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The mobility for the elderly population encompasses different dimensions of urban life including housing, transportation, work-related activities and social interactions. The initiatives for the elderly are mainly undertaken in the areas of health while in reality, this is only a part of the overall picture that might be considered while planning urban accessibility strategies.

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Elderly Mobility

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SMART MOBILITY AND ELDERLY PEOPLE

CAN ICT MAKE THE CITY MORE ACCESSIBLE FOR EVERYBODY?

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ABSTRACT

The ageing population is a phenomenon whose relevance grows over time and quickly spreads in different territorial contexts. Therefore, cities will have to take into account the ageing population and define policies and strategies to improve the quality of life. For this purpose is particularly remarkable the transport sector because it allows to use the urban services and to promote an active ageing. Within the field of urban studies aimed at facing the new challenges related to social developments, including that of the ageing population, the Smart City paradigm has been spread to make cities safe, accessible and sustainable. The strategies to improve accessibility and safety of the mobility system using ICTs can have positive impacts in terms of ensuring elderly people the ability to lead an autonomous life and participate actively in society according to one's individual needs. In this framework, the aim of the paper is to analyse how Italian cities are declining the topic of Smart Mobility, with particular attention to the use of new technologies to improve the elderly trips. The paper attempt to show that in the sample of Italian cities analysed the ICTs applied to the transport sector do not fully realize their potential; this is not due to the limited fields of application, but rather to the lack of a "system-orientated" perspective when applying innovations. The adoption of a smart approach cannot be limited to a market-induced uncritical introduction of devices or sensors, instead, it will be necessary to refine the tools for understanding the needs of specific categories of users, such as the elderly, to define integrated strategies able to operate on many aspects simultaneously.

KEYWORDS
Elderly; Smart Mobility; Italian Cities

1 INTRODUCTION

The ageing population is a phenomenon whose relevance grows over time and quickly spreads in different territorial contexts (UN, 2001; Christensen et al., 2009). At the beginning of 2016, in Europe, the percentage of population aged 65 or over was 19% with an increase of 2.4% compared to 10 years before (Eurostat, 2016). TFPAhis trend is common to all EU countries and the percentage of elderly is predicted to grow up to 30% by 2080. The increase in the percentage of elderly people can also be observed in Italy: in 2016 the elderly were 22% of the population and the old age index (ratio of the 65-year-old population or over to the 0-14 age group) was 161. This index, according to ISTAT, is expected to raise to 215 in 20 years (ISTAT, 2017).

Therefore, cities will have to take into account the ageing population and define policies and strategies to improve the quality of life for this specific category of users.

According to the World Health Organization (WHO, 2007) the strategic topics to make an age-friendly city are eight: housing, outdoor spaces and building, transportation, social participation, respect and social inclusion, civic participation and employment, communication and information, community support and health services. Among these, the transport sector is particularly remarkable because it allows to use the urban services, to interact with others and therefore to promote an active ageing, optimizing opportunities for health, participation, and security in order to enhance quality of life as people age (WHO, 2011).

Within the field of urban studies aimed at facing the new challenges related to social developments, including that of the ageing population, the Smart City paradigm has been spread to make cities safe, accessible, sustainable and, at the same time, more cohesive and inclusive (Papa et al., 2015; Papa et al., 2016). Thanks to the application of the Smart City paradigm, solutions have been defining to improve the performance, usability and environmental compatibility of urban services for all city users.

A central issue of this approach is the use of ICT to effectively address some environmental challenges (pollution and energy consumption reduction, etc.) by making urban settlements more sustainable. Furthermore, with the use of ICTs, "smart" solutions can improve not only the performance of urban services for citizens, firms and city users, but also the quality of life and the accessibility to infrastructures (Santinha & de Castro, 2010). All these aspects are included in the model of Smart City (Giffinger et al., 2007), consisting of six dimensions – Environment, Governance, Economy, People, Living and Mobility.

Among the above-mentioned dimensions, many cities are investing in Smart Mobility due to technological advances and the interest of large enterprises in the transport sector. Although there are several meanings and interpretations of the Smart Mobility concept, it can be defined as a network system mainly characterized by connections, both digital and physical, in order to satisfy people’s needs; use of appropriate technologies to enhance performance and attractiveness of the mobility system; sustainability to reduce the need of travel and consequently energy consumption and carbon emissions, according to previous studies on this issue (Lam & Head, 2012).

However, the application of ICTs in the Smart Mobility is a useful means both for transcending distance and optimizing traffic fluxes and, at the same time, for collecting citizens’ feedback about livability in cities and quality of public transport services (Lyons, 2016; Benevolo et al., 2016). However, if ICTs allow to improve transport efficiency and reduce its impact on the environment, an integrated combination of multiple aspects such as accessibility, safety and ICTs is necessary, in order to take into account the needs of its users, including the elderly ones (Joumard et al., 2010).

The strategies to improve accessibility and safety of the mobility system using ICTs can have positive impacts in terms of ensuring elderly people the ability to lead an autonomous life and participate actively in society according to one's individual needs.

In this framework, the aim of the paper is to analyse how Italian cities are declining the topic of Smart Mobility, with particular attention to the use of new technologies to improve the elderly trips. The study concerns Italian provincial capitals with a population of 100,000 or more inhabitants in 2017.

Through a critical approach and considering that ICT cannot be considered as a solution, the paper pursues three main aims: (i) exploring the actions that can be implemented to ensure better accessibility for the elderly in urban areas; (ii) identifying the actions that should be taken into account to improve the elderly accessibility, through the study of some European projects ICTs based; (iii) analyzing how Italian cities are declining the topic of Smart Mobility, with particular attention to the use of new technologies to improve the elderly trips.

The paper is divided into 4 parts: the first one, through a review of the literature, defines the three components of Smart Mobility for the elderly; the second part analyses the initiatives and the actions that can have positive impacts on the elderly mobility according to the three categories of Smart Mobility (accessibility, safety and ICT); the third one describes the Smart Mobility for the cities surveyed through a set of indicators (extension of the pedestrian areas and cycle paths, car sharing supply, public transport stops, electronic bus stop signs, etc.); the fourth highlights the critical issues to be tackled in order to implement a smart mobility for the elderly.

2 SMART MOBILITY: ACCESSIBILITY, SAFETY AND ICT

It is well known that since the 1990s a new interpretative model has been established for the study of the urban phenomena of the Smart City, which has seen a rapid and pervasive affirmation in recent years worldwide (Mahizhnan, 1999; Caves & Walshok, 1999; Graham & Marvin, 2001; Komninos, 2002).

Among the different features that according to many authors (Giffinger et al., 2007) contribute to the making of smart cities, a relevant role is assigned to mobility: a smart city is also an "accessible" city where – thanks to the use of ICT – solutions to improve the performance, efficiency and environmental compatibility of transport for all city users are adopted.

Similarly to the many heterogeneous definitions of Smart City (Albino et al., 2015; Batty et al., 2012; Caragliu et al., 2011; Mosannenzadeh & Vettorato, 2014; Papa et al., 2015), there are many different approaches and points of view on the subject of mobility that can be deduced from literature.

Many authors have recently highlighted the interrelation and overlap between the concepts of smart and sustainable mobility (Lyons, 2016; van Nunen et al., 2011; Noy & Givoni, 2018; Zawieska & Pieriegud, 2018), arguing that since transport is significantly responsible for the phenomena of environmental pollution an intelligent mobility is first and foremost a sustainable mobility. In this sense, the ICTs should be aimed primarily at minimizing the negative impacts of transport on the urban environment.

The role that ICTs play in the Smart City approach in general, and more in detail in the mobility sector, has been the subject of numerous investigations. For example, according to a research promoted by the European Community in 2014, technologies are essentially tools that can support the management of networks, improve services and enhance the level of information for the community (Manville et al., 2014).

However, several authors (Staricco, 2013; Benevolo et al., 2016; Papa & Lauwers, 2015; Battarra et al., 2018) emphasize the low effectiveness of an uncritical adoption of ICT to pursue a hypothetical improvement in the efficiency of mobility, to intervene (when necessary) with integrated actions that operate simultaneously on different aspects (networks, components, management, etc.).

Within the general framework briefly outlined, how does smart mobility specialize in serving the elderly?

As previously mentioned, in the case of "weak" users (elderly, disabled, children), difficulties or even impossibility to reach certain destinations or to move freely in the city may be grounds for isolation and social exclusion (Banister & Bowling, 2004; Engels & Liu, 2011; Titheridge et al., 2009).

In that respect, the first essential component that characterizes Smart Mobility for the elderly is accessibility, which can be defined as the "ability of places to be reached, in order to make elderly able to participate to city daily life, by preventing inequality in terms of spatial access" (Aguiar & Macário, 2017; Lättman et al., 2018; Solá et al., 2018).

In fact, accessibility is interpreted by many as a multidimensional concept that includes "a transport dimension (e.g. transport mode), a land use dimension (e.g. the built environment), a temporal dimension (e.g. travel times), and an individual dimension (the needs, abilities and opportunities of individuals)" (Geurs & Ritsema van Eck, 2001). For a long time accessibility was considered to be necessarily connected to the individual journeys by car, but in the case of the elderly in particular (whose motor and cognitive skills decrease over the years and thereby the risks related to travel, such as accidents, falls, etc., increase), accessibility must essentially be guaranteed by the Local Public Transport (LPT) and soft mobility (on foot or by bike, provided that their physical conditions allow them to). In this sense, then, Smart Mobility for the elderly increases the level of accessibility of the city through "safe" and even "sustainable" modes of movement. The presence of pedestrian areas, restricted traffic zones and cycle paths in the urban planning is therefore of crucial importance for the elderly to move safely. Thus, the other essential component of mobility for the elderly is safety, which can be defined as the capability not to restrict elderly's opportunities to move without endangering their own health and that of others.

Smart Mobility for the elderly cannot fail to take into account the need for interventions in cities, which might help them move around safely (such as the construction of pedestrian paths, equipped public transport stops, maintenance of sidewalks, pedestrian crossings with traffic light systems, urban furniture), but also the need for public transport management policies aimed at facilitating this mode of movement (from the distribution of stops to the training of on-board personnel) (Abou-Raya & ElMeguid, 2009; Tournier et al., 2016;).

In this context, the ICT applied to all the components of the transport system – from those relating to the infrastructure network (whether related to the transport of goods and people or information) to those more closely managerial – can facilitate the achievement of the objectives of accessibility, sustainability and safety mentioned above. In other words, far from an approach that assigns to communication and information technologies a decisive role in improving mobility, there is no doubt that devices, networks, sensors as well as the Intelligent Transportation System (ITS) applied to vehicles can improve the transport services and therefore support the mobility of the elderly too. It is not a matter of uncritically adopting a business like approach oriented to the interests of the market, but of verifying whether and under what conditions ICTs can contribute, together with other factors, to improving accessibility.

Beyond the various positions briefly referred to herein, it is clear that one of the challenges that cities will have to face is to become more accessible to everyone by promoting strategies and interventions aimed at improving the performance of the mobility system in terms of accessibility to services and urban spaces and increasing sustainability through the reduction of the negative impacts of the transport system.

3 SMART MOBILITY FOR THE ELDERLY: INITIATIVES AND MEASURES

In order to assess whether the introduction of ICT is contributing to making cities more accessible to all categories of users (including the weakest sections of the population, such as the elderly), we have analysed some experiences currently going on in Europe, setting aside the Intelligent Transportation Systems1 and focusing attention on less specialized projects for elderly users.

Within the framework of the strategies promoted by the European Commission aimed at innovating the transport system through the introduction of ICTs, there are numerous projects specifically addressed to the elderly.

One of the projects financed under the Horizon 2020 program is *City4Age - Elderly-friendly city services for active and healthy ageing* that promotes the use of the Internet of Things to create urban spaces where the elderly can move independently. The cross-referencing of data collected from various technologies (wearable and mobile devices, smartphones, sensors installed in the city and inside the elderly's homes) serves to detect and warn on alarming negative behavior changes. The trial launched in 2016 provides for tests on groups of elderly people resident in six pilot cities: Madrid, Athens, Montpellier, Singapore, Lecce and Birmingham.

Many projects involving the use of ICTs to increase autonomy and mobility of the elderly are included in the *Active and Assisted Living program (AAL) - ICT for ageing well*. The program aims at funding enterprises for the development of ICT-based products, systems and services that could effectively support the elderly in their daily lives. The philosophy behind the program is that applying technology-based solutions will enable elderly people to organise their lives by choosing where and how to live. Within the framework of the *AAL Program*, which concerns different aspects of the daily life of elderly people (health, housing, etc.), some projects on targeted mobility have been financed. They include *Com'on project*, developed by the Copenhagen Living Lab, with the objective to address the issues of orientation during the travels of the elderly by public transportation. The overall objective is to develop, test and implement a digital platform that provides services to support the elderly people to move around on their own with public transportation. The services provided should increase their trust and autonomy, by giving specific information on mobility and designing interfaces easily usable by the elderly, even by those not accustomed to the use of information technology.

Stimulate project envisages the use of advanced communication technologies to optimize travels of the elderly in order to carry out surveys on the neighbourhood scale. To this end, the Luxembourg institute that designed this project aims to provide support and advice in the planning of trips, optimize the choice of transport means and itineraries, receive personal assistance while travelling. For ease of use, all the services offered by the platform, which uses GIS technologies, will be accessible via web browsing, PC, tablet and mobile phones.

The NavMem system, developed in Oldeburg (Germany), is targeted at elderly people with mild cognitive impairments and focuses on assisting them during their travels in unfamiliar environments, such as in parts of the city located outside their neighborhoods. Through the ICTs it is possible to simulate a virtual navigation companion that provides spatial indications, such as direction and distance to the next intermediate goal (which could be a bus stop, for example), but also detailed instructions related to the

[1] For more detailed information on the points specified above, see: Yang & Coughlin, 2014; Guo et al., 2010.

landmarks. The system can also temporarily share the user's position so that direct assistance can be provided whenever needed.

Happy walker is an easily accessible and affordable platform facilitating a consistent, intuitive, personalised set of mobility enhancement services, e.g. outdoor monitoring and safety, self-management and life-style. Personalisation refers to both (current) characteristics of the user (profiling), e.g. physical condition, preferences, motivation, and (current) characteristics of the direct surroundings, e.g. living accommodation, neighbourhood, and further range of aims and actions of the user, e.g. visiting family, public transport, etc..

SIMON project - Assisted Mobility for Older and Impaired Users is a pilot project being tested in Madrid, Lisbon, Parma and Reading. Its purpose is to manage the incorporation of ICT solutions by providing services through a platform that helps identify public parking spots and access to restricted traffic zones by using the LPT (Fig. 1).

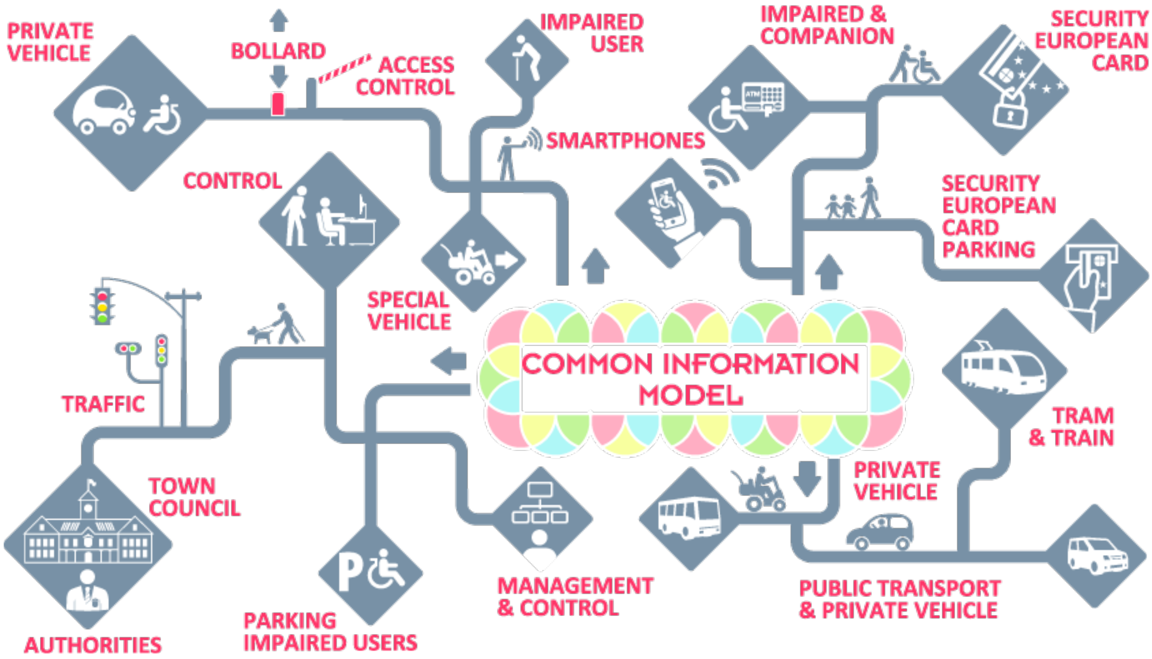


Fig. 1 The SIMON project diagram

Other projects promote innovative actions aimed at increasing the use of public transportation, rather than making extensive use of ICT, as in the case of the *Bus Buddying - Mobility Training to Become Independent Travellers project* – developed in Leeds – and the *GOAL project*. The first one provides that some volunteers support elderly and disabled people during their trips to gradually make them get used to the means of transport; the *GOAL project* (*Growing Older and staying mobile*) aims to deepen the knowledge on the travel needs of the elderly to better orientate public intervention strategies.

Another field of application of ICTs is that of the traffic light network aimed at making pedestrian crossings safer for the elderly. For example, *CrossWalk* app communicates automatically with the traffic light as soon as a pedestrian approaches the intersection. By giving a specific group green light for longer instead of all pedestrians, the car traffic doesn't get obstructed too much. The innovative technology makes it possible to align the duration of the green pedestrian traffic light with individual needs.

ICTs and GIS technologies have contributed to improving the performance of car sharing and paratransit systems, for example by optimizing the routes of the fleets, making available online booking and payment for the race, etc. (Fig. 2).

The framework briefly outlined provides information on several measures that are being implemented, which – when set alongside more traditional ones that do not necessarily require the use of ICTs – complete the framework of strategies aimed at improving the accessibility to urban spaces by elderly users (Tab. 1).

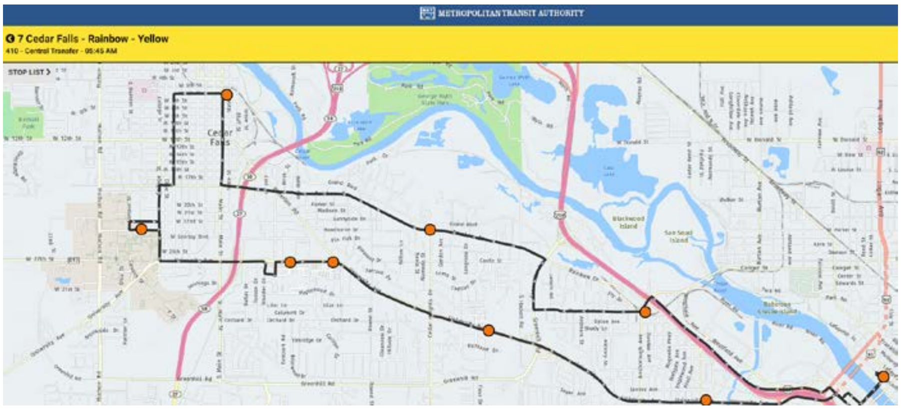


Fig. 2 Waterloo, Belgio, US, UK – Real Time Paratransit Map

The first two categories, namely "Improvement of public transport" and "Improvement of Public transport comfort", are specifically aimed at increasing accessibility through the use of LPT. To this end, it is necessary to operate not only on the best organisation of the network by preparing an adequate number of stops and locating them in relation to the presence of specific services for the elderly, but also increasing the comfort during travel and waiting times.

As regards the Smart Mobility component linked to Safety, actions are mainly directed to the optimal configuration of the traffic light network and to street lighting, while others are aimed at promoting soft and sharing mobility.

The last category collects high technological devices and products that should support the elderly in choosing the most suitable modes of transport and during their travels by providing information on waiting times, routes, intermodal exchanges, service interruptions, etc.

In conclusion, it is worth emphasizing that several enterprises developed products and services targeted to the elderly with the aid of technologies considering that the senior market segment will further expand in the next few years, but these products and services do not always result from a careful knowledge of this market segment and therefore are not suitable to meet the real mobility needs of the elderly.

Furthermore, cases of large-scale application are still rather rare, as these are often projects financed within European programs that have as one of the expected results the development of products/tools to be provided to local authorities, in the form of guidelines, prototypes, pilot projects; but how much of what is experienced in research environments is then transferred to practice? Such interventions are often not included within a coherent framework of strategies and probably they do not adhere to the real needs of a very heterogeneous target such as that of the elderly. ICT uncritically grafted into a backward context becomes a superstructure, a captivating but superfluous label.

CATEGORIES	ACTIONS
Improvement of Public Transport	Stops near activities of interest, high presence of stops, high frequency of the service, reduced fees
Improvement of Public Transport comfort	Presence of benches, platform roofs, low-floor buses, reserved seats, Video Surveillance Systems, communication and information campaigns
Improvement of road network	Road crossings signaled by traffic lights, sidewalks, speed bumps, street lighting, street lighting with variable green time
ITS for private transport	In-vehicle signing systems, special intelligent cruise control, systems that give information on the characteristics of complex traffic situations the driver is about to cross
Promotion of soft mobility	Cycle network, pedestrian zones, restricted traffic zones
Promotion of sharing mobility	Car and bike sharing, ridesharing, paratransit
Implementation of info-mobility services	Variable message signs, ticketing and travel planner, mobile apps

Tab. 1 Types of Smart Mobility measures for elderly

4 METHODOLOGY

ICT Innovations and the emerging Internet of Things (IoT) related to the creation of an open network of sensors can contribute to improve sustainability and efficiency of urban mobility. However, these technologies need to be integrated with mobility habits of people to guarantee their success (Battarra et al., 2018; Lee et al., 2018; Papa et al., 2016; Wilkowska et al., 2018). In particular, quality of life and well-being of senior citizens can be enhanced by these technological advances, supporting them through services, infrastructure and new forms of urban organisation that better respond to their requirements.
Against this background and in light of what described in the section above, the proposed methodology is aimed at evaluating if and how some Italian provincial capitals are improving the urban accessibility of elderly by applying the Smart Mobility approach. To reach this aim, the following four main steps have been developed: selection of city sample, selection of parameters and related data collection, standardization of parameters and construction of the ternary diagrams.

4.1 SELECTION OF URBAN CITY SAMPLE

As stated in the paragraphs above, the issue of accessibility for the elderly and measures for its improvement is closely linked to the physical and functional characteristics of the urban system (extension, population, density, clivometry, etc.) and of the transport system (infrastructural network, local public transport service).
The sample of the cities to be investigated was selected on that basis and taking into account that the objective of this contribution – as already mentioned – is to analyse whether and to what extent the ICTs applied to mobility could improve accessibility for the elderly. We chose medium-large sized cities because, as widely supported in literature (Banister, 2014; Manville et al., 2014; Komninos et al., 2014; Yigitcanlar & Bulu, 2016) and evidenced by existing experiences, they represent the most fertile ground for the testing of innovations, also because it is where the interests of private enterprises mainly focus. The sample of investigations is represented by the Italian cities having between 100,000 and 3 million inhabitants as of 2017. By using this size threshold, we selected 45 provincial capitals together accounting for 24% of the

Italian population (about 14 million people). Thus, it would appear that in a very small number of municipalities (0.5% of Italian municipalities) resides about one quarter of the Italian population. Therefore, this sample can be assumed as representative of the most Italian urbanized areas where numerous Smart Mobility initiatives have been promoting (Papa et al., 2016).

In relation to their demographic size, cities can be divided into 3 classes shown in Tab. 2, while Tab. 3 summarizes the main elderly demographic data.

CLASS	INHABITANTS	N° OF CITIES	CITIES
I class	from 580.000 to 2.900.000 inhabitants	6 cities	Rome, Milan, Naples, Palermo, Genoa
II class	from 150.000 to 400.000 inhabitants	21 cities	Bologna, Florence, Bari, Venice, Verona, Messina, Padova, Trieste, Taranto, Brescia, Prato, Reggio Calabria, Modena, Parma, Reggio Emilia, Perugia, Livorno, Ravenna, Cagliari, Foggia
III class	from 100.000 to 150.000 inhabitants	19 cities	Rimini, Salerno, Ferrara, Sassari, Monza, Siracusa, Latina, Pescara, Forlì, Bergamo, Trento, Vicenza, Terni, Bolzano, Novara, Ancona, Piacenza, Andria

Tab. 2 Sample of the cities partition

The six cities included in the first class are Rome, Milan, Naples, Turin, Palermo and Genoa, which alone collect over 50% of the population of the cities surveyed.

The elderly population (65 years old and over) is 23% of the overall population of the cities surveyed (about 3.3 million): this percentage differs little from the national average of 22%. Looking at the average percentage of elderly population in the three classes of cities, there are no significant differences, but if we look at each class in detail, significant differences emerge. In the first class, the average percentage goes from a minimum of 19% for the two cities of Southern Italy (Naples and Palermo) to the maximum percentage of Genoa that together with Trieste and Venice (II class) and Ferrara (III class) represent the cities that as of 2017 have the highest percentage of elderly people (over 28%).

Upon analysis of the cities included in the second class, the percentages of elderly people range from 20% in Reggio Emilia to 28% in Trieste and Venice. The cities with the lowest percentages of elderly people (with certain exceptions) are those located in Central and Southern Italy. As regards the third class, Ferrara is the city with the highest percentage (28%).

Considering the old age index as of 2017 (that is the ratio of the number of elderly people aged 65 and over compared to the population under the age of 14) it appears that 32 cities out of 45 have a higher index than the national average (165). There are significant differences among the largest cities: the indices of Naples and Palermo are almost half that of Turin and Genoa. The city with the highest old age index is Cagliari (270), while Andria, with its old-age index of 109, has the lowest one.

The index of elderly dependence (ratio of the elderly population aged 65 and over to the population aged between 15 and 64) once again reflects a similar trend as the old age one.

Comparing the 2012 data with those of 2017, there had been an overall increase of 7.3% in the cities surveyed, which is a lower percentage than the national average (9.4%).

In conclusion, it can be said that the ageing process seems to involve mainly the Central-Northern Italian regions, given that, as mentioned above, Liguria is the "oldest" region of the country (the percentage of over 65 years old people is 28.2%), whereas the "youngest" is Campania (17.8%).

CITIES	65 YEARS OLD AND OVER	OLD AGE INDEX	ELDERLY DEPENDENCE INDEX	% 65 YEARS OLD AND OVER	VAR. % 65 YEARS OLD AND OVER 2012 - 2017
Genoa	165,813	249.50	47.20	28.41	3.13
Turin	226,188	207.68	41.00	25.51	4.79
Milan	315,044	178.76	36.62	23.31	1.10
Rome	630,604	163.77	33.94	21.95	10.62
Palermo	133,474	138.70	30.06	19.81	13.51
Naples	186,812	131.12	29.15	19.26	7.71
I class	**1,657,935**	**170.0**	**35.2**	**22.59**	**7.01**
Trieste	57,925	253.71	46.91	28.36	3.00
Venice	72,532	238.46	45.63	27.69	2.73
Livorno	41,311	211.10	42.14	26.00	6.74
Cagliari	41,003	269.81	41.89	26.61	10.26
Florence	98,674	214.84	41.52	25.81	5.15
Padova	53,886	210.57	41.34	25.68	5.49
Verona	65,085	200.23	40.74	25.29	5.78
Bologna	98,614	214.90	40.44	25.39	1.12
Brescia	48,718	188.04	39.92	24.77	6.63
Ravenna	38,877	193.67	38.84	24.44	7.33
Modena	43,997	174.41	38.09	23.82	6.62
Perugia	39,127	175.58	37.17	23.47	8.49
Taranto	46,043	173.54	36.26	23.07	19.31
Bari	75,574	188.65	36.24	23.31	11.21
Parma	43,897	171.55	35.14	22.58	6.25
Messina	52,594	170.84	34.24	22.20	7.16
Prato	41,972	151.27	34.19	21.81	9.43
Foggia	32,194	151.65	32.75	21.22	14.70
Reggio C.	38,790	157.09	32.58	21.25	12.09
Catania	65,398	145.95	32.19	20.87	11.12
Reggio E.	34,990	137.07	31.53	20.40	8.11
II class	**1,131,201**	**189.04**	**38.20**	**24.12**	**7.21**
Ferrara	37,017	263.45	45.73	28.04	5.19
Terni	29,246	218.68	42.49	26.24	6.17
Ancona	25,794	207.53	41.29	25.62	4.61
Pescara	30,690	203.03	41.13	25.49	7.00
Forlì	29,760	191.22	40.98	25.23	6.46
Piacenza	25,472	194.78	39.92	24.89	3.34
Monza	30,261	183.98	39.69	24.61	7.51
Bergamo	29,727	194.92	39.47	24.71	5.40
Vicenza	27,237	187.65	38.66	24.28	6.00
Bozen	25,190	164.19	37.93	23.55	6.75
Salerno	32,472	201.66	37.64	24.08	6.34
Rimini	34,913	177.25	37.02	23.45	10.94
Novara	24,194	180.27	36.29	23.20	8.26
Trento	26,231	160.35	35.06	22.34	12.36
Sassari	28,061	186.45	33.24	22.00	15.77
Siracusa	26,071	155.05	32.94	21.36	15.68
Latina	26,240	145.63	32.04	20.80	23.13
Andria	17,112	109.33	25.33	17.06	14.68
III class	**505,688**	**183.03**	**37.55**	**23.75**	**8.74**
TOTAL	**6,083,960**	**169.55**	**35.21**	**23.17**	**7.22**
ITALY	**13,528,550**	**165.33**	**34.80**	**22.33**	**9.36**

Tab. 3 The elderly in the sample of cities - 2017 (sorted by "Elderly Dependence Index")

4.2 SELECTION OF PARAMETERS AND DATA COLLECTION

After identifying the sample of 45 Italian cities, 24 parameters have been selected (Tab. 4) with the aim of providing a quantitative and therefore objective evaluation of each one of the three components of Smart Mobility for elderly:

- Accessibility: needs to be guaranteed, in order to make elderly able to participate in city daily life, "by preventing inequality in terms of spatial access" (Santana, 2017);
- Safety: needs to be guaranteed, in order not to restrict the mobility of elderly;
- ICT: needs to be guaranteed, in order to help elderly move easily and independently.

The definition of these three components derive from the study of the Smart Mobility initiatives and measures collected before (see section 3), as most of them aim at increasing accessibility. Since the elderly are vulnerable users and require welfare, their everyday trips can be facilitated by digital devices and services.

The proposed set helps quantify some of the main characteristics of a city "elderly-friendly", such as walkability, access to activities, network connection, communication and information.

The selection of parameters has been made according to the previously mentioned works about the Smart Mobility and accessibility for elderly issues, as well as the availability of data for measuring them. These data have been collected from ISTAT database for the period 2012-2014, common to all the parameters used. The set (Tab. 4) describes the main elements related to public road transport and soft urban mobility, according to the fact that elderly are more likely to use these travel patterns (e.g. Kim & Ulfarsson, 2004; Schmöcker et al., 2008). In this perspective, the selected parameters illustrate the urban mobility supply and some of the physical-functional characteristics of urban system, consistent with available data at local level.

CATEGORY	ID	PARAMETER	UNIT
Accessibility	A1	Public transport demand	No. passengers/inh.
	A2	Public transport supply	No. veicles/inh.
	A3	Bus stop density	No. stops/sq.km.
	A4	Toll parking	No. stalls/1,000 cars
	A5	Taxi licenses	No./10,000 inh.
	A6	Car sharing demand	No. users/1,000 inh.
	A7	Car sharing supply	No. available vehicles/100,000 inh.
	A8	Bike sharing supply	No. bikes/10,000 inh.
	A9	Altimetric zone	Lowlands/Middle-mountain areas
Safety	S1	Elderly deceased in traffic accidents	No/100,000 inh.
	S2	Elderly pedestrians dead or injured in traffic accidents	No/10,000 inh.
	S3	Pedestrian zones	Sq.m./100 inh.
	S4	Restricted traffic zones	Sq.Km./100 sq.km.
	S5	Cycle lanes	km/100 sq.km.
	S6	Street lighting	No./sq.Km.
ICT	ICT1	Electronic payment park systems	1 or 0
	ICT2	Road panels with variable message	1 or 0
	ICT3	SMS for traffic	1 or 0
	ICT4	SMS for public transport information	1 or 0
	ICT5	Electronic bus stop signs	1 or 0
	ICT6	Electronic travel ticket by mobile devices	1 or 0

Tab. 4 Set of Smart Mobility parameters

4.3 STANDARDIZATION OF PARAMETERS

The data collected were not comparable, as they were measured in different units (e.g. n° available cars/100,00 inhabitants, sq.m/100 inhabitants, etc.). In particular, Accessibility and Safety components collect continuous parameters, while ICT is expressed by binary values. This last aspect is still the weak link for studies that seek to assess in a quantitative way the effects of Smart Mobility initiatives, as ICT component cannot be withdrawn but binary values have the major disadvantage of containing less information.

To convert Accessibility and Safety continuous parameters into binary ones we made use of Natural Breaks classification and this operation was implemented in GIS environment, in order to elaborate a dataset useful for the next steps of the research. Then, the average binary value was calculated for each one of the three Smart Mobility components, by referring to the 45 Italian cities surveyed. This step allowed to obtain a qualitative weight, expressed as percentage, useful to assess the Smart Mobility for the elderly "performance" of every city of the sample.

4.4 TERNARY DIAGRAMS

The last step of the methodology was to plot Accessibility, Safety and ICT average values on ternary diagrams, in order to identify the Italian cities that implement Smart Mobility for elderly by integrating all its three components or focusing on some of them. In fact, in the middle of the diagram there is the balance area, while at the vertices there are the areas of the three components of SM (which surfaces are defined by calculating an integral). The remaining areas are the ones where the components can be read in pairs.

Therefore, in the ternary diagram it is possible to identify seven areas and, according to the position of each city, it is possible to read which component/s of Smart Mobility characterize/s it. Fig. 3 represents those areas:

- Area 1 - Safety;
- Area 2 - ICT;
- Area 3 - Accessibility;
- Area 4 - Enabling, as ICT can be considered as a tool to increase urban accessibility of elderly;
- Area 5 - Sustainability, as soft (referring to Safety component) and sharing mobility (referring to Accessibility component) contribute to increase sustainability of transport;
- Area 6 - Inclusion, as technologies can support older people's engagement in city life by increasing their security;
- Area 7 - Balance area.

5 RESULTS

The methodology described above allowed evaluating if Smart mobility in the Italian small-medium sized cities is oriented to elderly needs. Four ternary diagrams have been obtained: one for each cluster (according to the demographic sizes) and one for all the samples (Fig. 4 collects all the results). Furthermore, within each cluster a further articulation of the old population (over 60) was made by Quartile method, in order to take into account both the demographic size of the cities and the different distribution of senior citizens within them. In particular the percentile classification obtained is the following:

- percentile 1: cities about 21% of elderly;

- percentile 2: cities about 23% of elderly;
- percentile 3: cities about 25% of elderly;
- percentile 4: cities with more than 25% of elderly.

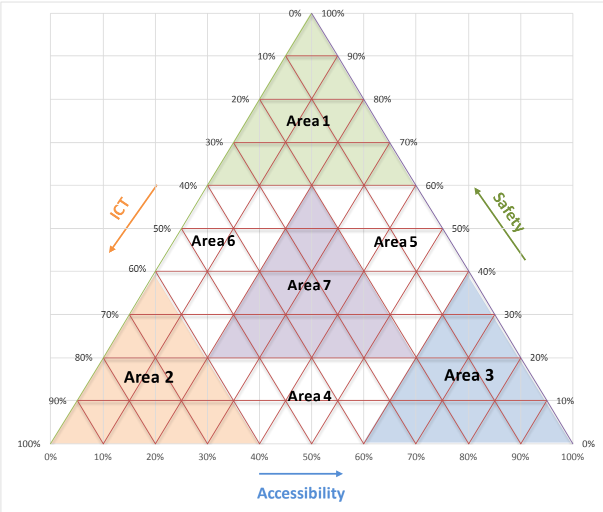


Fig. 3 The seven areas of Smart Mobility

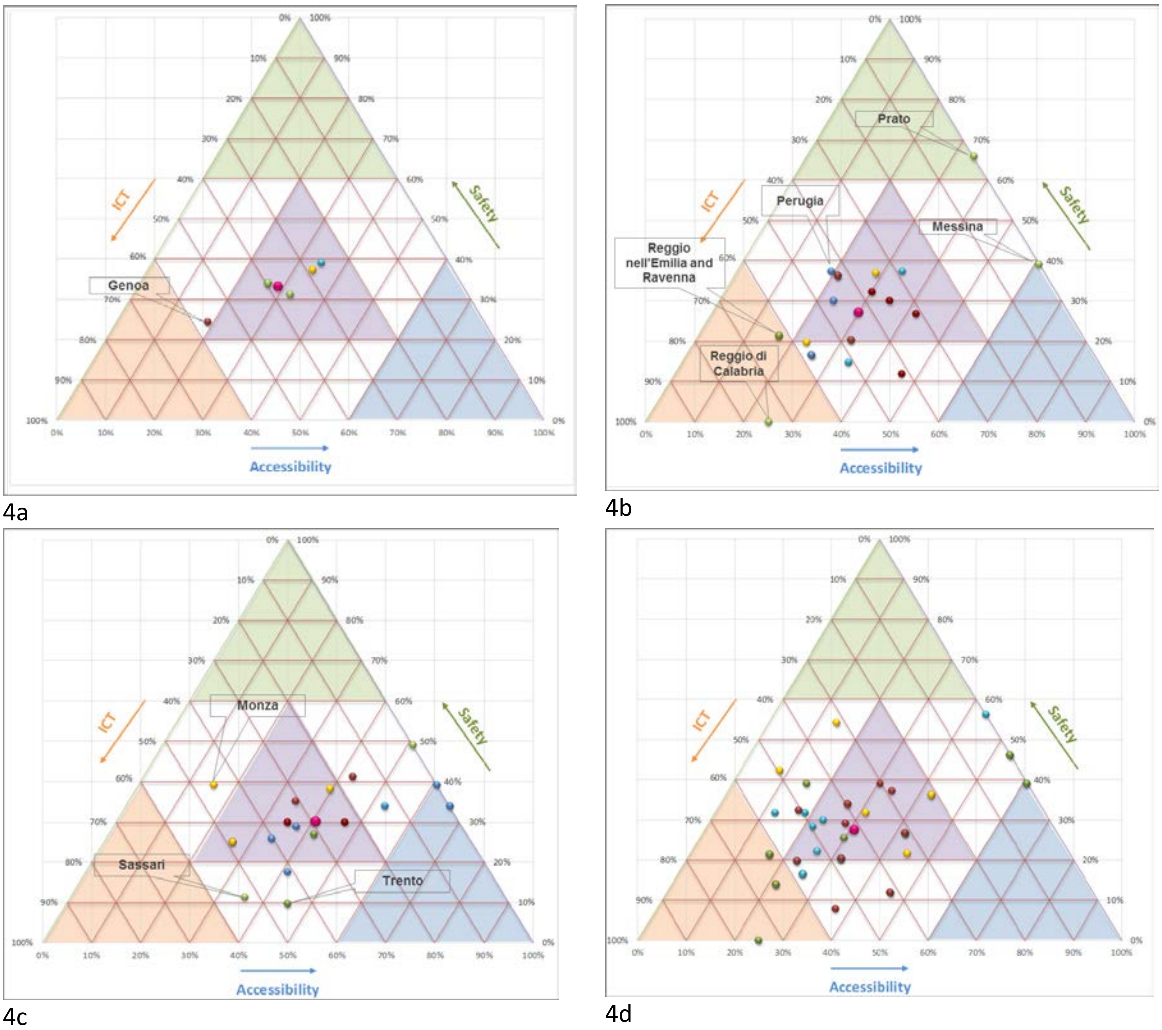
The average value of cluster 1 is located within the Balance area (Area 7, Fig. 4a) and it means that the biggest cities of the sample have the three components of Smart Mobility in balance. This first result can be explained by the fact that the greater the number of inhabitants of a city (and therefore its transport demand), the greater the supply of public transport with all the related services.

Focusing on the individual cities of cluster 1, Milan and Turin are more oriented towards Safety (39% and 37.2% respectively), while the three remaining cities in the balanced area seem to pay more attention to ICT. Only Genoa is outside the Balance area and has the highest value of the ICT component than the whole cluster (57% compared to an average of 37%). In fact, Genoa has been investing in the ICT Innovations for the last years and has committed itself to guaranteeing the right to move for everyone, to improving the quality of public transport offered and to reducing emissions of pollutants (Battarra et al., 2015). In particular, many interventions have been launched to promote sustainable mobility (car sharing, bike sharing, cycle paths) and infomobility services through participation in European projects and funding (Schaffers et al., 2011).

Compared to cluster 1 the ternary diagram of cluster 2 is more oriented to the ICT component (Area 2), according to the position of the average value (43%) and almost all the cities within the Balanced area (Area 7) are characterized by a high elderly population (at least 23%, Fig. 4b).

Reggio Calabria, Reggio Emilia and Ravenna have the best performance in the ICT (75% for the first city and 62% for the other two). These high performances depend on the fact that they host several ICT companies operating in several fields, from mobility to industry, commerce and so on.

Along the Safety axis, there are Prato and Messina that have mainly invested on one individual component that is Safety (66%) and Accessibility (61%) respectively, completely overlooking ICT (0%). Therefore, these two cities result to be unbalanced regarding the Smart Mobility for elderly.



percentile 1: cities about 21% of elderly
percentile 2: cities about 23% of elderly
percentile 3: cities about 25% of elderly
percentile 4: cities with more than 25% of elderly

Average value

Fig. 4 The triangles of Smart Mobility for elderly

Perugia is the only city in the area of Inclusion (Area 6) and this can be due to the geographic position of its city center that is not easily accessible. To provide its older inhabitants with easier access to their activities of interesting, internet accessible public services were developed, escalator and elevator systems improved and a “helping hand” (online and by telephone) was ensured to assist them when they encounter problems using the online services.

The ternary diagram of cluster 3 shows that Smart Mobility components are less balanced than the other two clusters (Fig. 4c) and that in the smallest cities of our sample accessibility seems to be guaranteed, according to the average value (41%).

As for cluster 2, there are few cities along the Safety axis: Latina, Novara and Salerno are the least balanced cities (0% for the ICT component) and those that have invested more in Accessibility (51%, 61% and 66%), compared to the whole cluster 2.

Monza is the only city in the area of Inclusion (Area 6) with a high performance in ICT (56%), while Sassari and Trento are located within the Enabling area (Area 4) by using ICT for improving the accessibility of elderly.

It is worth noting that both the Safety and Accessibility areas do not collect cities and this interesting configuration within the third ternary diagram can be explained according to two main considerations: (i) the normalization method used by the authors – as ICT data were binary – determines a lack of information related to these data; (ii) the kind of ICT data were qualitative and therefore they only inform about the presence or absence of this component of Smart Mobility in a city. In particular, this last aspect represents a limit of this research that authors intend to overcome by contacting and directly involving ICT companies and public bodies in their research work.

Moving on to the cluster of the whole sample surveyed, some considerations can be made:

- Most provincial capitals are concentrated within the Balance Area (about 1/3 of the sample) and have the largest percentage of elderly people, such as Bologna, Rome, Milan;
- Along the Safety axis there are five cities of the sample that do not give particular attention to this component and have few elderly inhabitants;
- Within the Areas of Inclusion and Enabling (Area 6 and Area 4) there are several cities oriented to the use of ICT to facilitate the walkability of the elderly;
- All previous results seem to highlight that Italian cities pay attention mainly to ICT and Accessibility issues.

6 CONCLUSIONS

This research work, starting from a definition of Smart Mobility that integrates the technological component with those of accessibility and safety, has attempted to answer the question posed in the title: can Smart Mobility make the cities more accessible for the elderly? To answer this question it seems appropriate to make some preliminary reflections.

The researches for this paper started from the review of some of the recent experiences of Smart Mobility to support the mobility of the elderly, which inspired us on the possible actions to be implemented in urban areas. These actions have been articulated in what have been defined as the three main components of Smart Mobility for the elderly: accessibility, safety and ICT. Subsequently, a set of indicators that could provide a Smart Mobility reliable framework was selected as to verify the current situation of the cities surveyed with respect to the three components.

The framework outlined by research is extremely varied and uneven as regards the current connotation of cities in relation to Smart Mobility.

This scenario can be attributed to several factors. Firstly some specific elements of the analysed contexts (clivometry, morphology, territorial distribution of the population, etc.), as well as socio-economic and cultural factors that characterise the elderly population, can have decisive impacts on the chances of travel. These impacts are difficult to evaluate by using a set of variables, which inevitably flattens out the differences, thus making the interpretation of the results less obvious in some respects. During the research work, we tried to take into account these aspects as much as possible (by inserting the % indicator of mountainous territory and articulating the analysis of the results in relation to the size thresholds of the cities), but in the subsequent research developments we will need to verify how to take into account the

specific nature of local contexts both as regards the characterisation of the elderly population and the peculiar physical-morphological conditions of urban centers.
As already assumed within the European Community, another pivotal aspect to think about is that although ICT can play an important role in improving the mobility of the elderly, it is also true that little or nothing is known – at least in Italy – on the elderly ability to use new technologies. Many have addressed the issue of e-inclusion of the elderly, believing that new technologies risk becoming an insurmountable barrier and that the digital divide will become a new form of marginalization for the elderly (Bobillier Chaumon et al., 2014; Carlo, 2014; Mordini et al., 2009; Niehaves & Plattfaut, 2014).
If, therefore, trusting the infomobility systems (that, for example, can simplify the use of LPT) seems to be justified by the many ongoing experiences, it is necessary to increase the level of familiarity of the elderly with smartphones, apps, etc. in order to promote targeted strategies that allow a better use of ICT. Currently, in Italy statistics are only available at national level (and the data are not reassuring), while a level of analysis at a more detailed territorial scale would be necessary.
Still in the attempt to answer the initial question, from this study as well as from other research carried out on the issue of Smart City it is possible to state also for the mobility sector that cities with the best performances in terms of greater accessibility for weak users are those that integrated "traditional" policies with those that instead require the use of ICT. Information campaigns, coaching and training in the use of the LPT, tariff incentives, but also public vehicles made more comfortable and the provision of new stops carefully located in relation to the units of services specifically addressed to the elderly (ASL, medical clinics, administrative offices, places of worship, etc.) can achieve significant results if integrated with strategies that envisage the adoption of ICT in the mobility system. Indeed, the cities operating in this direction (Milan, Genoa, Florence, etc.) that adopted an integrated approach rank at the top of the Italian rankings on the smart cities (Boscacci et al., 2014; FPA, 2017; Papa et al., 2014).
In conclusion, it could be claimed that, although in subsequent research developments the indicator system used to "measure" what is being done in Italian cities in adopting a "Smart Mobility" approach to support the mobility of the elderly will be improved, to date ICTs applied to the transport sector do not fully realize their potential. This is not due to the limited fields of application, but rather to the lack of a "system-orientated" perspective when applying innovations.
In other words, the adoption of a smart approach cannot be limited to a market-induced uncritical introduction of devices, sensors, technological platforms or apps in the mobility sector, in the name of a "more efficient mobility" and a user-friendly city. Instead, it will be necessary to refine the tools for understanding the needs of specific categories of users, such as the elderly, to define integrated strategies able to operate on many aspects simultaneously. Given the complexity of the studied issue, long-term future research efforts will be required, ideally by considering this work as a starting point. One of the possible topics of study could concern the increase of the set of parameters by including the local public transport charge for elderly, the presence of protected paths and the urban microclimate (air temperature). In fact, parameters of this kind could allow to consider socio-economic aspects and environmental characteristics of built environment. A further analysis could concern the comparison of Italian cities with European ones, in order to identify similarities and differences of local urban policies for increasing elderly quality of life.

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