

# Medium-Sized Smart Cities: A Smart Vision for Urban Centralities and Buildings. From the European Case History, to a Proposal for the City of Parma, Italy



**Monica Bruzzone**

**Abstract** Smart city arouses the image of metropolis or even megacities, and many Smart city models aim at enhancing the performances of big cities. Yet in Europe, it is necessary to deal with a fact: most people dwelling cities, live in Medium-sized cities. These cities therefore create an important critical mass, both because they are very numerous, and because they suffered the greatest criticalities in terms of environmental pollution, life quality, mobility and also building sustainability. Beginning from the scientific literature and the rankings of Medium-sized cities, as well as the concept of Functional Urban Area, this research deepens medium city as a territorial issue, with an urban attractive core, and a wider complex landscape. The boundaries definition of a medium city, and the analysis of its geomorphological, infrastructural and functional criticalities, may be the key for a new interpretation of Smart strategies for their sustainable development. The research output is the proposal of an innovative tool, addressed to leaders and planners of the Smart Medium-sized city. This tool may allow a critical reading of the city, by georeferencing material and immaterial data about the city and its functional area, crossing open data and morphological characters in an interactive dashboard. After the case history of European Medium-sized cities, the research focuses on the role of Parma, Italian Medium-sized city, with a proposal about a future smart development, for consolidating results obtained during 2020, with the cultural leadership of the Italian Cultural Capital award.

**Keywords** Smart city · Smart building · Medium-sized city · Territory · Resilience

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M. Bruzzone (✉)

University of Parma, Parma, Italy

e-mail: [monica.bruzzone@unipr.it](mailto:monica.bruzzone@unipr.it); [monica.bruzzone@economia.unige.it](mailto:monica.bruzzone@economia.unige.it)

University of Genoa, Genoa, Italy

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## 1 Smart Policies for Medium-Sized Cities: A Still Open Research Field

The words Smart city concern the city growth in relation with the disruptive development of new technologies and digitization; it embraces a wide range of meanings and approaches. The Smart city process may be developed at several dimensions: from the large scale of new megacities in emerging countries, to the small size of the provincial cities, up to the new phenomenon of Smart villages ([10], [22], [21], [23]), dealing with the Smart strategies for little towns and the rural areas.

The social necessity to design an intelligent city, appropriate for the ever-changing needs of contemporary culture is a problem crossing the history of civilization. Giving intelligence to the space we live, in order to adapt its vocations to the community needing [11], has always been a target, in any masterplan addressed to the city and the landscape transformation. As well, what qualifies the Smart city development process, from a traditional approach?

First of all, there is a change in the timeframe. Smart city is an innovative process, based on the growth of competitiveness and economic development, and it requires quick actions. It includes the concept of immediacy, both in the execution and in the impact evaluation: this attitude may often create negative results, when a smart strategy is not aligned with the rhythms of nature that requires a long time to respond to the anthropic transformation [18].

Then, there is a change in the methodological approaches. A Smart city aims at improving the quality of life, increasing attractiveness; but it also aims at preserving and enhancing the environment with adaptive strategies nowadays called *Resilience*. However, the Smart strategy policies often seem to give partial answers to general problems especially in Medium-sized cities. The punctual solutions they create seem to contrast with the landscape complexity, that goes beyond its administrative limits, and requires a systemic strategy, to be checked in medium and long terms. Designing a city strategy, in particular for Medium-sized cities, therefore needs a dynamic vision of the territory as well. Both in its spatial terms, considering the city as a core element of a wider landscape, and in temporal terms, considering the nowadays cities as the result of a morphological, historical and cultural development, with cyclic repetition of physical and geological events.

The aim of this research is to provide a definition of Medium-sized Smart city, with particular reference to the European condition, as well as to propose an approach model based on the interactive territorial analysis, useful for governance and planning processes. The research is divided into 4 points, described in Sects. 2–5, as follows. Section 2 provides a definition of Medium-sized Smart cities, in accordance with the European vision, and focusing on the creation of specific rankings and on the Functional Urban Area concept. Section 3 identifies Parma as a Medium-sized Italian city: a good case study for an urban analysis model, aiming at integrating environmental, cultural and functional issues with a digital dataset based on the big data georeferencing, in order to create an operational tool for policy makers and planners. The Section also summarizes the results of a case history of 10 medium Smart

cities in Europe, for better understanding the Parma conditions, in order to create a new approach model to the urban phenomenon, preliminary for any governance and planning Smart strategy. Section 4 deals with the premises for a geo-referenced interactive map, as a multilevel analysis on the urban phenomenon. This dashboard will help recording and querying the three types of memory acting on the city and involving citizens: the form memory and the function memory based on the “brick and stones” city, and the recent digital memory, based on the relationship between the real city and the big data or digital traces left by sensors and people living and moving in the city. This new map may geo-reference spatial data, and also hook intangible data to real places. The interpretation model could also be useful to define an ideal area of intervention on the city, where the effects of Smart strategies can be maximized, and also to monitor the impacts of Smart policies extended to the landscape over time. Section 5, summarizes the first conclusions and explains guidelines for activating the following research.

## **2 The Medium-Sized Smart City: A Context Analysis**

The scientific community begins a discussion about Medium-sized cities’ smartness with a certain delay. The first topic concerns the performance indicators, for checking and evaluating impacts of Smart projects in Medium-sized cities, on medium and long terms. In a first phase, indicators were inherited by the big cities, with negative results for smaller cities, constantly obscured by the larger impact of the larger Smart cities. Projects with big effects on Medium-sized centers did not emerge in the international rankings: this lower visibility also determines a low competitiveness and attractiveness for stakeholders and entrepreneurs. A very bad goal for the Smart strategies’ implementation process [19].

### ***2.1 Smart City: Project and Governance. a European Approach***

For a scientific definition of the medium city smartness, a premise is needed: through the meanings of the word Smart city, held by the scientific community over the last 10 years, we may identify a kind of European approach [8]. The increasing interest in smart policies for Medium-sized cities could be better understood if contextualized in the European physic and cultural landscape.

A shared definition of Smart city concerns the development of urban life quality, using new technologies and digitization [5]. From this perspective, many models have been developed around the world: each of them responds in a different way to a specific geography, culture, economic development, social needs, governance strategy [3]. In North America, where Smart policies are strictly connected with urban

development models, we may appreciate the foundation of new cities and neighborhoods, often funded by hyper-technological global corporations, as experiments for innovative ideas. In other parts of the world, particularly in emerging countries, Smart cities are also utopian experiments of fully technologically controlled organisms. They aim at responding to individual daily needs, using artificial intelligence and big data, for integrating a wide control process, managing the citizen's life as well ([16], [17]).

In the most cautious and dense countries of European identity, cities and communities have strong historical roots. They have generally little dimensions, and their historic centers and first expansion areas, almost saturated, are the main elements of an extensive and complex territorial system. It is no longer conceivable to have political unpreparedness that proposes innovative projects without a dynamic interpretation of the historical environment, and also without a methodological approach based on the definition of a wider area and of a long-term period strategy. Also, in Europe we appreciate the need to replace a former urban expansion model, based on land consumption, with virtuous processes of regeneration and building replacement, and also with new projects of Smart building infiltration strategies, in the density of the historical texture. Another objective is to encourage a development of environmental quality: for instance, the enhancing of green lungs for the city, as new smart and sensitive models of public space.

This kind of European approach has roots in the guidelines proposed by the European Union to direct governance actions. The approach has been implemented by national and local laws, and more recently it also entered into the daily practice of the local communities. It is also necessary to take into account the 2030 Global Agenda for Sustainable Development: here the United Nations promotes the best Smart strategies and practices, for developing topics as the environmental sustainability, economy, innovative industry, energy efficiency, sustainable mobility, reduction of social inequalities [20]. As we may see, the development of Smart city processes in Europe, has got very different approaches and purposes than in other parts of the planet. The first result of this character is a deep interaction between the notions of smartness and sustainability, two sides of the same development process, improving urban life quality with Smart processes and enhancing the domestic comfort and effectiveness with the Smart building projects and the Smart grid planning.

## ***2.2 The Medium-Sized Cities in Europe: Guidelines for a Smart Approach***

The Smart approach to urban design is an almost recent issue, which has been growing in the scientific literature since the mid-1990s, and the 2000s [8]. Scientific debate documents how Smart city processes were focused, at the very beginning, on big cities and metropolis. Here an exponential dimensional growth quickly amplifies ancient problems, such as pollution, mobility, accessibility to services; and creates

new challenges. The first researches on urban development strategies, the first Smart city projects and the first impact evaluation, are about the big cities, where the most innovative governance models and best practices were tested. In Europe, Smart cities such as London, Amsterdam, Helsinki, Stockholm have firstly been distinguished and then consolidated. In this first phase, and in the subsequent development of good practices and models, a focus on the development approach for Medium-sized cities was missing. Medium cities inherited the Smart approach models from big cities, based on the big size of the metropolitan problems, as well as the evaluation parameters and indicators created for cities with very different dimensions and challenges.

Yet, in Europe most of the urban population lives in Medium-sized cities, where environmental, social and cultural criticalities are revealed in a most disruptive way. Scientific literature began to deal with Medium-sized cities in the 2000s, addressing specific problems within emblematic or paradigmatic case studies.

The main challenges of these cities are: the increase of environmental pollution [15], the land consumption, and the critical mobility between the center, suburbs and rural areas. The leading cause could be a wide fragmentation of governance and service facilities, which prevents the adoption of large-scale governance measures.

### **2.3 What Is a Medium Sized City?**

For a deep discussion it is necessary to adopt a definition about the smart development of Medium-sized cities. Firstly, by fixing dimension and boundaries, then analyzing the common challenges and potential solutions, and lastly examining the specificity and uniqueness of each city, in order to create a balance between the replicability of some models, and the uniqueness of a social and morphological landscape system, that often represents the main richness of a medium city.

From this perspective some notions register an increasing importance. The first one, identifies analogies and the common challenges between medium cities: it is the notion of *Smart Medium-sized city*, well expressed by some scientific researches since the 2000's ([1], [2], [12]). The second one aims at considering Medium-sized cities as the core of a wider identity system, and it demonstrates the inefficiency of Smart action plans based on the administrative boundaries of the single municipality. It is the notion of *Functional Urban Area* (FUA), used by OECD (since 2011–2013), to identify how the city center is often a big attractor, capable of a large influence area.

Then, what does “Medium-sized city” mean? The commonly used tools for measuring a city (small, medium, large, extra-large [13]) are, in the scientific literature, the bigness (how many sq.km?), and the inhabitants (how many residents? We will see how the concept of “who lives the city?”, may be variously interpreted). From these parameters, a density index emerges (how many inhabitants/sq. Km?):

**Table 1** Medium-sized city: A comparison between definitions

Medium-sized City. Dimension		
Institution	Inhabitants min.	Inhabitants max
Giffinger (2007—UE)	100,000	500,000
OECD-FUA (2012—UE)	100,000	250,000
ANCI-CNSPU (2015 IT)	50,000	250,000

an issue for better understanding the compactness of the city built, neighborhood-by-neighborhood. A diagram of the Medium-sized cities definition will better explain the distance between the researcher's positions (Table 1).

In Italy, the National Center for Urban Studies,<sup>1</sup> gives a definition of Medium-sized city based on the number of inhabitants, also acquired by the ANCI: National Association of Italian Municipalities. According with this definition, Medium cities have a population of between 50,000 and 250,000 people, they provide coordination policies between urban and internal areas, and they have a high development potential [6]. ANCI, created a list of 105 Medium-sized cities,<sup>2</sup> and stressed on the analogies between critical issues, problems and potential. Other scientific researchers consider Medium-sized, the cities with a population of between 100,000 and 500,000 inhabitants. A broader classification especially if compared to the small size of Italian cities, where the 14 metropolitan Italian cities host about 34% of Italian population, and the majority of the remaining 66%, lives in cities between 50,000 and 500,000 inhabitants. This information well represents the impact of medium cities: a critical mass where it is decisive to intervene with innovative policies. In Fig. 1 we may see the graphic of the high soil dispersion index in some Italian cities, according with the XIV Report by Ispra, 2018, and compared with the dataset of the air pollution (Pm10 level) in the main city of the Emilia region.

## 2.4 *About a Ranking of the European Medium-Sized Cities' Smartness*

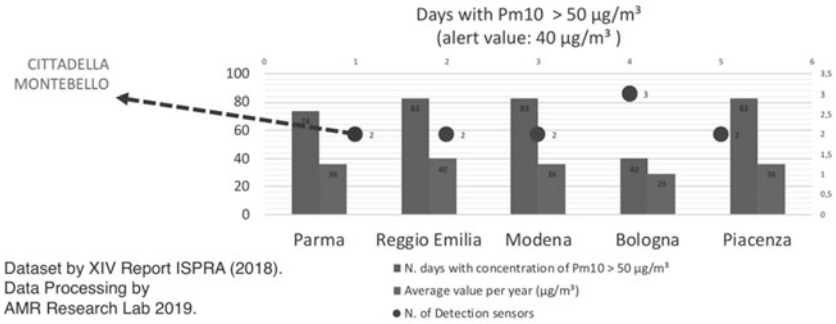
The first issue concerns the relationship between the characteristics of a Medium-sized city and its development potential: a matter for evaluating the scientific parameters for smart performances. A first contribution comes from the mentioned research published in 2007, from a team composed of the Polytechnic Universities of Vienna, Delft, and Ljubiana, under the coordination of Professor Rudolph Giffinger. This research verifies European Medium-sized cities as a critical mass with a high development potential and also with big criticalities. In percentage terms, the largest number

<sup>1</sup>Urban@it. The Italian Study Center for the Urban Policies, an association established in 2014 with the cooperation of the Italian Universities.

<sup>2</sup>Medium cities have in Italy a dispersion index higher than the European in 59% of analyzed cities (Source: Ispra Dataset 2018).

	Parma	Taranto	Brescia	Trieste	Padova	Prato	Modena
Sup. Comunale Km <sup>2</sup>	261	299	90	84	93	97	183,2
% suolo consumato su tot. Comune, nel 2017	23,60%	23,10%	45,40%	34,80%	50,10%	33,70%	25,80%

The Urban dispersion index, according with the XIV Report ISPRA "Qualità dell'ambiente urbano" (2018)



**Fig. 1** The soil dispersion index and the air quality in some Italian Medium-sized cities (dataset Ispra 2018 report—data process: AMR Research lab)

of European cities are Medium-sized. They host the majority of the population living in cities, and they show similarities in critical issues and potentials, which are very different from the ones witnessed in big cities.

The Giffinger ranking places cities with a population of between 100,000 and 500,000 inhabitants under a magnifying glass: urban centers with high growth potential, needing attentions for a sustainable development. In 2007, the European cities with these characteristics were about 600, with a total of 120 million inhabitants. About 40% of European population living in urban areas, dwells cities of medium size. The website created to disseminate the results: [www.smart.cities.eu](http://www.smart.cities.eu), is a support for checking the transformations of these cities over a period of a few years, from 2007 to 2014. The proposed ranking coordinates the Medium-sized cities starting from 6 major topics or specialization strategies: Economy, People, Governance, Mobility, Environment, Living.<sup>3</sup> The second research goal concerns the timeframe, and aims at monitoring these cities over time, in order to obtain data about their development ability in medium and long terms.

<sup>3</sup>The choice by Giffinger includes cities with a population of between 100,000 and 500,000, with an overall catchment area of less than 1.5 million people and the presence of a University. This scientific selection criteria allows researchers to reduce the number of cities from 600 (Medium cities in UE) to 256. The lower number of 94 includes cities with a homogeneous database to deal with: Urban Database and Eurostat Audit.

## 2.5 *The Concept of Functional Urban Area by OECD: Potential and Limits of the Definition*

The second issue concerns the definition of *Functional Urban Area (FUA)*,<sup>4</sup> proposed by the OECD in 2011–2013. This concept is very important to outline a systemic vision of the Medium-sized cities, and meaningful for the governance models [9]. The FUA area is defined by the attractiveness of the city center on the peripheries, and it may define the bigness of the city for urban governance. Scientific literature considers today the administrative limits of any urban agglomeration, less and less representative of the city and the citizen's needs. OECD investigates the functional relationships between the more attractive center, and the peripheries and small centers around. The dossier outlines two reference perimeters: the attractive heart of the system, called *Core area*, surrounded by a wide area of functional influence, called *Commuting zone*, which establishes a boundary for the daily migration. These two perimeters make up the *FUA*.<sup>5</sup>

The OECD dossier distinguishes the FUA in cities of different sizes, and defines medium cities with a FUA population of between 100,000 and 250,000 inhabitants. Here, the wide or small attractiveness of the center on the boundaries, can mark a difference between population living in the Core area, and people moving every day, at certain times, from their municipality, towards the most attractive city. The scientific criterion applied by OECD is based on the workers' flows, and it includes all those municipalities, near the Core area, where at least 15% of the population is working in the chief town. The report and the open data made available by OECD, are very important for studying the Medium-sized cities. For instance, we may verify that the mobility flows between the center and the periphery, may create some critical issues concerning infrastructure conditions, services availability and pollution levels.

The model proposed by OECD has some structural limits that make it only partially applicable. First of all, in order to have homogeneous data, it standardizes the process, using only data available for all the examined cities. As well, the minimum unit for the analysis is the municipality. An aspect affecting the real definition of Core area for Medium-sized cities, where population density is often higher in the historic center than in the first expansion zones, characterized by a high dispersion index and sometimes by small settlements and rural areas too.

The second problem reflects the differences between residents and inhabitants of the Core area. The FUA Commuting zone, just analyzes commuter's flows, but there are many other flows moving daily from the periphery to the center. For instance, commuters moving for educational services (high schools and universities), health services (hospitals and diagnostic centers), culture and sports (sport facilities, theaters, cinemas, museums, libraries). We also have flows of visitors and tourists, which can affect the urban population, especially concurrently with some

<sup>4</sup>Definition of Functional Urban Areas (FUA) by OECD. Internet open database: [www.oecd.org/cfe/regional-policy/functionalurbanareasbycountry.htm](http://www.oecd.org/cfe/regional-policy/functionalurbanareasbycountry.htm), last accessed 20 February 2020.

<sup>5</sup>OECD provides a database of georeferenced vector maps, connected with an open data protocol, which allows the upload of the Core area and the Commuting zone.



topic events: temporary exhibitions, fairs and trade shows, or special awards like in Parma, Italian Cultural Capital. For these reasons, inhabitants referred by the FUA dossier, may represents a conservative estimate, compared to the real people who daily live the city.

### **3 The Italian Medium-Sized City of Parma: A Smart Development After the Cultural Capital 2020–2021?**

The research takes into account Parma as a good Italian case study. Parma is nowadays interesting, because of its cultural and urban regeneration process, enhanced by the role of Italian Capital for Culture in the year 2020, extended to 2021 after the Covid-19 pandemic. The application research aims at developing the basis for an urban strategy project for this city after the year 2020, analyzing its characteristics and renewed identity and outlining an urban interpretation tool studied for Parma, but replicable in other Medium-sized urban conditions.

#### ***3.1 Research Methodology and Case-History***

The methodological approach was conducted as follows. First it deepened the city of Parma as a morphological and functional organism. Then it focused on the people's need: both resident population and inhabitants of the FUA area. The first results highlighted some structural problems, with strong analogies to the main topics that emerged in other medium-sized cities from the scientific literature. This report reveals three major problems: the unsustainability of private mobility (both connected to traffic and infrastructure congestion, and to the vehicle pressure on the urban center); the low air quality level and the pollution (Pm10 levels connected with many related health diseases); the serious issue of land consumption. The main cause for the inefficiency of some Smart strategies concerns the difficulty of planning at a landscape scale beyond the municipality borders, involving both the Core Area and the Commuting zone in the strategic choices.

Beginning from a scientific literature review and the analysis of the rankings proposed by the website [www.smart.cities.eu](http://www.smart.cities.eu), the research selected 10 medium-sized cities, characterized by analogies with Parma, for performing a scientific analysis and comparison of Smart visions, models and good practices. Of course, the morphological and cultural conditions of the 10 cities, all in northern Europe, are very different from the Parma situation. The aim of the selection is to highlight the Smart models applied and, above all, to deepen the strategic governance process for choosing the most suitable Smart specialization strategy for each city.

Finally, the compared results of the 10 cities analyzed became a grid for an optimal interpretation of Parma Medium-sized city, with its values and criticalities. The aim

is not to replicate virtuous Smart projects in a very different context, but to create a model of urban reading, capable of enabling the rulers and choosing the best way for a good Smart governance process.

### ***3.2 The Medium-Sized City of Parma and the Morphological-Functional Basin***

One purpose of the research is to identify the best wider area for extending the Smart city strategies.

Other purposes include facing the territorial challenges with favorable impact on the city and landscape, respecting the short timeframe required by Smart strategies without contrasting with the environment's medium and long reply time. The proposed tool, takes into account the city as a system, consisting of a center and a complex area around. It aims at specifying the concept of Functional urban area proposed by OECD, widening the criteria. The purpose is to shift from the concept of Functional area to the concept of Morphological-Functional basin, matching, in a systemic perspective: attractiveness, accessibility, city vocations, potential, as well as critical issues and environmental risks. The tool can also be used for defining the performance indicators, checking the effectiveness of Smart strategies for the life quality in Medium-sized cities, and planning verification steps on the short, medium and long term. This interpretation key may enhance the impact of urban planning strategies, supporting governance, helping the identification of a Smart specializations and driving the best practices for increasing urban Resilience.

As we may see in Fig. 2, Parma is a Medium-sized city: it has an urban area of 208.8 sq. km and about 195,000 residents. The former Province (dotted line) is 3449 sq. km and the overall resident population stands at 447800 units [7]. Data available from the OECD definition of FUA, verify that, in addition to the 195 thousand residents in the Core area of Parma municipality (dark gray), there is a Commuting zone (light gray) to better analyze from a morphological and cultural point of view. The Functional urban area of Parma defines an attractive zone, more realistic than the extension of the old province. It is limited to the south by the morphological boundaries of the Apennines, breaking on the Cisa Pass, while to the north, the river Po [14] is a natural border. Along the via Emilia, an axis with the main infrastructures of highway and railway, the FUA could hypothetically expand its boundaries, instead it is contained from the attractiveness of the Fidenza city to the west, and from the city of Reggio Emilia to the east, confirming the role of the via Emilia as a polycentric corridor, where the quick pace of many cities, limits the expansion possibility for each of them. According with OECD, the Parma Core area coincides with the Municipality extension and the Commuting zone includes 18 municipalities with a very low population density (as reported in Fig. 2): 17 are part of the former Province of Parma, and one, Brescello, belongs to Reggio Emilia, marking a gap within the cultural and administrative continuity. People who daily



The research proposes a redefinition of the FUA borders, based on the real perimeter of the Core Area, which can be reduced by the whole municipality to the historic center and the first suburbs. In fact, zones furthest from the historic center, are characterized by small villages and rural areas. At the same time, people living in the belt municipalities, are attracted by the Core area, for work and other purposes like education, health, culture, sports services. It is necessary to identify the Morphological-Functional basin and the real flows, for checking landscape criticalities such as, traffic, air quality and land use, detecting the overlap between Functional area and Geomorphological boundary, aiming at managing some criticalities at a higher level than the municipality governance. As we may see in Fig. 2, the land use, could appear for instance as a less complex problem if managed at the FUA level. While the Core area has been pursuing the zero-consumption target for some years, some municipalities of the belt have pursued a hard land use policies. This new perimeter must be used to overcome punctual intervention and plan in a systemic view, for a better risk mitigation.

### 3.3 Case History: Mapping Medium-Sized Smart Cities in the EU

Aiming at creating a systemic approach for Medium-sized Smart cities, the research developed a case-history. The analysis is held by the AMR Research Lab,<sup>6</sup> with the Project Works by the students in *Architectural design for the Smart City*,<sup>7</sup> Parma University. Each smart model is studied on the basis of its ability to face the main urban problems and challenges, its capability in creating quality and competitiveness, the expected results, and the impact found. All the data should have been represented as georeferenced maps, enriched with graphics and tables, to communicate directly and effectively the results. The Project Works involved 10 European Medium-sized cities, chosen as representatives of good Smart policies and practices. Each model can lead the city to a different Smart strategy, when dropped in contexts with different vocations, cultural identities, morphological structure, economic resources, and ability to attract financial and human capital. The scientific criteria for selecting the 10 Medium-sized cities are:

1. Cities with a FUA population in the same slot of Parma.
2. Cities in the first 30 positions in the ranking by Giffinger [12] which maintained good positions in the following checks (2013–2014).
3. Cities with a University strictly connected with the landscape activities.

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<sup>6</sup>The Research lab AMR—Architettura Musei Reti is, since 2005, an observatory on the dynamics of territorial development. It also gives third mission activities of scientific support to private companies and public administrations. Coordinated by Aldo De Poli and Monica Bruzzone, from the University of Parma, Department of Engineering and Architecture—Architecture Unit.

<sup>7</sup>Course of *Architectural design for the Smart City*, year 2018–2019; teacher: Monica Bruzzone; contributors: Michela Montenero, Matteo Casanovi, Simone De Lisi, Ilaria Russo.

**Table 2** The 10 cities selected for the benchmark

Table	City	KMQ Municipality	KMQ province	Municipality Population	Province Population	FUA Population	Ranking 2007 position
Italia	Parma	260,80	3.449	197.132	447.779	330.000	N.D.
Denmark	Aarhus	91,00	6.846	336.411	865.830	490.000	2
France	Nancy	15,00	5.246	108.000	734.403	480.000	23
France	Clermont Ferrand	42,67	7.970	144.817	649.819	480000	26
Finland	Tampere	523,40	687,9	226.696	477.000	440.000	9
Austria	Graz	127,48	1213,68*	286.292	439.236*	420.000	16
France	Angers	42,70	7.106,64	151.229	810.934	410.000	11
Nederlands	Enschede	142,75	3.420,74	158.969	1.156.886	400.000	29
Germany	Göttingen	116,89	1.753,41	119.529	328.036	370.000	24
Austria	Salzburg	65,64	1070,64*	153.377	304633*	350.000	3
Nederlands	Nijmegen	57,60	5.136,31	176.508	2.072.328	320.000	22

#### 4. Cities (or Regions) with a Smart specialization strategy.

The selected cities main data are resumed, in Table 2.

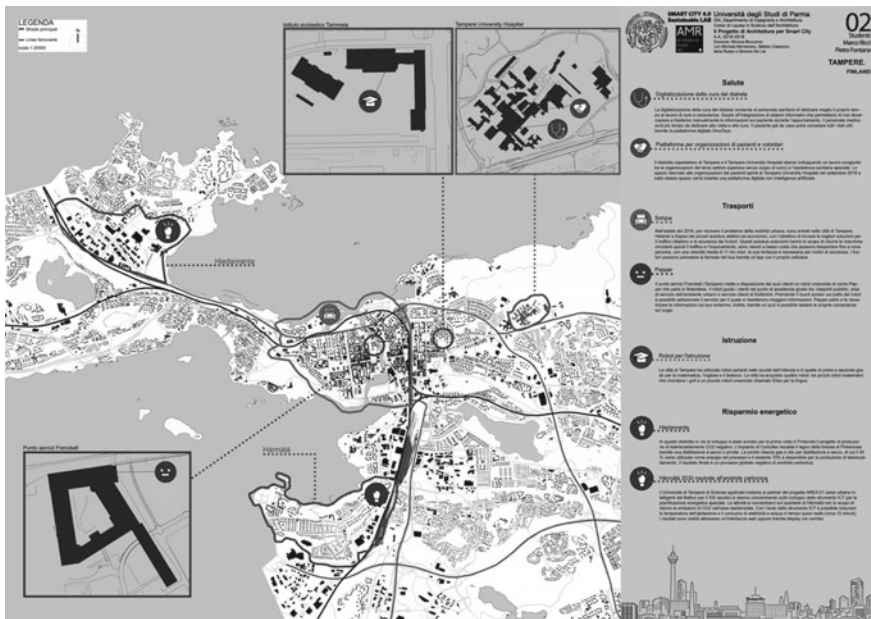
Each group of students,<sup>8</sup> analyzes a city. Every city is equipped with an open dataset, a digital plan, the vector file of the Core area and the Commuting zone boundaries, and also with a first bibliography and sitography. Every group needs to integrate this data with a profound research, to obtain the tools for enhancing the analysis and answer, with a mapping representation, to the five questions grid, reported in Table 3:

The maps in Figs. 4, 5, 6 held by the groups of students, are graphic representations of the Smart strategies applied in some Medium-sized European cities. Tampere, in Finland, part of a regional Smart strategy based on the Helsinki centrality, is specialized in the Smart people aspect, involving citizens in a digitalization process mainly focused on social issues. In Aarhus, Denmark and in Göttingen, Germany we have a Smart vision based on mobility, with different solutions. Aarhus focuses on multimodality, and the creation of zero-carbon central areas, while in Göttingen prevails the theme of Digital mobility and the Smart communities with a deep people involvement. The maps allow a morphologic visualization of the smartness level in each Medium-sized city, identifying projects and connections between the Core and the Commuting areas. The geo-referencing of physical and immaterial data, is

<sup>8</sup>Students engaged in the Project works (with city): Martina Bacchi (Enschede), Andrea De Padova (Aarhus), Stefano Gobbi (Göttingen), Davide Mansanti (Graz), Sara Leber Luis (Nancy), Lucia Vidal Iglesias (Angers), Silvia Herrera Ojeda (Clermont Ferrand), Alessandro Castronovo (Nijmegen), Pietro Fontana and Marco Ricci (Tampere), Nazariy Sydiy and Alberto Brozzi (Salzburg).

**Table 3** The 5 questions grid for the analysis

Smart vision vs smart projects (what model for the city)?
City vs Area. Are the smart strategies applied to the city, to the province, or the region?
Specialization. Has the city a smart specialization strategy? (e.g. Green, digital,) and what are the main planning directions? (e.g. Mobility, Smart Grid, Smart Building, Energy efficiency, People, Social Inclusion ...)
New buildings vs urban regeneration. The policies about land consumption.
Citizenship. How important is the citizenship involvement? Do we have hints of bottom up projects?
Funding. What are the funding sources (public funding, private funding, public-private agreement)?

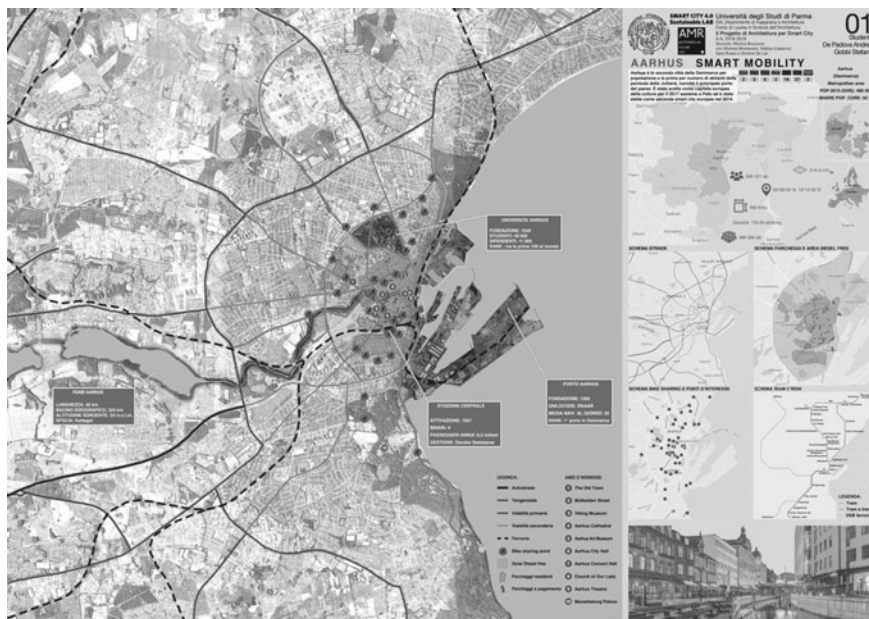


**Fig. 4** The city of Tampere, Finland. Project work by Marco Ricci and Pietro Fontana, University of Parma. Smart specialization strategy: People

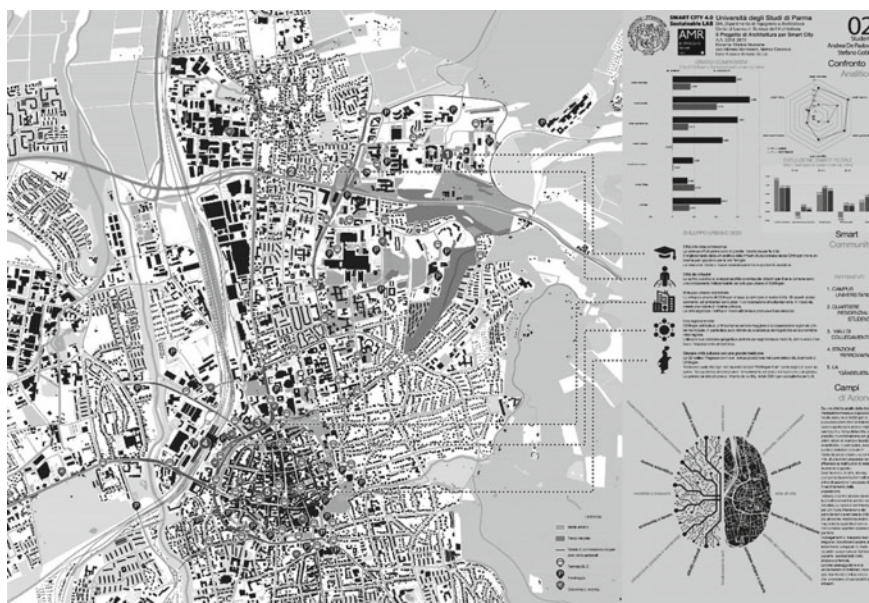
represented with graphics and diagrams, and aims at specifying the purposes of the Smart strategy; testing the coherence between the urban development strategy, and highlighting the impacts. The comparison is summarized in Table 4.

In the best performing cities, Smart visions coordinated by governance are applied both to the city and to a larger area. In the cities that do not take off, the spot creation of smart pilot projects with good quality is prevalent, but which hardly keep the growth constant over time. All the Smart city strategies with a better impact, have a focus on issues related to the pillars proposed by the EU (People, Environment, Mobility,





**Fig. 5** The city of Aarhus, Denmark, Project work by Andrea De Padova and Stefano Gobbi, University of Parma. Smart specialization strategy: Mobility (Comparison with Gottingen)



**Fig. 6** The city of Gottingen, Germany, Project work by Andrea De Padova and Stefano Gobbi, University of Parma. Smart specialization strategy: Mobility and digital community (comparison with Aarhus)

**Table 4** A comparison between the 10 European cities analyzed by the project works. The sign + or – specify the continuity or not of the Smart strategy. (\*) Enschede is a city in decrease since 2007 to 2014, today the smart growth seems to have a stop

Smart city	Vision vs projects	City vs area	Land use vs regene ration	Active citizenship	Fundings
Parma	_____	_____	_____	_____	_____
Aarhus (+)	Vision: Smart Mobility	Area: intermodal mobility projects	Regeneration	High involvement top-down (Smart people—communities)	Public funding (scientific supports by University and research centers)
Nancy	Vision: Digital city	Area: digital connections with green policies of Commuting zone	Regeneration	High Digital involvement top-down; Smart communities	_____
Clermont Ferrand	Projects: Energy efficiency, green	City (with projects extended to the Area)	Regeneration	Medium involvement (information, communication)	Public funding (mainly by municipality)
Tampere (+)	Vision: Smart people Smart health & wellbeing	Region and Area (Smart neighborhood specializations)	Regeneration	High involvement top-down (Communities for healthcare)	Mixed: Public-Private funding (agreements)
Graz (–)	Projects: (Mobility, tradition—innovation)	City (mainly)	Regeneration	Light involvement of citizens	_____
Angers	Projects: Innovation for Cultural and natural Heritage	Area	Regeneration	Light involvement of citizens	_____
Enschede (*) (–)	Projects: Mobility Smart environment	City: Mobility and inclusion. Environment green tours	_____	Light involvement (top-down, inclusion)	Private funding (after a pilot phase driven by the public)

(continued)



**Table 4** (continued)

Smart city	Vision vs projects	City vs area	Land use vs regene ration	Active citizenship	Fundings
Göttingen (+)	Vision: Smart people	Area (Connections University historic centers)	Regeneration	High involvement top-down cultural goals—soft localization	Mixed: European and National public funding; private investors
Salzburg	Projects: Smart energy; Smart buildings & neighborhoods	Area (Connection with FUA districts—river green axis).	Land use & Regeneration	Light citizens involvement	Mixed: Private investors and public funding; Partnership
Nijmegen (+)	Vision: Green city (mobility, junks, green spaces, energy)	Area Commuting zone	Regeneration	High involvement top-down (University people—recycle)	Mixed: Private investors and public funding; Partnership

Digital, Energy). It may be considered as a testimony of the rewarding role of the EU funding policy, particularly in the first approach to the smart development (where public financing is a necessity for every city). As well, there is a strong prevalence in projects of regeneration policies than in the land use and soil consumption. The Medium-sized cities with the higher level of smart growth, always adopted a mixed model of public funding supported by private investors (stakeholders and companies interested in enhancing competitiveness of the city), and almost all of them improve the model by involving people in the communication of the strategy and the performances. The more virtuous cities also demonstrate a good level of integration between two smart identities: on one hand we always have mobility as a support for city accessibility and traffic reduction, and on the other hand, we may appreciate the development of a specific smart vocation in different fields. The regional projects of Smart policies are very few and limited to specific conditions, with a low density of people and towns. In the research, the virtuous case study of Finland is an excellent model of a regional Smart strategy, but also an exception.

The citizens involvement is quite an effective tool for sharing and increasing the awareness of the Smart policies. However, in the best projects, the citizens' role does not arise from *bottom-up* strategies, but is foreseen in the Smart strategy, and coordinated by urban policies.

From this case history, an abacus of policies and good practices to be replicated did not emerge, rather, it determined that most of the Medium-sized cities have the common need to implement urban accessibility with smart models and requires each of them to then develop their own Smart vision based on of their specific identity and vocations.

#### **4 An Innovative Tool for Designers, Planners and Leaders of the Smart City**

The main research objective is to create an interpretation model for Medium-sized cities. It could be an interactive grid or dashboard, simple to use, update and implement, by mapping and georeferencing material and immaterial data about the city. This map will be addressed to designers, planners, leaders and managers engaged in the Smart city development process.

After deepening a European case history, the research comes back to Parma, with the aim of creating a tool to help stakeholders in reading effectively the city, defining the best area for the Smart strategies application, detecting analogies with other contexts and territorial uniqueness to be enhanced. The comparison between the definition of a good area for developing Smart strategies in Parma, and the case history of the European Medium-sized cities, leads to some considerations.

#### ***4.1 Switching from the FUA to the Morphological-Functional Basin Concept***

First of all, the research verified the effectiveness of a strategic vision that may define a Smart vocation for the city and its commuting zone, rather than the sum of individual projects, which rarely lead to continuity in urban development. If we compare the European case history with Parma, we understand how the creation of an intermodal mobility plan between the core area and the commuting zone could be important, as well as an optimal mobility solution for the connections between small villages and their rural areas: a support for any future Smart specialization strategy. Lastly, it is necessary to coordinate the governance of municipalities with a multilevel approach, aimed at encouraging strategic and transversal actions, more incisive and wide-ranging over the medium and long term. A key role is played by the attractiveness of public and private capitals.

From this research a first document emerges: a grid that can be considered a basis for the future dashboard planning. The grid, represented in Table 5, has two objectives. On the one hand, it aims at identifying the Morphological-Functional basin of Parma, that may specify the FUA boundaries with geographic and physical indicators, infrastructures and real people flows, daily attracted by the main center. On the other hand, it aims at mapping policies related to mobility, environment and digitalization, checking its effects, impacts and criticalities on the nowadays city. The grid includes material and immaterial data, to be referred to the real city, and particularly open data available from the public administration and research structures (of course deprived by personal data and augmented with the database of the city of origin).

The grid has got two main purposes: firstly, the identification of the morphological-functional basin where to extend the smart city policies in order to obtain the best results in raising life quality and competitiveness. Secondly the interaction between spatial and immaterial data that, thanks to the georeferencing protocols, can be literally linked to specific points in the city for enhancing the level of knowledge of the city itself. The grid reported in Table 5, summarize the results of this research.

#### ***4.2 Mapping the Social Media Feelings: A Quality Perception for #Parma2020?***

For testing, provocatively, the effectiveness of georeferencing intangible data, a very virtual theme was chosen: mapping the empathy between people and the historic center of Parma through the social hashtag# Parma2020. It's a big data analysis, aiming at matching expectations and needs of citizens and visitors, as digital traces left on the social media, for creating a kind of digital city memory [4]. The social media language is used for testing connections between places and people's feelings towards the perceived quality of the historic center. Using the example of the social

**Table 5** The research grid base of the dashboard

Functional urban area re-definition People policies and land use		
1. People flows	Work	Checking people working in the Core and living in the Commuting zone (OECD's FUA Database)
	Health services	Lists of admissions (patients and day hospital) linked with the city of origin
	High schools & Universities	Lists of inscriptions linked to the city of origin
	Cultural services	Ticketing of museums, exhibitions, libraries, theaters, cinemas, linked with the city of origin
	Sport services	Selection of the main sport facilities (sports fields, gyms, swimming pools), users with city of origin
	Temporary events	Trade fairs and salons, local fairs, data per month, from on-line ticketing, linked with the city of origin
	Visitors and tourists	Checking tools: hotel arrivals and presences (Open Data Emilia Romagna Region); origins of the cultural services users; Social media activity links between origin of the users, and GPS big data
2. Mobility policies	Railway traffic	Traffic of people of the Railway Stations (Open data Trenitalia and MIT) <sup>a</sup>
	Bus Traffic	Bus frequency and users (both for urban and suburban lines) (TEP dataset)
	Highway exits	Incoming and outgoing traffic at the main booths.
	Parking—parking lot	Parking lot fee, interchange Parking (Municipality dataset)
	Slow mobility and green mobility	Car-sharing and bike-sharing dataset
3. Green policies	Pm10 Value Alert	Monitoring how many alert-days per year: data per month and Phenomenon repetition (Ispra dataset)

(continued)

**Table 5** (continued)

Functional urban area re-definition People policies and land use		
	Parma, Taro Enza and Po flood events	Monitoring how many alert-days per year: data per month and Phenomenon repetition Ispra AIPO Municipality, Protezione civile dataset.
	Landslide	Monitoring number, dimension and position of the landslide (data per year and per month) Ispra—Protezione Civile dataset
	Land consumption	Cubic meters of new buildings per year/per municipality (Ispra dataset)
4. Digital policies	Digital infrastructures in the cities and the rural areas	Digitalization of rural areas Telephone company dataset; free wifi, social media actions
	Digital service—online desks	Monitoring the number of people using online desks linked to the origin city (dataset Health services - Municipality of Parma)
5. Smart building	New Buildings and regeneration goals	Tax relief database for energy efficiency, and home automation service implementation (dataset Agenzia delle Entrate)

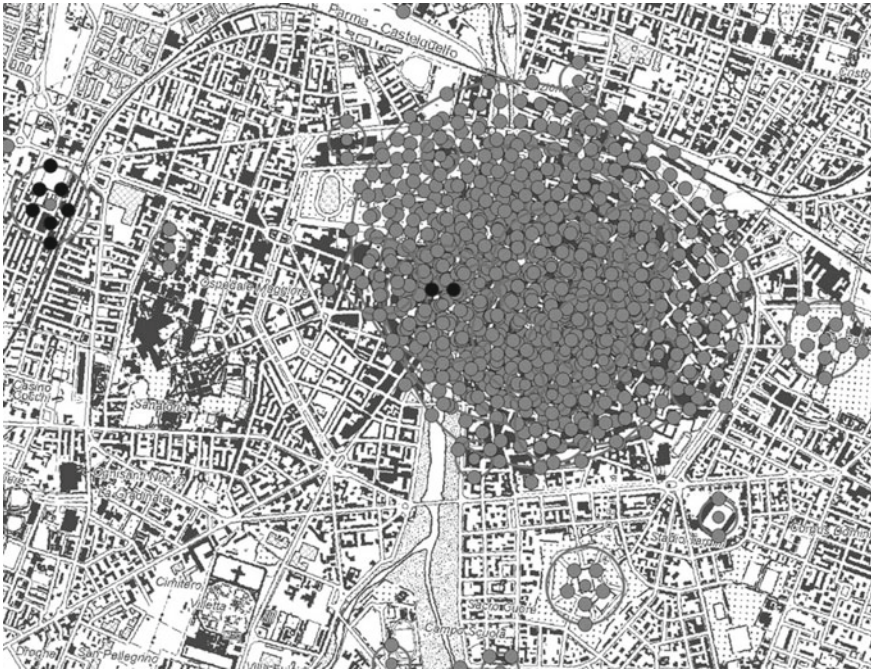
Definition from UNESCO: Cultural and Creative Industry

<sup>a</sup>Trenitalia ([www.sciamlab.com/opendatahub/it/dataset/fs\\_o-s-trenitalia](http://www.sciamlab.com/opendatahub/it/dataset/fs_o-s-trenitalia)); MIT Ministero delle Infrastrutture e Trasporti dataset (<http://dati.mit.gov.it/catalog/dataset>). Last accessed 20 February 2020

media platform Instagram, people use to publish an image, as a representation of a specific feeling in the personal social profile. The photo is often connected with a message underlined by a #hashtag, expressing empathy, pleasure, happiness, rather than disapproval or hate. The test aims at giving GIS coordinates to these feelings, creating a map representing the people engagement within the city.<sup>9</sup> The research collected all the images posted on the social network Instagram, about the historic center of Parma, from the 1st to the 31st of January 2020. Each image has to be connected with the tag #Parma2020, localized with GPS coordinates, and scheduled to report a positive or negative opinion (Fig. 7).

The results led both to investigate the places considered “to remember” in the historic center, and to understand the overall quality perception of each of them.

<sup>9</sup>This research is held by the architects Matteo Casanovi and Simone De Lisi, from the AMR Research lab. Researcher analyzed open big data of the social media Instagram, tagged with the official hashtag # **Parma2020**, selecting the images posted by people, on the historic center of Parma. Every picture has a GIS reference, a connection to the #Parma2020. The research also excluded all the inappropriate or promotional images.



**Fig. 7** A GIS elaboration of big data. Instagram images of the city with the #Parma2020 (Source AMR Research Lab)

The first results brought an interesting finding. There are many places, in the historic center of Parma where we have a strong digital memory, or a digital density composed by big data and virtual traces left by people, generally reporting a positive feeling. The deepest aim of this test, however, is not to give answers, but to create a provocation. What about the digital memory of a place? Is there a scientific criterion for analyzing the quality perception from immaterial dataset as well as social media? What conclusions can be drawn from mapping and geo-referencing big data and social shares? Even this research may become a useful tool, if it is considered a part of a wider interactive grid, able at mapping material and immaterial data, and giving a route for designers, planners and leaders of Smart strategy, interpreting the general models of Medium-sized cities on the basis of a specific and contemporary urban identity (Fig. 8).



**Fig. 8** A detail of the big data collected on the Instagram post about #Parma2020 (Source AMR Research Lab)

## 5 Open Topic and Conclusions. Notes About a Tool for a Smart Development After #Parma2020

The research results about Smart strategies on Medium-sized cities, provide a good basis point for a future innovative model aiming at querying the city and collecting material and immaterial data based on dataset grid, linked point by point to the real city. This model, thanks to an interactive geo-reference map, may give an augmented knowledge of the city.

After a comprehensive definition of Medium-sized Smart cities, in accordance with a European vision, the research highlighted the most important problems affecting cities of medium dimensions, and verified their presence in the case study of Parma. Main problems are traffic and mobility, land consumption and pollution, especially related to the air quality control. Then the research created a benchmark of 10 Medium sized cities in Europe, characterized by analogies and differences with the case study of Parma [7]. This further research has allowed some conclusions about the development of effective Smart models for Medium-sized cities with particular reference to the European context. The study noticed that cities with higher development, adopted a Smart vision (rather than a collection of individual Smart projects), based on two elements: a systemic approach to the mobility problem, faced both with effective public transport projects and a widespread strengthening of the digital infrastructures; and a Smart specialization strategy that takes into consideration vocations and characteristics of that specific city, enhancing its potential, without forgetting its identity. The research also verified that the main obstacle to the



Smart strategy implementation for Medium-sized cities concerns the administrative fragmentation which gives a stop to all the strategic decisions capable of involving a larger area, and therefore adequate to tackle smartness not as a punctual phenomenon but with a systemic perspective.

Then the research focused again on Parma, analyzing the landscape and the open data related to the city, with the aim of proposing a grid for the creation of a dataset, composed by material and virtual data, useful for defining the best area where a Smart city process can be more effective, and for distinguishing it from many points of view. This area may define a kind of Morphological-Functional basin: it takes into consideration both the territory as a physical and morphological question, and the Parma area of influence: an attractive center for city commuters and users.

The future research aims at deepening this grid, creating a dashboard simulation, with interactive maps based on open data and administrative dataset. This dashboard, from the city of Parma, may be extended to other Medium-sized cities, with the aim of creating a replicable device for reading the urban phenomenon, helping managers and planners of the Smart city, to both face new challenges, and to choose the best Specialization strategies for a smartness process extended from the city to a wider landscape.

## References

1. Balsas, C. (2000). City center revitalization in Portugal: Lessons from two medium size cities. *Cities*, 17, 19–31. [https://doi.org/10.1016/S0264-2751\(99\)00049-9](https://doi.org/10.1016/S0264-2751(99)00049-9).
2. Berardi, U. (2013). Sustainability assessment of urban communities through rating systems. *Environment, Development and Sustainability: A Multidisciplinary Approach to the Theory and Practice of Sustainable Development*, 15(6), 1573–1591.
3. Bruzzone M. (2018) Costruire utopie urbane. Città perfette di nuova fondazione. In *Area, Rivista di Architettura e arti del progetto* (pp. 84–85). New Business Media, Milan, n. 157+.
4. Bruzzone M. (2014). Time, memory, architecture and public spaces for the contemporary city. *Eurau 2014, Composite cities, European symposium on research in architecture and urban design, technisches Universitat, Istanbul*.
5. Bruzzone M., & Dameri R. P. (2018). *Smart City. Pianificazione e sviluppo economico territoriale*, AMR—DIA.
6. Ciapetti L. (2015). Centro nazionale di studi per le politiche urbane Urban@it.
7. Comune di Parma stats. (on line jan 2020). [www.comune.parma.it/comune/Dati-statistici.aspx](http://www.comune.parma.it/comune/Dati-statistici.aspx).
8. Dameri, R. P., & Rosenthal-Sabroux, C. (Eds.). (2014). *Smart city: How to create public and economic value with high technology in Urban Space*. Springer International Publishing (on line January 2020). <https://doi.org/10.1007/978-3-319-06160-3>.
9. Dijkstra, L., Poelman, H., & Veneri, P. (2019). *The EU-OECD definition of a functional urban area*. In OECD Regional Development Working Papers (2019/11; OECD Regional Development Working Papers). OECD Publishing. <https://ideas.repec.org/p/oec/govaab/2019-11-en.html> (on line January 2020).
10. Doloi, H., & Donovan, S. (2019, October 31). *Affordable housing for Smart villages*. CRC Press (on line January 2020) <https://www.routledge.com/Affordable-Housing-for-Smart-Villages-1st-Edition/Doloi-Donovan/p/book/9780367190781>.
11. Gambi L. (1972). I valori storici dei quadri ambientali. In *Storia d'Italia Einaudi*. Vol I. I Caratteri Originali, Einaudi, Torino.



12. Giffinger, R., Fertner, C., Kramar, H., & Meijers, E. (2007). *City-ranking of European medium-sized cities*. Centre of regional science, 1–12.
13. Koolhaas, R., & Mau, B. (1995). *S, M, L, XL: \*Small, medium, large, extra-large*. Monacelli Press.
14. Masotti, L. (2019). La ricerca geocartografica per la gestione di territori esposti a rischio: riflessioni e percorsi. In *Acque di terraferma, il Padovano*. Marsilio.
15. Pilidis, G., Karakitsios, S., & Kassomenos, P. (2005). BTX measurements in a medium-sized European city. *Atmospheric Environment*, 39 (33).
16. Ratti C., & Claudel M. (2013). *Le smart cities di domani*. Aspenia, n. 63.
17. Rosenzweig, C., Solecki, W. D., Romero-Lankao, P., Mehrotra, S., Dhakal, S., & Ibrahim, S. A. (2018). Climate change and cities: Second assessment report of the urban climate change research network (pp. 703–704). Cambridge University Press.
18. Salgaro, S. (2018). *Il paesaggio agrario tra obsolescenza e degrado*. Patron, Bologna: Riflessioni e materiali per il recupero e la valorizzazione.
19. Stathakis, D., & Tsilimigkas, G. (2015). Measuring the compactness of European medium-sized cities by spatial metrics based on fused data sets. *International Journal of Image and Data Fusion*, 6(1), 42–64. (on line January 2020). <https://doi.org/10.1080/19479832.2014.941018>.
20. United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. United Nations (on line January 2020). [https://www.un.org/ga/search/view\\_doc.asp?symbol=A/RES/70/1&Lang=E](https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).
21. Visvizi, A., & Lytras, M. D. (2020). Sustainable smart cities and smart villages research: Rethinking security, safety, well-being, and happiness. *Sustainability*, 12(1), 215 (on line January 2020). <https://doi.org/10.3390/su12010215>.
22. Visvizi, A., Lytras, M. D., & Mudri, G. (2019). *Smart villages in the EU and beyond*. Emerald Publishing Limited (on line January 2020). <https://books.emeraldinsight.com/page/detail/Smart-Villages-in-the-EU-and-Beyond/?k=9781787698468>.
23. Zavrtnik, V., Kos, A., & Stojmenova, E. (2018). Smart villages: Comprehensive review of initiatives and practices. *Sustainability*, 10, 2559, 411–424 (on line January 2020). <https://doi.org/10.3390/su10072559>.