

Smart Cities in Italy: An intelligent Contribution to Sustainable Development

Vinci G., Ruggeri M., Rapa M., Ruggieri R

Abstract: *A smart city is a place capable to manage resources intelligently, aims to be economically sustainable and energy self-sufficient, and is attentive to the grade of life and needs of its citizens. It is a concept that goes beyond the simple idea of a "digital city", as a smart city incorporates multiple levels of development for innovative urban development management: use of renewable energies, environmental care, sharing economy, bike and car sharing, these are just some of the many features that make up a smart city. However, these places should not be seen only as a set of solutions, but a real different approach on how to solve the problems of a community and a territory. In this study a broader understanding of the topic is presented, with particular reference to the current situation in Italy, where the northern part, led by Milan and its winning model, is very advanced, and the southern part is very underdeveloped.*

Index Terms: *ICT, Italy, Smart Cities, Sustainability,*

I. INTRODUCTION

According to a United Nations perspective, by 2050, 70% of the global inhabitants will be in urban centers, which consume 75% of the world's energy, producing between 60% and 80% of greenhouse gas emissions. In this context, governments and citizens will be required to define a balance between economic, social and environmental aspects. These problems can be simplified through the integrated use of technology, or better yet, of the "Information and communication technology" (ICT), which becomes the fundamental tool in anticipation of increasingly populated urban centres. Smart cities can be seen as the adaptation of cities to technological progress, and they are new and strategic ways of conceiving urban centres. A Smart City is based on an urban development model that integrates recent ICT for managing the heritage of a city, as well as all its components. It's a way of understanding the urban environment whose development leans on the availability of natural capital but also on intellectual and social capital. It could be considered an innovative approach to solve the problems linked to the urban agglomeration process, to the rapid expansion of the population and to the increase in the well-being of citizens.

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Vinci G., Department of Management, "Sapienza" University of Rome, Via del castro laurenziano 9, 00161 Rome, Italy

Ruggeri M., Department of Management, "Sapienza" University of Rome, Via del castro laurenziano 9, 00161 Rome, Italy

Rapa M., Department of Management, "Sapienza" University of Rome, Via del castro laurenziano 9, 00161 Rome, Italy

Ruggieri R., Department of Management, "Sapienza" University of Rome, Via del castro laurenziano 9, 00161 Rome, Italy

The idea of smart city goes beyond the simple concept of a "digital city", but involves different levels of development, like social inclusion, environmental protection, quality of life and sustainable usage of resources, thus, it is a concept that strongly depends on the context in which it develops (country, government, natural resources, knowledge and IT skills). [1]

So, even if there is no a unique and global definition of "smart city", the key concept is a city inherently digital and heavily based on information and communication technologies, such as cloud computing, sensors, wireless networks, etc. through the application of this technologies the information networks are linked to citizen's life and to the territory, to ensure a sustainable and effective development.

An example, in a smart city, through the use of technology it's possible to optimize the irrigation of parks or street lighting, monitor the concentration of pollution and losses in the water network. The rubbish bins can send sound alarms when they are almost full to optimize collection operations and the use of drones makes the safety of citizens more efficient.

The purpose of municipal administrations is to build a socio-economic environment in which citizens, businesses and governments have the possibility to access services and resources more efficiently, and to provide and supply data and information more quickly. [1]

This work aims to analyse the main aspects related to smart cities, the reference framework, the factors involved and the Italian current situation. Moreover, the methodologies to classify a smart city were highlighted, such as the "smart city ranking" and the "ICity Rate".

These tools point out the Italian excellences, as well as the cities that are making the greatest efforts in trying to become "smart".

II. SMART CITY CLASSIFICATION

To distinguish themselves from other cities and to promote innovation, in smart cities the parties involved must be multiple, and their role is fundamental in order to create an interactive network: companies, governments, citizens, research centres, universities [1]. In concordance with above, the "model of the triple helix" of Etzkowitz e Leydesdorff have to be taken as reference [2]. This model has three factors that correspond to three key sectors of a city: Governments (public), companies (privates), universities (research). Each of the three systems, in addition to their independent role addressed to service the citizen, interacts with the other two to create useful mechanisms to trigger innovative processes, and in the process of



strategizing a smart city, to promote economic development and innovation. Therefore, the combination of elements from each of the three sectors is a leading factor. Notable is the weight of the universities, as a relevant factor in the development of innovation [3].

Actually, the university acts as a producer of economic and innovative impressions, such as for example the care of start-ups, knowledge-depth services, and as a means of knowledge transfer [4]. The metamorphosis of the university had the results that at the two typical missions of teaching and research, the universities were called upon to support a third one: the transformation of scientific knowledge into business skills. So, universities can bring that missing knowledge as a key requirement for co creation of successful stakeholders, and then create that useful knowledge for the effective evolution of an intelligent city, acting as an intermediary between the parts of the ecosystem [5].

Therefore, the university has a fundamental importance in the design of a smart city, because it is from there that much scientific knowledge develops, which must then be transferred to governments and businesses.

A. Smart city ranking

The “smartness” of a city could be measured by various ways. One of them is the “Smart City Ranking”, theorized by some researchers from the University of Vienna in cooperation with the University of Ljubljana. This ranking measures the smartness of a sample of 77 medium sized European cities, throughout six criteria (Economy, People, Governance, Mobility, Environment, Living). These dimensions can be divided into other 31 relevant factors, as reported in Figure 1 [6].

1) SMART ECONOMY
Innovative spirit; Entrepreneurship; Economic image & trademarks; Productivity; Flexibility of labour market; International embeddedness; Ability to transform
2) SMART PEOPLE
Level of qualification; Affinity to lifelong learning; Social and ethnic plurality; Flexibility; Creativity; Cosmopolitanism/Open - mindedness; Participation in public life.
3) SMART GOVERNANCE
Participation in decision-making; Public and social services; Transparent governance; Political strategies & perspectives.
4) SMART MOBILITY
Local accessibility; (Inter-) national accessibility; Availability of ICT - infrastructure; Sustainable, innovative and safe transport systems.
5) SMART ENVIRONMENT
Lack of pollution of natural conditions; Pollution; Environmental protection; Sustainable resource management
6) SMART LIVING
Cultural facilities; Health conditions; Individual safety; Housing Quality; Education Facilities; Tourism; Social Cohesion

Fig. 1: The six dimensions of Smart City Ranking

Then, each factor is standardized through a z - transformation in order to make them comparable and agreeable. This was also confirmed by Rudolf Ginger, teacher

of Vienna’s University and head of the project of studies on smart cities, that states [6] a medium-sized city is considered a smart city when, on the base of the blending of interior data and the assignments made by governors, the economy and the environments themselves, it presents a lasting development over time of the six characteristics mentioned above.

But when is a city considered a “medium – size city”? As there is no clear definition, researchers have defined some criteria (Table 1). Possible cities are all European Functional Urban Areas (FUA). Within this group only cities with less than 500,000 inhabitants were selected. So, within 584 cities remained, only 364 were picked out which had minimum one university, which points out a presupposition for basic awareness and smart local growth. Within these cities, 256 cities have been selected, accounting a catchment area that does not exceed 1,5 million inhabitants, and finally, 70 cities remain as a matter of data accessibility

Table 1: Criteria for the “medium – size city” definition

Criteria	Cities
European functional urban areas	1,595
Cities with a population between 100,000 and 500,000 inhabitants	584
Cities with minimum 1 University	364
Cities with a catchment area does not exceed 1,5 million inhabitants	256
As a matter of accessibility and data quality	70

In the final ranking, on the top there were cities from *Benelux*, *Scandinavia* and *Austria*, and cities like *Montpellier* and *Ljubljana* (the only one capital in the ranking), whereas in the final position are situated the new EU - member states.

The ranking is an index, but it is essential to understand the weakness and strengths of the cities, to develop strategies aimed at improving the conditions of the urban environment. Moreover, according to Giffinger [6], to rethink and redesign a smart city it’s very important involving many subjects, both public and private, at local, national and international level, to improve the territory and to increase quality and creativity.

B. The ICity rate

Even in Italy cities have also begun to strategize smart cities, and the main ranking of these cities is the “Icity Rate”, drawn up annually since 2012, by “FPA s.r.l.”, an italian consultancy company of the “Digital 360” group, specializing in fostering the meeting and collaboration between public administration, companies, the world of research and civil society [7]. The “Icity rate” is a ranking starts from the 6 dimensions of Giffinger to which another has been added: The dimension “legality”. The 2016 edition of the ICity rate has reported in Table 2 [8]. Since the sixth edition, [9], following the Sustainable Development Goals (SDGs), the sustainability objectives introduced by Agenda 2030 [10], the company has redesigned the ICity rate. The statistical indicators were reorganized, expanded and merged according to 15 scope indices, included in 5 dimensions, abandoning the 7 traditional dimensions. The SDGs are shown in Table 3.

Table 2: ICity Rate of 2016

DIMENSIONS	STATISTICAL INDICATORS	Σ
ENVIRONMENT	Air quality, separate waste collection, water purification, energy consumption, green availability, green companies, air control, dispersions in the water network, municipal photovoltaic system, incidence of green, ecomanagement, networks for sustainability, common spaces	13
ECONOMY	Productivity, entrepreneurship, job qualification, directionality, credit availability, productive internationalization, dissemination of productive innovation, concentration of research and development, innovation, e-commerce, innovative behaviors, international relationality, fablab, attractiveness of funding, business creation	15
PEOPLE	Education level of the population, social participation, labor market fluidity, participation in events, hospitality, gender balance in employment, number of families with internet connection, attractiveness, home banking broadcasting, school computerization, intellectual migration, school accessibility	12
LIVING	Health care, school dropout, child care, elders assistance, job opportunities, economic suffering, connection infrastructures, residential connection services, coworking, entertainment offer, cultural internationalization, urban attractiveness	12
MOBILITY	Accessibility of the areas, terrestrial accessibility, fluidity of the territorial structure, TPL offer, interchange, accidents, railway usability, sustainable mobility and mobility, traffic limitation, cycling, ecological adaptation of the cars, propensity to collective mobility, bike sharing	13
GOVERNANCE	Election participation, trust levels, economic stability, management capacity, gender balance in representation, open data, Twitter penetration (followers per 100 residents), SPiD, green governance, Pago PA, governance of the smart city	11
LEGALITY	Microcriminality in the city, non-regular work, administrators threatened, journalists threatened, cement cycle, waste management, efficiency of the courts, company rating, procurement, relocated confiscated assets, commissioned municipalities, organized crime and mafia, commercial illegality, money laundry, voluntary homicides	15
TOTAL		91

Table 3: The sustainable Development Goals (SDGs)

1. No poverty
2. Zero hunger
3. Good health and well-being for people
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, Innovation, and Infrastructure
10. Reducing inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnerships for the goals

According to the 17 goals, for the seventh edition [11] the indicators used are 107, as the number of cities considered. In Table 4 are shown all the indicators.

Table 4: The ICity rate 2018, 5 dimensions, 15 scope indices, 107 indicators

DIMENSIONS	SCOPE INDICES	STATISTICAL INDICATORS	#	Σ
ENVIRONMENT	Water and air	Water dispersion, waste, water service coverage, pm ₁₀ , pm _{2.5} , NO ₂	6	12
	Urban green	Incidence of the green, Availability of public green, Green planning	3	
	Territory and soil	Dynamics of pro capite consumption, share of land consumed, risk mitigation	3	
SERVICES	Management of urban rubbish	Incidence of separate collection, waste production, waste initiatives	3	21
	Energy	Adaptation of the municipal heritage, consumption trend, quality of the electricity service, agreement of the mayors for climate and energy	4	
	Sustainable mobility	Incidence of the LTZ, promotion of intermodality, promotion of cycling, adaptation to emission standards for cars, incidence of fossil fueled vehicles, promotion of electric mobility, bike sharing, car sharing, local public transport offer, propensity for collective mobility, trend of mobility accidents, incidence of pedestrian areas, TPL speed, IT Mob	14	
ECONOMY	Economic growth and solidity	Pro capite added value per capita, IRPEF average income, entrepreneurship rate, credit availability, productive consolidation, productive internationalization,	6	21
	Employment	Participation in the labor market, gender balance in employment, employment spread, incidence of unemployment, qualification of work, irregular work, accidents, rate of non-participation in youth work (15 - 29 years)	8	
	Research & innovation	Dissemination of production innovation, e-commerce, high-knowledge companies, Start-up, FabLab density, coworking density, innovative services	7	
SOCIETY	Social inclusion	Economic suffering, population that risks poverty, housing problems, evictions, hospital emigration, child care, assistance to the elderly, health personnel, reception, private health and social services	10	26
	Education	Neet, tertiary education, school accessibility, supply of university education, density of public education, continuous education	6	
	Tourism	Participation in shows, attractiveness, cultural occupation, cultural internationalization, cultural heritage, tourism rate, historical enterprises, non-summer tourism, cultural entrepreneurship, tourism expenses	10	
GOVERNANCE	Participation	Dissemination of social cooperation, social participation, electoral participation, ISTAT - BES regional index of politics and institution, innovative planning and urban development, shared administration, green PA, social innovation, percentage of women in municipal councils, transparency of websites	10	27
	Safety and legality	incidence of petty crime, incidence of murders, commercial illegality, money laundering, efficiency of the courts, social re-use of assets, commissioned municipality, organized crime, territorial protection	9	
	Digital transformation	Home banking, broadband access, digital adaptation, open data, social PA, online services, public WiFi, municipal APPs	8	
TOTAL				107

It is noteworthy that the main change is the dimension “People” becomes “Society”. The “Living” dimension, now “Social Inclusion”, flows also in the Society dimension.

The dimension “mobility” is merged in a new dimension named “Services” and “Legality” flows in “Governance”. The result of the synthesis of these 107 data is the “Smart City Index” (SCI), a score which measures the smartness of Italian cities. Figure 2 shows the ranking development process, starting from 2008 to today. Below are the data of the “ICity rate” from 2014 to 2018 with the Smart City Index for each city [8,9,11-13].

In Table 5 have been listed the first 15 cities and the last 15 ones.



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Table 5: ICity rate, 2014-2018. (S.C.R. = Smart City Ranking)

2014			2015			2016			2017			2018		
#	CITIES	S.C.R.	#	CITIES	S.C.R.	#	CITIES	S.C.R.	#	CITIES	S.C.R.	#	CITIES	S.C.R.
1	Milan	623,0	1	Milan	637,9	1	Milano	624,0	1	Milan	599,1	1	Milan	640,2
2	Bologna	610,1	2	Bologna	612,8	2	Bologna	565,4	2	Bologna	597,4	2	Florence	621,6
3	Florence	557,7	3	Florence	587,4	3	Venezia	513,8	3	Florence	571,1	3	Bologna	620,0
4	Modena	543,9	4	Modena	567,7	4	Firenze	511,0	4	Venice	553,3	4	Trento	583,6
5	Padova	539,4	5	Venice	557,2	5	Padova	508,9	5	Trento	545,8	5	Bergamo	567,1
6	Venice	534,1	6	Parna	555,9	6	Torino	505,6	6	Bergamo	538,1	6	Turin	547,7
7	Ravenna	533,4	7	Reggio E.	550,5	7	Parna	499,9	7	Turin	532,9	7	Venice	544,1
8	Reggio E.	526,7	8	Trento	550,0	8	Trento	498,6	8	Ravenna	517,6	8	Parna	539,1
9	Trieste	525,7	9	Padova	548,8	9	Modena	498,5	9	Parna	513,9	9	Pisa	538,6
10	Parna	524,7	10	Trieste	548,4	10	Ravenna	495,9	10	Modena	513,3	10	Reggio Emilia	532,8
11	Brescia	519,8	11	Turin	541,0	11	Bergamo	495,6	11	Reggio E.	510,7	11	Padova	532,5
12	Rome	519,5	12	Brescia	540,7	12	Brescia	488,8	12	Padova	509,5	12	Ravenna	531,7
13	Trento	518,5	13	Ravenna	540,3	13	Bolzano	484,0	13	Pisa	503,3	13	Pordenone	529,9
14	Turin	515,6	14	Forli	527,0	14	Reggio E.	482,9	14	Bolzano	502,0	14	Trieste	523,2
15	Verona	505,5	15	Verona	525,3	15	Pisa	482,0	15	Trieste	500,5	15	Rome	522,7
...
92	Brindisi	279,3	97	Benevento	309,3	94	Benevento	279,3	92	Reggio C.	283,0	93	Foggia	298,2
93	Ragusa	275,6	98	Messina	307,6	95	Isernia	279,2	93	Caserta	281,9	94	Catanzaro	296,9
94	Messina	271,6	99	Cosenza	307,0	96	Ragusa	276,3	94	Ragusa	281,5	95	Avellino	296,7
95	Benevento	269,2	100	Caserta	304,8	97	Catania	272,8	95	Cosenza	278,4	96	Ragusa	296,2
96	Catania	264,1	101	Avellino	302,7	98	Nuoro	270,3	96	Taranto	278,0	97	Reggio C.	292,5
97	Siracusa	259,1	102	Catania	298,2	99	Cosenza	268,5	97	Benevento	276,0	98	Benevento	287,6
98	Cosenza	257,5	103	Siracusa	292,8	100	Avellino	264,2	98	Foggia	270,8	99	Caserta	283,0
99	Andria	254,6	104	Enna	285,6	101	Caltanissetta	252,0	99	Catania	269,5	100	Brindisi	278,3
100	Enna	239,4	105	Andria	284,6	102	Trapani	243,3	100	Enna	260,2	101	Enna	275,1
101	Reggio C.	229,0	106	Trapani	263,3	103	Enna	235,6	101	Catanzaro	255,8	102	Taranto	268,9
102	Trapani	227,2	107	Reggio C.	255,2	104	Catanzaro	231,9	102	Crotone	242,6	103	Crotone	248,8
103	Caltanissetta	227,0	108	Caltanissetta	249,6	105	Crotone	230,0	103	Agrigento	230,1	104	Trapani	237,4
104	Vibo Valentia	220,6	109	Agrigento	241,6	106	Reggio C.	227,4	104	Caltanissetta	221,4	105	Caltanissetta	235,9
105	Agrigento	206,3	110	Vibo Valentia	232,8	107	Agrigento	215,6	105	Vibo Valentia	214,6	106	Vibo Valentia	227,6
106	Crotone	201,5	111	Crotone	212,9	108	Vibo Valentia	202,1	106	Trapani	211,3	107	Agrigento	225,2

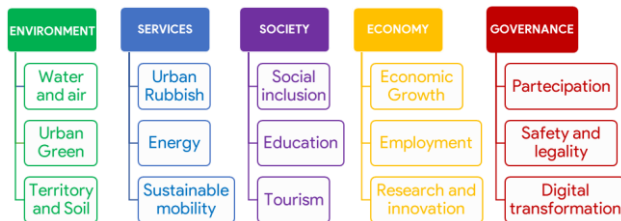


Fig. 2: Ranking development process, 2008 - today.

First of all, the ICity rate confirms the gap existing in Italy between the north and south of the country (Figure 3). In fact, for all 5 years, and still for the 2018, the first 15 positions are occupied largely by the same cities, which belong to the north and centre of Italy (green dots). Among these 15, for the year 2018, raising Rome and Pisa, all belong to the Northern Italy. To find the first city of the southern Italy, we have to move to the 43rd position, where there is Cagliari [11].



Fig. 3: ICity rate 2018 distribution, North vs South.

Another alarming fact is that, for 5 years and also for 2018, all the last 15 positions have been occupied by southern cities (red dots), with heavy deficiencies in sectors such as work, economic solidity, research and innovation and among the last 5 positions, there have always been the same cities: Vibo Valentia, Caltanissetta (except for 2016) and Agrigento.

At the same way, it is noteworthy that at the first three positions of the ranking there are the same cities: Milan, Florence and Bologna, for 5 years (except for the year 2016).

These cities follow very different urban development models: Bologna's strengths are governance, participation, energy, civil participation and business, while Florence confirms its leadership in tourism-cultural activities, sustainable mobility, work. [11].

Milan is positioned for the fifth consecutive year at the top of the ranking, resulting even in 2018 as "the smartest city in Italy", and resulting a model that is difficult to replicate in Italy, reaffirming its excellence in many scopes: economic growth, thanks also to its sharing economy models [14] that help to reduce costs and environment impact; [15] energy, [16] sector in which, by investing in renewable resources and photovoltaic panels, it is possible to save on the purchase of electricity; [17 – 18] work; innovation and urban development; [19] attractiveness (Milan is considered one of the big four world fashion capitals) and a series of sustainable mobility policies. In this scope are notable smart parking sensors, [20] efficient carsharing systems, [21] the massive use of the public transport, especially the three subways.

Furthermore, the policies and projects of the Lombard city is aimed at electric mobility. On the basis of the plans envisaged by the Urban Plan of sustainable mobility, in Milan by 2030 [22] there is the will to make public transport completely electric in order to reduce polluting emissions for the frequently PM₁₀ limits exceeded [23].

Moreover, currently, in Milan there are (per million inhabitants) 345 public hotspots, 2,000 cars in car sharing with the 52% of citizens subscribe to car sharing services, 3,400 bikes of BikeMI (The public Bikesharing of Comune di Milano), 12,000 Bikes OFO and MoBike [23,27]

Milan also represents a model of excellence in waste management, resulting in a very clean city, thanks to an efficient service by AMSA (Azienda Milanese Servizi Ambientali), the company that deals with waste collection. [24] In 2017, separate waste collection was 54%. Furthermore, scattered around the city there are 5 "recyclers", places where it is possible to recycle some waste, following the circular economy model, thanks to which it is possible to mitigate the loss of natural resources through the recycling and reuse of raw materials. [26 – 26]

Finally, Milan is very advanced in productivity (the pro capite added value is about €47,000 more than double of the other cities "capoluogo"), average value of IRPEF declaration (more than €32,000, against €26,000 of Bologna) and entrepreneurship rate (12,9 active companies every 100 inhabitants).

All the projects and activities mentioned above will generate an increasingly large business for Milan, which, to 2017 is a very rich city, with a GDP of € 47,000 per inhabitant, (more than cities like Barcelona, Lyon and Monaco) and an unemployment rate of 6,5%. [23,27]

III. CONCLUSIONS

The ICity rate still confirms that in 2018, the situation existing in Italy, is the same as always, bivalent and inhomogeneous. The northern part of the country is rich, evolved and full of well-being, while the southern part is backward and unable to grow, with heavy structural delays in sectors such as employment, economic solidity, research and innovation, energy. This inequality has deep roots linked to historical reasons such as internal migrations and social matters, that is the low level of education of the southern population. One of the starting points for the growth of a smart city is an adequate level of knowledge and education. In fact, among the top 10 cities in the ICity rate there are almost all cities with historic or prestigious universities. Milan that has the Politecnico, Bocconi, Cattolica, Bicocca; Bologna with the "Alma Mater Studiorum", the oldest university in the world (founded in 1088); Florence with its university founded in 1321, Venice where there is the University "Ca'Foscari" that is considered the oldest business school in Italy and the world; Turin, where there is the "Università di Torino", founded in 1404, and "Politecnico di Torino", excellence in engineering and architecture. This once again demonstrates the great importance of universities for the formation of knowledge and human capital, fundamental for an adequate level of urbanization, innovation and development of new solutions. Milan, despite being a metropolis with more than 1,300,000 inhabitants, is in the first position for the fifth consecutive year thanks to excellent performances in various fields such as economic growth, mobility and innovation, and was able to commit itself to being ever closer to citizens' needs, representing a model of excellence in Italy.

If industrialization brings many economic benefits, on the other hand it creates significant damage to the environment. Milan in 2017 had as many as 97 days with levels of PM₁₀ above the permitted limit, making it one of the most polluted cities in Italy, which is the reason why the municipal administrations are studying various solutions to make the city increasingly sustainable through the reduction of the environmental impact of its activities. There three points to be reached by 2030, the first is to make electric the entire public transport fleet, with an estimated CO₂ reduction of around 75,000 tons a year; the second one is to build sustainable buildings, for example the "Vertical nest" is under construction, a building formed to isolate from the winter cold and prevent the heat in the summer, with a very limited consumption of resources; the last one is the strengthening of the underground lines. These projects can represent an opportunity not only for Milan, but also for other cities, which can consider the "Milan model" as a reference point for improvement, but also a risk, because a possible scenario could be the ever-increasing polarization of investments in the Lombard city.

A solution to try to thin the inequality among southern and northern Italy could be the promotion of "smartcitizenship" which, however, cannot disregard a close collaboration between administrations and citizens. The former through the provision of those fundamental tools, such as the network, 5G, data, sensors, information, infrastructure etc., the latter through active participation, awareness, and above all, the ways of appropriate behavior.

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