐	☐
Banche e assicurazioni	☐	☐
Fornitori di servizi (es. servizi di lavaggio o ricarica a domicilio)	☐	☐
Università e centri di ricerca	☐	☐
Startup innovative	☐	☐

Altro (*specificare nel campo note*)	☐	☐

Note:

Il questionario è concluso, la ringraziamo per la collaborazione. Qualora volesse, può aggiungere ulteriori commenti sul tema.

Osservatorio Connected Car & Mobility (Smart Mobility: gli ambiti applicativi considerati)

Definizione di Connected Car & Mobility: Percorso (già avviato) nello sviluppo tecnologico grazie al quale, attraverso la rete Internet, si abilita la connettività dei veicoli, l'offerta di nuovi servizi rivolti al consumatore, l'integrazione tra veicoli e l'infrastruttura circostante e lo sviluppo di modelli di business completamente nuovi.

Ambiti applicativi Smart Mobility

• *Gestione dei parcheggi*: monitoraggio dello stato di occupazione dei parcheggi e invio delle informazioni all'utente finale così da ottenere una riduzione del tempo necessario per la ricerca del parcheggio, nonché lo stato e la durata delle soste; • Gestione del traffico: misurazione del flusso reale del traffico urbano e utilizzo dei dati raccolti per evitare congestioni, regolare gli accessi a zone con limitazioni di traffico e gestire in modo dinamico il sistema semaforico;

• *Mobilità Elettrica*: stazioni di ricarica (fisse o mobili) per veicoli elettrici al fine di consentire ai privati e/o ai gestori di servizi di shared mobility di effettuare la ricarica; soluzioni per l'incremento dell'autonomia energetica dei veicoli;

• *Sharing Mobility*: servizi di condivisione temporanea dei veicoli (es. auto, scooter, biciclette) offerti da terze parti o da altri privati (peer-to-peer) tramite App o sito web;

• *Trasporto Pubblico*: localizzazione dei mezzi pubblici per fornire ai cittadini informazioni affidabili sui tempi di attesa, abilitare criteri di preferenza semaforica e migliorare in modo dinamico la gestione dei flussi.