Smart cities and Smart buildings:
analysis of the Italian context over the last 10 years

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ABSTRACT

Smart cities represent a paradigm shift in urban development, leveraging digital technologies to enhance the efficiency of traditional networks and services. This transformation aims to benefit inhabitants and businesses by improving resource use, reducing emissions, and fostering a more interactive and responsive city administration. This article delves into the characteristics, trends, and specific examples of smart city initiatives in Italy over the past ten years.

KEYWORDS: Smart Cities, Smart City Market, Global Trends, Italy, Italian Smart Cities.

1   DEFINING SMART CITIES

A smart city goes beyond the use of digital technologies for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population. [Web-1]

The European Commission outlines six key characteristics of smart cities: Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, and Smart Living. Each characteristic is defined by various factors and indicators, which are crucial for assessing the performance and development of smart cities.

To describe a smart city and its six characteristics, it is necessary to develop a transparent and easy hierarchical structure, where each level is described by the results of the level below. Each characteristic is therefore defined by a number of factors. Furthermore, each factor is described by a number of indicators. The factors were defined in several workshops, always having the overall target of smart city development in mind. Finally, 33 factors were chosen to describe the six characteristics. To analyse the performance in each factor, 1-4 indicators were selected and assigned to each factor. For two factors, "Ability to transform" and "Political strategies & perspectives," it was not possible to receive sufficient data at the moment. Therefore, 31 factors finally remained for the ranking. However, for further rankings, it is

recommended to include and elaborate on these two factors as they seem important for the completion of the model. [1]

The European Smart City Index evaluates the smartness of medium-sized cities across Europe based on key criteria. This index provides insights into how cities can evolve through innovative and sustainable urban planning and governance approaches. The Smart Cities Marketplace, a significant initiative by the European Commission, aims to bring together various stakeholders to improve citizens' quality of life, enhance city competitiveness, and achieve energy and climate targets.

EU Missions have ambitious goals in order to reach tangible results by 2030, by combining research and innovation, governance and collaboration, engaging citizens. EU Missions are a novelty of the Horizon Europe research and innovation programme for the years 2021-2027 [Web-2].

Some Key Goals of the EU Smart Cities Mission are:

- **Climate Neutrality by 2030**: the primary objective is to enable 100 cities to become climate-neutral within a decade, ahead of the EU's 2050 goal for the entire continent.
- **Innovation and Digitalization**: the mission promotes smart solutions through digital technologies, artificial intelligence, and data-driven approaches to manage energy, transport, and other urban services efficiently.
- **Citizen Engagement**: involving citizens in decision-making processes is central, encouraging participatory governance to co-create sustainable urban environments.
- **Replication and Knowledge Sharing**: cities that achieve success through the program will share their best practices and experiences to help other cities across Europe, especially medium and smaller cities. [Web-3].

2   SMART CITIES MARKETPLACE

The Smart Cities Marketplace merges the European Innovation Partnership on Smart Cities and Communities (EIP-SCC Marketplace) and the Smart Cities Information System (SCIS). It is a major market-changing undertaking that aims to bring cities, industries, SMEs, investors, banks, researchers, and many other smart city actors together. It supports sustainable urban mobility, integrated infrastructures, citizen focus, policy and regulation, and knowledge sharing. The Marketplace operates through an Explore-Shape-Deal process, facilitating knowledge exchange, capacity building, and the development of bankable projects. [Web-4]

The Marketplace's main areas of cross-cutting operation include sustainable urban mobility, sustainable districts and built environment, integrated infrastructures and processes in energy, information and communication technologies, and transport. It also focuses on citizen engagement, policy and regulation, integrated planning and management, knowledge sharing, baselines, performance indicators and metrics, open data governance, standards, business models, procurement, and funding.

The Smart Cities Marketplace has many followers from all over Europe and beyond, many of which have signed up as members. Their common aims are to improve citizens' quality of life, increase the competitiveness of European cities and industry, as well as to reach European energy and climate targets.

The Smart Cities Marketplace's operations are structured by its integrated Explore-Shape-Deal Matchmaking process, purposefully geared towards knowledge exchange, capacity building support, and the development, implementation, replication, and upscaling of Smart City solutions. It is organized in three phases building on each other:

- **Explore – See and learn what's next**: This phase enables access to the collected Smart Cities knowledge, including that of linked projects and initiatives. It is a continuous process that helps keep an overview of which solutions and best practices have already been successfully implemented and creating ideas for own projects.
- **Shape – Shape project and action plans**: Once a vision for a project has been developed, this phase helps to shape that idea into a solid bankable project, which is fit to attract public and private investors. This phase will also enable a structured dialogue between all key stakeholders involved.
- **Deal – Create relations and opportunities**: The third and last phase enables a one-to-one exchange between project promoters and members of the financing community to ultimately close deals.

To manage the wealth of news, projects, insights, stories, knowledge, and guidance available on the pages of the Smart Cities Marketplace and to feed into both the above-mentioned Explore-Shape-Deal process as well as the Focus and Discussion groups, the Smart Cities Marketplace features the Green Cities Wiki. It lends its structure from the previously published Smart City Guidance Package and gives easily navigable access to the respective areas of interest of stakeholders involved in sustainable urban development. It will also be further augmented with results from the Discussion and Focus groups as well as other action streams of the Smart Cities Marketplace, such as projects resulting from the Matchmaking process.

The Smart Cities Marketplace and Scalable Cities are separate initiatives of the European Commission. Both play an important role in accelerating the just and green transition of European cities. They improve citizens' quality of life, enhance the competitiveness of cities and industry, and help achieve European energy and climate targets across urban sectors like transport, mobility, logistics, built environment, energy infrastructures, urban data, digital assets, environment, citizen engagement, and urban governance. [Web-5].

3   CHARACTERISTICS OF A SMART CITY

Smart cities are characterized by their use of digital technologies, commitment to sustainability, and promotion of active citizen participation. They utilise ICT, big data, IoT, and AI to enhance various urban aspects, including mobility, energy, security, health, and education. Sustainability efforts focus on renewable energy, effective waste management, and social cohesion. Citizen engagement is fostered through tools for consultation, dialogue, collaboration, feedback, co-creation, sharing, learning, etc. Citizens are also considered not only users of services, but also producers of them in a win-win logic of active citizenship and open government.

There is no single definition of smart cities, but we can identify some common characteristics that distinguish them:

- **Use of Digital Technologies**: All smart cities use the World Wide Web, information and communication technologies (ICT), big data, cloud computing, the Internet of Things (IoT), and artificial intelligence (AI) to collect, process, and share data to improve various aspects of urban life such as mobility, energy, security, health, education, culture, tourism, etc.
- **Attention to Sustainability**: Smart cities are attentive to environmental, economic, and social sustainability, with the aim of reducing the negative impact of human activities and consumption. Other smart city program points include the use of renewables for electricity production, effective waste management, protection of natural and cultural

heritage, social cohesion, the fight against poverty, and creating job and development opportunities.

- **Promotion of Active Citizen Participation**: Smart cities involve and empower citizens in the process of digital transition and innovation of their city by means of tools for consultation, dialogue, collaboration, feedback, co-creation, sharing, learning, etc. Citizens are also considered not only users of services but also producers of them in a win-win logic of active citizenship and open government.

4   SMART CITIES TRENDS WORLDWIDE AND IN ITALY

The global Smart Cities Market size was valued at USD 549.1 billion in 2023 and is expected to grow: the revenue forecast for 2028 is projected to reach $1,114.4 billion, according to a CAGR of 15.2% from 2023 to 2028.

Globally, IoT services in smart cities generate significant revenues, particularly in smart grid, visual surveillance, public transport, lighting, and traffic management. For the services component, professional services, such as consulting, deployment and system integration, support, and assistance, are worth about double the managed services, demonstrating how the industrial component prevails over outsourcing. As for solutions, the network management component progressively decreases as a percentage of solutions, going from 18% in 2020 to 14% in 2026, to the advantage of an increase in data management and in the reporting and analysis of the data itself. According to IDC, the use cases that contribute most to spending in the period 2018-2023 are smart grid, fixed visual surveillance, advanced public transport, intelligent lighting, and intelligent traffic management. These five use cases represent more than half of all spending for smart cities. According to Markets and Markets, the greatest developments will be in the Smart Transportation sector, and especially in Smart Citizen services, which include Smart Healthcare, Smart Education, Smart Public Safety, Smart Street Lighting, and eGovernance. [Web-6].
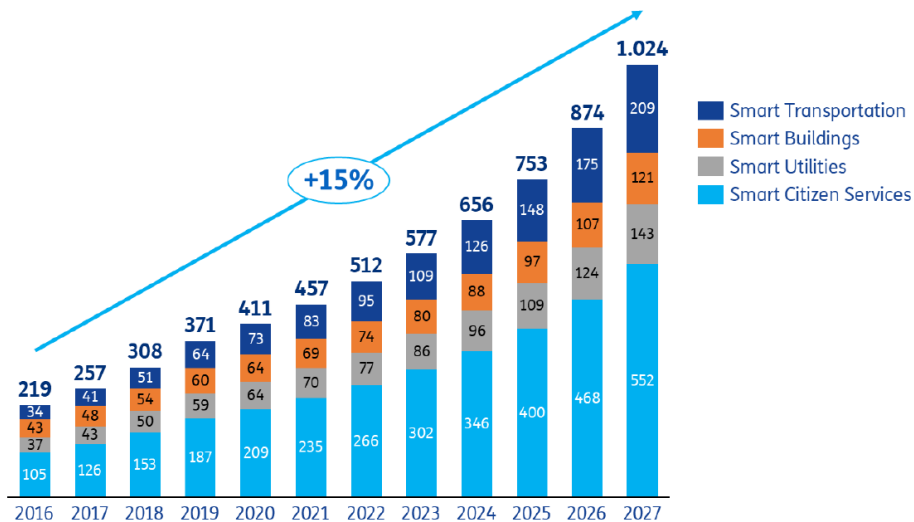

Figure 1: Focus Smart City Market Worldwide [Billion $]

In Italy, smart city projects are influenced by the diverse urban landscape. Large cities like Genoa, Turin, and Milan have adopted holistic approaches, integrating various projects and governance mechanisms. Medium-sized municipalities have implemented high-quality interventions in specific sectors, while some urban areas lag due to infrastructural challenges.

The development of Smart City projects in Italy is naturally affected by this peculiar situation, characterized by significant differences that can be summarized as follows:

- **Large Cities**: a nucleus of large cities (Genoa, Turin, Bari, Milan, Florence) which, in particular thanks to the push of Italian and European calls for tenders, have started structured paths towards the Smart City through a "holistic" approach of systematizing projects and interventions with a unitary perspective, as well as multilevel governance mechanisms between public actors, the world of production, the world of banking, research, and culture.
- **Medium-Sized Municipalities**: a significant number of municipalities, especially medium-sized ones, which over the years have experimented and implemented high-quality interventions in specific sectors (sustainable mobility, e-government, energy efficiency, enhancement of cultural heritage, integrated data management) and which are now starting to work towards integration with other areas of city intervention.
- **Urban and large area contexts**: especially due to a significant territorial, dimensional and infrastructural divide, they still appear to be behind in adopting planning models and interventions based on the integration of networks, services and territorial actors. [2].

The Smart City market in Italy is growing rapidly, driven by significant investments and the push for digital transformation. In 2022, the market saw a 23% increase, reaching approximately € 900 million. This growth is powered by initiatives in areas like smart public lighting, mobility, metering systems for utilities (electricity, water, and gas), and smart buildings. Much of the funding comes from Italy's National Recovery and Resilience Plan (PNRR), which has allocated € 17.1 billion towards smart city initiatives.
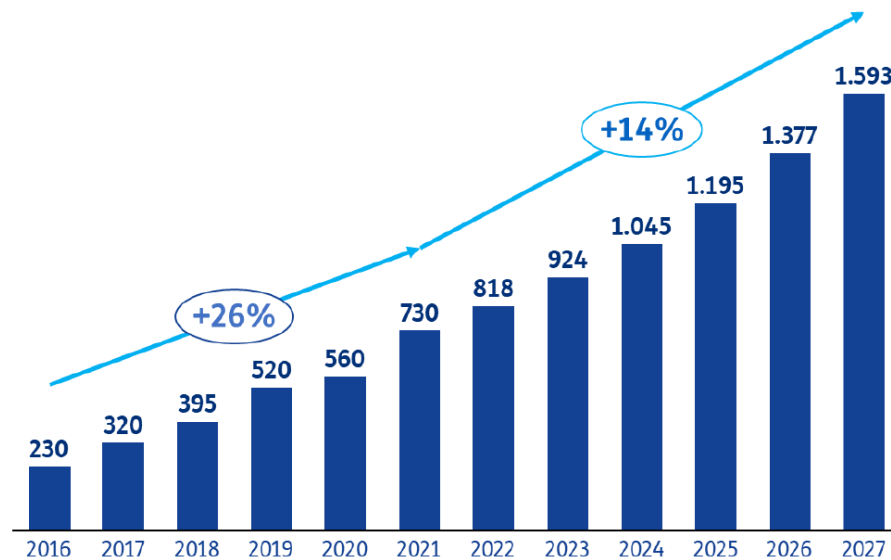

Figure 2: Smart City Market Italy [M€]

Key areas of investment include:

- Smart mobility and intelligent lighting systems.
- Green energy solutions such as renewable energy communities.
- Urban regeneration efforts focused on modernizing city infrastructure, especially in metropolitan areas.

- Smart utilities through advanced metering and network systems. [Web-7].

5   SMART CITIES IN ITALY: THE RANKINGS IN THE LAST 10 YEARS

In 2016, The Smart City Index in Italy was published by EY (Ernst & Young), in collaboration with the Osservatorio Nazionale Smart City of ANCI (Associazione Nazionale Comuni Italiani). This report evaluated and ranked Italian cities based on their level of "smartness," measuring how cities leveraged technology to improve services, sustainability, mobility, and governance. [3]

The Smart City Index 2016 ranked cities across Italy based on a series of key performance indicators (KPIs) related to:

- Digital and ICT infrastructure.
- Mobility solutions.
- Sustainability and energy efficiency.
- Healthcare and education services.
- Public safety and governance.

According to this Index, the smarter cities in Italy in 2016 where: Bologna, Milano, Torino, Mantova, Parma, Trento, Brescia, Reggio Emilia, Roma, Firenze.

Figure 3: The 10 smartest cities in Italy in 2016

The Smart City project in Italy has gained momentum over the years, and 2020 was a key year for its evolution, also thanks to the growth of digitalization initiatives in response to the COVID-19 pandemic. The definition of a smart city implies the use of innovative technologies to improve the quality of life in cities, optimizing the efficiency of public services and resources, and promoting sustainable development from an environmental, economic and social point of view. The Smart City Index 2020 ranked cities across Italy based on a series of key performance indicators (KPIs) related to:

- Sustainability and Mobility.

- Digitalization and Smart Government.
- Sustainable urbanization and efficient use of resources.
- Integration with the Internet of Things (IoT).

The smarter cities in Italy in 2020 where: Trento, Torino, Bologna, Mantova, Milano, Bolzano, Brescia, Bergamo, Pordenone, Ferrara [4].

Pos.	Città	Punteggio	Pos.	Città	Punteggio
1	Trento	100,00	11	Modena	73,58
2	Torino	92,90	12	Parma	72,64
3	Bologna	89,84	13	Udine	72,47
4	Mantova	89,17	14	Reggio Emilia	72,08
5	Milano	84,51	15	Padova	71,30
6	Bolzano	84,03	16	Treviso	71,30
7	Brescia	82,74	17	Monza	70,98
8	Bergamo	74,78	18	Cuneo	70,75
9	Pordenone	73,91	19	Cremona	68,05
10	Ferrara	73,90	20	Firenze	65,67

Figure 4: The 20 smartest cities in Italy in 2020

The EY Human Smart City Index 2022 ranks Italian cities based on their transformation into more people-friendly, sustainable urban environments. It focuses on three key areas:

- Digital transition
- Ecological behaviour
- Social inclusion

The smarter cities in Italy in 2022 where: Milano, Bologna, Torino, Trento, Parma, Bergamo, Padova, Brescia, Venezia, Firenze [5].

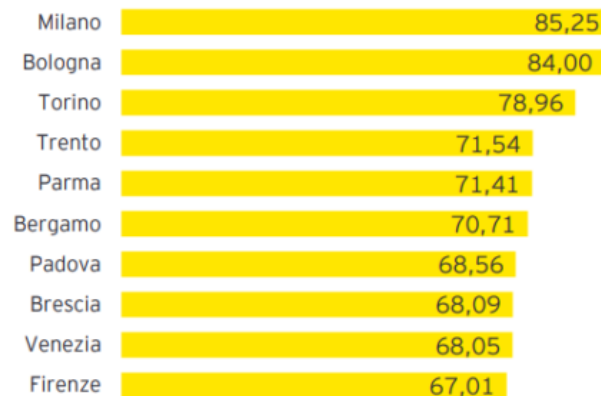| City	Score
Milano	85,25
Bologna	84,00
Torino	78,96
Trento	71,54
Parma	71,41
Bergamo	70,71
Padova	68,56
Brescia	68,09
Venezia	68,05
Firenze	67,01

Figure 5: The 10 smartest cities in Italy in 2022

As it is shown in the figure below, there is a large gap between the smart level of Italian cities depending on their geographical location: most of the cities between the first and the thirty-seven place in the ranking are in the north, the centre sees an intermediate level, while southern Italy leads to most of the cities in the last places of the ranking. This underlines the urgency not

only of a greater implementation of smart strategies in Italian cities, but also of a homogenization of the geographical distribution of smart cities.
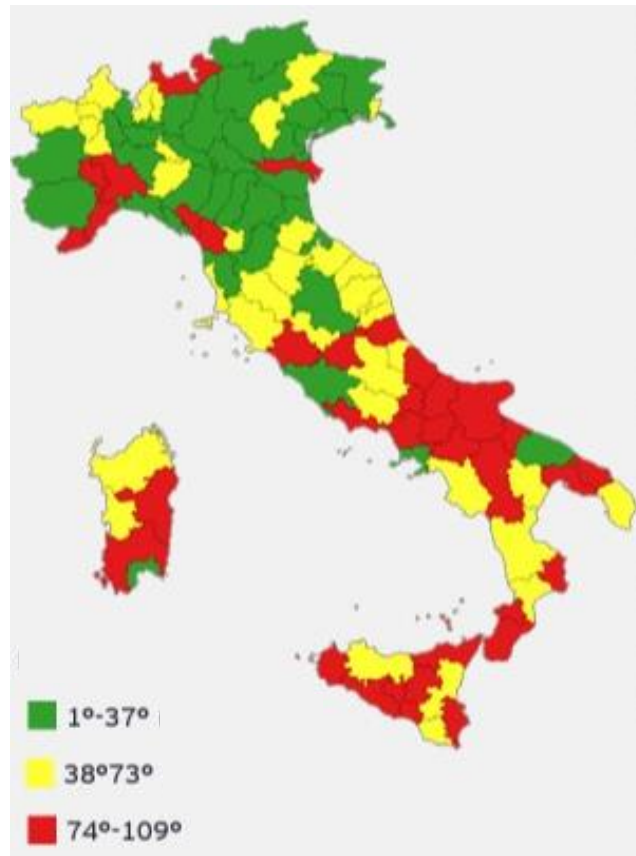

Figure 6: Location of smart cities in different ranking positions in Italy in 2022.

In 2024 Milano was the smartest city in Italy, followed by Bolzano and Trento, Bologna and Torino. These are some of the results of the research by the Smart City Observatory of the School of Management of the Politecnico di Milano, presented on May 10, 2024 at the conference "Smart City: in search of a winning strategy" [Web-8]. They are followed by several cities in the Center-North, while the South and the Islands are not in the top 10.
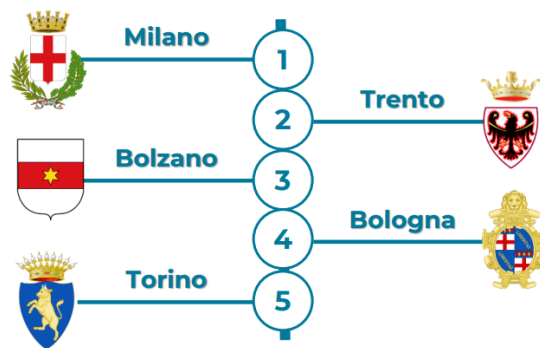

Figure 7: The 5 smartest cities in Italy in 2024

Comparing the rankings in the last years, it can be noted that three cities are always among the top 5, with different positions depending on the year: Milano, Bologna, Torino. For each city, the main initiatives that have made them the smartest cities in Italy are described [6].

MILANO

Milano is the economic capital of Italy, with a continuous growth trend in the real estate sector and in the main sectors related to services. The main thematic areas in which concrete actions have been developed in recent years that have made it the smartest city in Italy in 2024 are [Web-9]:

- **Sustainable mobility**: to envisage the expansion of the metro network, expansion of public transport, bike sharing, car sharing, restricted traffic zones, pedestrian areas and smart parking, charging stations spread across the city.
- **Energy efficiency**: to reduce CO_2 emissions, increase energy production from renewable sources and improve Eco-friendly buildings and Smart Grids.
- **Digitisation plan**: to envisage the deployment of ultra-broadband and fibre optics, the creation of an integrated platform of online services for citizens and businesses, the promotion of e-government, e-learning, e-health, m-health and e-culture.
- **Waste management**: to promote the use of Smart Bins and the adoption of Recycling Programs.
- **Innovation Hubs and Research**: to create and integrate space for research and innovation, as Politecnico di Milano and "Mind, Milano Innovation District".
- **Smart health and public safety**: to promote Digital Healthcare and Smart Policing and Safety.
- **Participation**: to involve the creation of meeting and co-working spaces, the valorisation of social and associative networks, and the implementation of social innovation and urban regeneration projects.

BOLOGNA

Bologna, thanks to its university vocation, it is one of the most lively and active Italian cities. The main initiatives which have been increasing the smart index in the last years [Web-10]:

- **The cycle mobility plan**, which will create a network of cycle paths, spread bike sharing, create parking areas for cyclists and promote awareness and incentive campaigns.
- **The air quality plan**, the aim of which is to reduce vehicle traffic, adopt limitation and disincentive measures, promote the use of public transport, and experiment with innovative solutions such as car-pooling, car sharing, bike sharing, etc.
- **The plan for culture and creativity**, which aims to enhance, as much as possible, the artistic and cultural heritage, realise events, festivals, exhibitions, shows dedicated to culture and innovation, create spaces and opportunities for cultural production and use, promote cooperation and exchange projects between cultural operators and institutions, etc..
- **The plan for participation**, which will create an online platform for citizen consultation and involvement in public decision-making, promote civic collaboration projects and care for the commons, and create a network of urban laboratories for experimentation and social innovation.

In addition to these plans, there are a series of important actions related to the promotion of specific themes such as:

- **Energy Efficiency and Sustainability**, promoting Green Buildings, Smart Grids and Renewable Energy Projects.
- **Digital Services and e-Governance**, to develop Online Public Services and Open Data Initiative.
- **Smart Waste Management**, to increase the use of Smart Waste Bins and Recycling and Waste Sorting.
- **Innovation and Research**, to create "Innovation Hubs", hubs and startup incubators for innovation, and to promote University of Bologna researches on specific themes, as urban sustainability, digital innovation, and smart technologies.
- **Smart Health and Well-being**, to promote eHealth Services and Smart Aging Programs.
- **Public Safety and Urban Security**, to use Smart Lighting for public spaces, and to promote the city uses of the Internet of Things (IoT) and AI-based surveillance systems.

TORINO

Torino, thanks to a long industrial, scientific and cultural tradition, was one of the first in Italy to bet on the smart city concept. The most relevant smart initiatives are [Web-11]:

- **The e-mobility plan**, which envisages the creation of a public and private recharging network, the introduction of electric vehicles in the city's vehicle fleet and the testing of innovative solutions such as carpooling, car sharing and taxi sharing.
- **The smart lighting plan**, which aims to replace conventional lamps with LEDs, adjust light intensity according to environmental and traffic conditions, install sensors and cameras for monitoring and security, etc..
- **The plan for digital culture**, which plans to create a centre of excellence for training, research and business development in the field of digital technologies, to organise events, exhibitions, festivals, workshops and competitions dedicated to creativity, and to enhance the historical and artistic heritage through multimedia applications, augmented reality (AR), virtual reality (VR) and related technologies;
- **The plan for participation**, which envisages the creation of an online platform for citizen consultation and involvement in public decisions, the promotion of crowdfunding and civic hacking projects, the creation of a network of neighbourhood centres for sociality and solidarity.

In addition to these plans, there are a series of important actions related to the promotion of specific themes such as:

- **Smart mobility**: the network of cycle paths has been significantly increased in recent years, to promote sustainable mobility in better safety conditions, in addition to the promotion of electric mobility.
- **Energy management and sustainability**: to promote green buildings and a sustainable approach also in the renovations of existing buildings.
- **Culture and innovation**: to create Innovation hub, as OGR - Polo dell'Innovazione, or Torino City Lab.

6   CONCLUSION

The development of smart cities in Italy over the past decade has shown significant advancements in integrating digital technologies and sustainable practices into urban environments. The analysis highlights the importance of a comprehensive approach that includes smart mobility, energy efficiency, digitalization, and active citizen participation.

Key findings indicate that the European Smart City Index and the Smart Cities Marketplace are essential tools for evaluating and enhancing the performance of smart cities. These frameworks help cities benchmark their progress, share best practices, and foster collaboration among various stakeholders.

The global smart cities market is expected to grow substantially, driven by innovations in smart transportation, healthcare, education, public safety, and e-governance. In Italy, the growth is supported by significant investments, particularly from the National Recovery and Resilience Plan (PNRR), which aims to modernize infrastructure and promote sustainable urban development.

Despite these advancements, challenges remain, particularly in addressing the disparities between different regions. The gap between northern and southern Italy underscores the need for targeted strategies to ensure equitable development and the widespread adoption of smart city initiatives.

Looking forward, the focus should be on scaling successful projects, fostering public-private partnerships, and leveraging funding opportunities to continue the transformation of Italian cities into smart, resilient, and vibrant urban centers. By prioritizing sustainability, innovation, and inclusivity, Italy can further enhance the quality of life for its citizens and achieve its energy and climate goals.

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