POLITECNICO DI MILANO

School of Industrial and Information Engineering

Master of Science in Management Engineering

Smart Mobility: state of the art and emerging trends for Italian municipalities

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Introduction

Global population is expected to enormously grow in the next years, reaching the dizzying threshold of 8.5 billion in 2030 and 10.9 in 2100 [1]; most of this increase will be absorbed by urban agglomerates that, by 2030, will contain up to 60% of human beings. It is obvious that in such perspective new challenges – that have even been exacerbated by the sanitary crisis of the last two years – will emerge for cities and for their administrations. Pollution, safety, noise, the provision of essential services, livability in all its aspects, will become harder. Local administrators are therefore called to provide *"safe, healthy, accessible, affordable, resilient, and sustainable cities and human settlements to foster prosperity and quality of life for all"* [2] and the best way to pertain to all these objectives is to transform cities they manage into Smart Cites. The definition of the smart city has many different acceptations, but the general concept is to exploit innovative ICTs to meet current and future generations' needs in the most sustainable way. Among the founding elements of a city – transports, economy, people, governance, environment, etc. – the transformation of its mobility system into Smart Mobility, represents probably the main driver for its conversion into a smart city. Again, the introduction of innovative technologies is crucial: the creation of a connected ecosystem, by means of information and communication technologies, in which different actors can continuously exchange information, represents a first step toward the creation of innovative, efficient transports means. Nevertheless, the revolution of mobility entails something more. In recent times, the mobility of smart cities, became more than cars, buses, trains, and bikes equipped with digital technologies. It became the connectivity of people and/or goods, able to ensure sustainability, inclusivity, and affordability. The combination of these two aspects – the introduction of technologies and the attentions toward sustainability concerns – represents the core of modern Smart Mobility's debates.

The concept is complicated, and it may be declined in a vast number of practical solutions. From electric cars, smart charging columns, and innovative wireless charging roads, to connected autonomous vehicles able to exchange information about accidents, roads conditions, and directions. Possibilities are many and the specificity

of each different city opens different paths for different implementations. Guidelines, knowledge, and instruments to evaluate impacts and criticalities, are required to properly deploy Smart Mobility projects.

Objectives of the work

Starting from a detailed analysis of the existing Smart Mobility projects and strategies among Italian municipalities, the main objective of this manuscript is the creation of a framework to support local administrations during planning activities. The instrument created is thought to be used as a tool to evaluate different possibilities when implementing Smart Mobility projects, depending on the desired outcomes and the available resources. The final result was possible thanks to the elaboration of three main questions, that allowed to provide a structure to the whole discussion.

1. *Which is the state of the art and the future perspective of Italian municipalities with respect to Smart Mobility projects?*

1.1. *Which are the main differences when looking at Smart Mobility projects in Europe and in the rest of the world?*

2. *Which future directions can be envisioned for Italian cities?*

The methodologies adopted

The methodology adopted in to find an answer to the research questions and to create the framework was the following:

1. *A review of the existing literature to increase the knowledge base about the topic.*
   Given the complexity of the topic, it was necessary to understand the context and its characteristics. Starting from the broad notion of Smart City, the literature review allowed to understand how to decline its paradigms in the mobility sector and how such innovations could help in achieving global and national strategic plans. The review of more than 20 academic papers, company reports, and journal articles, provided interesting insights about possible implication of Smart Mobility for modern cities' development.

2. *A detailed survey to collect relevant information about the Italian Smart Mobility development state.*
   A 21-qiestions survey was delivered to 735 Italian municipalities between July and the beginning of September 2021. Answer collected came from towns of all dimensions, from less than 15.000 to more than 80.000 dwellers, and distributed all along the Italian peninsula. With a total number of 111 answers, the response rate attested at 15% and these represented the main source of information about the Italian Smart Mobility ecosystem. Questions investigated themes about the

interest toward Smart Mobility, the main development areas of present and future projects, the effects of the pandemic, the main objectives and barriers perceived.

3. *The creation of a database gathering more than 120 foreign and national initiatives.*
   To complement the picture created with the survey, numerous web analyses were made. This allowed to gather details about foreign projects launched, and about other national initiatives not investigated through the questionnaire. More than 120 initiatives were carefully examined and mapped inside a specifically made database: details about implementations areas, partners selected, benefits desired and achieved, and many others were listed per each project. The creation of such database permitted to gain information about the foreign panorama of Smart Mobility and moreover, allowed to build the framework.

4. *The creation of a framework to categorize projects according to two dimensions and to support public administrators' decisional process.*
   The final step of the methodology adopted, was the construction of the framework. This matrix was made selecting two dimensions among the ones of the database, namely the *implementation field* and the *benefit desired* of the initiative. Once these two dimensions were selected, they were categorized according to a 5-grade scale in which:
   - Implementations fields were arranged according to the *typology of innovation* created: *1* was given to *technological innovations*, those projects which main scope is to test and implement innovative technologies and *5* was given to *behavioral innovations*, meaning all those innovations revolutionizing the way people interact with mobility and transport systems.
   - Benefits were arranged according to the *typology of benefit* desired: *1* was given to *social benefits*, meaning all those projects which scope it to increase safety, comfort, and transport's experience and *5* was given to *environmental benefits*, projects which main goal is to reduce the carbon footprint of the transport sector.

   Once the four quarters of the matrix generated were populated with online-collected projects, it was possible to represent them according to two easy-to-be-visualized dimensions. The final instrument to support local administration was therefore created.

Introduction to the Italian Smart Mobility scenario

According to the answers received to the survey, Smart Mobility is a "*relevant*" or "*very important*" topic for 95 cities out of 108. The interest, and more important, the awareness about the topic, seems thus to be well diffused. In the last three years moreover, 65% of interviewed administrators have already launched at least one Smart Mobility initiatives. The percentage of projects being implemented is increasing year after year: from only 29% of municipalities implementing such innovations in 2019, to almost 60% in 2021.

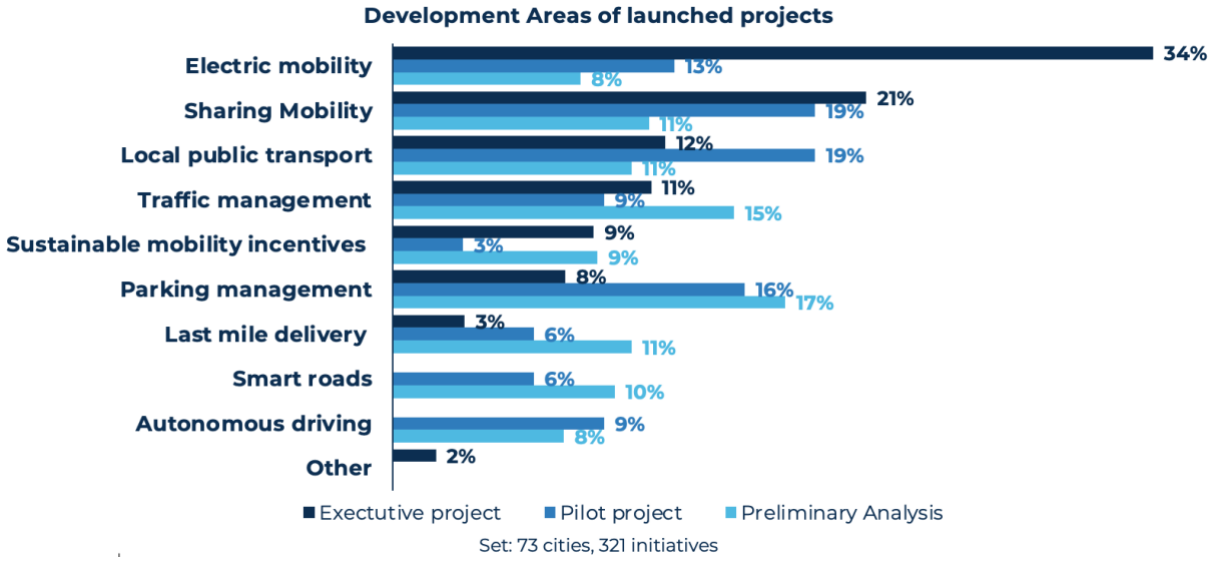


Figure 1: Development Areas

As demonstrated by figure 1, some projects are at their initial phases (pilot projects and preliminary analyses) while other are already in execution. Anyway, without making any distinction, it is possible to claim that more than 300 initiatives are being implemented in Italy: a surprising result.

Most of projects already in the executional phase regards *electric mobility*, that resulted to be the area of highest interest for Italian cities. Such initiatives aim at substituting the current vehicle fleet, mainly constituted by internal combustion engines' cars, with last generation electric vehicles. Primary goal is therefore the reduction of dangerous emission and air pollution, protecting the environment and enhancing quality of life in urban centers. To achieve these objectives, electric mobility projects may consist in the expansion of the charging infrastructure for cars, in the provision of digital technologies to increase the efficiency and effectiveness of charging processes, new manufacturing processes for batteries, the provision of economic incentives for electric vehicles (cars, bikes, etc.) purchase and so on and so forth.

Sharing mobility represent the second category per executive projects. In this case, projects regard for example the provision of cities with fleets of vehicles to be shared

with other commuters (cars, bikes, kick-scooters, and more) and the development of digital platforms to share private vehicles when not needed. Sharing mobility solutions can be very effective in tackling the congestion problems of big cities, shifting a good portion of daily journey from private cars to shared ones. Moreover, many shared services providers employ active or electric vehicles, contributing to reduce CO_2 emissions.

The third area per executive projects is the *local public transport*. The innovation of local public transports can be achieved through various solutions. The integration of trams, buses, subways, with digital features can allow citizens to be constantly updated about their position, state, and condition. Otherwise, public transports can be equipped with radars and sensors to spot dangers and avoid accidents. With such innovations the efficiency and safety of public transports is radically improved.

Many others executive projects are present in almost all the remain areas: *traffic management systems*, *sustainable mobility incentives* and *parking management solutions*. The only exceptions to be made concern the *autonomous driving* and *smart road* areas.

Smart roads projects consist in the integration of innovative sensors, radars, connections, and smart signals into existing infrastructures. Smart roads have the ability to communicate with vehicles, transmitting information and sharing data with other actors, moreover, last generation smart roads can also be equipped with the technology allowing them to share energy with electric vehicles moving over them. These solutions require thus big investments and entail a high level of complexity, it is therefore normal that Italian cities are only implementing pilot projects and preliminary analyses to gather data and knowledge for future implementation.

Similar considerations can be made for *autonomous driving* projects. In this case main reasons explaining the only presence of preliminary analyses and pilot projects, can be imputed to a still-inadequate regulation. New laws and procedures are needed before autonomous cars will be allowed to move around urban territories. In the meantime, projects and experiments remain limited to selected testing areas.

With respect to future perspectives, most of the Italian municipalities interviewed claim to have intention to launch one or more Smart Mobility initiatives. Out of the 111 cities, 79 are planning to innovate their transports ecosystems and in particular, most of future projects are about electric mobility, parking management, sharing mobility and traffic management solutions.

Analyzing the precise implementation time horizon of projects, the picture that emerges is the following.

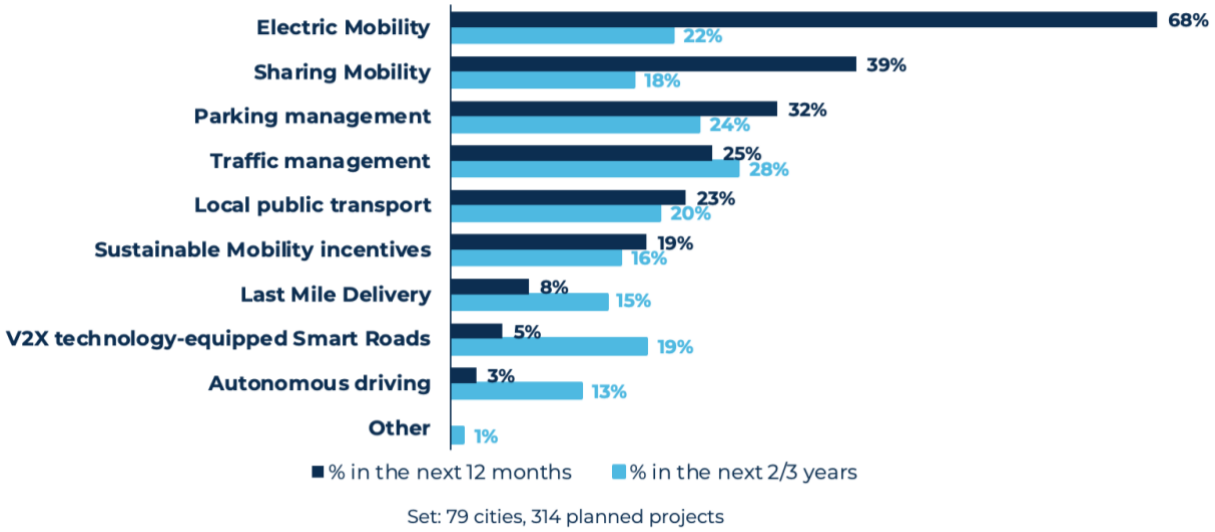


Figure 2: Implementation time horizon of Smart Mobility projects

The cited areas will be the ones developed in the short period: in 12 months indeed, a conspicuous number of projects to manage parking, to extend the electric vehicles' fleet, and to offer shared vehicles' services will be developed. Other implementation areas like autonomous cars and smart roads, but also last mile delivery services, will require 2 to 3 years to be executed.

Many Italian municipalities have thus positive attitude toward Smart Mobility, many projects are already in their executional phase and others are planned for future implementations. The total number of initiatives is surprising and moreover, most of cities demonstrated an increasing sensibility toward sustainability concerns and toward the provision of efficient and innovative services to their citizens. The creation of user and environmental centric urban agglomerates is key and will guide the development of future cities. Nevertheless, some obstacles have been spotted: the scarcity of knowledge and competencies, the lack of economic resources and the bureaucracy's complexity are among the most cited.

The main problem observed when facing a Smart Mobility project, is the scarcity of knowledge and competencies about it. This issue concerns all the stakeholders involved in the process, from cities' administrators not understanding the possibilities behind it, to users not properly embracing the change. Prompt communication campaigns must diffuse consciousness about the benefits and possibilities of Smart Mobility and must sensitize the population. Moreover, the promotion of best practices, the sharing of data, and the creation of knowledge-intensive environments must foster the development of innovative ideas. Italian government decided to insert in local administration some technical human resources to fill the competencies gap: the Mobility Manager figures is made exactly for these reasons and must be adopted by

many municipalities; this normative is potentially perfect. Despite that, Italian cities have still work to do. A negative trend is highlighted by the way collected data are used: as today only 10% of the 111 interviewed is sharing data with external companies and 23% is using them for internal purposes. Using data for internal purposes is correct, since it helps monitoring and better administrating the city; the problem is that a higher percentage of data should be shared with other companies as well as with other municipalities: this would ensure knowledge diffusion and foster innovation. Future intentions to create partnerships with innovative startups and universities are positive signals of a change in the actual paradigm.

The scarcity of economic resources is the second most frequent problem, and it is a characteristic typical of small cities. Reasons behind can be various, for example it may depend on the lower ability of smaller towns to efficiently manage their resources (save and collect money to dedicate to these projects), or in their lower interest toward Smart Mobility topic (they could decide to focus on more practical and daily issues).

Figure 3: Barriers

Here communication campaigns have again a central role since they must demonstrate cities the economic benefits of such solutions. Moreover, there are many additional measures meant to tackle the problem; from statal bonuses and incentives for sustainable mobility decisions, to European funds and investment calls. They represent a great opportunity also for smaller administrations, but the bureaucratic process must be adequate. Many time indeed, bureaucracy hampers the innovative momentum, slowing down processes. This must change, and a simplification work is necessary, in order to allow also smaller and less structured administration to benefits of public funds.

Willing to answer the first research question and define a global picture of the Italian Smart Mobility panorama, it is possible to claim that there are still many barriers to overcome. Knowledge, supported by data, must be diffused and awareness about the

implication of innovative transports' projects must be created. Many Italian municipalities are already taking the right path, and the high number of initiatives launched demonstrated it, moreover, it is worth noticing that an incredible demonstration of resilience came from the reaction to Covid-19 pandemic. The sanitary crisis indeed, did not change the urgency about the topic for 43% of cities, and made it even more urgent for 41% of them. Moreover, according to 61 cities, the pandemic only slowed down the realization of Smart Mobility projects of some months, did not impact it, or even accelerated it. It was therefore an opportunity to evaluate the current mobility paradigms, to re-think them, and to implement smarter solutions. The revolution of Italian mobility ecosystem is therefore at a turning point: good projects are distributed all along the peninsula but what really seems to be missing is a comprehensive innovative ecosystem. Administrations must assume new roles toward Smart Mobility projects, opening their databases to bait third actors and sharing relevant information between each other, additionally a national effort to unify them and to provide defined governances is still missing. Adequate resources must be well managed, and the support of central government must always flank the implementation of Smart Mobility projects both in big and small cities.

The matrix's creation process

Guidelines and proper instruments to individuate best options within the complicated Smart Mobility ecosystem, are very important. Each different project has different specificities, and each different city has different characteristics, necessities, and constraints. Urban administrators are called to find the right solution to satisfy their citizens' needs and to ensure better life conditions, but most of the time many options are available. For these reasons, the scope of the work was the creation of a support tool, that could help local authorities to find the right direction toward which to guide their Smart Mobility strategies.

The tool created consisted in a qualitative framework representing the intersections of many different objectives, achievable with the implementation of Smart Mobility projects, and many different typologies of technological innovations. It must be intended exactly as a qualitative tool, since it is created according to qualitative analyses, considerations, and observations, made on the information collected online about 122 foreign, and national, Smart Mobility projects. It is therefore though to be at its primary version, to be integrated with additional, technical, detailed measures in future works.

As previously mentioned, the matrix was created starting from the information about 122 initiatives collected online. Information were grouped inside a detailed database, that allowed to list many details of each case. Once the database was created, 2 dimensions to represent the two axes of the matrix were selected: the *implementation field* and the *benefits* of the projects.

The implementation fields of the projects were the ones listed in question 12 of the survey: *autonomous mobility, electric mobility, sharing mobility, traffic/parking management solutions, last mile delivery, local public transport, sustainable mobility incentive, V2X smart roads* plus an additional *mobility as a service (MaaS)* field. Benefits were considered starting from the objectives of administrations, these latter listed in question number 14: *environmental sustainability improvement, new services introduction, services improvement, security, traffic flow optimization*, *cost reduction* and *social inclusion.*

Some characterizing traits about these two dimensions were then easily identifiable. With respect to the implementation fields, some of them consisted mainly in the introduction and testing of technological innovations into existing procedures or infrastructures, others instead, implicated innovations in the way citizens deal with the mobility ecosystem – sharing mobility for example, is primarily an innovation in cars' ownership concept. For what concerns benefits, some of them mainly targeted the improvement of the environmental impacts of mobility, while others, aimed at improving users' experience in terms of safety, comfort, and cost. With this distinction in mind, the two dimensions were re-organized respectively according to the *typology of innovation* and the *typology of benefit*, and a 5-graded scale was created to represent the distinction.

Grade	Typology of innovation
1	Technological innovations
2	Technological innovations requiring behavioral innovations
3	Balanced cases
4	Behavioral innovations requiring technological innovations
5	Behavioral innovations

Grade	Typology of benefit
1	Social benefit
2	Social benefit with environmental concerns
3	Balanced cases
4	Environmental benefits with social concerns
5	Environmental benefits

Table 1: The two scales

The final matrix resulted using the typology of innovation scale as x-axis, and the typology of benefit as y-axis. Four quarters were in this way individuated, each of them grouping different projects achieved with different objectives and implemented with different technologies:

- *First quarter:* cases in which the focus is to improve environmental conditions employing innovative technologies. Most solutions are under the electric mobility category but there are also examples of advanced e-robots to cover the urban last mile (LMAD), and innovations in the charging infrastructure (smart grids for example).
- *Second quarter:* the goal is always to increase sustainability of the mobility system but in this case, innovative technologies are not used. Projects use

already existing technologies in a more efficient way, and users are required to change their perception of transports. Examples are vehicles sharing platforms, reward-bases sustainable mobility applications, and public initiatives that modifies urban mobility paths.

- *Third quarter:* cases in which the attention toward the provision of better services to citizens (safety, efficiency, effectiveness, etc.) thanks to innovative technological applications. This class represents IoT applications to create a connected ecosystem in which cars can communicate (V2X) and technological applications enabling autonomous driving capabilities (AV and ADAS).
- *Fourth quarter:* the last quarter collects all the initiatives which scope is to improve citizens' experience without necessarily implementing innovative technologies in their business models. In this class for example, there are all the intermodal mobility solutions (MaaS) that, by mean of a platform, allow users to seamlessly move and pay inside the mobility ecosystem.

Results

The matrix collected a vast number of existing implementation cases and made it possible to group and visualize them according to two intuitive dimensions. It was also possible to use the survey's answers to find a proper location for Italy inside the framework: it was easier, in this way, to look for interesting implementation cases and to define future directions for Italian municipalities. This resulted useful to answer the two remaining research questions.

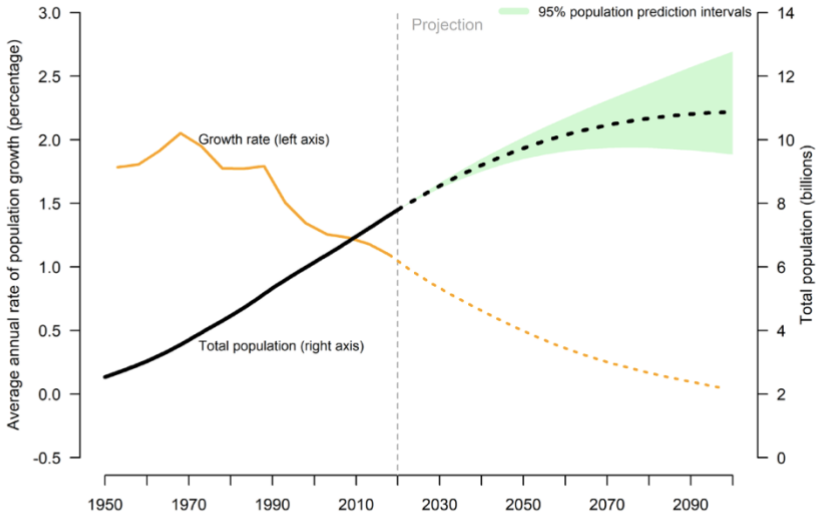
The survey's data suggested that, given the scarcity of competencies and knowledge affecting most of its towns, Italy should get inspiration from projects located in the left side of the matrix; in this area indeed the typology of innovation is the behavioral one, that does not require sophisticated technical competencies. For what concerned the second dimension, Italian cities demonstrated similar interest both toward sustainability and toward the provision of innovative, efficient services to citizens; thus, both the upper and the lower part of the matrix were adequate. Some projects located in these two areas (the 2nd and the 4th quarter) and based on sharing and electric mobility, and mobility as a service solutions, resulted interesting and could represent an inspiration for Italian cities: the Münster bewegt App and the Jatelindo consortium in Jakarta are two examples. Moreover, going on with the database population process, additional projects could for sure emerge and constitute even better role models for Italy. The matrix also demonstrated that even if technology is fundamental in every Smart Mobility project, good results and positive impacts can be achieved even thanks to relatively simple business models. Examples are all those solutions that, through digital platforms, integrate different shared, active, public mobility services available on the territory, and that are comprehended under the mobility as a service umbrella.

If managed with proper partners, such intermodal solutions only require the municipality to provide relevant data to external actors, that take the responsibility of integrating different services and managing the payment system. Other plausible future directions for Italy are in the electric mobility field, for example the extension of the EVs charging infrastructure and the provision of incentives for electric vehicles adoption.

The Smart Mobility future for Italy thus, will probably be characterized by and extensive adoption of projects based on non-sophisticated technologies for the reduction of carbon footprint and the provision of efficient services to citizens. To this extent, prompt communication efforts must diffuse awareness about the possibilities of intermodal, mobility as a service solution and the specificities of electric mobility. Moreover, existing successful Italian cases must be taken as role model and their process replicated. Resources, economic and material, are many times already available, the only problem is to efficiently exploit them: for this reason, municipalities should open themselves, creating the space for third actors to operate; these latter could use data and transport means to deliver tailored made solutions to satisfy different users' needs. Administrators' willingness to create future partnerships with startups and universities goes in the right direction and could represent an exceptional opportunity to continue testing more innovative solutions like smart roads and autonomous vehicles. The framework created helped individuating two possible directions for Italian cities; in future works, its integration with detailed measures regarding for example structural dimensions of the city, could surely make it more precise. By the moment, it helped in stating that overall, Italy seems to be on the right path.

1. Smart Cities and Smart Mobility

For what concerns the *globalization* phenomena, two different but strongly interrelated schools of thought can be distinguished. From one side stand those who consider only the positive aspects, for example the creation of favorable economic and financial conditions (like open exchange markets), safer and more inclusive infrastructures and the fast diffusion of innovative technologies. From the other side, it is possible to locate those mainly underlining the negative aspects of it, the enhancement of inequalities between richer and poorer social classes above all. These two perspectives cannot be separated when deep diving into the analysis of this process and the inequalities generated from one side, must be balanced with better and more inclusive services provided thank to up-to-date innovative technologies. Moreover, the progresses in economy, technology and sanity create more and more favourable conditions for human development and as reported in many studies, causes a relentless increase in urbanization, that in the end increase frictions with existing urban infrastructures. The advancements of society thus, can sometime be considered as the main causes of its problems. In this context the 2030 Agenda for Sustainable Development [3] and its 17 SDGs (Sustainable Development Goals) are located. The objective is to provide procedures and guidelines for governments in order to tackle problems like pollution, global warming, the creation of accessible, safe, and inclusive infrastructures, the creation of workplaces and the reduction of social disparities. One of the goals of the Agenda, the SDG number 11, is of grounding importance for the argument of this manuscript and it is about the necessity to adapt the existing cities to the excepted increase in human population. "*The world is becoming increasingly urbanized. Since 2007, more than half the world's population has been living in cities, and that share is projected to rise to 60 per cent by 2030*". Moreover, according to the United Nations [1], the global population will grow up to 8.5 billion in 2030 and to 10.9 billion of humans in 2100 (Figure 4).



Source: *United Nations, Department of Economic and Social Affairs, and Population Division* (World Population Prospects 2019 - 2100)

Figure 4: World Population Prospects

Cities and their administrations must therefore prepare and find new solutions to answer to the challenges they will have to face. If no actions are undertaken, urban agglomerates will become more crowded, polluted, dangerous and the quality of life of their inhabitants will dramatically decrease. One of the central areas of interests to tackle these problems is of course mobility: the necessity of people, goods, and materials to move from A to B is inescapable but is also among the main causes of dangerous gasses emission, fatal accidents, and congestions, in few words it represents an inefficiency for many cities.

The discussion presented in the next chapters will therefore be about the future of our cites and in particular, will revolve around the transformation of the transport system.

1.1 Definition of Smart City

The New Urban Agenda [2] calls for "*just, safe, healthy, accessible, affordable, resilient, and sustainable cities and human settlements to foster prosperity and quality of life for all*". One approach to attaining these objectives is through a Smart City (SC). To allow the reader to better understand the topic, the following paragraphs will analyze the definition of Smart City and, further on, the sub-area regarding the Smart Mobility will be investigated.

According to Professor Anthony Giddens [4], from the London School of Economics, the modernization process of cities is exposing them to an increasing number of risks and many of them are "manmade risks". These arose because of the development of new technologies and the advancement in scientific knowledge that are typically associated with the smartness of cities. In this context, Liotine, Ramasprasad and Syn [5] proposed a view of the modern city considering it as an "anthropomorphism" (i.e., the attribution of human characteristics to the city) because it is based on the ability of the city to sense and respond to its challenges smartly, using natural and artificial intelligence embedded in its information systems.

Defining the smart city is a complex task, many authors and scholar attempted it (there is a vast literature to prove it) elaborating each time a definition that is similar - but different at the same time - to all the other ones. As described above, smartness is used by cities in answering to their challenges but, depending on the perspective adopted, the smartness itself can have a dual nature. It can be intended as the technological component of innovative information systems or the ability of humans and city administrations to wisely use resources and plan actions; "smart" and "intelligent" in this case becomes almost perfectly interchangeable terms. To this concern, the ontological work of scholars Ramaprasad et al.[6] is useful to take into consideration many points of view not only when describing to which degree a city is smart, but also to which degree a city is a city. Combining many different definitions of smart city, the authors of this framework (Figure 5) built a solid tool that allows to extrapolate a different sense of the concept.

Smart								City			
Structure		**Functions**		**Focus**		**Semiotics**			**Stakeholders**		**Outcomes**
Architecture	[to]	Sense	[+]	Cultural	[+]	Data		[by/from/to]	Citizens	[for]	Sustainability
Infrastructure		Monitor		Economic		Information			Professionals		QoL
Systems		Process		Demographic		Knowledge			Communities		Equity
Services		Translate		Environmental					Institutions		Livability
Policies		Communicate		Political					Businesses		Resilience
Processes				Social					Governments		
Personnel				Technological							
				Infrastructural							

Source: *Ramaprasad, Sánchez-Ortiz, Syn* (A Unified Definition of a Smart City)

Figure 5: Smart Cities Framework

Deconstructing the fundamental elements of the words "smart" and "city", the authors of the work elaborated this interesting idea: the city is made of *Stakeholders (citizens, professionals, communities, institutions, businesses, and governments)* and *Outcomes (sustainability, quality of life, equity, livability, and resilience)*; the term smart is deconstructed into four dimensions: *Structure, Functions, Focus,* and *Semiotics* (not all listed for brevity) where structure, function and focus provide means for semiotics which represent the iterative process of generating and applying intelligence.

Depending on the combination of elements from the framework used, the concept of the smart city assumes a different acceptation. For example: *Infrastructure to sense environmental information from citizens for quality of life;* the infrastructure to sense citizens information about environmental issues to affect and tackle their quality of life. The SC concept can thus be described as a fluid idea, that keeps changing and adapting to the context it is inserted in.

Despite that, the scope of this work required the identification of some characteristic and thus from now on the Smart City will be that city distinguished by the elements of both the following definitions, from authors Giffinger and Höjer & Wangel:

1. *It is well performing in a forward-looking way in these six characteristics: Smart Economy, Smart People, Smart Governance, Smart Urban Mobility, Smart Environment.* [7]
2. *It is: a) able to meet the needs of its present inhabitants; b) without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations; c) supported by ITC.* [8]

The Smart City thus will be that city able to wisely make use of available resources to excel in most of the areas described by Giffinger and that will put the focus on generating valuable outcomes for its dwellers, investors, and stakeholders. The support of ICTs is unquestionable but, in order to be attributed the name, the SC will also have to look toward sustainability concerns, satisfying both present and future needs.

This definition of smart city is necessary to understand the main topic and to help the reader localize inside these global trends the following reasonings. In the next paragraph, the focus will be on one aspect of it: the Smart Mobility.

1.2 The Smart Mobility

Starting from ancestral times, roads have always played an important role in human history; they permitted the mobility of people and goods allowing ancient population and empires to expand over their boarders, bringing with them knowledge and innovation. It is sufficient to think at Rome that, as described by Victor von Hagen, "*became a mobile source of civilization*" thanks to its roads, and at the Silk Road, the commercial route connecting two completely different worlds - Asia and Europe.

Today more than ever, roads, and more precisely, the mobility of people, goods, and services inside urban agglomerates, are at the centre of a tumultuous debate. Cities are investing in innovative solutions to improve their road systems and trailways, in tools for an efficient management of their logistic fleets, into the promotion of active and cleaner modes of transport and into digital features to complement their public transport systems. These interventions, many times are encouraged by central governments and the interests of world-class automotive companies and, considering the already mentioned urbanization trends, are necessaries without any doubt. But what does an urban mobility system require to be labelled "smart"?

1.2.1 A definition for Smart Mobility

As per the smart city, the mere application of some Information and Communication Technologies (ICTs) is crucial but not enough. The attention toward the sustainability of the solution developed, the adoption of innovative forms of propulsion, environmentally friendly fuels and the engagement of citizens are all aspects that need to be taken into consideration as well. Let's review the existing literature to arrive at an exhaustive definition of the concept.

First of all, it could be useful to start from the point of view Paiva et al.[9]: in their 2021 article they made different considerations when analysing the transport of goods and the transport of people. Regarding the first, it is easy, and probably right, to attribute smart characteristics to a logistic system that "simply" employs Internet of Things, Big Data and Artificial Intelligence to monitor, improve and manage its vehicles' fleet. These technologies can indeed provide relevant on-time information to allow system managers to promptly intervein, dynamically answering to daily urban infrastructure changes (accidents and congestions). But when talking about the mobility of people, the situation changes: a smart mobility system for humans is more than an instrument equipped high computational power and intelligent – intended as the ability to adapt to obstacles - features. Associating the world "smart" to transportation, means to provide the mobility ecosystem with efficiency and with consciousness about its impacts – of course a lifeless tool cannot (yet?) be self-conscious, but its use and application should be. The worlds smart and sustainable thus, become strictly related and the boundaries between them, increasingly blurred. Glenn Lyons [10], in her 2018 article, defines smart urban mobility as:

"*Connectivity in towns and cities that is affordable, effective, attractive and sustainable*".

It is immediately possible to distinguish some important elements:

- *Connectivity:* it can be both physical (when between people and people, people and places or peoples and goods) and digital (the connection of information, data, and knowledge by means of ICTs). In both cases dealing with mobility concerns transcending distances.
- *Affordability:* the connection must be affordable, in the sense that these intelligent systems must recognize a wider audience than the smartphone-wielding urban knowledge worker (here also a sense of inclusivity is given).
- *Effectiveness:* connectivity systems should be able to satisfy different needs of different users.
- *Attractivity:* in satisfying users' needs, the mobility infrastructure should ensure satisfying working and urban living experiences. Moreover, it must also be economically attractive in terms of return on investments, only in this way investors, VCs and other resources are attracted.
- *Sustainability:* to conclude, connectivity must be sustainable. All these achievements must be able to be maintained on a long-term basis, economically, socially, and environmentally.

The last dimension described, is perhaps the most important: Lyons says "*[…] it may be easy to lose the focus when labeling urban mobility with the word smart […], but the objective of creating an affordable, effective, attractive, and sustainable connectivity can only be achieved bringing together technological and social considerations*". In other words, leaving smart urban mobility and sustainable urban mobility as unaligned paradigms, will determine their failure. This vision about the importance of sustainability is shared also by other authors. Battarra et al.[11] for example, even if they categorize the elements of Smart Mobility systems into three slightly different categories (accessibility, sustainability, and ICTs) they claim: "*[…] the best application of technology is that able to make urban mobility more sustainable"*. The technological dimension of the smart mobility assumes in this optic the function of an advanced, powerful instrument serving a higher goal: the basic idea behind Smart Mobility thus is to apply technology to ensure quality services to the citizens while at the same time minimizing the impact on the surrounding environment [9]. As these brief examples demonstrated, the literature is full of definitions for the concept of Smart Mobility. One last definition, that managed to successfully ensemble the importance of technology, sustainability, inclusivity, affordability, effectiveness, and the multidisciplinary inclination of the topic, was given by an Intesa Sanpaolo Innovation Center [12] report:

"the term Smart Mobility encapsulates concepts linked to technology, to infrastructures for mobility (car parks, recharging networks, road signs, roads and bridges, etc.), to solutions for an efficient, economical and sustainable management of mobility and lastly to models of consumer use of varying degrees of innovation."

This definition could be defined exhaustive since it entails all the elements previously mentioned. From technological applications to roads signs, car parks and streets, to inclusive models of consumer use, like the sharing of vehicles and the integration of public and private transport. Now, let's briefly review which are the main theological applications that enable Smart Mobility and which its main benefits.

1.2.2 Technologies for Smart Mobility

The creation of a connected ecosystem of vehicles, devices, infrastructures, and cloud services is probably the most important enabling factor for the revolution of mobility. The Internet of Things (IoT) along with Information and Communication Technologies (ICT), plays a key role in the creation of such environment and must ensure that the exchange process of data collected with sensors and cameras, is smooth, secure, and efficient. The more sophisticated and impactful applications of SM indeed rely on the prompt availability of high-quality data that, for this reason, are shared with specific communication protocols and connection technologies, like Wi-Fi, LTE, and 5G. To have an insight about the main smart mobility enabling technologies, it is useful to refer to the classification inside Professor Sara Paiva's article [9]:

- *Smart Sensors and IoT:* they constitute the intelligent and energy efficient technology to sense and monitor streets conditions, pedestrians, vehicles to provide an effective mobility management. Radar, lidar, proximity and ultrasonic sensors are frequently adopted.
- *Geospatial technologies:* intelligent geospatial technologies, like GPS, used to provide accurate tracing information of vehicles and flows of people.
- *Blockchain:* used to provide a privacy-preserved, transparent, and trustless architecture for mobility services. An example are smart contracts based on the blockchain to ensure transparency and security for a MaaS platform's payment systems.
- *Artificial Intelligence:* based on data collected, AI algorithms can be developed and trained to provide autonomous decisions as well as to predict future trends and opportunities.
- *Big Data:* they represent the backbone of the smart city since the huge amount of data generated by IoT devices and sensors can provide valuable information that need to be extrapolated.
- *Clean Energy:* innovative sources of energy, such as solar energy, wind energy, hydro energy, and biomasses, must complement smart mobility initiatives.

But how can these technologies be translated into practical solutions to revolutionize the movement of people, goods, and the distribution of services inside today's cities? Some examples are listed below.

Assistance services and enhanced experience: provide the driver the possibility to access to a series of assistance services, like real time information about the maintenance level of his vehicle, the possibility to call for help directly from the car display, and

additional services (entertainment, delivery services, etc.) to enhance the inside-cockpit experience.

Autonomous driving: use Artificial Intelligence and Big Data to feed software solutions that enable autonomous driving, complete or partial, capabilities. The autopilot and automated parcel delivery services are clear examples.

Electric mobility: innovative solutions for the charging process of electric cars (like electrified road lanes) and systems enhancing the autonomy of their batteries. New charging stations and infrastructures to enable EVs' drivers/producers to receive or donate energy (Smart Grids) equipped with smart digital features (App to manage the charging process and to book them). This category also includes electric buses and other public transport means, that even if not provided with digital features, contributes to the revolution of urban mobility's impact.

Fleet management: solutions to provide a fleet of vehicles, commercial and/or private, with connectivity features that allow managers to continuously monitor and optimize its performances – information may be for example data about the fuel consumption, the precise localization, and the effective distances covered.

Infotainment: all those technological applications that allow drivers to be more informed about real time conditions of the surrounding environment (about traffic and weather for example) and to access to some entertaining services (music, videos, evens games like in late Tesla models). Access to all these services is usually made through vocal input or App.

Last mile delivery: the technology is used to revolutionize the way the last mile is covered. Solutions may involve the deployment of small, automated drones for goods delivery or the elaboration of efficient routes using machine learning algorithms.

Micro mobility: scooters, bikes, kick-scooters, and other active based mobility solution enriched with digital features like platforms and Apps.

Mobility as a Service: platforms employing smart software to create a multimodal net of transports using many different mobility services (buses, trams, subways, and active ways of transport) and an integrated ticketing system: citizens experience becomes seamless, efficient, and effective.

Parking management: remote monitoring of parking places – using sensors and cameras – to inform the final user about their status, to help him saving time and resources while reducing pollution.

Public transport: installation of sensors and positioning devices to continuously monitor the localization and occupancy status of public transport vehicles. These solutions increase the efficiency and inclusivity of urban services.

Safety: hardware and software solutions that allow to reduce the probability of accidents to occur; real-time dangers signalling, driver vital parameters live monitoring and communication between close vehicles. Inside this category there are

also some of the ADAS technologies: *adaptive cruise control, automatic parking, automotive night vision, blind spot monitor, closing avoidance systems, cruise control, driver monitoring system, forward collision warning, lane keeping assist, vehicular communication systems, etc.*

Smart Infrastructure: the creation of an urban infrastructure entailed with some smart features. Sensors, cameras, and wireless connections allow the collection and distribution of data to inform drivers, local administrations, pedestrians, and service providers about possible events that, e.g., may be useful for their safety. Inside this category there are a lot of applications, from traffic and parking management solutions to infotainment and smart grids; commonly used terms are Vehicle to Everything (V2X), to Infrastructure (V2I), to Vehicle (V2V) and to Pedestrian (V2P).

Sharing mobility: sharing services of cars or other vehicles (e.g.: bikes, scooters, kick-scooters) provided by third parties or by other private users (peer-to-peer) through Apps or platforms.

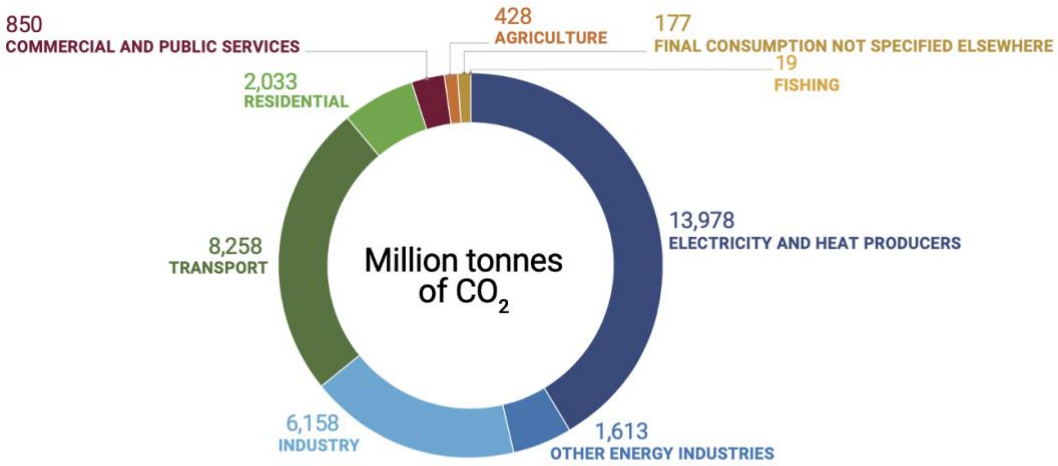
Traffic management: measurement of the effective traffic level and implementation of measures to optimize the city's viability, like the dynamic management of traffic lights. These solutions employ technology to avoid congestions and jams and create leaner traffic flows.

1.2.3 Benefits of Smart Mobility

The transport sector, with all its elements and actors, is one of the main areas on which innovation efforts should concentrate to achieve goals of sustainability, livability and compliance with regulations and strategic objectives. Consider for example that according to the Department of Economic and Social Affairs [3], up to 92% of the SDG targets are linked to a sustainable and resilient infrastructure – including the transports system.

An overview over the main benefits of Smart Mobility is here presented.

Sustainability: as shown in Figure 6, in 2018 the transport sector was responsible for 24% of the global direct CO_2 emissions from fuel combustion and the passenger road transport was the largest contributor to their total volume [13].



Source: United Nations, *Sustainable Transport, Sustainable Development*. Interagency report for second Global Sustainable Transport Conference. 2021. (CO_2 emissions by sector 2018)

Figure 6: Global CO2 emissions by sector

It is clear how changing the actual paradigm and incentivizing the shift toward sustainable propulsion systems, green sources of energy, low-emissions electric public transport systems, active and shared vehicles would have enormous impact on pollution reduction. This is the reason why sustainability can be considered as one of the main benefits of SM.

Livability: the improvement of environmental parameters (like the quality of air) directly affects the livability of cities. Moreover, congestions reduction solutions and traffic management technologies decrease the number of cars, accidents, jams, and noise level typical of crowded urban agglomerate.

Costs reduction: Smart Mobility enable shared solution for mobility and technologies for an efficient usage of public transports. The cost for users as well as the ownership

costs of cars and their maintenance is therefore dramatically decreased. The creation of a connected infrastructure moreover enables a prompt and continuous monitoring of urban flows and the maintenance level of streets and curbs: urban managers and administrators can thus save money and efficiently use the available resources.

Safety: as already anticipated in the discussion of livability, technologies for Smart Mobility play a key role in people's safety. Drivers can receive prompt information about incoming cars and pedestrian crossing, and if distractions or human errors occur, ADAS systems can intervein, reducing their potential impact: this result in a drastic reduction in the number of (fatal and not) accidents.

Smart Mobility is a wide concept, that affect many actors and aspects of urban life. Its benefits are so numerous that reducing them to the list presented above would be reductive. The discussion could indeed go far beyond, including for example: *social inclusion, job creation, city's image enhancement, vulnerable groups and women empowerment, education, health* and so on. Anyway, for the scopes of this work, it seemed sufficient to list the main one's, that have direct impacts on our everyday lives.

2. Purposes and Methodologies

The starting point for the creation of this thesis work was the process of desk and field research that allowed to gather knowledge around the Smart Mobility thematic and, in the end, to elaborate a critical opinion about it. Some doubts and key questions emerged, and, looking for an answer, it was possible to build up the core body of the whole document.

In the next section these key questions, the objectives, the main methodologies, and clear overview over the instruments adopted will follow.

The whole work was conducted together with the supervision of the Connected Car & Mobility Observatory, that continuously provided support and reasoning material for the elaboration of the final concept.

2.1 Purposes and key questions

As previously presented, papers, articles, and talks described a scenario characterized by environmental and social concerns regarding sustainability and livability of cities in the future. Global authorities urged for a change of paradigm in the mobility sector, supported also by the effects of the Covid-19 sanitary crisis - restrictions to people movements put the discussion about innovative, adequate, and sustainable transport systems under a new light. It was natural, at this point, to wonder how the topic was being faced in Italy and whether a comparison with foreign countries was possible or not.

The key questions emerged and that this work tries to answer are the following:

1. *Which is the state of the art and the future perspective of Italian municipalities with respect to Smart Mobility projects?*

1.1. *Which are the main differences when looking at Smart Mobility projects in Europe and in the rest of the world?*

2. *Which future directions can be envisioned for Italian cities?*

2.2 Methodologies

If on one hand the mere reasoning was an important source of insights, on the other hand, a defined methodology was necessary to find an answer to the presented questions. Here listed the main activities and instruments used:

- A review of the existing literature to understand the topic.
- A survey to collect most relevant information about the Italian Smart Mobility panorama.
- A database of 122 national and foreign initiatives, projects, and public partnerships, to analyze the foreign context.
- A framework built to categorize projects and to compare them according to two selected dimensions.

2.2.1 The Literature Review

The literature review was the starting point for the creation of a solid knowledge base around the thematic. Indeed, even if the main aspects of the Smart Mobility were already clear, a deep analysis of its mechanisms, main actors, impacts, and characteristics was necessary: this allowed to increase the awareness about the importance of the topic, evidencing how and to which extent it affects people and modern cities.

To this end, an heterogenous source of information was used: it included more than 20 between academic papers and company reports, journal, and web articles. Academic papers were identified using online search engine for scientific publications: Scopus (scopus.com) and Research Gate (researchgate.com), while for the other sources simple Google research were made.

2.2.2 The Survey

The Italian picture around Smart Mobility was pictured thanks to an online survey administered and created by the Connected Car & Mobility Observatory (see Appendix A for the full text of the survey).

The survey, made of 21 questions, was delivered to 735 Italian municipalities and answers were collected between July and the beginning of September 2021. The total number of answers collected, coming from all regions of Italy, were 111: with a total response rate that reached the 15%. Once answers were collected, they were organized and analyzed inside a database: this was useful to create graphs to further communicate results obtained. Information allowed to picture the perspective of Italian cities about the Smart Mobility, the objective of administrations, the role of partnerships and the main barriers to related projects' implementation, highlighting also the role played by Covid-19.

2.2.3 The Initiatives database

The willingness to compare results of the survey with some existing cases required to collect additional and sufficient information about Smart Mobility in other countries and with different instruments. To this end, a 120 initiatives-made database was created: private initiatives, public partnerships and agreements, and real use cases were collected and carefully analyzed. The database allowed the systematic grouping of information, like:

- The project typology (pilot, executive or preliminary analysis).
- The main actors and partners involved.
- The main benefits and beneficiaries.
- The main area of implementation.
- The main technologies used.

Dimension collected were many others, as described in Appendix B. The creation of such database was useful in order to gather additional knowledge and to investigate for trends and relationships between projects typologies, implementations areas and benefits: this was the basic idea behind the creation of the structured framework further described.

2.2.4 The Framework

The latest activity performed in order to find an answer to the last of the three questions proposed, was the creation of a qualitative tool to compare different Smart Mobility initiatives, each implemented with different objectives, technologies and in different areas of the world.

Two dimensions needed to be found and so, the ones selected were: *the implementation area of the project* and *the benefit desired and achieved*. The selection process of the two dimensions was the result of a trial-and-error approach and moreover, they were easy-to-collect information.

The two dimensions were then reorganized and classified into a 5-grade scale according respectively to the innovation introduced, technological or social, and to the benefit generated, environmental or not (explained also in chapter 4 and in the appendix). This framework allowed to identify 4 different regions in which to classify countries (or projects) depending on their attitude toward the innovation of transport systems.

1. *Region of technological innovations for sustainability.*
2. *Region of behavioral innovations for sustainability.*
3. *Region of technological innovations for users' experience.*
4. *Region of behavioral innovation for users' experience.*

The final objective of the analysis was to find a collocation for Italy inside the matrix, individuating its approach and possibilities with respect to Smart Mobility.

3. The Italian Smart Mobility Scenario

The primary source of information used to define the Italian Smart Mobility panorama was the "Survey Smart Mobility 2021": a 21-question survey created and delivered to Italian cities' administrations between July and September 2021 by the Connected Car & Mobility Observatory of the Politecnico di Milano. The survey's goal was to present a qualitative overview of the state of the art of innovative mobility projects, pointing out already existing initiative, main barriers, and drivers for their implementation, and defining possible future collaborations and horizons. The next paragraphs will thus analyze the answers received.

Before entering the details of the survey, two specification needs to be done: first, this is not a technical analysis and therefore there are no specific questions about technologies used for Smart Mobility projects. The second consideration, that is even much more relevant, is that many of the questions composing the questionnaire take into consideration an element that emerged in the last 2 years and that characterized many of the aspects of our lives: the uncertainty determined by the coronavirus pandemic today we are still fighting. The sanitary emergence, and all the consequences related - from indoor spaces restrictions to social distancing and back to hygiene conditions monitoring - have nowadays a central role both in how people behave and in the decisional process of actors, private and public, offering services to citizens needing them. Transports and mobility are among the most important services a city administration needs to delivery to its inhabitants, and among the ones in which there is a higher probability of strangers getting close each other. Therefore, this survey could not avoid including this topic from its investigation perimeter. Among the 20 questions, 3 makes direct reference to the pandemic and asks the interviewee to compare the current condition with a pre/post emergence scenario, all the other implicitly consider this element in their analysis.

This acknowledged, the overall structure of the survey is the following. After a brief introduction and description of the survey's scope, the first question collected personal details of the respondent, then 5 common questions were asked mainly regarding the relevance of the topic. Question number 5 was key since its goal was to determine whether the municipality launched one or more Smart Mobility projects in the three years between 2019 and 2021 or not; the ones answering "Yes" were then asked to

answer 4 specific questions concerning the progress state of such projects, the way data collected are being used, the realization time and their acceptance among citizens. The ones answering "No" were simply asked to skip until question number 11.

The rest of the poll is then common. It went through future Smart Mobility ambitions of municipalities, the objectives administrations should pursue, the actors to involve in possible partnerships, the barriers slowing and complicating the implementation of these initiatives, the integration services between smart cars and urbans infrastructure, the possible role of municipality and in the end, the biggest challenges to face when lunching this kind of projects.

In attachment, there is the complete survey. It is in Italian language since it was conceived for Italian municipalities.

3.1 The Sample Used

Every year contents and questions' text are modified with relevant trends and topics and, every year, a detailed review of the reference person to contact is necessary: the survey is sent via e-mail to mobility assessors, offices or directly to majors and these administrative figures indeed may change during time, moreover some of the previous versions may have been sent to the wrong person or contact. For these reasons, before sending the 2021 survey version, all the received-back/wrong answers were reviewed and updated with correct contact details.

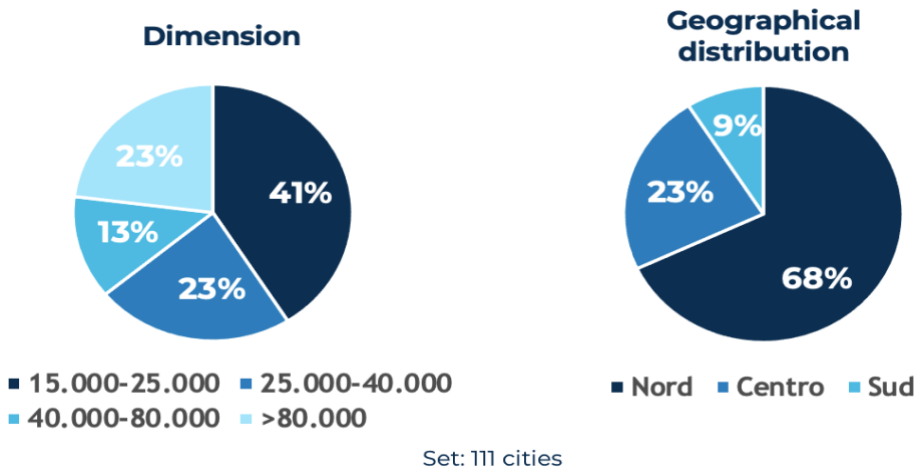


Figure 7: Sample Composition

The survey was administered between July and the beginning of September 2021 and was delivered to 735 Italian cities. Answers collected were 111, with a total response rate of 15%. Responses were deeply analyzed and, for most interesting cases, additional research about the ongoing Smart Mobility projects was conducted. The sample was quite heterogenous, but most of the answers, as shown in Figure 7, came from small/medium-sized cities of the North of Italy.

3.2 The Big Picture

What first is worth to be noticed is that the thematic under analysis - everything that regards innovative solutions for urban mobility, public transport, urban planning and more in general, mobility management - is considered a hot topic by almost all the respondents. The first question "*How relevant is Smart Mobility for your city?*" was answered by 108 municipalities, 95 of them (88%) stating that it is "*Relevant / Very important*". Only 13 cities thus answered that it is a topic of "*Little importance*" but, among them, 9 answers were from small towns. This data provided first evidence that Smart Mobility seems to root better in bigger municipalities.

Being this topic so relevant for Italian cities, it was interesting to understand which could have been the impact of the sanitary crisis on its perception. *Q.3: Considering the pandemic, does Smart Mobility projects represent a priority for your city?*

The 108 answers received to question number 3 can substantially be divided into two main clusters: the first 43% stating that the pandemic had no influence on the perceived urgence around it, in the sense that it was already a priority before Covid-19. And the second cluster, made of 42% of answers saying that the pandemic made the topic even more relevant than before, a perception that is characteristic both of small and big cities.

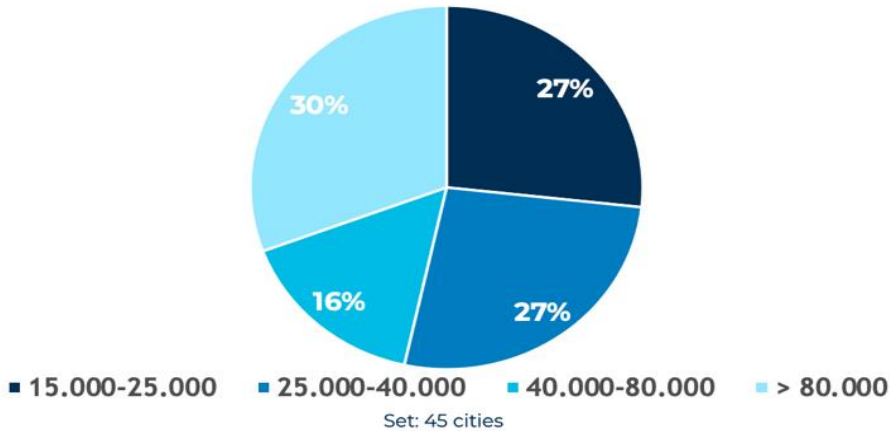


Figure 8: Dimension of cities perceiving Covid-19 as a boost for Smart Mobility projects.

Figure 8 shows that there are no substantial differences when analyzing the number of inhabitants of the city and both big and small ones felt the current emergency as a boost for Smart Mobility projects adoption. The low percentage registered on municipalities between 40.000-80.000 citizens can be easily explained considering the composition of the original cluster analyzed. These results were thus encouraging; much of the respondents already considered the thematic inside their priorities lists

before the crises, and the rest understood its possible positive impacts and applications and now recognizes its importance.

This acknowledged, it was natural to wonder if the pandemic not only affected the perception about these topics, but even if it had a tangible effect on Italian citizens' habits. *Q.4: Which have been the most used means of transport during the first pandemic months, and which will be the ones looking at a future post-pandemic scenario?*

As Figure 9 explains, the use of private vehicles, scooters and motorbikes is expected to decrease in the post Covid-19.

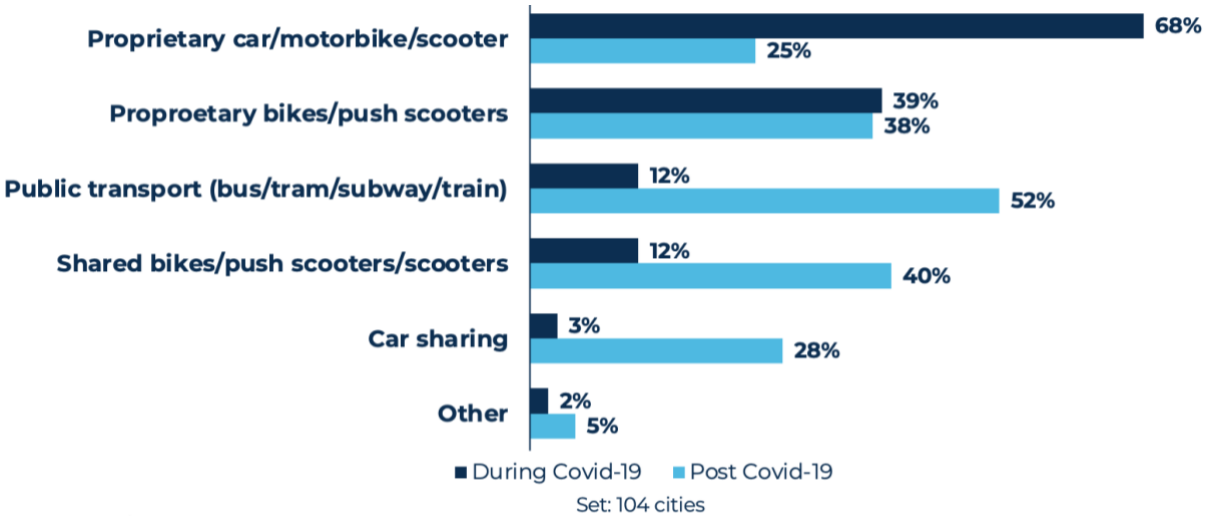


Figure 9: Urban means of transport pre and post the pandemic

Since they were the only solutions to move around able to ensure safe distancing and to limit virus circulation, proprietary vehicles were naturally the mostly used transport means during the pandemic (68% of cities selected them). But the boom in private vehicles utilization brought out all its negative effects: bad air quality in city centers, traffic congestions, noise, and accidents. Therefore, when imagining a post-pandemic future, cities' administrators expect their citizens' preferences to radically shift toward more sustainable, flexible, and economic ways to move inside and outside the civic territory. In close-future scenarios people will still go to work, to do the grocery and to leave kids from school using their private car, but a greater portion of urban mobility will be managed through last-generation sustainable vehicles, public transport (thanks to good surfaces purification and updated safe measures) and through new, or already existing, shared mobility services. This last point, about shared mobility, deserves dedicated focus.

The expected increase in the adoption of such mobility solutions is unquestionable: considering cars, bikes, scooters, and all other shared transport means together, there is a 65% increase in the number of cities selecting them for a post-pandemic scenario. Sharing mobility will thus characterize the transport ecosystem of many Italian cities,

and moreover, it seems that these solutions will be adopted by small, medium, and big cities indiscriminately. What instead can be noticed is that this positive trend seems to be pulled by northern towns.

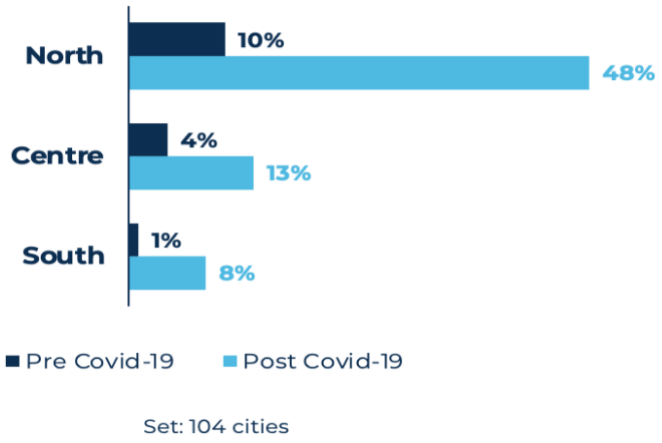


Figure 10: Sharing Mobility solutions adoption by region

Within sharing mobility solutions there are bikes, motorcycles, kick-scooters and cars.

In Figure 10 it can be noticed that the bigger increase is registered in the northern regions of Italy. If only 10% of them considered the adoption of sharing-based business models before the pandemic, almost the half (48%) claimed that they will implement such solutions in the post Covid. Percentages dramatically decrease when moving toward South and indeed, the number of southern municipalities claiming that they will adopt these paradigms only increased by 7 percentage points. Reasons behind these results can be various: for sure they are impacted by the lower representation of South in the sample, but the discussion can go further. Determinants of could also be the lower development and maintenance level of infrastructures that typically affect those regions and that disincentivize the usage of active-based transport means (bikes and kick-scooters). In the end, the lack of knowledge about the possible benefits of course has a role in this: as an instance, many southern cities are indeed small and their roads tiny and uneven, the decrease of the total number of cars achieved shifting to shared means of transport, could facilitate people mobility and provide more space for maintenance.

When talking about sharing mobility, results are thus overall positive, but it is appropriate to specify that cars will probably not live the same glorious days as other transport means. As reported by an article published by Corriere Motori (November the 27th, 2021), while kick-scooters registered an outstanding boom in the number of available units (+665% vs the 5 previous years), shared cars by the end of 2020 were 7.300, with a 12% decrease with respect to the previous five years of strong increase. And this negative trend is expected to continue: in 2021 the industry is registering a 50% decrease in volumes compared with 2019; the reasons are mainly to be attributed to a major player leaving the city of Milan (Share'n go [14]), the larger adoption of

smart working polices that caused a big decrease in the number of shared business vehicles, and, of course, to the intrinsic skepticism that sharing something generates in a "distancing" period. The same article mentions a study conducted on the city of Rome carried on by the Centro Studi Fleet&Mobility, revealed that providing the capital with a 20.000 shared vehicles fleet would reduce the circulating cars number of 228.000 units, with an emission reduction of 10% (83 PM10 Tons/year) and again, further studies [15] state that the average city worker could save up to 30% (c.a. 1300 €/year) using sharing mobility solutions instead proprietary ones. Therefore, even if benefits are well known, prompt and clear communication campaigns will have a key role in ensuring a fast recovery in the shared cars segment and new service will be asked to offer more safety and efficient solutions. An example is Volvero [16], a 2018-born Italian platform for peer-to-peer vehicle exchanges, that allows car owners to share their vehicle while they are not using it: this dramatically reduces cars-idle time, increase revenue possibilities, and increase security through a blockchain-based insurance policy.

Wrapping all up, the next future urban mobility will probably be mostly managed through shared services, except for shared cars that will need a little more time to take back the loss terrain. Moreover, public authorities and local administrations should worry to enlarge the adoption of these solution in the South of Italy, where, given the characteristics of towns, they could even have better impacts. The answers to this question allowed the collection of useful insights about possible future scenarios and reactions to Covid; now it was the moment to understand which were the present progresses in the field of innovative mobility among the interviewed municipalities.

Question number 5 "*Has your municipality launched Smart Mobility projects in of before the 2019-21 triennium?"* provided interesting insights. Most (76%) of interviewed assessors, mobility managers and majors claimed that their municipality launched one or more smart mobility project in the specified years. Considering that a single city could have started more than one project per year, the overall initiatives number was 136 and to gain more valuable insight it was useful investigate the precise year of launch of these activities.

Figure 11 makes it possible to notice how the progresses around the Smart Mobility thematic are going on. Year after year, cities are becoming smarter, and administrations' consciousness is growing at fast pace: 59% of the 76 municipalities with at least on project, are launching these innovative mobility services (with no distinction between trials, pilots, or effective executive projects) in 2021.

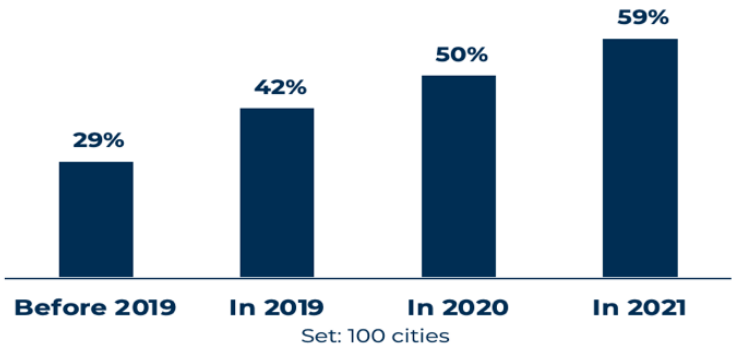


Figure 11: Launch year of Smart Mobility projects

This is a clear indicator about the interest around the innovation in the mobility field. Many of the solutions included under the Smart Mobility umbrella, like electric mobility, innovative parking systems, accidents detection technologies, sharing mobility paradigms and active-mobility-based business models, not only will allow cost savings, but will also increase citizens quality of life and well-being. This is gold in the pandemic era.

The other side of the coin is that almost 1 city out of 4 (24%) claimed that there have been no Smart Mobility projects launched between 2019 and 2021 or before. This data must be taken as a warning, especially when detailing the analysis to the dimension of these cities: 67% of them had between 15.000 and 25.000 citizens, and the percentage increased to 88% considering the 25.000-40.000 range. Difficulties faced by smaller towns in developing innovative solutions on their territories have thus been brought to light but, is it a matter of economic resources?

When asked *"has your municipality planned the activation of economic incentives/bonuses to foster the adoption of sustainable mobility?"*

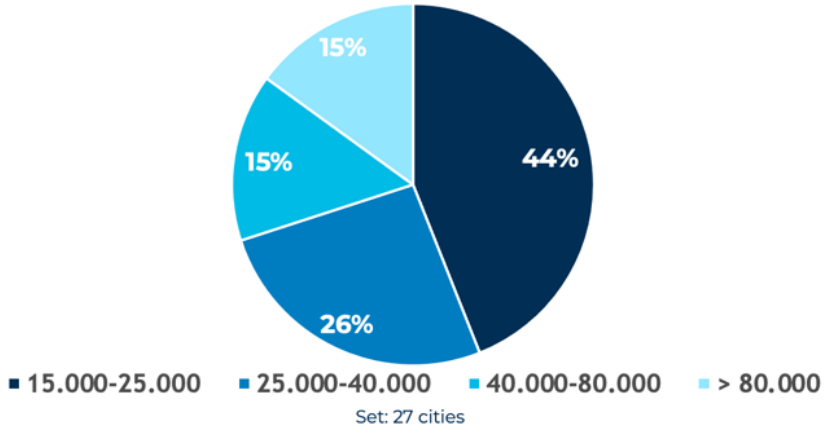


Figure 12: Dimensions of cities not providing incentives or economic stimulus to Smart Mobility projects

Only 27 out of 98 cities (28%) answering said "*No*" and the major part (Figure 12, 70%) of them were effectively medium/small-sized cities. But this must not lead to misunderstandings. Smaller cities claimed to be facing higher difficulties in activating bonuses and economic incentives, not that they were not receiving adequate funds. This could be explained saying that some smaller towns are less interested in Smart Mobility projects (see Q.2 discussion) and that they can be considered less economically efficient than bigger ones. By contrast indeed, small, and medium towns also represented the higher percentage of cities answering "*Yes*", as displayed in Figure 13.

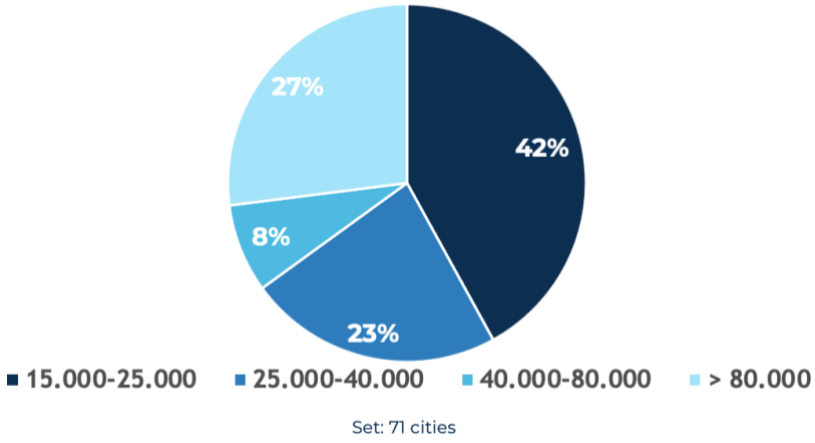


Figure 13: Dimensions of cities stimulating Smart Mobility projects with bonuses or incentives

The activation of monetary incentives to stimulate the diffusion of such initiatives, stands therefore in the ability of the management board to efficiently manage the available resources and to conduct the city's ordinary administration in the best way possible. It is thus plausible that if on one hand being small means to have less expenses and higher flexibility to test innovations, on the other hand smaller dimensions could mean lees urgency toward these thematic: urban centres with less inhabitants may concentrate their attentions and energies to solve more daily and practical issues. Here is explained the higher percentage of small towns not incentivizing Smart Mobility.

To conclude, the fact that 72% of cities answered "Yes" pictured an overall good situation in Italy, in which most of the cities are able to support smart mobility initiatives with economic aids. The remain 28% of municipalities require the state to help them and perceive the lack of economic funds as a barrier. Anyway, as it will be presented further on, the scarcity of economic resources is not the only obstacle for the launch of smart mobility projects. Difficulties may come in the form of bureaucratic obstacles, technological problems, frequent changes in the administrative personnel and social resistances. In the end, answers will show how also municipalities with a high number of people living may be negatively impacted.

In this section the past and present propension toward Smart Mobility projects was introduced. Referring to the sample used, it is possible to claim that many of the Italian cities have already implemented solutions to optimize their urban infrastructure or at least, have recognized its importance and value. Covid-19 also played a crucial role, changing the rules of the game and making the take of action more and more urgent for many cities. Nevertheless, there is still a long way to go before and extensive adoption of new mobility paradigms in our country takes place. What is now useful, is to deep dive into the details of the existing and future initiatives to understand in which direction is Italy really going: *which are the projects perceived as more useful? How urgent is really the thematic? Is it a matter of 2/3 years or more?* And again, *what should we expect for the future, and which are the barriers and objectives for the administrations?*

The answers to these and many other questions are reported in the next sections and will provide a clearer picture of the Present and Future Scenario.

3.3 The Present Scenario

A good portion of the interviewed cities claimed to have already started at least one project in the 19-21 triennium (*question 5*) and therefore, it was worth noticing the progress status of the initiatives already implemented: *Q.7 please for each launched projects, indicate the progress status (preliminary analysis / pilot project / executive project).*

The survey was built considering 9 possible Smart Mobility fields and 3 different progress status:

1. *Preliminary analysis:* this category refers to experiments launched to collect data about needs to be satisfied and social acceptance of specific services.
2. *Pilot project:* the first trial of the project conduced to test its key assumptions and usually is conducted by means of prototypes on a restricted user base.
3. *Executive project:* the implementation phase. If the preliminary analysis phase resulted in good opportunities for implementation and if the pilot resulted in effective feasibility, the project is executed.

In this case answers collected came from 73 cities and, given the possibility to select 9 implementation fields, information about 321 different projects were received. Half of the sample refers to the experimental phase i.e.: preliminary analyses and pilot projects (first accounted for 41% and second for 10% of initiatives). The remaining 49% of total projects launched is already in the execution phase.

These data allowed a better understanding of the current situation of Smart Mobility - half of the cities interviewed is already implementing these innovations but is only considering the detailed area of implementation that a clearer picture about the general direction toward which cities are moving emerges.

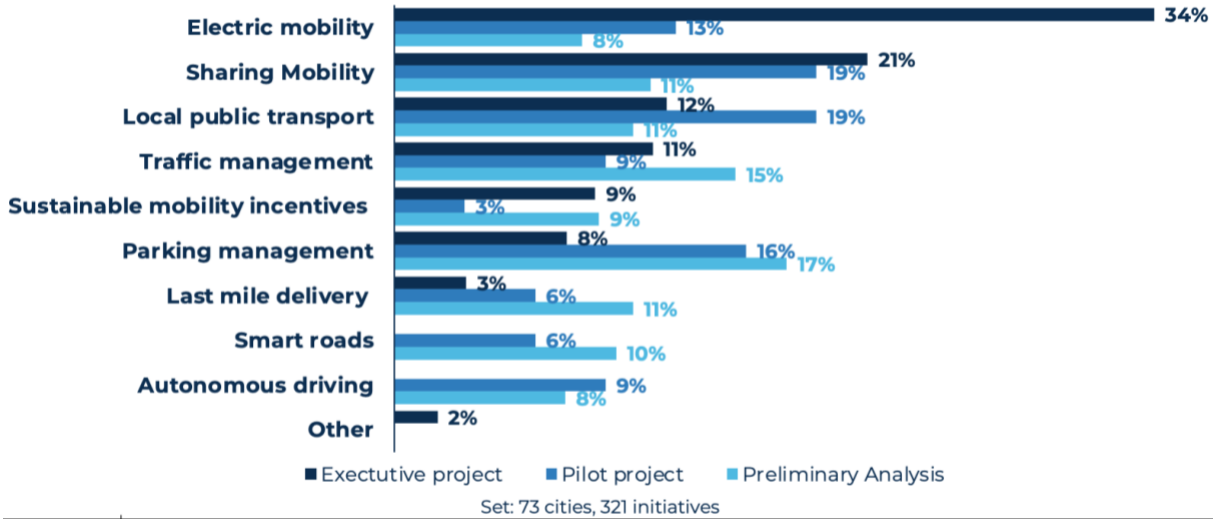


Figure 14: Development areas of launches initiatives

Considering for example the total number of executive projects, how many Electric Mobility initiatives was it possible to count? Answers to questions like this are presented in Figure 14.

Electric Mobility accounted for the 34% of all the projects that have already passed the experimental phase - it was also the most cited area, appearing 68 times (53 executive projects, 11 preliminary analysis and 4 pilots). This mean that most of the Italian cities are implementing solutions like the creation of dedicated charging stations for EVs, the electrification of existing fleets or, more in general, incentivizing sustainable mobility. An interesting example of the creation of an extended EVs charging infrastructure is the "Mi Muovo Elettrico" project [17], launched (at a pilot level, but extended over 11 cities) in Emilia-Romagna. It consisted in the installation of a net of charging columns on the territory manged by three different operators (Enel, Hera and Iren): the electric vehicle's owner then signs a supply deal with one of those companies but, thanks to the interoperability principle the project is based on, can access to charging services on all the infrastructure. Another example came from the city of Merano (BZ) that in 2020 with the "E-bike2work" project [18] provided an e-bikes fleet for everyday car users. Bikes were accessible with a public bid in which higher points were given according to the home-office distance, the need to pick-up children from school etc. Electric mobility represented only the 8% of the preliminary analysis, thus it seems to be a quite established and well-known development area.

Sharing Mobility also was cited many times (54) and the 21% of executive projects are related to this innovative mobility paradigm. This, more than a revolution of mobility infrastructure, is a cultural change, that requires people perception of a car to shift from something to own to something to exploit in the most efficient manner possible. An example of its implementation was seen in the Sardinian city of Cagliari with the "PlayCar" project [19]: an integrate platform that allow users to rent cars and bikes in free floating, one way (pick and leave the vehicle at the charging station) or round-trip (same pick up / return point) modality.

Local public transport solutions are still in the experimental phase representing 19% of total pilot projects (6 out of 32). Public means of transports represent indeed a very delicate point for administrations: they constitute the infrastructure of every developed city, and they affect lives of many peoples: when dealing with innovations in these areas, long preparation and precise testing phases are required. Moreover, many pilots' tests must be conducted and successfully carried on before their implementation can expand to the entire urban territory. Some interesting experiments are defining the direction to take: the "Tech Bus" project [20] in Milan is testing a V2I - vehicle to infrastructure - hybrid bus on a dedicated line. 5G connectivity ensure continue monitoring and the projects aims at setting new standards in terms of sustainability, autonomous viability, and safety.

The survey also demonstrated how cities with a higher number of citizens seem to consider some specific areas more relevant than others: traffic and parking management are two examples.

Traffic Management was mentioned 41 times, 46% of citations coming from cities with more than 80.000 inhabitants. It was also the second application field with the highest preliminary analysis projects percentage (15%). *Parking management* was mentioned 40 times, 4 citations out of 10 from big cities (80.000+ citizens) and it represented the 17% of the total number of preliminary analyses.

These results are unquestionable: bigger cities are the ones where more cars and vehicles are transiting and thus where more congestions and parking-related issues are more likely to occur. In the city of Milano for example a project [21] started in 2017 consisted in the installation of smart sensors on the ground, able to recognize when a vehicle is stopping over or not. A low range net then sends data a mobile application that the user can consult to get information about the free parking spaces.

Anyway, innovate parking systems, means more than only installing smart cameras and sensors to identify free spaces (that are very efficient and effective solutions). As an instance, the city of Treviso, in Veneto, found a different way [22] to manage historic city centre parking spaces. Reducing the minimum parking payment-time to 30 minutes, the municipality was able to reduce the medium ticket price together and to increase in the total number of parking tickets emitted. Parking lots were used more efficiently the construction of an under-ground parking was avoided.

To wrap up, from the survey emerged that there are some interesting projects in the implementation stage, but also that additional research and trials are necessary before an effective solution to be found.

This question pictured an Italian Smart Mobility panorama characterized by electric and sharing mobility projects already in the implementation phase, innovations in urban transport infrastructures waiting for results of the first tests and areas such as traffic and parking management that require additional in-depth studies. *Smart Roads*, *Autonomous Mobility* and *Last Mile Delivery* are three areas in which it was possible to collect the fewest application cases (15, 13 and 21 respectively). Regarding the first two fields, there are projects, like "Arena del Futuro" [23] that is creating a smart road ring for electric/connected mobility between the cities of Brescia and Milano, currently being tested, but it is reasonable to claim that most of Italian cities are not yet mature enough to fully embrace these technologies. *Last Mile Delivery* is another issue typically affecting the mobility of bigger cities - think about the congestions created by delivery trucks stopping many times in the same narrow street in Milan – and indeed the 52% of the 21 total mentions was from big towns. Start-ups like Blink [24], that is trying to shift e-commerce last mile deliveries in crowded cities (Rome and Milan by now) on bikes and electric vehicles, are already tackling the problem but a definitive solution, especially given the boom in e-commerce caused by lockdowns, requires further analysis and trials.

Answers collected with the survey, helped picturing a nowadays Italian scenario that seems to live peaks and valleys – some areas are already quite developed while others are still far from the implementation – but considerations about the usage of data, the perspective of citizens experiencing these initiatives and the impact of the pandemic on the implementation time of Smart Mobility projects, can provide further relevant information.

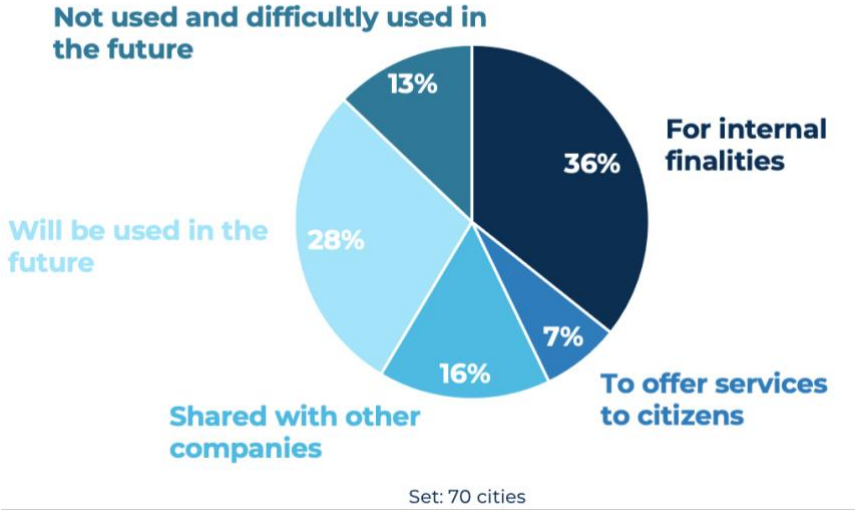


Figure 15: How municipalities use data collected with Smart Mobility initiatives

For example, which considerations can be made regarding the usage of the data collected with Smart Mobility projects? (*Q.8).* Data sharing is fundamental to fully exploit the intrinsic value they entail. This is true both when administrations are conducing preliminary analysis and restricted pilots' projects and both when dealing with empiric data collected from city-wide implementations. Data sharing allows knowledge diffusion about possible hidden impacts and opportunities, allows to take into consideration different points of views and expose our ideas to criticisms, an important innovation source.

As shown in Figure 15, 25 out of the 70 (36%) cities that answered, were using data for internal finalities, only 7% to provide services to their citizens and only 16% were sharing collected information with other companies - internal or external to their administration. In the end, 28% of respondents claimed that they are not using data nowadays but that they have future intentions to do it. Even though only 9 cities claimed that they were not using data now nor they would do it in the future, these percentages cannot be considered positive. The percentage of data being shared with other actors for example, is still too low and, looking at the future, it would be wise to incentive it - by means of fiscal rewards, economic incentives, etc. The final objective of administrations should be the creation of an integrated ecosystem, in which knowledge, competencies and innovations could flourish: the constant sharing of information will therefore have a crucial role in it.

Additionally, also the portion of data used to provide services to citizens should increase. As defined in the first chapter indeed, a Smart City should put its citizens at centre and should do its best to satisfy their present and future needs providing efficient services. If correctly used, these data can have direct benefits on people' lives since administrations can for example improve existing public transports and create on-demand services to manage people flows peaks at rush hours.

As a proof of that, it was interesting to evaluate citizens approval for Smart Mobility projects: *Q.10 how have citizens accepted the Smart Mobility projects that have been launched?* Acknowledged that 31% of the 67 answers collected came from cities that to have not investigated the appreciation level of citizens, the rest of answers to this question were mainly positive - only 13% of "*Services have been poorly / not used*". 35 cities out of 67 (52%), claimed that their citizens "*Used and benefitted of the services delivered*", demonstrating and overall positive impact of Smart Mobility initiatives on people. Moreover, this demonstrated that more than 1 out of 2 people found these projects useful and that the approach with them was positive.

Wrapping up, an increasing number of Italian cities should start collecting citizens opinions; these data then, should be shared with external actors to create valuable partnerships and promote knowledge diffusion, or should be used to define a roadmap for new future projects and/or improve existing services.

To conclude the current scenario of Italian Smart Mobility, *Q.9, "has the pandemic affected the realization time of Smart Mobility projects?"*, provided interesting insights about the impact of Covid-19 on projects realization.

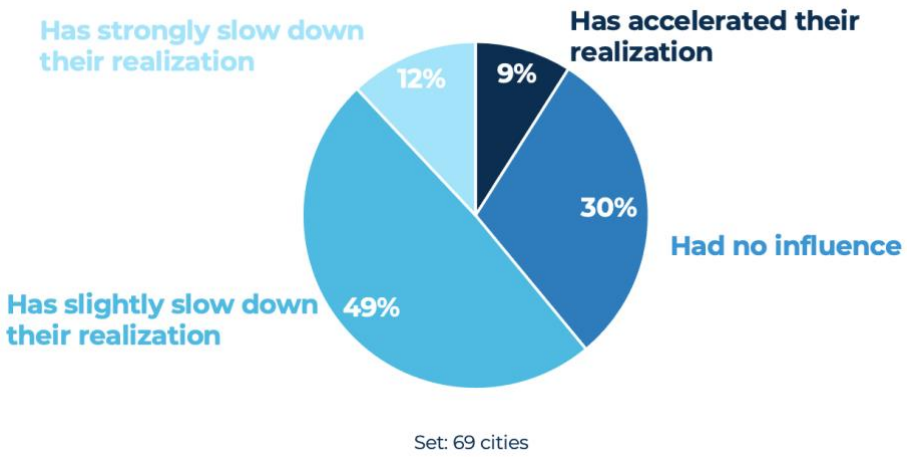


Figure 16: The impact of Covid-19 on Smart Mobility projects realization

As could have been expected, most of cities' executives claimed that the pandemic affected the realization of these projects: 49% of answers received stated that projects delayed, but only of few months (see Figure 16). This was of course due to the initial strong and unforeseen impact of the crisis, that shocked the entire world: stakeholders and governments needed to shift their attention toward the emergency and therefore, some projects may have been reasonably postponed. What is surprising from these answers is first, the portion of cities, 30%, that stated that the pandemic had no influence over the realization time of Smart Mobility projects, and second, the 9% of cities in which projects' implementation even accelerated. Considering the number of answers collected, 27 cities out of 69 (39%) thus perceived the revolution of mobility as a primary issue even before Covid-19 and moreover, they were already prepared to start with the implementation phases of related projects. Aggregating these results together, it is possible to claim that c.a. 88% of Italian administrations promptly reacted to the pandemic – demonstrating a good resilience level – and that the future Smart Mobility is on its way.

According to all these answers, the current Italian Smart Mobility scenario was characterized by the presence of Electric Mobility and Shared Mobility based initiatives, with apparently a good acceptance received by citizens and with administration that had an overall good reaction to the sanitary emergency. Some implementations fields require additional analysis and trials and the importance of data management and their diffusion, with the objective to increase knowledge, must be promptly communicated.

3.4 The Future Scenario

The environment in which Smart Mobility initiatives are implemented is never static: social and cultural trends frequently change, people behavior is difficult to be predicted, consequently regulations and laws need to be frequently readapted. Moreover, the experience of the last 2/3 years should have taught the entire world to never give anything too much for granted. To take into consideration all these elements, the following section is made of those questions of the survey that required the interviewed to describe, or to imagine, the future ecosystem toward which they are guiding the cities they manage and to compare it with the present.

A good starting point was to understand whether Italian cities had intentions to implement innovations in their mobility systems or not, and in positive cases, when and in which specific areas they would concentrate their resources. Question number 12 *"Does your municipality have future plans of launching Smart Mobility projects?"* collected a total of 83 answers, 99% of them reporting information of cities planning to launch at least one Smart Mobility project in the future, with no time distinction.

Percentages in the below figures (17 and 18) are computed on the total number of municipalities that claimed to have at least one project planned, 79: each city could select more than one implementation field and indeed, 314 total future initiatives were collected (an average of 4 projects per city).

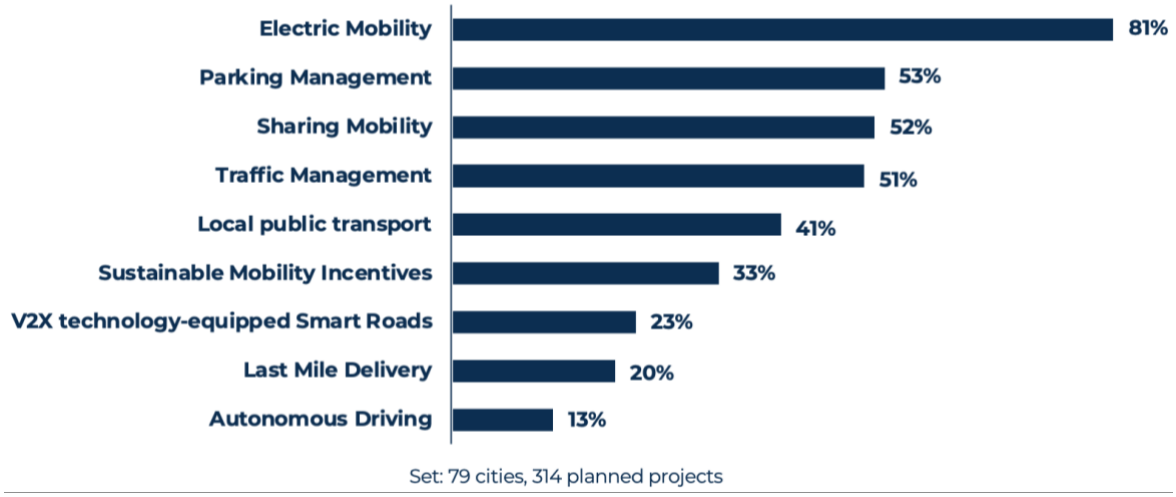


Figure 17: Implementation fields of future projects

The graph describes municipalities willing to implement at least one Smart Mobility initiative in the next 3 years.

One data, among the ones reported in Figure 17, stands alone: 81% of cities (71 out of 79) with future initiatives planned, is going to deploy one or more electric mobility projects.

This topic is at the center of a great debate today; on one hand, there are world-class famous companies, like Tesla pushing toward a fast conversion to a battery-based mobility systems, supported by blind trust of markets and investors, while on the other hand, there many controversies regarding its effective environmental impact and the problem of batteries' second life still to be solved. Italy in this sense seems to be reasonably willing to keep up the pace with this global hot topic, preparing the necessary infrastructure for the next future. New projects about Parking and Traffic Management solutions, and about Sharing Mobility are on the agenda, each of them selected c.a. 50% of times; this can be imputed to a greater awareness about traffic-related problems and the return of chaotic jams into metropolises' streets after the pandemic vacuum.

But how fast are Italian cities going? Are these changes going to happen soon or is it a matter of many years? Question number 12 was structured in order to gather this information. This latter, combined with the typology of project planned, was useful to understand which was the priority for public administrations.

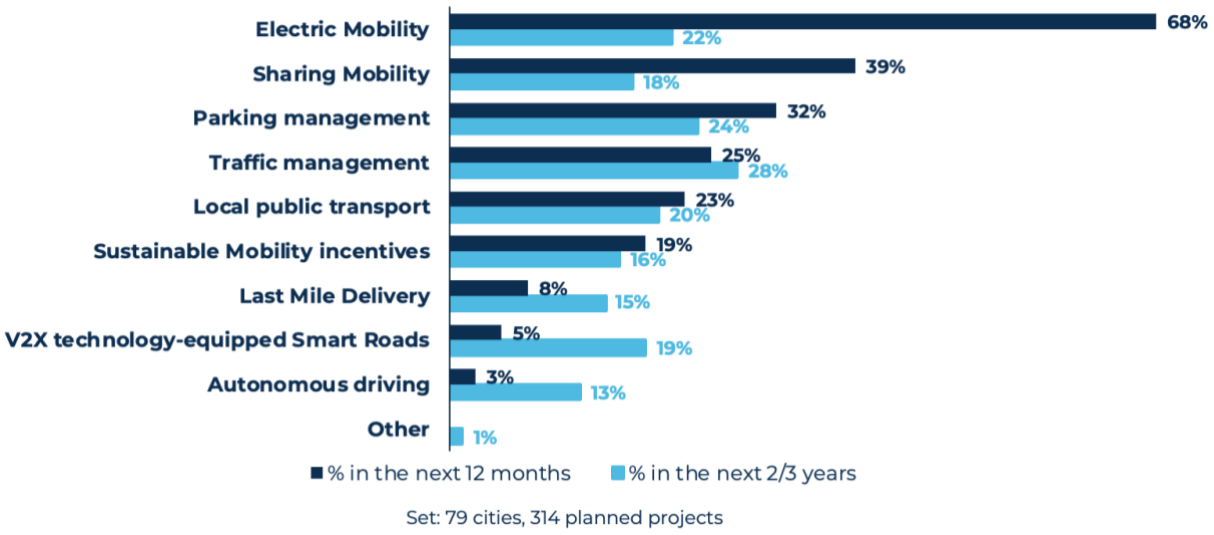


Figure 18: Implementation fields of project in the next 12 months and the in the next 2/3 years

While shorter implementation horizons can be associated with problems already affecting today's city life like air quality, viability, traffic, and parking, longer planning times can be related to more sophisticated projects. This also because solutions that ensure concrete and tangible effects are of course seen as more relevant. As an example, take the perspective of a small city major that needs to compare an Electric Mobility project and Autonomous Driving one: enlightening the benefits and the advantages of the second solution, requires greater effort than for the first. Electric cars

ensure pollution reduction, that itself ensure a healthier life: this is straightforward. Cars and public transport without drivers may seem quite futuristic at first, but their advantages are hidden. Vehicles enabling assisted driving technologies unlock the possibility to dramatically reduce the rate of human errors, increasing safety and security. Higher flexibility of personnel, no downtime and idle time reduction mean possible economic savings and thus more resources to be deployed to life quality-enhancing solutions. Moreover, autonomous driving technologies can also play a crucial role in decongesting traffic. Good communication and the ability to foresee the impacts of these projects is therefore key and specialized figures, technicians and experts are necessary. Additionally, also consider the technological maturity: projects for which the technology available is not yet fully mature are reasonably more distance in time.

In the next 12 months (in the beginning/first half of 2022 considering that the survey was conducted between July and September 2021) the great majority of projects expected are in the field of Electric Mobility, Sharing Mobility and Parking/Traffic Management. This last point especially, was a good signal since (see Figure 14) these were the areas where the higher number of preliminary analysis initiatives were found: the fact that many related projects are coming in the next month highlight that cities may have produced and gathered the right amount of knowledge around those topics and thus, that they are going in the right direction.

Some specific types of initiatives seemed to be mainly a "long time plan", with implementation horizon going from 24 to 36 months ahead. 19% of the 79 cities willing to launch at least one project, claimed that in their future there is a Smart Road with Vehicle-to-Everything technology program and similar percentages have been registered for Last Mile Delivery and Autonomous Driving projects (15% and 13% respectively). Also in this case, the comparison with Figure 14 is positive and municipalities demonstrated coherence: past projects were mainly pilots and analysis and, even if the progress status distinction is not available for the future, an increasing number of trials will lead to concrete results. Even for the above-mentioned areas of Traffic/Parking Management, Sharing Mobility and Electric mobility cities prepare to launch projects in the long period but this does not change what claimed in the previous paragraph: first because these projects were much more frequent, and thus it is normal that a portion of them is planned in the future; second, because experimentation and new knowledge creation will always be necessary.

Italian Mobility's near future hence will be characterized by a higher portion of smart projects based on electricity-powered cars, sharing-based business models and new parking or traffic management systems. Looking instead at 2/3 years in the future, many innovative autonomous and connected solutions for people's mobility will take place.

Because of the high importance that Electric Mobility have, and will have, in the future of Italian cities, question 13's scope was to investigate the possible smart solutions that administrations regarded to have an interesting integration with it.

In Figure 19 the technologies that Italian cities think that will be frequently integrated with electric cars, are presented.

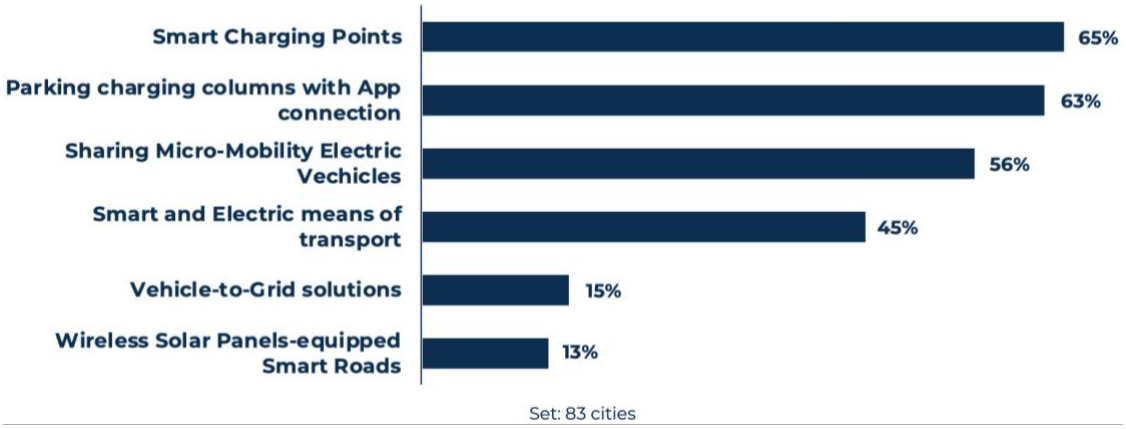


Figure 19: Smart solutions in the Electric Mobility field

- *Smart Charging Points*: charging stations with smart features able, for example, to recognize when and how to charge batteries or to recognize when the car is parked and ready to be charged.
- *Parking Charging columns with App Connection*: charging point that can be located by means of mobile devices. This requires the integration of digital software, LTE or 4/5G connectivity and localization services.
- *Sharing Micro-Mobility Electric Vehicles:* these solutions are already present in many cities and include e-cars, scooters, bikes, and kick-scooters.
- *Smart and Electric Means of transport*: like e-taxis, e-buses, and e-trucks with connectivity technologies.
- *Vehicle-to-Grid (V2G) solutions:* dedicated points in public spaces where cars can store or donate energy connecting to the local electric network.
- *Smart Roads equipped with solar panel able to charge cars wireless*: this category does not need further explanations.

The fact that Smart Charging Points and Parking with App-connected Charging Docks were mentioned the 65% and 63% of times means that municipalities, both big and small, not only are willing to install e-vehicles charging stations in streets and parking, but that they are also looking for services able to provide them with mobile integration and smart features. Furthermore, municipalities aim at integrating additional micro mobility services based on electric propulsion vehicles into their territories. This requires differentiating the already consistent presence of public and private companies providing this kind of services. Clear regulations, laws and security measures will be thus necessary. High interest there is also around Smart and Electric

Means of Transport category, but as it could have been expected this solution was mainly mentioned by medium/big-sized cities: 55% of municipalities have 40 to more than 80.000 citizens.

Finally, the survey showed that there is a low but not irrelevant interest toward Smart Grid and Wireless Charing Smart Roads projects. These two application fields represent the futuristic perspective of electric mobility and the lower intertest demonstrated is mainly related to the fact that they first require a large adoption of electric vehicles to be effective; their benefits thus will arrive only in a second moment. Anyway, it is correct to consider them when analyzing the evolving of Italian Cities Smart Mobility scenario.

The interest toward the integration of digital technologies in parking spaces for a better exploitation of cars' idle time – the time wasted when they are parked for example - was made explicit also by answers to question number 18: *"which are the future smart car-urban infrastructure integrations services that could be more useful for your municipality?"*. Among the possible options reporting useful connected mobility features - the connection of cars and traffic-lights, guardrails, curbs, other cars and street signage - 77% of answers were for "*Car and parking connection"*. Even if in this case connection services meant things like the signaling of free spaces and the possibility to directly pay the stop from the car: the digitalization of parking spaces with new technologies seems to be a relevant field of action. People are recognizing the value loss entailed in looking-for-spaces processes and in cars' down-time itself, hence, what is to be done is to elaborate new plans and innovative solutions to reduce these resources wasting. Even if it may seem quite useless, the integration of technologies to ease users parking procedures will contribute to this process, reducing the time spent driving around, pollution, and possibly increasing municipality's revenues. As already discussed, the same thematic (resources wasting avoidance) is tackled also by other solutions, like sharing mobility: the integration of the two paradigms will ensure optimal result.

One last useful point to consider, to have a clear overview of the future Italian scenario, was to understand how cities were operating. Were they planning and developing these innovations with their own strengths and resources or where they being supported by the help of some strategic private/public partner? *Q.15 "which actors could be involved (or already are being) by your municipality for the future Smart Mobility projects development?".*

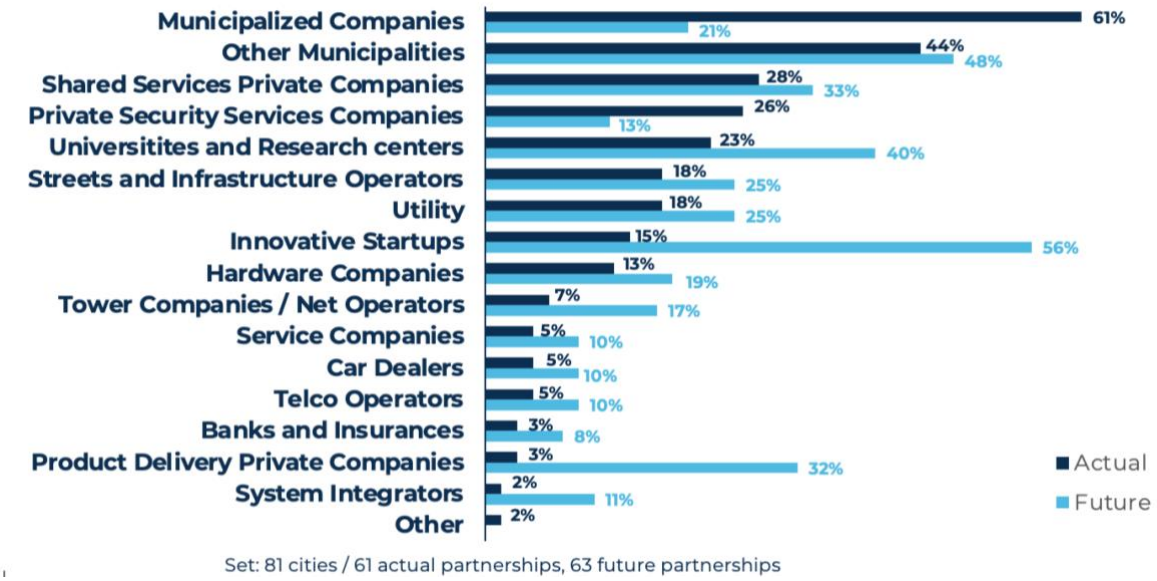


Figure 20: Actual and preferred future partners for Smart Mobility projects development

As pictured in Figure 20, by the time the survey was conducted, most of the Italian cities claimed that many of the partnerships they have already developed was together with municipal companies. These latter are public businesses without profit-making goals that are mainly used as instruments by local entities (a clear example is Enel SpA). They are established exactly for the objective to support local administrations in delivering proper services to satisfy citizens' requests, hence it is reasonable to see a great portion of collaborations signed with them. This system will apparently be abandoned in the next years (as the figure shows, only 21% of the future partnerships will be together with these companies): among the main causes of this change, there could be for example the slowness in managerial decisions and personnel acquisition processes, that are mainly carried on through long and tedious public competition announcements. For future agreements, Italian cities demonstrated to be interested in creating relationships with innovative and knowledge-based actors and with private companies.

56% of the 63 future partnerships are planned to be with innovative startups. As already discussed, when dealing with innovations like the ones entailed in many Smart Mobility projects not only substantial economic resources are necessary, there is more. Innovative mindsets, procedures and attitudes are key advantage factors. Startups are flexible, they risk and many times they are guided by enlighten personalities. Together with universities and research centers (40% of future collaboration), these newborn businesses can foresee future scenarios, create knowledge, and diffuse new practices. Other municipalities have also been frequently mentioned as a possible future partner: this result could be interpreted as a good indicator of an increasing value given to the concept of mobility innovation as a

common process – a change that will take place only thanks to the joint effort of all the actors on the landscape and not guided by independent out-of-the-blue actions.

Looking at the private sector, two typologies of businesses showed to be regarded as good partners for future collaborations: shared services providers and product delivery private agencies.

Shared services providers were of course already present in many of the already existing relationships, representing the 28% of the current partnerships, but according to the answers received, the future will be characterized by an increase in their adoption (33% of future collabs).

Different considerations can be done for product delivery private companies. If one hand results of the survey showed a low percentage (only 3%) of present initiatives based on these companies, on the other hand it allowed to infer that they will represent more than 30% of future collaborations. E-commerce, food delivery companies and every other business model based on bringing goods directly to customers' door, was positively affected by the sanitary crisis: people were locked inside their houses and therefore the demand for home delivered products naturally increased a lot. Once the pandemic will be completely over, it is reasonable to expect a decrease in delivery-services usage, but modified consumers purchasing habits will continue pushing their utilization. Best partnerships will therefore be the ones with those businesses able to offer best services, with higher care for customers, for the environment, and with scalable business models.

The main characteristics of the future scenario of Italian Smart Mobility, have therefore been discussed. Here is a brief recap:

- Most of short-term projects regard the fields of Electric Mobility, Sharing Mobility and Parking/Traffic Management. With respects to Connected and Smart Roads and Autonomous Driving projects, the time horizon seems to be little longer, from 2 to 3 years.
- Municipalities showed high interests toward the integration of digital technologies with parking spaces and charging station for e-vehicles.
- Projects will be launched partnering mainly with innovative startups, other cities, universities and with private delivery-services companies.

With all this in mind it is now possible to analyze the last questions to understand which are the main objectives of municipalities, which barriers are slowing their innovation efforts and which the role they are willing to occupy in the process.

3.5 Objectives, challenges, and roles

According to the answers received to question number 14, the main objective, both for big and for small municipalities, resulted to be the improvement of environmental sustainability of the transports system (the reduction of CO2 emissions, energetic efficiency etc.). The second most selected goal was the introduction, made possible thanks to the exploitation of data and digital technologies, of new services to citizens (49%), followed by the improvement of the existing ones (39%). In the end, 30% of cities claimed that their goal is to increase security.

Figure 21: Administrations' desired objectives

The graph represents the objectives the municipalities desire to achieve with the implementation of Smart Mobility initiatives on their territories.

Objectives like the ones described above can have both benefits on citizens lives and both on the city itself.

Improving environmental conditions for example, has a direct impact on the image of the city, that becomes greener, more sustainable, and attractive for a variety of actors and entities. The low consideration for Image Improvement can so be explained saying that it could have been considered inside the first goal.

Social Inclusion is another important point that today is widely discussed; creating inclusive infrastructures and business models able to ensure access to disadvantaged social classes to modern services, is positive in many senses. Grab [25], a Singapore-based company, for example not only created the platform and business model to help local entrepreneurs delivering their products to clients, but it also created different financial products to sustain them when the sanitary crisis arrived (micro loans and insurances made for small business owners to go through the pandemic and to have access to the needed economic instruments). Such objective - the social dimension of

smart mobility - should be better communicated since its impacts on the image of the city image, and its management, are relevant.

The interest toward the possibility to create valuable databases and to reduce costs resulted to be quite limited, only 7% and 6% of cities selected them. The topic of the value entailed into comprehensive databases has already been faced, they can be shared or used to deliver tailored-made services, and administrators must recognize it.

Out of conspicuous initial investments, Smart Mobility projects have also great potential of costs reduction both in terms of direct monetary costs and in terms of indirect costs avoidance: reductions gasses emissions and in fatal accidents can indeed be translated into monetary savings. According, as an instance, to the Osservatorio Connected Car & Mobility [15] an adoption by every Italian car of ADAS systems (Lane Keeping Support, Forward Looking Warning, and Intelligent Speed Assist) could ensure a reduction of 14 to 16% in the number injured, victims and damaged cars, meaning 1.7 billion euros, per year. Percentages grow until 31%, equal to 3.3€ billion, also considering the adoption of Blind Spot Technology. Savings thus are both from the service provider and from the user side. These benefits must not be underestimated and moreover, should represent key reasons to invest in these projects.

The achievement of the above-mentioned benefits would result in an incredibility improvement in cities livability, sustainability, and citizens' satisfaction, but what about unsuccessful projects? A question about the possible barriers slowing, or even preventing, the successful deployment of planned projects was necessary: *Q.16 which are the main barriers slowing or obstructing the launch of Smart Mobility projects?*

According to 83 communalities the biggest obstacles to overcome in order to successfully launch or scale up innovate mobility projects are the lack of knowledge of the topic and the absence of the adequate competencies.

Figure 22: Main barriers obstructing Smart Mobility projects implementation

Knowledge and awareness about the implications and about all the possible benefits linked to these solutions are central. Every stakeholder involved in the decisional process – also the direct beneficiaries (citizens most of the times) – must take part in it and recognize that, the revolution of the mobility sector is something that will radically affect their lives. Professional figures play a very important role in this sense since their involvement into decisional processes may help providing fundamental support to public administrations.

The shortage of knowledge and competencies is mentioned equally both by big and small cities and Italy demonstrated to be willing to tackle the problem: with the decree of May the 19th, 2020, converted then in the 77/2020 law, the Italian government expects public administrations and companies located in state capitals, metropolitan cities or in municipalities with more than 50.000 habitants, to adopt the PSCL (Piano degli Spostamenti Casa-Lavoro) and to elect a Mobility Manager with support, planning, and optimal mobility solution promoting and managing functions [26]. This is an optimal sign of the intention of Italy, the Mobility Manager figure, and the adoption of uniform plans to manage the way people and employees cover the house-workplace distance, are superb measures to face the challenge with cohesion. With respect to small/medium-sized cities one possible solution is represented by the numerous academic paths and post-graduate courses that have been launched in the last years, with the exact objective to train such figures. Their future integration into decisional boards and the creation of team with heterogenous competencies will then be crucial.

The lack of economic resources was among the most mentioned barriers. Sometimes this problem is a real deterrent (the case of small cities missing the ability to provide incentives and bonuses) that prevents the launch of mobility projects but, considering the different population ranges of the interviewed towns, it was possible to observe a slow decrease of the percentage of municipalities mentioning it. It was indeed selected by 69% of the cities with 15 to 20.000 inhabitants and only by 33% of the cities counting more than 80.000 people (decreasing percentages per each population band). Reasons could be like the one already faced in the discussion of Figure 12 and 13: economic inefficiencies and scarce interest toward Smart Mobility issue seems to be typical of smaller cities. Possible solutions may be the use and a more efficient distribution of statal subsides (examples are the bike and kick-scooter bonuses dispensed between 2020 and 2021), a higher support to private initiatives, and the utilization of alternative financing instruments (like incubators, accelerators, and crowdsourcing campaigns). Another interesting and with high potential solution could a more efficient organization and use of already available resource. This would mean for example to aggregate available transport solutions (subways, trams, sharing mobility services, scooters, and bikes) into integrated platform, to exploit all their potentialities and deliver an improved service to citizens. Solutions of this kind are all grouped under the Mobility as a Service umbrella and to understand if and to which extend Italian cites were considering them, *Q.17 "Would you be interested in the development of MaaS services for the future of your city?"* was asked.

Figure 23: Mobility as a Service

On the left, the number of cities interested in Mobility as a Service projects. On the right, the typology of solution desired.

As Figure 23 demonstrates, almost all answers received were positive: MaaS solutions' value is therefore recognized it is reasonable to expect and increasing number of projects in this field. More in detail, 48% of respondents claimed that they are interested in the development of an incentives and bonuses-based solution, that reward sustainable mobility decisions. Of these answers (39 in total), the 44 % came from cities with 15 to 25.000 citizens. This result can be interpreted saying that providing discounts and bonuses to promote sustainable mobility requires less resources and it is easier than the other options, and thus that it is more suitable to smaller towns. By contrary, "An application to integrate various mobility systems, providing information about travel times, costs and environmental impacts" was selected the higher number of times by bigger cities. Of 28 total answers, 11 were from 80.000+ inhabitants' towns. This is probably because: a) bigger cities have a higher number of transport systems to integrate with MaaS applications; b) connecting to the discussion made for small cities, more developed urban areas may have better resources and competencies to create the digital platforms and data pools to integrate diverse systems. It is important to remember that most of the times, mobility services are offered by various private and public actors: integrating data coming from heterogenous sources requires caution and ability.

Going back to the discussion of barriers, bureaucracy was the third most mentioned. This could have been expected, especially when considering interventions in cities' infrastructures and partnerships between public and private actors: processes become slow and difficult, and the momentum typical of the innovation processes is hampered.

Considering the problem of partnerships, the coordination between actors with different objective problem enters the stage: public administration goal is usually to offer the best possible services to its citizens while, most of the times, private actors

delivering services on the territory aim at maximizing their profits. New solutions, new modus operandi, and strong partnerships, like Public-Private Partnerships (PPPs), are necessary. According to authors Fabre and Straub [27], given the good contractibility of services and assets and the existence of many reliable market tests, the transport infrastructure, roads, and railroads, represent a very good candite to benefit of PPPs. They are a particular typology of collaborations that consist in contractual agreements between two parties, the public authority (like a local or a central government agency) and the private supplier for the delivery of some specific services. The cited paper presents tangible benefits [27, p. 27,28] observed when, for example, the local bus service in a sample of US cities was transferred to private concessionaries: higher efficiency in the service execution due to an optimal labour force allocation and its consequent unit cost reduction (from 46 to 68% decline).

The last questions analyzed provided information about the main objectives of Italian cities when launching Smart Mobility projects and about the barriers they need to overcome. But what can be added with respect to innovative propension of Italian cities? How are they going to try to overcome the mentioner barriers and which role are they willing to occupy in such projects' implementation? *Q.19 Which role should the administration play with respect to a Smart Mobility project?*

With this question it was possible to analyze the intention of cities, defining their propensity and involvement level, when taking smart mobility initiatives into consideration. In this context, the possible roles an administration can play are:

- *The Promoter:* the municipality is the main actor and encourages the development of the project, outlines objectives and priorities and fosters its implementation. The promoter moreover pushes from more projects to be started in the future.
- *The Enabler:* in this case the municipality should provide to third parties data and infrastructures of its own competence to allow them to deliver valuable services for citizens. The municipality in this case is creating favourable conditions for Smart Mobility projects implementation.
- *The User:* when possible, the administration should use third parties' data and infrastructures to deliver valuable services for its citizens. In this case thus the city has not an active role in the project but uses information collected to deliver new services.

As Figure 24 shows most of the respondents claimed to be willing to assume the role of the Promoter. 77% of cities will promote the Smart Mobility innovation, exercising a strict control over projects' execution, the use of resources and the monitoring process of the initiative's outcome: it will be actively involved in its delivery. If on one hand this result represented a positive attitude of Italian cities, on the other hand it was negative since it demonstrated that external actors' involvement is still limited. Only 40% of cities indeed claimed that its role would be the one of the Enabler, the

entity that would create the favourable conditions for a partnership among different actors. 35% of municipalities would like to assume the User role: even though active roles are preferred, there is a good percentage of cities that recognized the advantages of being the user of someone else' data. Third parties may be much more specialized and efficient in collecting relevant information and in managing infrastructures; this could result in an easier work for administration that could concentrate their efforts in delivering tailored made services to their citizens' needs.

Only 2% of respondents would turn down all the effort and assume the passive role, leaving private actors to manage the entire project. Once again, the tendency of assuming and active role instead of a passive one is brought to light.

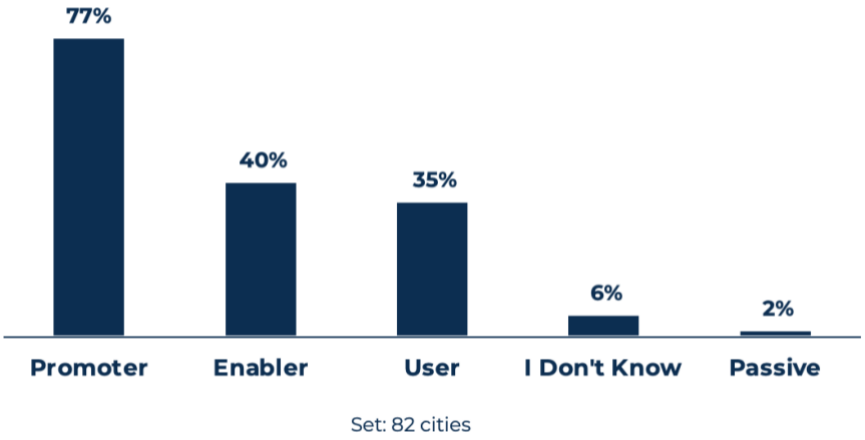


Figure 24: Which role should the administration occupy with respect to a Smart Mobility project?

To conclude the reasoning about the possible position of Italian municipalities, 6% of them claimed that they do not know which could be their best role. This could be related to the fact that different projects would require different roles, and thus that that a better specification of the question is required, or simply, to misunderstandings in the differences between the possible options from the interviewed. Anyway, even if this percentage is already quite low, better communication and guidelines could reduce it, helping cities in understanding the details of the projects, the ways to approach them and in the end, the role they can play.

Most of Italian cities claimed to have clear objectives and to know the barriers to face and the role they want to occupy with respect to Smart Mobility projects. This is important because to run a good project, having always in mind the "great picture" is fundamental and is the best way to follow the implementation from top to bottom. But even in this scenario, it is rare to see projects implemented without difficulties, therefore the last question posed was: "*which is, in your opinion, the greatest challenge to face to develop a successful Smart Mobility project?*". Figure 25 displays the answers received.

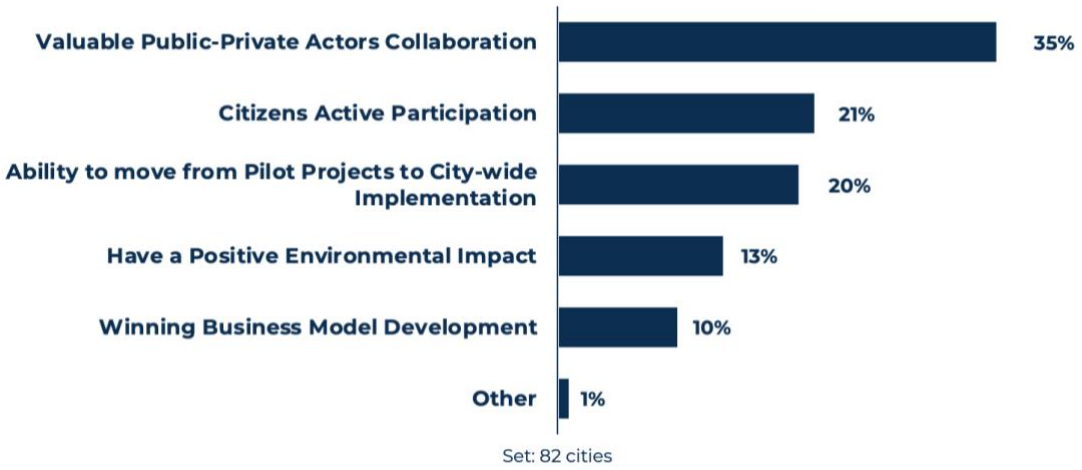


Figure 25: Greatest challenge to face to develop a successful Smart Mobility project.

Starting from the bottom, it seems that cities did not have consistent problems in developing innovative business models or in achieving positive impacts on environment. Innovative business models, like As-a-Service models (Subscriptions and Pay-per-Use) and Digital Platforms, are indeed quite frequent in innovative mobility solutions; using and implementing them, resulted to be a problem only for 10% of cities. Only 13% of them claimed to have problems in achieving positive environmental impacts, a good remark of the benefits of these innovations. In this case, the distinction of the answers by population band provided interesting insights.

As shown in Figure 26, most of small cities answering that their main problem was to create valuable partnership with public and/or private actors. To develop such strategic agreements a city must be attractive, must support innovative ideas and must demonstrate private actors that investments on their territory can have providable returns and extended visibility. All these characteristics often are easier to be found in bigger municipalities than in smaller. Moreover, partnering with a private actor is not a success warranty: the partner selected must be the right one and it must be able to adapt its projects' characteristics to each city's specifications. The selection process is therefore delicate, and municipalities need to ensure to have proper competencies and resources to scout partners not to incur in unvaluable collaborations.

The lack of adequate competencies may also be the reason why the second most selected problem for small cities was the achieving of positive environmental impacts: evaluating sustainability results indeed requires sophisticated competencies and abilities to elaborate data. Moreover, less organized and structured municipalizes may also have higher difficulties in collecting, organizing, and sharing environmental data.

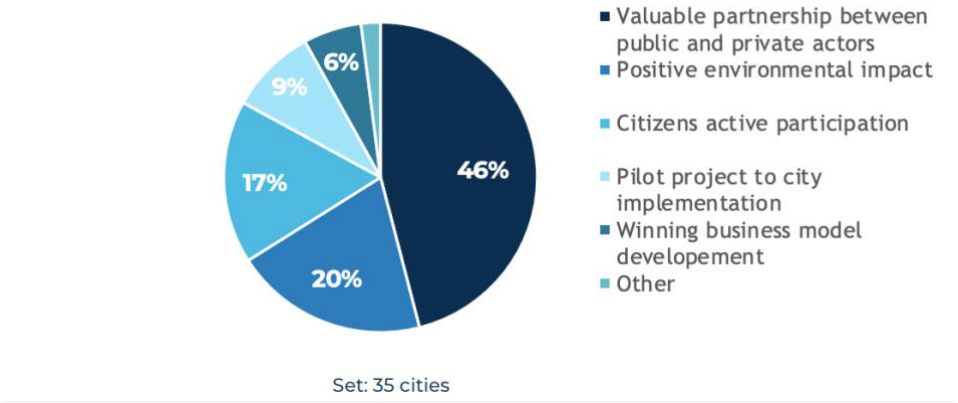


Figure 26: Small cities' challenges

The pie chart considers cities from 15.000 to 25.000 inhabitants.

With respect to challenges like the fostering of active participation of citizen in projects, the implementation of projects on a city-scale and the development of innovative business models, small cities, seemed to be performing better than bigger ones.

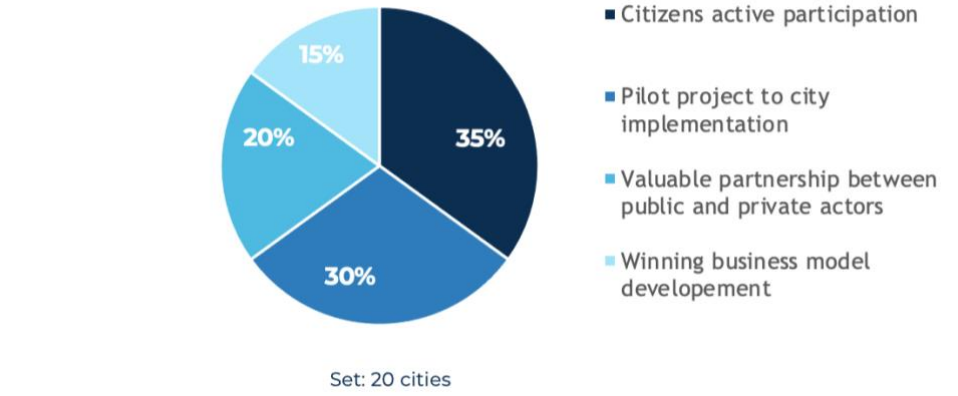


Figure 27: Big cities' challenges

The pie chart considers cities with more than 80.000 dwellers.

Figure 27 pictures the main differences between the challenges typically affecting big cities with respect to the smaller ones. While in this case the achievement (and evaluation) of environmental impacts is not even mentioned, among the main difficulties there are the promotion of an active participation of the population in the projects and their diffusion process form the pilot to city-wide dimension.

An active involvement of citizens in Smart Mobility projects is a very delicate point. It can ensure an efficient collection of feedbacks and data, and a better response rate to the overall project: this does not ensure the success of the initiative, that can always end up in a failure, but is necessary to understand whether the investigation area is the correct one. Public communication and incentives to foster participation are key to solve this problem.

When talking about populous cities, difficult resulted also to be the ability to move from the pilot project to its effective city implementation. This result is not surprising: bigger cities have more resources and better competencies but when is to extend pilot projects to a wider territory they must deal with a higher number of possible problems: they must replicate processes and procedures a higher number of times, and actions on public infrastructure affect a bigger number of actors and citizens. 30% of cities with more than 80.000 inhabitants selected it (even 50% when considering the 10 towns with 40 to 80.000 people answering). Smaller cities are in this sense much more flexible, and projects' expansion is easier. Possible solutions to overcome such difficulties are the diffusion of knowledge and its standardizations: this could allow to have clear procedures to follow when developing the initiative. Also, legislation of course must help, and it must be clear, lean, and fast.

In the end, it is worth noticing that only 2 out of 10 big cities perceived difficulties in the creation of valuable private-public partnerships.

3.6 Conclusions and Remarks

In this section, the analysis of the answers collected from the survey and the review of relevant literature and existing cases, allowed to define the characteristics of the present and the future scenario of Italian Smart Mobility.

What emerged is that the Smart Mobility thematic is positively considered by most of the Italian cities. A good portion of them have already implemented interesting initiatives in the Electric and Sharing Mobility field, contributing to the ecosystem innovation, while others are conducing important analysis and pilot projects. Nevertheless, a total and unified innovation in the mobility sector is still far from being reality and many different barriers need to be faced. Examples are the economic recourses scarcity, theme that needs to be faced together with central governments, and the shortage of adequate human resources. An unpredictable element was a remarkably good reaction to the Covid-19 pandemic: the crisis seems to have act as a booster for the take of action on a sector that, many times, was erroneously considered as already mature. It was an opportunity to re-think established paradigms and many cities, recognized by themselves the importance of an innovative mobility, and demonstrated to be ready to embrace the revolution.

Looking at the Italian mobility's near future what emerged is that it will be characterized by an increasing adoption of Electric Mobility solutions and by their integration with smart and mobile technologies. The infrastructure here is key, admirations must undertake prompt actions to innovate the existing ones before being overwhelmed by this wave. Sharing Mobility services and Parking/Traffic Management projects will also claim their spaces while Last Mile Delivery innovations, Autonomous Cars and Connected Roads will appear in longer times. What is common is that a collective effort is necessary: Italian cities demonstrated a positive attitude toward the creation of new valuable partnerships together with startups and research institutes but, to fully exploit the hidden potential of these innovations, a shift in their openness and willingness to share relevant data with third parties/other municipalities will be fundamental. This process must in the end involve both big and small cities, the first should act as model, communicating important innovations and demonstrating effective impacts, the second ones acting as street opener, exploiting their ability to be flexible and acting as testing fields for wider implementations.

The next chapter is dedicated to a detailed analysis of the database of foreign and national Smart Mobility initiatives already developed.

4. The Matrix

The survey thus allowed the collection of information about Italian municipalities' attitude toward Smart Mobility and the areas over which they are willing to concentrate resources.

But what considerations can be made concerning the objectives of such projects? Are local administrations facing them as an opportunity or as a "new regulation" they are forced to align with? And again, answers collected with the questionnaire listed the main barriers when implementing SM projects, enlightened that there is a marked gap between the necessary and the available competencies and, that economic resources and bureaucracy obstacle the innovative stream. Is this always true? Is it possible to overcome such barriers with smart and flexible solutions like Mobility as a Service? To find an answer to these questions, 122 foreign and national Smart Mobility initiatives were arranged inside a database (appendix B). This latter was then used to create a tool – represented by a graphical visualization of different smart mobility scenarios – to compare them according to two dimensions: *1) the implementation field of the project, 2) the benefits achieved thanks to it*.

The objective was to understand whether successful use cases in American, Asiatic and European cities were always supported by first-rate technical skills or not. As demonstrated by the case of the city of Barcelona [28] indeed, the first enabling factor, to allow the revolution of the urban transport systems, was a good communication campaign and the creation of an innovative ecosystem (fostering data sharing with external actors for examples) favorable to the development of such initiatives. Available resources in this case were thus already enough, the problem was only that they were not being used correctly.

Before entering the discussion about the matrix, some preliminary considerations about the two dimensions selected are necessary.

1. The survey analyzed Italian cities according to the number of inhabitants, and, in previous reasonings, this characteristic was used to draw some assumptions (like bigger cities may be more efficient and smaller more flexible): would it have been possible to make same reasonings also for the foreign context?

Absolutely yes. The problem was that the survey allowed to arrive to a very high detail level and thus, investigating for Smart Mobility initiatives implemented in foreign cities with compatible population distributions (15-25k, 25-40k, etc.) would have been too dispendious.

2. Considering demographical or structural dimensions like the density of population, the distribution of essential services and the extensiveness of primary roads, would have provided better insights about the development status of smart mobility initiatives. Since the survey lacked this information, it was not wise to look for it while analyzing the foreign context.
3. Italian municipalities demonstrated a high consideration with respect to the topic. Moreover, regardless their dimensions, they recognized the presence of some barriers, and they have also indicated some preferred development areas for their mobility future.
4. Italian cities showed high interest toward themes like sustainability and the prevision of better services to their citizens. These *"objectives"* for the implementation of their Smart Mobility initiatives, represented also the *"benefits"* that final users would/should have perceived.

4.1 The first dimension: the implementation field

Let's now focus our attention on the first dimension, the implementation field of the initiative.

The information collected online about foreign cases had a broader detail level with respect to the classes listed in the survey. Projects for example, were classified under the autonomous mobility category, the IoT, the artificial intelligence, the parcels delivery services, the smart infrastructure, the payment services, and so on. In order to make a reasonable comparison with the results of the survey, some re-elaborations were necessaries. Therefore, once mapped all these details, each initiative category was re-classified following the schema of the survey's 12th question, that was inserted in the "Main mobility typology" field of the database.

A brief recap of the schema follows:

- *Autonomous mobility*: high-tech solutions that enable autonomous features in cars and public transports. AI, ML and Big Data and the all the ADAS systems for people's safety.
- *Electric mobility:* initiative launched to incentivize the adoption and development of e-mobility.
- *Sharing Mobility:* platforms and innovative business models enabling the sharing of transport means.

- *Traffic and Parking management solutions:* IoT, cameras and smart sensors-based solutions to monitor and manage traffic and parking places conditions.
- *Last Mile Delivery:* solutions tackling the problem of the last mile in urban centre. Eco-friendly vehicles, bikes with digital features, and autonomous robots are examples.
- *Local public transport:* the integration of digital technologies into urban public transports and the substitution of obsolete vehicles fleets with connected and sustainable ones.
- *Sustainable mobility incentives:* reward-based applications, public subsidies, bonuses, and digital platforms that incentivize sustainable mobility.
- *V2X Smart Roads:* the installation of sensors and cameras on roads to enable vehicle-to-vehicle and vehicle-to-infrastructure communication.

Considering the high number of initiatives compelling to it and the fact that it was specified in question number 17 of the survey, the *Mobility as a Service* - platforms and Apps integrating many different transport means, public or private, into a unique solution, to enable the users a multimodal, seamless experience - implementation field was added.

Now that the matrix first dimension's introduction is completed, let's move to the second one.

4.2 The second dimension: the benefits

The obtained benefit represented the second dimension chosen for the classification of projects. Conducting an analysis over the benefits of Smart Mobility initiatives meant to analyze the environmental, social, economic, and strategic impacts deriving from the implementation of smart technologies and innovative business models to the transports system. Furthermore, it allowed to evaluate what did "Smart Mobility" mean for people, and which were the objectives of local administrations.

As per the previous dimension, all the mapped benefits were re-classified according to the main objectives listed in question number 14 of the survey, repeated below:

- *Environmental sustainability improvement:* projects launched with the goal of reducing the environmental impact of transports. Emissions reduction, renewable energy sources, "green" means of transports and car-less city areas.
- *New services introduction:* the creation of a friction-less transport ecosystem to provide a better experience to the user. Home-delivery services, predictive road maintenance, on-demand transport systems, etc.
- *Services improvement:* improvement of the already offered services.

- *Security:* devices and digital applications to increase the driver and citizen's safety.
- *Traffic flow optimization:* traffic conditions monitoring and optimization by mean of technologies that allow administrators to intervein when needed (dynamic traffic light management for example).
- *Cost reduction:* vehicles' sharing platforms, dynamic assurances services, new payment channels and integrated ticketing platform. All solutions that allow a cheaper usage and access to transport services.
- *Social inclusion:* solutions to create more inclusive and adequate infrastructure. Typical examples employ disadvantaged people in their business models, or they decrease their access cost.

It can be noticed that in this list not all the objective of question 14 are present: this is because it was decided to refer only to the most-citied ones and moreover, as already explained in Chapter 3 regarding the "image recognition" case, some of them were included in others. To conclude, even in this case, all the projects gathered online were re-elaborated and their benefits aligned with the ones above-mentioned.

4.3 The matrix construction: x- and y-axis.

To build a matrix, simply using the two selected dimensions, would have been technically quite straight-forward. The problem was that, given the high number of fields of each measure, their intersection would have resulted in a messy visualization, with a lot of points representing projects different by subtitle details. To avoid this issue, it was decided to find a way to aggregate both dimensions according to some specific characteristics: this solution, meticulously described in the next paragraphs, made possible to define two axis and 4 areas of the matrix, in which to locate the 122 initiatives.

4.3.1 The x-axis: the typology of innovation

The x-coordinate is the result of the aggregation of the implementation field dimension according to the *typology of innovation* produced. How was this aggregation made?

For each project, information regarding the "Main implementation field", "Second implementation field" and the "Offered service" (a logistic service, a peer-to-peer sharing App, an intermobility application, etc.) were mapped. The combination of these three dimensions allowed to preserve the database intrinsic heterogeneity and to identify different classes of projects, distinguishing the cases in which they required:

a. *A behavioral innovation*, intended as an innovation in people's approach to the mobility/transport sector. Such innovations change the way services are offered

and provided and require users to adapt to new fruition models. A clear example is sharing mobility, that requires people to abandon the classic car's ownership paradigm.

b. *A technological innovation* intended as the implementation of a technological innovation to test its functionality. For example, the collection of street data with innovative pressure sensors.

This distinction was then represented into a 5-graded scale, with values ordered as follow:

1. Pure technological innovations.
2. Technological innovations that require a change in their users' behaviors.
3. Projects in which the distinction is not marked: the change of behavior and the technological innovation are at the same level.
4. Behavioral innovations, supported by the introduction of innovative technologies.
5. Projects that mainly require a change in the way peoples approach the mobility system.

In the end, each project was given a value of the scale, as shown in the table below.

Project n°.	*Main implementation field*	*2nd implementation field*	*Offered service*	*Class*
1	Last Mile Delivery	Micromobility	Logistic Services	**4**
2	Electric Mobility	Electric Mobility	Charging infrastructure and services	**3**
6	Autonomous Driving	Electric Mobility	Public Transports integration	**3**
9	Last Mile Delivery	Micromobility	Parcels Delivery	**1**
11	Traffic/Parking Management	Big Data & Analytics	Analytics Tools	**3**

Table 2: Innovation classes

4.3.2 The y-axis: the typology of benefit

The construction of the second axis followed almost the same process as per the first one and, even for this measure, 3 benefits were mapped for each project - following the list of administrations' objectives listed in the survey (and in paragraph 4.2).

Benefits were re-elaborated, mixed, and what emerged is that 2 different classes of them, differentiated by *the typology of benefit*, were identified.

a. *Environmental benefits:* some projects' main objective was indeed the reduction of emissions and the improvement of environmental conditions.
b. *Social benefits:* intended as the provisions of better services to citizens (safety, services' efficiency, and services' effectiveness, etc.).

Again, benefits classes were ordered in a 5-graded scale:

1. Projects only aiming at improving the users' experience in the mobility ecosystem.
2. Projects which main objective is the improvement of users' experience but that also tackle the environmental issue.
3. Projects in which the two objectives are in a perfect balance.
4. Projects that aim at reducing the pollution level, offering improved services to citizens.
5. Projects that only aims at improving environmental conditions.

Table 3 provides an example about the benefit-class attribution process.

Project n°.	*1st benefit*	*2nd benefit*	*3rd benefit*	*Class*
1	Environmental Sustainability Improvement	Traffic Flow Improvement	New Services Introduction	**5**
2	Environmental Sustainability Improvement	Environmental Sustainability Improvement	New Services Introduction	**5**
3	Environmental Sustainability Improvement	New Services Introduction	Services Improvement	**4**
13	New Services Introduction	Environmental Sustainability Improvement	Social Inclusion	**4**
26	Environmental Sustainability Improvement	Traffic Flow Improvement	Cost Reduction	**3**

Table 3: Benefit classes

It is worth mentioning that innovations and benefits classes were identified according to qualitative considerations, resulted from the collection of online information and from the combination of different labels attributed. It is thus possible, that some classifications may not be fully reliable.

4.4 Expected results

Before presenting the matrix, it is appropriate to repeat the reason behind its creation.

The goal was to create a qualitative tool that could be used to map existing and future initiatives distinguishing them according to the technology adopted and to the objectives desired in the launching phase. With respect to this specific work for example, the matrix will be used to identify where the Italian scenario can be located inside one of the four quadrants and to study some inspirational cases.

4.5 The matrix: a graphical representation

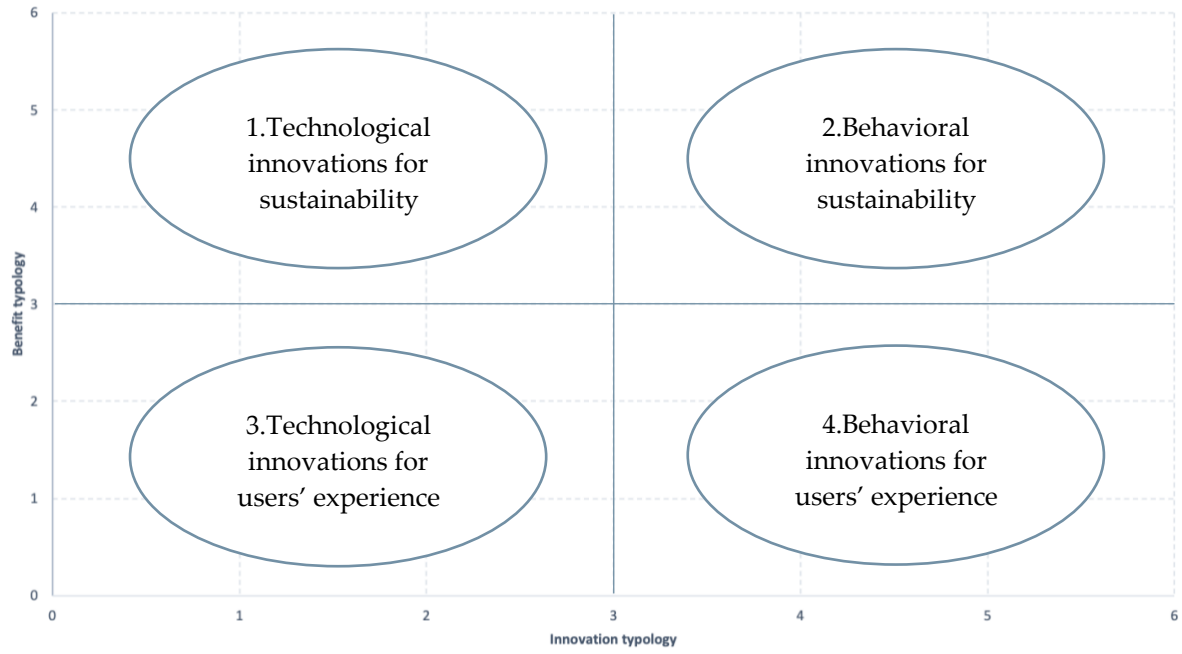


Figure 28: The matrix
The picture represents the structure of the matrix and its 4 regions.

In Figure 28 is shown how the matrix results. The two axes, made of 5 sizes each (0 and 6 are only used for graphical purposes and no projects have been given such values), created 4 quarters in which Smart Mobility were inserted.

Each of the quadrants represent different situations:

1. *First quarter:* the first area portrays the cases in which the focus is to improve environmental conditions, to reduce gasses emission and to test innovative green-energy sources, employing innovative technological solutions. Existing

solutions are disrupted, and new business models are tested: most solutions are under the electric mobility category but there are also examples of advanced e-robots to cover the urban last mile (LMAD), and innovations in the charging infrastructure (smart grids for example).

2. *Second quarter:* in the second quarter the goal is always to increase sustainability of the mobility system but, in this case, innovative technologies are not used. Projects use already existing technologies in a more efficient way and users are required to change their perception of transports. Examples are vehicles sharing platforms, reward-bases sustainable mobility applications, and public initiatives that modifies urban mobility paths.
3. *Third quarter:* in the third quarter, the cases in which the attention toward the provision of better services to citizens (safety, efficiency, effectiveness, etc.) thanks to innovative technological applications, are mapped. This class represents IoT applications to create a connected ecosystem in which cars can communicate (smart roads with V2X technology and parking/traffic management solutions) and technological applications enabling autonomous driving capabilities (AV and ADAS).
4. *Fourth quarter:* the last quarter collects all initiatives which scope is to improve citizens' experience without necessarily implementing innovative technologies in their business models. In this class for example, there are all the intermodal mobility solutions (MaaS) that, by mean of a platform, allow users to seamlessly move and pay inside the mobility ecosystem. The subtle difference with the second quarter is that in this case there are no clear and direct mentions about the environmental impact of the implemented solution.

Now that the matrix creation process and its main characteristics have been disclosed, the next chapter will analyse its contents. Comparisons between different geographical areas will be presented and, in the end, an overview over the Italian scenario and its possible characterisation according to the framework's dimensions will be discussed.

5. The matrix and projects analysis

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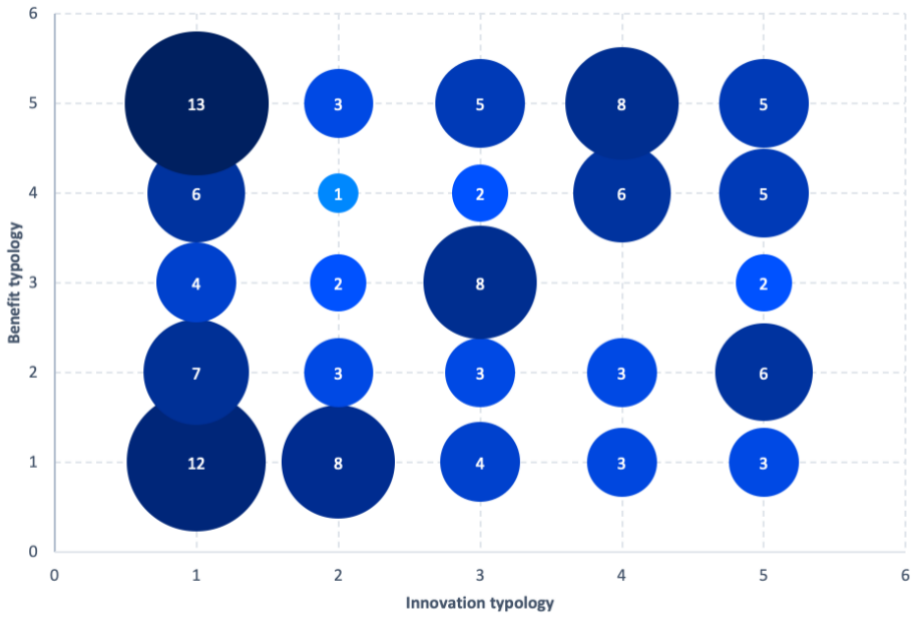


Figure 29: Global distribution of projects

database inside the matrix.

The projects collection seems to be sufficiently heterogeneous since every implementation field listed in chapter 4 is represented. There are 26 electric mobility projects, 17 autonomous mobility, 16 sharing mobility, 15 traffic/parking management and last-mile delivery, 14 smart roads with V2X technology, 9 mobility as a service, 6 local public transport and in the end, 4 projects providing sustainable mobility incentives. Without considering the initiatives positioned on the 2 axes of the framework, the four quadrants result to be populated with a homogeneous number of projects: 23 in the first, 24 in the second, 30 in the third and 15 in the fourth.

Albeit the characterization of the Smart Mobility initiatives was sometime ambiguous (as explained in the previous chapter and due to the different specification of each project), this demonstrate that the database correctly collected both diverse benefits and innovations typologies.

The matrix 1;5 and 1;1 coordinates points collected the major number of projects: in the first case there are 10 electric mobility projects, 2 last-mile delivery services and 1 autonomous mobility initiative and the main objective is to reduce gasses emissions; in the second case there are 8 connected mobility projects implementing V2X paradigms and 4 solutions to enable autonomous driving, the main goal here is to enhance citizens safety by means of technological innovations. The x=1 column collects most of the projects: there is a predominance of strong technological innovations both targeting environmental sustainability and drivers/pedestrians' security and experience. The importance of innovative technologies to enable smart mobility is therefore confirmed.

Few words need also to be spent with regards to those projects placed along the axis. 8 of them are on the 3;3 coordinate point: projects in which there is both a consideration for environmental issues and for the quality of services offered to citizens, and in which both innovative business models and innovations are implemented. In a relevant number of cases thus, smart mobility was implemented with mixed objectives and/or methodologies.

An analysis according to the geographical dimension will be now presented.

5.1 The geographic detail

The database represents 32 different countries from all over the world: the research method consisted in mainly simples web research, and this inevitability made some countries to be more resented than other. Albeit the precision of the database this way created could be discussed, the matrix could first be used to scout for possible interesting comparison to be done with Italy.

5.1.1 Europe

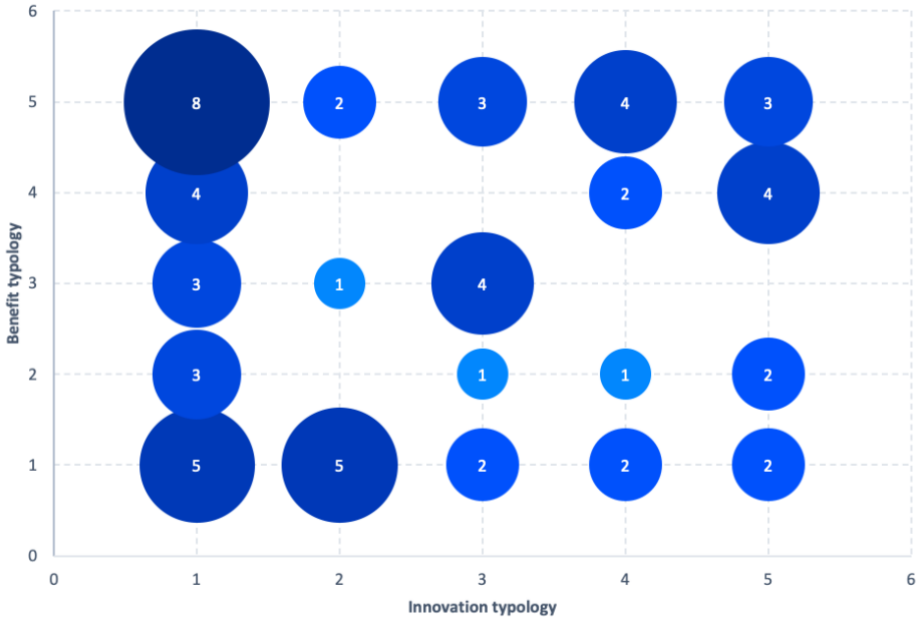


Figure 30: European projects
The image represents the European projects without considering the Italian ones.

Even without considering the 20 Italian projects, Europe is the most represented area with 61 initiatives. Follows Germany with 12 as well as in the Nordics (Sweden, Finland, Denmark, and Norway), 8 in Spain, 5 in the UK and the rest is distributed. Main application fields are sharing mobility (14 projects), electric mobility (12), 10 last mile delivery initiatives and 7 V2X smart roads.

The European scenario, also given the high number of initiatives collected, is very heterogenous (Figure 30) and projects pertains to all the four quarters. The upper half

of the matrix is overall the area gathering the highest number of infinitives, revealing that many of information collected regarded the implementation of solutions to reduce mobility's environmental impacts.

Some interesting examples can be found both with respect to social and technological innovations.

5.1.1.1 Sustainable Mobility Incentives: *Münster bewegt [29]*

- *Case typology:* executive project.
- *Location:* Münster, Germany.
- *Partners:* Changers, Wells for Zoë and MOTIONTAG.
- *Benefit class:* 5.
- *Innovation class:* 5.

This first example consists in sustainable mobility incentives app, created for Münster' residents by a partnership between three actors and launched in 2020. The project combines the revolutionary gamification-based approach of Changers' fit App to stimulate sustainable mobility solutions (bicycles, public transports, e-vehicles, feet, etc.), with the analytical capacities of the data-software company MOTIONTAG and the charity actions of the small Irish voluntary organization Wells for Zoë. The "Münster bewegt" App created enable citizens to move around the city with bikes, buses, or train, and to collect climate tokens (special rewards obtained for sustainable mobility decisions). All mobility services are integrated into one solution thanks to MOTIONTAG's data management ability and users can seamlessly navigate through them. Different environmental impacts, in terms of CO_2 balance, are displayed and eco-friendly decisions are rewarded with tokens that can be redeemed for tree planting (Wells for Zoë plants tress in Malawi), donations, or vouchers for employees, city administration or merchants.

This case was interesting since it demonstrated the result of a collaboration in which the local administrator mainly behaved as the enabler: the Müster city indeed opened the access to relevant data and created the favorable ecosystem to allow external parties delivering innovative services to its citizens. Beyond the positive environmental impact, the adoption of the App allowed many local businesses to improve their recognition and image.

5.1.1.2 Electric Mobility: *The Evolution Road project [30]*

- *Case typology:* pilot project.
- *Location:* Lund, Sweden.
- *Partners*: Swedish Transport Administration, Innovative Skane, Elenroad Ab, Lund Municipality, Lund University of Technology.
- *Benefit class:* 5.
- *Innovation class:* 1.

The evolution road project aims at testing and demonstrating the benefits of the latest generations of Electric Road Systems (ERS): a road stretch one kilometer long, near the city of Lung, was transformed into a smart road, in which the electric infrastructure able to charge vehicles' batteries, was mounted under the ground floor. Cars, buses, and other types of transport means are automatically charged when parked or when transiting over the road: this increases the efficiently of batteries, extends their range, and reduces the dimension/number of batteries needed. The purpose of the projects is to increase knowledge about electric roads and their potential to be part of a fossil-free transportation system.

This project was commissioned by the Swedish Transport Authority to Elenroad AB (and external, specialized charging infrastructure provider) and it was conducted with the help of a consortium of many different public and private actors with strong competencies. The local authority could be defined the promoter, since it directly commissioned the project, and moreover, it was able to gather the necessary technical abilities together. The Evolution Road projects was given an innovation class level of 1: its main goals were to test the function of an innovative technologies, moreover this kind of projects requires solid knowledge, technical competencies, and huge investments, before an extended implementation could take place.

5.1.2 North America and Asia-Pacific

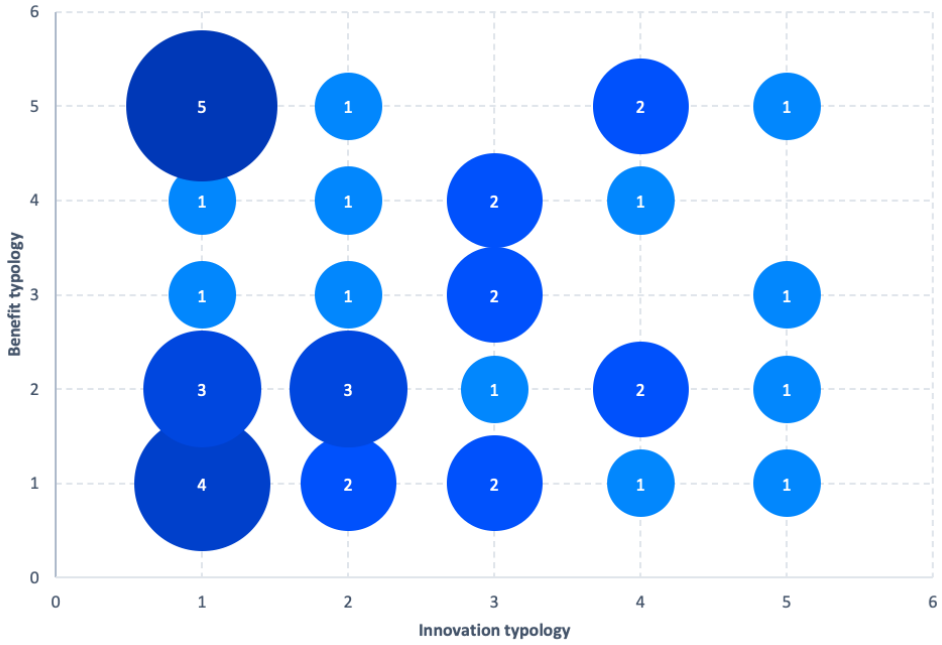


Figure 31: American and Asian projects
American projects include United States and Canada. APAC area represents China, India, Oceania, and Middle East.

North America (US and Canada) and Asia (China, India, Middle East, and Oceania) are considered together. The first geographical area is represented by 22 initiatives, 6 are traffic/parking management technologies, 6 electric mobility and 4 are in the autonomous mobility field. Most of the projects resulted to be positioned on the left side of the matrix: the implementation of innovative technologies is predominant, and beneficiaries are both the environment and travellers. Projects consisted mainly in the expansion of the infrastructures to sustain electric mobility, the implementation of Big Data-based analytical tools to monitor traffic and manage parking, and the installation of sensors to allow the development of V2X paradigms. With respect to the Asian world, 17 projects are mapped, and the principal category is autonomous driving, with 7 projects. In this case it is possible to identify a higher number of initiatives mapped in the lower half of the matrix: innovations both in the way people interact with mobility and in the technology used, with the objective of providing safer, inclusive, and efficient means of transport.

Comparing it with Europe, the analysis of these two areas highlighted a higher number of projects based on technological applications and less initiatives proposing innovative business and fruition models. Albeit environmental concerns were always

taken into consideration, most projects' objectives were to ensure more efficient and safe services to citizens.

Again, results were affected by the research methodology; further integration with other data, could led some different trends to emerge. As per Europe, some interesting examples follow:

5.1.2.1 Electric Mobility: *The V2G Electric School Bus [31]*

- *Case typology:* executive project.
- *Location:* Henderson, Colorado.
- *Partners*: Nuvve, Colorado/West Equipment, Blue Bird Corporation.
- *Benefit class:* 5.
- *Innovation class:* 1.

An interesting case of V2G (Vehicle to Grid) technology application. The initiative consisted in the delivery of a fleet of last generation electric buses (manufactured by a Colorado/West Equipment and Blue Bird dealership), equipped with Nuvve's V2G technology, to the local school district. Vehicles were transformed into mobile energy storages, able to connect to the grid and to donate back electricity: during parking time, between 5pm and 9pm, the buses supported the higher energy demand. The intelligent energy management platform, provided by Nuvve, allowed not only the creation of bi-directional energetic flows, but also to charge EVs batteries during low-rates hours (in the night). This increased the efficiency of buses, improving environmental conditions and reducing costs.

The project demonstrated how valuable could be an integration among external actors and already available services: the school bus is indeed an essential service existing in many administrations and it is an idle resource for lots of hours during the day. Scouting for the right partners, like in this case, is a key point for local administrations to implement such innovations.

5.1.2.2 Autonomous Mobility: *Navya*

- *Case typology:* pilot projects.
- *Location:* Lake Nona and Jacksonville, Florida.
- *Partners*: JTA, Lake Nona, Beep, Navya.
- *Benefit class:* 2.
- *Innovation class:* 1.

The French leader in autonomous vehicles and driving systems Navya, offered two interesting cases: both concerned the implementation of last generation technologies, but the scopes were slightly different.

In the first example, Navya partnered with the Jacksonville Transportation Authority for the implementation of a level 4 autonomous shuttle in Mayo Clinic's campus [32]. Vehicles were used to move from drive-through testing sites to the hospital's laboratories (about 0.5 miles track) more than 30.000 medical test samples. The service, made without the necessity of human attendants, was active between March and July 2020, and allowed to respect safety and sanitary rules, ensuring and efficient service. The innovative technology in this case did not require any change in its users' behaviors, that continued working in the same way, but allowed them to reduce contacts in the pandemic period, enhancing their safety.

In the second example, the autonomous shuttles service is offered to a 17-square-mile district and is used to connect the Lake Nona's entertainment community with residential ones [33]. Vehicles can drive up to 15 mph and are continuously monitored with advanced technologies by Beep's (an autonomous mobility company offering services for passengers' mobility) remote headquarter: internal and external cameras allow the continuous collection of relevant data to implement effective guidance and detection systems, to optimize navigation and safety features. The implementation of the service was strategically made on a restricted district, where the interaction with a consistent (but limited) number of actors enables the collection of sufficient data. Moreover, Navya and Beep delivered training sessions to demonstrate attendees how to interact with the vehicles in daily usage and dangerous situations: knowledge is in this case diffused by the service providers themselves. This case demonstrates a successful deployment of autonomous vehicles for public use in residential districts: the limited testing area, the continuous collection of mobility parameters and the interaction of different actors (Beep and Navya) resulted to be the key aspects of its success.

To sum up, the Navya case allowed the provision of innovative services to citizens, ensuring safety and security, and thanks to the implementation of electric vehicles, also allowed the reduction of mobility's carbon footprint. Sophisticated competencies were necessary both with respect to the hardware (Navya provided the vehicles) and to the software (Beep took charge of monitoring the shuttles).

5.1.2.3 Autonomous Mobility: *SAIC Mobility Robotaxi [34]*

- *Case typology:* pilot project.
- *Location:* Shanghai, China.
- *Partners*: Momenta, SAIC Mobility.
- *Benefit class:* 1.
- *Innovation class:* 2.

The Shanghai Automotive Industry Corporation's Mobility division and Momenta signed a partnership to test and validate the use of a fleet of 20 robotaxis for Shanghai's riders. SAIC Mobility, one of the top Chinese OEM, partnered with Momenta to integrate its vehicles with the autonomous mobility company's technology. Momenta is indeed leader in the industry and combines a data-driven approach and "two-leg" product strategy focusing on both mass production ready technologies and a driving solution targeting full autonomy. The project tests the delivery of an autonomous shuttles service in which drivers willing to use the robotaxi, only need to book it through the mobile App, the level 4 autonomous vehicle will arrive and behave as a normal tax.

The SAIC mobility robotaxi was not the only one found in China: Pony.ai and Baidu (an autonomous mobility player and the most famous Chinese web engine) are for example testing the same technology in a specific trial area near Beijing [35]. With respect to SAIC, this case is larger, since it is testing a 100-vechicles' fleet and moreover, the two partners also received the approval to charge fees for users. This represents the first world case of commercialization of and autonomous mobility-based service.

These two examples demonstrated how advanced is China with respect this smart mobility field. Anyway, these projects are still in the testing phase and additional trials and regulations will be necessaries. By now, the objective is to verify how the service will enhance citizens' urban experience, optimize taxi efficiency, and ensure safety conditions and therefore, it was given a level 1 benefit typology (mainly for citizen safety and experience) and a level 2 innovation (testing innovative technologies for a future enhanced urban experience).

5.1.2.4 MaaS: *The Jatelindo consortium @ Jakarta [36]*

- *Case typology:* executive project.
- *Location:* Jakarta, Indonesia.
- *Partners*: PT Jatelindo, PT Aino, Thales, and Lyko.
- *Benefit class:* 2.
- *Innovation class:* 4.

A consortium led by PT Jatelindo, Thales, Lyko, and PT Aino was chosen by Indonesia's transport agency to sign and 8-year contract to deploy, operate and maintain a ticketing platform and mobility as a service (MaaS) solution. What is surprising in this example is its dimensions. With a population of over 31 million residents, the Jakarta metropolitan area is the most populous region in Indonesia and world's 3rd largest metropolis. The Greater Jakarta Transportation Master Plan is to shift on public transportation 60% of residents' journey and to cover 80% all roads of Grater Jakarta by 2029. Under the consortium, Thales, together with electronic payments services provider Jatelindo and payment processing operator Aino, designs and develops an integrated payment system that uses an account-based ticketing (ABT) solution for intermodal transportation. The Thales TRANSCITM platform forms the backbone of the system and for example, a total of 14 fare categorizations will be available, including students and elderly passenger rates, making travel more equitable for all. Lyko provides its technology and API platform to connect the user interface to the distribution of more than 2.000 transport operators, as well as its intermodal trip planning algorithms. The integrated technology will cover mobility needs and boost comfortable journeys for nearly 30 million people, should have more than 1 million active users, and allow several million trips per month - the size of this initiative is therefore unique.

Main objectives of this implementation are the provision of efficient and seamless experience to commuters, reasons according to which it is classified as a level 2 benefits typology (by moving a higher portion of daily urban journeys to public transports, the initiative is also tackling environmental sustainability, but this can be considered a side-effect). In the end, this project was given a level 4 innovation typology because even though it will radically modify users' experience (a single channel to search, plan and pay trips), the integration of the numerous different transports means, and the creation of a sophisticated payment systems required technical capabilities. The consortium, made of actors coming from different sectors, made possible the combination of all these competencies.

The Jatelindo example provided interesting insights about the possibilities of mobility as a service as a way to integrate existing services with the help of skillful partners to deliver efficient and inclusive services.

5.2 The Italian case

As said in previous chapters, the database collected a vast number of initiatives being tested and implemented in Italy. Moreover, the survey's answers allowed to define plausible future scenarios for Italian mobility, adding information about main obstacles and preferred objectives. This acknowledged, the following paragraphs will describe two different uses of the matrix: the first is an attempt to individuate the appropriate position of Italian municipalities inside the matrix, according to the answers received with the survey; the second, is an analysis of the Italian initiatives collected in the database.

5.2.1 Italian matrix from the survey

Using the benefits/innovations schema of the matrix, the survey's answers (widely discussed in chapter 3), allow to picture the following scenarios.

For what concerns the benefits dimension of the framework, answers collected to *question number 14* demonstrated that the improvement of environmental conditions, is the main objective pursued with the implementation of Smart Mobility. The second goal is the introduction of new services, followed by the improvement of the existing ones and the improvement of security. Italy thus seems to be willing to accommodate all sizes of the first measure.

Considering the second dimension, the typology of innovation introduced, is useful to consider two questions' answers. Again, q.14 provides useful insights, since the interest toward the provision of innovative services can be translated into innovations in mobility's business models, approaches, and practices. Moreover, adding the details provided by answers to *question number 16*, the main barriers faced when approaching Smart Mobility are the lack of knowledge and competencies about the topic. Innovations entailed with a high technological level and requiring specific competencies by the administrations could therefore be lees suitable to Italy.

According therefore to these reasonings, it is possible to assume that an ideal position of Italy within the matrix could be somewhere between the 2nd and the 4th quarter: a nation where mature technological innovations are delivered in the form of innovative services and business models, with the goal to improve both environmental conditions and citizens' mobility experience.

5.2.2 Italian matrix from the database

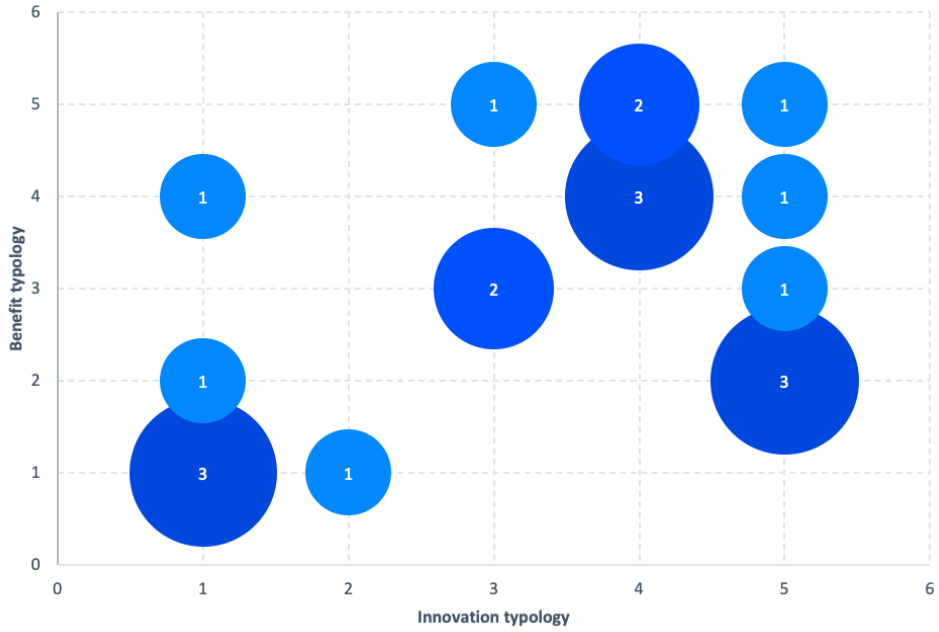


Figure 32: Italian projects

Now, positioning the 20 Italian projects collected in the database inside the matrix, it is possible to understands whether this discussion makes sense or not. According to what said in the previous paragraphs, most of the projects should be located in the right half of the framework.

After a first qualitative glimpse at the resulting matrix, some initiatives will be analyzed, and further considerations will enrich the argumentation.

It is immediately clear that most of mapped projects concentrated in the upper right part of the matrix, some are in the 4th and 3rd quarter and a limited number of them is in the 2nd: Italian scene seems overall aligned with what previously said. Compared to Europe, Italy seems to have a higher percentage of projects targeting environmental sustainability through behavioral innovations, and less initiatives testing innovative technologies. In the most populated area of the framework, electric mobility, traffic/parking management and last-mile delivery solutions are implemented. Three mobility as a service projects were found and mapped in the 5;2 coordinates point. Lastly, 3 autonomous mobility and V2X-technolgy implementation cases were listed in 1;1 point.

The discussion of some interesting cases follows.

5.2.2.1 MaaS: *the OpenMove in Trentino project [37]*

- *Case typology:* executive project.
- *Location:* Trento, Italy.
- *Partners*: Trentino Digitale, Università di Trento, Trentino Marketing.
- *Benefit class:* 2.
- *Innovation class:* 5.

OpenMove represents one of the first European Mobility-as-a-Service example – it was implemented in 2016. Integrating 7 different transport systems managed by 6 different entities, the OpenMove app connects more than 200 small mountains municipalities and the city of Trento with a unique public transport interface. The solution also offers a ticketing system that enables citizens, tourists, and students to move around the territory easily, selecting every time the most convenient fare.

Benefits are many: from the enhanced experience for the final user, to economic saving due to reductions of ticketing offices' materials and personnel. Moreover, the app also works as communication channel to directly interact with the final user.

OpenMove's case demonstrates how relatively simple, in terms of solutions provided, could be the provision innovative and efficient services to citizens. Albeit behind similar solutions there are technical capabilities and complicated integration processes, the municipality can simply understand their potentialities and promote their implementation, allowing external entities like OpenMove to create the desired service. Additionally, the OpenMove case was implemented at a regional level, allowing the local authority to exercise a continuous control over its execution. Successful stories such this one should be better communicated and promoted and should be used to underline the achievable benefits.

5.2.2.2 MaaS: *Strade Aperte project X Vianova [38]*

- *Case typology:* Executive Project.
- *Location:* Milan, Italy.
- *Partners*: AMAT, Vianova.
- *Benefit class:* 4.
- *Innovation class:* 5.

As part of the "Strade Aperte" project - through which Milan's municipality plans to dedicate 35km of streets to bikes and pedestrians - the partnership between the Agency of Milan (AMAT) and the French startup Vianova aims at delivering an improved shared mobility infrastructure and ecosystem. The main goal is to reduce emissions and traffic flows and to do so, AMAT required Vianova's analytical capabilities. Its

data management platform allowed the integration of various forms of mobility, from shared vehicles to electric bikes, to better manage city's spaces and to offer safer and more inclusive infrastructures. Vianova collaborated with many of the mobility operators present on the territory (Lime, Voi, Dott, Sharenow etc.), integrating their data and services into a unified solution: this was fundamental since it opened the way for the creation of a mobility as a service paradigm.

The database collected a vast number of similar cases in which public administrations partner with data-based companies able to manage and analyze huge amount of data coming from various sources. Another not mentioned example is the American Coord, that sustained Boston's administration in evaluating the impacts of the introduction of a new bus lane: Coord algorithms collected and integrated data coming from existing databases and from augmented reality tools for on-field observations. Ordered, analyzed, and presented them to allow local authorities to undertake fast and informed decisions about parking and public spaces management.

Partnerships with innovative data-based companies should be considered as an important method to overcome the lack of competencies barrier.

5.2.2.3 Electric Mobility: *SìRicarica [39]*

- *Case typology:* executive project.
- *Location:* Rome and Milan, Italy.
- *Partners*: NaturaSì, DriveWe, Garage Italia.
- *Benefit class:* 5.
- *Innovation class:* 4.

Three actors partnered together to the installation of smart e-charging stations in strategic places between Rome and Milan. NaturaSì, a bio-agriculture company serving Italians through a network of shopping centers distributed in the country, is nationally known and committed toward offering best possible product for human healthy and for environmental sustainability. DriveWe, an innovative software and hardware company offered the charging technology, creating a fast-charging column able to be managed via mobile application. Garage Italia, a mobility player with world class visibility and capabilities. The project consisted in the installation in NaturaSì shops' parking areas of electric vehicles charging stations: SìRicarica's client as well as common EVs owners can charge their vehicle while shopping or when needed.

The project's specificities stand in the selection of determined areas and clients for the diffusion of the technology: NaturaSì's clients are typically more sensitive to sustainability thematic and represent therefore an optimal base of early adopters for

its success. Moreover, targeting a restricted user base together with well-known partners like Garage Italia increased the initiative's success.

Main objectives were the reduction of gasses emissions and the diffusion of the infrastructure to sustain electric mobility by means of digital technologies to innovate the way people use their cars while shopping.

5.2.2.4 Smart Roads: *Anas Cortina Smart Road 2021 [40]*

- *Case typology:* Executive Project.
- *Location:* Belluno, Italy.
- *Partners*: ANAS.
- *Benefit class:* 1.
- *Innovation class:* 2.

The project, lunched in occasion of the 2021 World Ski Cup, aimed at developing the first extended Smart Road infrastructure in Europe. Technologies being installed and tested are: V2X and V2I connections; integrated WiFi in a roadside unit; smart cameras to monitor traffic; innovative ANAS IoT instruments to signal and monitor street works and conditions. The project objective is to optimize traffic flows, creating safer streets and enhancing the driving experience.

The Smart Road Cortina initiative resulted be interesting for the place where it is implemented: it is a world-know mountain destination, connected to main urban areas with state-roads and that in many periods of the year suffers from traffic congestions and related issues. Thanks to the project, innovative technologies have been implemented outside crowded city centers and not in developed highways (like in the 5G Carmen case). Moreover, given the concomitance with the Ski World Cup, its visibility is surely worth to be noticed.

Beyond these examples, the database collected many other interesting cases in many interesting fields, from IoT smart roads to autonomous last-mile delivery services. Anyway, given the characteristics of Italy, implementation areas like the mobility as a service, sharing mobility, and electric mobility seems to represent a feasible near future for Italian mobility ecosystems. Examples like the Jakarta's one, the OpenMove in Trentino, and the Münster bewegt App should be taken as role models not only by big cities but also by smaller urban agglomerates. Important development areas, like the autonomous mobility and smart roads equipped with IoT technologies are being tested through circumscribed pilot projects but need further efforts and regulations to be developed. With respect to the regulation for example, Germany seems to be good

role model: it is the first nation to approve a law authorizing level-4 autonomous vehicle to circulate in specific roads [41].

Now that such considerations have been made, a brief excursus about recent Italian regulations can help understanding whether the country seems to be moving toward the right direction or not.

5.2.3 An excursus on Italian regulations

To revolutionize its mobility infrastructure and ecosystem, a country needs coordination and constant support by central government. This ensures expert supervision and moreover, provides instruments and competencies to efficiently manage resources. Two ministries, in Italy, rules and manage infrastructures and urban and extra-urban mobility projects: the Sustainable Infrastructures and Mobility Ministry (MIMS) and the Ecologic Transition Ministry (MiTE). The first one is responsible for national infrastructures and public constructions, road communication networks, highways, and railways. The second, established in 2021, has a key role in the definition of the PNRR (the national strategic plan to access the Next Generation EU funds). Its duties go from environmental protection to renewable energies promotion, energetic efficiency, and the reduction of greenhouse effect gasses emissions. These two ministries cooperate frequently and play a leading role in the development of a national Smart Mobility strategy, defining laws, best-practices, and operational plans.

Looking at the national measures addressing transports, since the March 27th, 1998, ministerial decree "Ronchi" that introduced the Mobility Manager figure, many additional laws have been approved. In 2000 and in 2015, two decrees introduced the area and school mobility manager [42] - expanding mobility managers' action sphere. More recently, in May the 19th, 2020, the "Decreto Rilancio" was approved and converted into law (77/2020) [43], followed by the 179/2021 decree [44]. These two regulations, made the introduction of the mobility manager compulsory for companies with more than 100 employees, located in a region main city or in a municipality with more than 50.000 dwellers. The mobility manager must be selected among the eligible employees and must have a "*high and recognized professional competence and/or experience within the sustainable mobility, transports or environmental protection sectors*". Its main objective is the reduction of private cars' utilization, informing citizens and fostering a sustainable mobility culture. Among its main responsibilities there is:

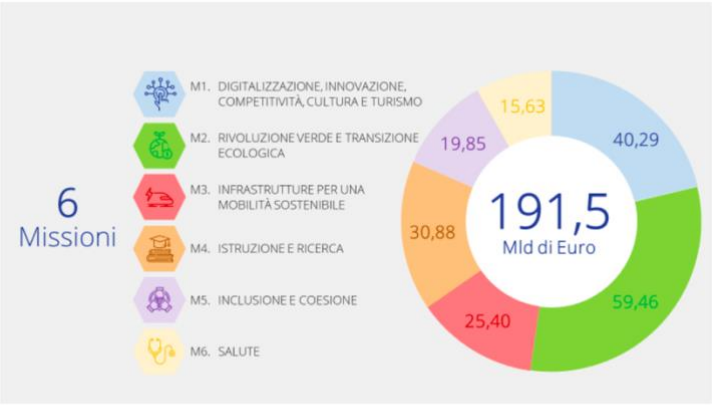
- The analysis of the existing local mobility environment: the legislation, the transport's means supply, and the relevant territorial characteristics.
- The identification of measures and strategies to incentivize sustainable mobility adoption.

- The creation of an informed environment, communicating with institutions and involving relevant stakeholders.
- The creation and diffusion of the PSCL (il Piano degli Spostamenti Casa-Lavoro): a detailed plan to re-elaborate movements of people, promoting sustainable mobility decisions and helping users in the decisional process.

In addition to all these regulations, Italian government launched some projects to support the mobility manager activity. The "CReIAMO PA" project [42] aims exactly at preparing the personnel to actively participate in mobility-related activities. To sustain projects targeting the transformation of urban mobility in small towns, the MiTE created the "Programma di Incentivazione della Mobilità Urbana Sostenibile" project [44]. It is a 15€ million public funding to promote Smart Mobility projects in cities with less than 50.000 dwellers.

National regulation seems to correctly support both big and small cities, asking them to insert professional figures to elevate their competence level and providing funds to sustain their operations. Despite that, in 2021 only 850 mobility managers were present within companies, and only 66 at a public level [45] These numbers demonstrate that such measures have still limited success among Italian municipalities.

Another useful instrument to help cities facing the crisis generated by the pandemic - and that could also help them overcoming the economic resources' scarcity – is the National Recovery and Resilience Plan (PNRR). It is the strategic national plan to pertain the innovations and reforms highlighted by the Next Generation EU (NGEU): a 750-billion euros fund created by the EU Commission to react to the structural crisis generated by Covid-19. The goal is to promote a robust economic recovery, enhancing thematic like the green transition, digitalization, and social inclusion. Each EU's



Source: *Piano Nazionale di Ripresa e Resilienza*, Italia Domani
(Allocazione risorse RRF alle Missioni)

Figure 33: PNRR missions

The image displays the PNRR's resources allocation to the 6 different missions.

member state thus proposed its actuation plan, and Italy was provided with a 191,5 billion euros fund.

As demonstrated in Figure 33, the plan is articulated in 6 different main missions that are aligned with EU's objectives and that are further structured into 134 investment announcements, to which municipalities are asked to present projects and ideas [46]. Many of these can accelerate the adoption of innovative mobility paradigms.

Green Revolution and Environmental Transition in the mission toward which the highest percentage of resources are destined and a total of 45 investments' announcements have been presented. Relevant projects go from the introduction of an electric bus fleet to the introduction of innovative technologies in e-vehicles' production chain. 3,6 billion are assigned to urban mobility: the "Sviluppo trasporto rapido di massa" project [47], aims at reducing urban traffic by 10% in some selected cities, favoring a 231km extension of the public transport network. The development of 365 additional urban kilometers for cyclists is addressed with 600 million € (50% of which to cities in the South). The development of an extended electric mobility charging infrastructure is also among the objectives of the plan: the "Installazione di infrastrutture di ricarica elettrica" announcement [48] aims at installing more than 20.000 charging stations by 2026 and it is financed with 741€ million. Interesting is also the creation of a 250 millions-investment fund (the Green Transition Fund) that will foster innovation and create economic conditions for the development of innovative initiatives.

Connecting to the Italian mobility as a service example previously discussed (OpenMove and Vianova), an interesting bid "Mobility as a service for Italy" was launched [49]. The goal is to find and select three appropriate metropolitan areas in which to test MaaS solutions. The first round of the competition was won by Milan, Rome, and Naples: pilot tests to integrate their urban mobility services into a unique solution will shortly begin. If successful, the MaaS project will be extend to a country level.

The digitalization of existing infrastructures is also important. It is the second most targeted mission, this representing a positive perspective for IoT technologies and connected-mobility paradigms implementations. As an instance, the "Reti ultraveloci – Banda larga e 5G" bid [50], destines €6,7 billion to ensure a 1Gbps connection to 8,5 million families and the diffusion of 5G on the whole Italian territory by 2026.

This chapter provided and overview over possible utilization of the framework created and provided examples and use cases of successful implementation of Smart Mobility technologies. The Italian picture emerged thanks to the answers received to the survey seems to be aligned with the one creates scouting for relevant initiatives online. Moreover, adding details about recent normative and calls for investments, it is possible to claim that the Italian central government is undertaking correct actions to sustain the transport sectors revolution with adequate professional figures and with proper economic stimulus. The next chapter will wrap up all the contents of this work, trying to define possible valuable integrations.

6. Conclusion and future developments

The main objective of this manuscript was to provide information about the current state of Smart Mobility in Italy and about possible directions to follow in order to pertain to future global, European, and national targets.

After a first introduction about the context and the main definitions of the topic, the formulation of three main questions helped providing a structure to the overall discussion.

With respect to the first question, the "Survey Smart Mobility 2021" was the main source of information. The answers collected allowed to picture an overall positive image of smart mobility in Italy. More than 70% of the interviewed towns has already launched one or more initiatives and moreover, the number or cities preparing to start their mobility systems' revolution is increasing year after year. Electric mobility, sharing mobility and traffic and/or parking management systems will represent the immediate future of the country's transport sector. Reasons behind may be the lower investments required as well as the lower necessity of technical competencies to carry out such innovations – worth remembering is that the integration of these systems with digital features will anyway represent a strategic competitive advantage. With respect to Italian smart mobility future, it is possible to define two main trends: on one hand, public administrators will incentivize and support the electrification process of the country and will provide their cities with more and more sharing-based transport systems (cars, bikes, scooters, etc.); on the other hand, there will be an increase in the number of autonomous mobility and connected smart roads projects. According to answers received, from 2 to 3 years will be necessary to see these last initiatives taking place, even though they will probably be limited to restricted experimental areas. To achieve the declared objectives of environmental conditions improvement, new services introduction and existing services enhancement in the short term, a cohesive national effort is required. Barriers limiting the large diffusion of smart mobility projects are many, like the shortage of competencies and knowledge about the topic, the scarcity of economic resources, and the excessive complexity of Italian bureaucracy. Governments have a key role in knowledge, and best practices diffusion and solutions like the introduction of specialized professional figures in local companies have in this sense a great positive potential. A quite unexpected factor positively characterizing the image of Italian smart mobility was the reaction to Covid-

19. More than 80% of municipalities already implementing or planning smart mobility projects was not penalized by the sanitary crisis: their projects' execution indeed was only shifted of some months, not impacted at all, or even accelerated. Among the main effects of the pandemic there is an expected decrease in the adoption of private cars utilization, in favour, to an increase of shared vehicles (cars, bikes, etc.) and public transports.

Both with respect to the current and future scenario it is possible to claim that a work of propaganda is compulsory. Central and local governments must spread knowledge, procedures, and objectives about the topic to increase the number of towns embracing the change. To this effort, answers collected demonstrated that an improvement area for Italy is the diffusion of data gathered with smart mobility projects. Many cities claimed to be using data for internal uses, like the improvement of existing services, but the percentage of them sharing information with third parties is quite limited. Italian administrations prefer to act as promoters of this process, exercising strict control over initiatives' execution. This is fine, but the number of cities acting as enabler, sharing data, and allowing third parties to operate, should increase. Despite that, improvement signals seem to arrive from the partnerships' side: Italian's future collaborations will be characterized by an increase of relationships between municipalities and private start-ups, universities and/or research centres, and other municipalities. These knowledge-based actors will positively affect the innovative ecosystem of the country, creating favourable conditions for smart mobility solutions to take place.

The remaining two questions were addressed thank to a framework specifically created; it allowed to compare existing initiatives according to the objectives and to the technologies adopted by the administration, highlighting main differences with the European scenario and possible ideal paths. It was structured starting from a database of smart mobility projects collected online. The projects were grouped according to the main mobility typology and the main benefits desired. These two dimensions were then re-classified according respectively to the typology of innovation implemented – technological or behavioural – and to the typology of benefit – environmental or social. Four different quarters were hence identified, each representing different projects requiring different technical competencies and ensuring different outcomes.

The European and Italian images created thanks to the matrix were similar. Despite that, some subtle differences were identifiable.

- Both regions demonstrated high interest toward sustainability concerns, but a higher number of European projects were in the left side of the matrix.
- Many European initiatives in the left region of the framework, consisted in solutions to revolutionize the last mile coverage and logistic sector by means of autonomous e-vehicles and drones. Even though such technologies seem quite

under-developed in Italy, they could represent a plausible future for its electric mobility scenario.

- In Germany, Spain and some countries of the Nordic region, a relevant number of collaborations between municipalities and digital, data-based, actors to develop MaaS-based systems were classified. Italy should follow their example and increase the number of strategic partnerships to integrate the abundant mobility services providers (shared, active, public, etc.) available on its territory.

Italy, with its specific characteristics defined through the survey, could find the right positioning in the 2nd and 4th quarter, where solutions based on mature technologies to reduce transports' carbon footprint and to enhance citizens experience are located. Interesting projects in these areas could be mobility as a service solutions and electric mobility; two development areas that probably represent the best, and most suitable, future of Italian mobility.

In conclusion, the innovation of Italy's mobility ecosystem could stand in:

a) the ability of administrations to efficiently exploit already available resources: sharing mobility services and local public transports, should be integrated in seamless solutions by mean of digital platforms, applications, and data analysis tools, to offer as-a-service paradigms. Citizens in this way could benefit of the whole transport systems, reducing for example, their private cars use.
b) The wise exploitation of funds and economic aids to support the electrification process of the whole country; this is of grounding importance to help addressing the environmental issues and long-term strategic plans.
c) The creation of an innovative ecosystem, partnering with start-ups, private companies, and universities. Italy should move as a single entity, following the successful examples of already implemented initiatives, and developing an innovative ecosystem for the mobility sector.

In future thesis works it would be interesting to deepen the topic about electric mobility, sharing mobility, and mobility as a service. Since these projects represent a plausible development area for Italian smart mobility, the collection of detailed data about their specifications (like the financing models, technologies used, and partnerships created) could provide relevant insights for cities willing to launch similar projects. With this respect it could be wise to create specific questions for Italian municipalities already implementing such initiatives at an executive level. Another path could be represented by the co-development of a dedicated survey with some selected foreign partners. Delivering a new survey together with a research centre or a university in a specific foreign country, would help gathering detailed information about projects implemented in small urban areas – information that easily get out of web research's hands. Interesting countries to involve in this process could be Germany, or one nation among the Nordics, for example. This implementation would

require additional efforts but, the vast net of partners and visibility of Politecnico di Milano, could ease the process.

Other development areas of this thesis work regard the composition of the matrix. First, the collection of projects online could of course have been affected by human biases: mapping a higher number of initiatives using different, and more sophisticated, search criteria, could increase the quality of the outcome. Second, readers must always keep into consideration that the framework was created according to qualitative analyses and re-elaborations of each projects' details; hence, its precision could sometime be discussed. Its improvement with additional dimension regarding the characteristics of the city in which projects are implemented, or regarding the technologies used, could represent a good way to improve its functioning. Dimensions like the extension of the city, the density of population, or the roads network development could be added and could transform the matrix in a more precise instruments for administrators. With such modifications, local authorities could, locate their city's structural characteristics inside the framework and look for projects that best meet their needs.

In the end, the provision of conspicuous economic resources, determined by the approval of instruments to react to the pandemic, will provide Italian municipalities with sufficient resources to achieve the desired results. This is true, but to evaluate the effectiveness of such instruments, it will be absolutely necessary to constantly monitor the way such aids are used and the execution level of funded projects.

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A. Appendix A

Survey Smart Mobility 2021 - Politecnico di Milano

Osservatorio Connected Car &Mobility – School of Management

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. 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 – 347 0035450). 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).

Q1: La preghiamo di inserire i suoi dati anagrafici:

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

Q2: 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 rilevante2= il tema è poco rilevante3= il tema è molto rilevante4= il tema è fondamentaleSelezionare una sola risposta

	1	2	3	4
Livello di rilevanza	◯	◯	◯	◯

Q3: Alla luce della pandemia, i progetti per la Smart Mobility rappresentano una priorità per il suo Comune?Selezionare una sola risposta

- ◯ SI, la pandemia ha reso ancor più prioritario il tema
- ◯ NO, la pandemia ha reso meno prioritario il tema rispetto ad altri
- ◯ Non è cambiato niente, il tema era prioritario già prima della pandemia
- ◯ Non è cambiato niente, il tema non era prioritario già prima della pandemia
- ◯ Non lo so

Q4: A suo parere quali sono stati i mezzi di trasporto più utilizzati per spostarsi in città durante gli ultimi mesi di pandemia, e quali saranno i più utilizzati guardando a uno scenario futuro post-pandemia?Selezionare una sola risposta per ogni riga

MEZZI DI TRASPORTO	Durante la pandemia	Post-pandemia
Auto/moto/scooter di proprietà	◯	◯
Car sharing	◯	◯
Bici/monopattini di proprietà	◯	◯
Bici/monopattini/scooter in sharing	◯	◯
Trasporto pubblico (bus/tram/metropolitana/treno)	◯	◯
Altro (specificare nel campo Note)	◯	◯

Note

Q5: Il Comune di cui fa parte ha avviato progetti Smart Mobility nel triennio 2019-21?Selezionare una o più risposte

- ☐ SI, abbiamo avviato almeno un progetto in ambito Smart Mobility nel 2021
- ☐ SI, abbiamo avviato almeno un progetto in ambito Smart Mobility nel 2020
- ☐ SI, abbiamo avviato almeno un progetto in ambito Smart Mobility nel 2019
- ☐ SI, abbiamo avviato almeno un progetto in ambito Smart Mobility prima del 2019
- ☐ NO

Q6: Il suo Comune ha previsto l'attivazione di incentivi/bonus per favorire la mobilità sostenibile (es. integrazione tra abbonamento trasporto pubblico e servizi di sharing, estensione piste ciclabili)?Selezionare una sola risposta

◯ SI ◯ NO

Note: if you have answered/chosen at least one of the following items: [5] in question 5, skip the following question

Q7: La preghiamo di indicare, per ciascun progetto Smart Mobility avviato dal suo Comune, lo stato di avanzamento (analisi preliminare, progetto pilota, progetto esecutivo).Se possibile, le chiediamo di indicare nel campo Note il nome dei progetti Selezionare una sola risposta per ogni riga

AMBITI APPLICATIVI SMART MOBILITY	Analisi preliminare	Progetto pilota	Progetto esecutivo

Gestione del traffico (gestione da remoto di semafori, tecnologie digitali per ridurre la congestione stradale, infomobilità, etc.)	○	○	○
Gestione dei parcheggi (monitoraggio dello stato di occupazione del parcheggio, etc.)	○	○	○
Trasporto pubblico locale (localizzazione mezzi pubblici, indicazione del tempo di attesa alle fermate, controllo accessi, monitoraggio del distanziamento sociale, etc.)	○	○	○
Mobilità elettrica (installazione e gestione di stazioni di ricarica per veicoli elettrici, etc.)	○	○	○
Sharing Mobility (servizi di sharing dei veicoli, quali auto, scooter, monopattini e bici, offerti da terze parti tramite App o sito web, etc.)	○	○	○
Guida Autonoma (sperimentazioni di veicoli a guida autonoma in specifiche aree urbane, etc.)	○	○	○
Sistemi incentivanti per la mobilità sostenibile (App per monitorare mezzi di trasporto scelti dagli utenti e attivazione di scontistiche dedicate, etc.)	○	○	○
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)	○	○	○
Altro (specificare nel campo Note)	○	○	○

Note

Note: if you have answered/chosen at least one of the following items: [5] in question 5, skip the following question

Q8: 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 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

Note: if you have answered/chosen at least one of the following items: [5] in question 5, skip the following question

Q9: La pandemia ha influito sulle tempistiche di realizzazione dei progetti Smart Mobility? Selezionare una sola risposta

- ◯ SI, ha rallentato leggermente la loro realizzazione, ma il ritardo sul programma è di pochi mesi
- ◯ SI, ha portato a rinviarli a quando l'emergenza sarà passata (es. rinvio dal 2021 al 2022 o oltre)
- ◯ SI, ha accelerato la loro realizzazione, perchè sono diventati più urgenti
- ◯ NO, non ha influito significativamente sulle tempistiche

Note: if you have answered/chosen at least one of the following items: [5] in question 5, skip the following question

Q10: Complessivamente, come sono stati accolti dai cittadini i progetti legati alla Smart Mobility che avete realizzato all'interno del Comune?Selezionare una sola risposta

- ◯ Hanno utilizzato i servizi e ne hanno tratto beneficio
- ◯ Hanno utilizzato i servizi ma non ne hanno percepito l'utilità
- ◯ Hanno utilizzato poco/non hanno utilizzato i servizi
- ◯ Non lo so, non è stata fatta una valutazione del gradimento dei progetti da parte dei cittadini

Q11: Con riferimento ai bandi di gara pubblicati dal suo Comune sul tema della mobilità negli ultimi 12 mesi, è stata considerata l’adozione di tecnologie digitali innovative (es. Internet of Things, Intelligenza Artificiale, ecc.)?Selezionare una sola risposta

- ◯ Non abbiamo pubblicato bandi di gara sul tema Smart Mobility negli ultimi 12 mesi
- ◯ NO, non è stata considerata
- ◯ SI, raramente
- ◯ SI, almeno nella metà dei casi
- ◯ SI, sempre

Q12:

Il Comune di cui fa parte ha in programma di avviare progetti Smart Mobility in futuro?

Nel caso si intendano avviare progetti, specificare gli ambiti applicativi di interesse ed il periodo temporale entro quando saranno realizzati.

Selezionare una o più risposte

Non avvieremo progetti per la Smart Mobility in futuro

MBITI APPLICATIVI SMART MOBILITY	Nei prossimi 12 mesi	Nei prossimi 2-3 anni
Gestione del traffico (gestione da remoto di semafori, tecnologie digitali per ridurre la congestione stradale, infomobilità, etc.)	☐	☐
Gestione dei parcheggi (monitoraggio dello stato di occupazione del parcheggio, etc.)	☐	☐
Trasporto pubblico locale (localizzazione mezzi pubblici, indicazione del tempo di attesa alle fermate, controllo accessi, monitoraggio del distanziamento sociale, etc.)	☐	☐
Mobilità Elettrica (installazione e gestione di stazioni di ricarica per veicoli elettrici, etc.)	☐	☐
Sharing Mobility (servizi di sharing dei veicoli, quali auto, scooter, monopattini e bici, offerti da terze parti tramite App o sito web, etc.)	☐	☐
Guida Autonoma (sperimentazioni di veicoli a guida autonoma in specifiche aree urbane, etc.)	☐	☐
Sistemi incentivanti per la mobilità sostenibile (App per monitorare mezzi di trasporto scelti dagli utenti e attivazione di scontistiche dedicate, etc.)	☐	☐

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)	☐	☐
Altro (specificare nel campo Note)	☐	☐

Q13: Quali sono le soluzioni smart nell'ambito della mobilità elettrica che ritiene più interessanti per i progetti che saranno sviluppati dal suo Comune in futuro?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
- ☐ Altro (specificare nel campo Note)
- ☐ Non ritengo nessuna di queste soluzioni interessanti

Q14: Quali obiettivi vorrebbe perseguire l'Amministrazione tramite (l'eventuale) avvio di progetti Smart Mobility in futuro?Selezionare al massimo 3 risposte

- ☐ Miglioramento dell'immagine del Comune
- ☐ Maggiori introiti per il Comune
- ☐ Riduzione dei costi per il Comune e/o gli altri operatori della mobilità
- ☐ Miglioramento dei servizi attualmente offerti ai cittadini
- ☐ Introduzione di nuovi servizi per i cittadini
- ☐ Creazione di un database ricco di informazioni rese disponibili dai progetti Smart Mobility (es. reale utilizzo dei mezzi pubblici, aree con maggior traffico)
- ☐ Miglioramento della sostenibilità ambientale (es. riduzione CO_2, efficienza energetica)
- ☐ Miglioramento dei flussi di traffico / riduzione congestioni stradali
- ☐ Sviluppo delle imprese del territorio
- ☐ Maggiore sicurezza stradale (es. riduzione della probabilità di incidenti, fluidificazione del traffico)
- ☐ Adeguamento rispetto a vincoli di legge e/o obblighi normativi
- ☐ Volontà di sperimentare soluzioni innovative
- ☐ Necessità di allineamento rispetto a quanto presente in altri comuni
- ☐ Maggiore inclusione sociale (es. abbattimento barriere architettoniche) e servizi sociali ai cittadini
- ☐ Altro (specificare nel campo Note)

Q15: 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 già 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)	☐	☐
Aziende private che offrono servizi di trasporto condiviso (es. Uber, Car2Go, Enjoy)	☐	☐
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)	☐	☐

Q16: 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 progetti pilota a iniziative su larga scala?Selezionare al massimo 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
- ☐ 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
- ☐ Difficoltà di integrazione di nuovo e vecchio hardware e software
- ☐ Resistenze da parte di organizzazioni esterne o di altri attori esterni al processo
- ☐ Resistenze interne (es. da parte dei dipendenti comunali)
- ☐ Problemi di privacy
- ☐ Altro (specificare nel campo Note)

Q17: In futuro, sarebbe interessato a sviluppare progetti di Mobility as a Service all'interno del suo Comune? Se sì, quali? Selezionare una sola risposta

- ◯ NO
- ◯ SI, un'App che consenta di scegliere le alternative di mobilità in modo integrato, fornendo informazioni su tempi di percorrenza, costi e anche impatto ambientale

- ◯ SI, un sistema di incentivi e bonus che premi la scelta di spostamenti eco-sostenibili in un contesto di mobilità integrata
- ◯ SI, un sistema che integri soluzioni di mobilità con servizi di altro genere (es. lavaggio dei veicoli quando inutilizzati, ottenimento di codici sconto da utilizzare nei servizi MaaS in seguito ad acquisti presso specifiche attività commerciali)
- ◯ SI, altro (specificare nel campo Note)

Q18: In futuro, quali sono i servizi di integrazione tra l'auto smart e le infrastrutture urbane che potrebbero risultare maggiormente utili per la mobilità urbana all'interno del suo Comune?Selezionare al massimo 3 risposte

- ☐ Connessione tra l'auto e i parcheggi (es. segnalazione parcheggi liberi, pagamento direttamente dall'auto)
- ☐ Connessione tra l'auto e i semafori in modo da ottimizzare il flusso del traffico (es. per adeguare il ciclo semaforico in base alla direzione di provenienza dei veicoli)
- ☐ Connessione tra l'auto e i guardrail (es. il guardrail avvisa automaticamente i soccorsi in caso di incidente)
- ☐ Connessione tra l'auto e i marciapiedi (es. il marciapiede avvisa nel caso di un attraversamento improvviso del pedone)
- ☐ Connessione con le altre automobili presenti sulla strada (es. per segnalare incidenti, code)
- ☐ Connessione tra l'auto e la segnaletica verticale (es. per segnalare un limite di velocità)
- ☐ Connessione tra l'auto e le colonnine di ricarica elettrica (es. per monitorare lo stato della ricarica da remoto)
- ☐ Connessione tra l'auto e le stazioni di servizio (es. per pagare il carburante direttamente dall'auto)
- ☐ Non sarei interessato a nessun servizio
- ☐ Altro (specificare nel campo Note)

Q19: Secondo lei quale ruolo principale dovrebbe rivestire in futuro il suo Comune nei confronti di un progetto Smart Mobility?Selezionare al massimo 2 risposte

- ☐ Ruolo di promotore: il mio Comune dovrebbe realizzare in futuro (ulteriori) progetti Smart Mobility, per rendere più semplici gli spostamenti e migliorare la qualità della vita dei cittadini
- ☐ Ruolo di abilitatore: il mio Comune dovrebbe mettere a disposizione ad attori terzi, quando possibile, i dati e le infrastrutture a sua disposizione al fine di consentire l'erogazione di nuovi servizi di valore al cittadino
- ☐ Ruolo di utilizzatore: il mio Comune dovrebbe usufruire, quando possibile, dei dati e delle infrastrutture condivisi da attori terzi per effettuare l'erogazione di nuovi servizi di valore al cittadino
- ☐ Ruolo passivo: il mio Comune dovrebbe rivestire un ruolo passivo nei confronti dei progetti Smart Mobility, lasciando la gestione di tali iniziative a soggetti privati
- ☐ Non saprei definire il ruolo più opportuno

- ☐ Altro (specificare nel campo Note)

Q20: Qual è a suo avviso la più grande sfida da affrontare per sviluppare un progetto Smart Mobility di successo?Selezionare una sola risposta

- ◯ Sviluppo di un modello di business vincente
- ◯ Attiva partecipazione da parte dei cittadini
- ◯ Proficua collaborazione tra attori pubblici e privati
- ◯ Capacità di passare dal progetto pilota all'implementazione estesa su tutta la città
- ◯ Sviluppo di una tecnologia radicalmente innovativa
- ◯ Impatto positivo sull'ambiente
- ◯ Altro (specificare nel campo Note)

Q21: Il questionario è concluso, la ringraziamo per la collaborazione. Qualora volesse, può aggiungere ulteriori commenti sul tema.

B. Appendix B

Two databases were used during the creation of this manuscript: the Smart Mobility Projects and the Survey's Answers databases.

The first one was created starting from an existing database of Smart City initiatives: some fields were updated, other deleted, and new fields, relevant to the scope of the entire work, were added. Its content is described in this appendix.

The second database was useful to collect and analyse the answers received to the smart mobility survey, largely discussed in chapter 3. Since previous versions had already been submitted and successfully monitored, the overall structure of the database was compliant with actual needs. Fields' contents were of course updated with data coming from received questions, and new formulas were added to perform ad-hoc analyses; all graphs used to describe the Italian scenario, are created basing on this database.

The Smart Mobility Projects database

In this database 122 foreign and national initiatives are collected. Different information are registered per each project and moreover, 2 files contain the innovation typology and benefit typology classification introduced in chapter 4.

- *Initiative name:* the name of the specific project.
- *Main partners involved:* list of the partners involved in the initiative.
- *Brief description of the initiative.*
- *Continent.*
- *Nation.*
- *Region/Municipality/City.*
- *Public actor (if involved):* if present, public actor involved in the project.
- *Main mobility typology:* one of the implementation fields listed in question number 7 of the survey. Traffic/parking management, electric mobility, local public transport, etc.
- *Second mobility typology:* additional detail about the implementation field. Artificial intelligence, autonomous mobility, Big data & analytics, electric mobility, IoT, MaaS, Micromobility and smart infrastructure.
- *Service offered:* the typology of service or product offered by the initiative. Logistic services, charging infrastructure and related services, APIs, On-demand transports, payment solutions, physical products, etc.
- ***Innovation typology classified:*** the classification on the 5-grade scale according to considerations made on the three previous fields.
- *Launch year.*

- *Main benefit:* one of the possible benefits listed in question number 14 of the survey. Environmental sustainability improvement, new services introduction, etc.
- *Second benefit:* the second most important benefit/objective pursued with the projects (same options listed in question 14).
- *Third benefit:* the third most important benefit/objective pursued with the projects (same options listed in question 14).
- ***Benefit classified:*** the classification of the 5-graded scale according on considerations made on the three previous fields.
- *Main beneficiary.*
- *Second beneficiary.*
- *Case typology:* executive project, pilot project or preliminary analysis.
- *Public, private, public/private finds.*
- *Regional / National / European:* the range of the initiative.
- *Communication technologies:* three fields to list the main communication technology used, e.g.: 5G, LTE, IoT, V2X, Wi-Fi, radars, sensors, etc.
- *General technologies:* other technologies used, e.g.: AI, Big Data, machine learning, etc.
- *Web site.*