smart cities

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A Cross-Reading Approach to Smart City: A European Perspective of Chinese Smart Cities

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Abstract: The present study, after a literature review of the smart city definitions and ranking tools in Europe and in China, presents a cross-reading approach to the Chinese smart cities concept and implementation. It is indeed nowadays mandatory to re-convert cities in sustainable and smart ecosystems and this can be done with different approaches. In this frame, the role of ICT—the glue of the smart city concept—is central and pervasive. The Smart city model could be a way to reverse the actual trend of cities, re-defining an integrated approach between tangible and intangible infrastructures of cities. Future cities are influenced by two main different visions with different connotations that come along with the planning capacity and with the ability of countries to follow a coherent and sustainable development project. European approach for planning is quite consolidated and based on a long term holistic vision, while Chinese vision is catching up with the dramatic speed of urbanization, deploying critical infrastructures in most cases without a long-term view. On the other hand, Chinese projects are in some cases exemplary for Europe where many constraints and regulatory issues put a strong limitation on the many possible implementations.

Keywords: Smart city; China/Europe; tangible/intangible infrastructures

1. Introduction

Many changes are affecting world cities and communities. The concept of the Smart City, SC, was created originally to give a functional response to the management of urban environments that are affected by human pressure generated by growing urbanization. Europe was already predominantly urban in the beginning of the 1950s. In the last century, Europe changed from a largely rural area to a predominantly urban continent. In 2017, around 74% of the overall EU population—was living in cities, towns and suburbs [1]. Although the speed of transformation has decreased, the share of the urban population keeps growing, such as it happens worldwide. As compared to China, Europe is characterized by a more polycentric and less concentrated urban structure. With 26 cities of more than 1 million inhabitants and additional 373 cities of more than 100,000 inhabitants, the EU only has 7% of the population living in large cities of over 5 million inhabitants.

In China, urbanization is one of the most prominent phenomena being in the most recent available data (2016) at 57.35% and being expected to surpass 60% by 2020. From the last China Statistical Yearbook [2] it is clear that urban population is increasing more than rural population, see Figure 1. Projections to 2050 show a large urbanization phenomenon reaching almost 80% of urbanization, with a total population that grows.

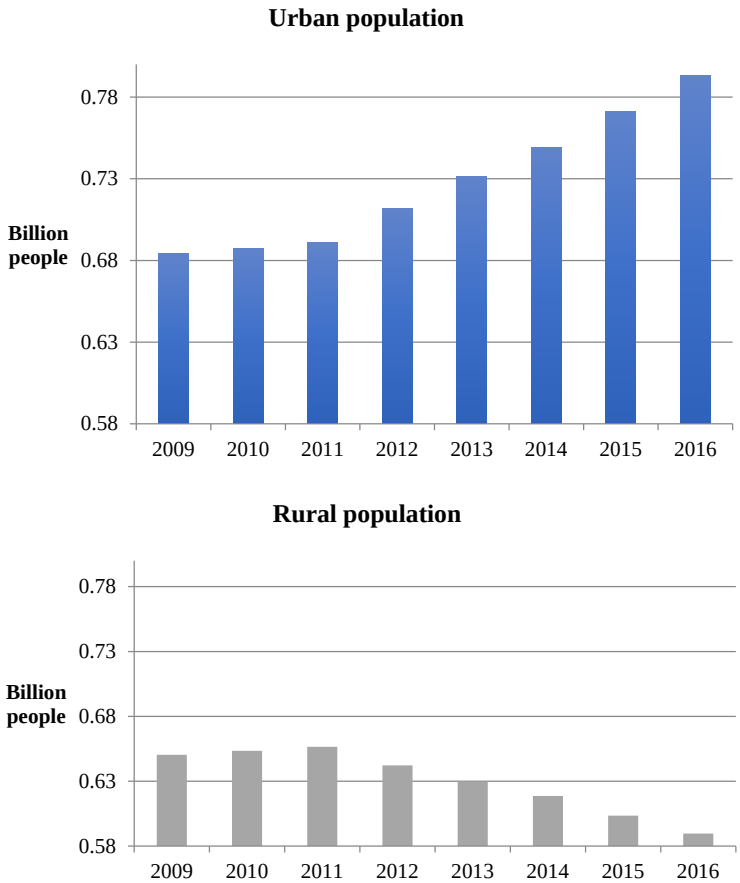

Figure 1. Urban and rural population data from China Statistical Yearbook, 2017.

In this scenario, the problem of smart development of cities is a matter of keeping together different features in Europe like in China, although in China the fast pace at which such development is carried out appears as jeopardizing harmonic development. Pollution, deriving from such extremely fast transformations, in particular, is considered as a very crucial feature even stopping the SC model implementation since pollution is perceived by citizens as a top priority [3].

Other studies in the literature compare the Chinese model to other SC development models.

A benchmark study was carried out by the authors of [4] in 2014 by the EU-China Green Smart City Cooperation Exchange Forum. In the final report, many issues were risen, although no more recent studies are available on this comparison since then. Moreover the available analytical studies comparing China and EU are not fully considering the different dimensions of the SC model [5].

A recent project has compared the way to Smart Eco-Cities in EU and in China are developing; a recent publication [6] highlights the dimensions to be considered for comparison. Top-down approach is not seen as a negative issue, but rather as a means to attain goals more rapidly. Other papers only present the Chinese way to Smart City projects implementation [7,8].

Most published works are indeed based on specific issues in most cases related to digitalization and big data [9,10]. To the knowledge of the authors, there are no papers in the literature comparing so extensively EU and China, with respect to the SC development model and implementation issue. The aim of this paper is a comparative analysis of the modern urbanization process supported by the Smart City, SC, model in China and in Europe. A summary of the most relevant findings is provided in a table at the end of this paper.

Besides, the SC development model, even if commonly adopted both in developed (Europe and US firstly) and fast emerging countries (South Asia, China, etc. . . .), does not show same connotations.

Indeed, as claimed by some authors [5], " . . . it can be expected that there is not just a unique paradigm of SC evolution throughout the world . . . "

Some authors [11] refer to it as a holistic vision: "A city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory governance . . . " While others [12] say that the SC about "leveraging interoperability within and across policy domains of the city (e.g., transport, public safety, energy, education, healthcare, and development)." Thus SC strategies require innovative ways of interacting with stakeholders, managing resources and providing services. The most common SC definition leads to an integrated holistic approach mainly based on six well known fundamental dimensions [13]:

(1) Smart Governance: a democratic and participatory bottom up governance also based on sharing practices, an innovative and well-organized open city government with international established networks and PPP (Public Private Partnerships);
(2) Smart Living: a healthy and safe environment of living;
(3) Smart Economy: a creative and challenging economic environment with the presence of start-up and spin-off companies, crowd-founding initiatives, local/global connections;
(4) Smart Mobility: a sustainable and technological mobility infrastructure based on multimodality;
(5) Smart People: an innovative environment"(citizens/people) with creative people, also inclined to use city-services through applications and apps;
(6) Smart Environment: a smart sustainable urban environment with a wise management of natural resources.

These dimensions highlighted by Giffinger in [13] imply a widespread use of new enabling communication technologies, whose role is central—the glue of the SC concept—and can be important for addressing future city goals [14]. However, the most new and convincing definitions about SC are those that link the concept of SC to that of sustainable urban development [15] through ICT applications and services. Smart cities hold a great potential to implement urban sustainability but in this case ICT must be directed for this specific goal. Recently Höyer and Wangel [16] defined a smart sustainable city as " . . . a city that meets the needs of its present inhabitants without compromising the ability for other people or future generations to meet their needs, and thus does not exceed local or planetary environmental limitations, and where this is supported by ICT . . . "

The smart and sustainable city definition is thus more concentrated on the ability of the humans to make/design sustainable cities supported by the enabling ICT.

For existing cities, as those in the European area, improve their liveability. A good balance between virtual and physical components can indeed produce a smart urban context: with respect to this topic the role of ICT and the new wave of distributed sensing and Artificial Intelligence is crucial [14,15].

Some of the SC dimensions—i.e., smart mobility and smart environment—are related to infrastructures in cities and they need a long time to be changed, especially in the European area, where cities have often resulted from an ancient historical layering.

Other issues can be more easily changed, such as those based on digital technology and ICT infrastructures (i.e., business models, city-apps for city-services). Still others concern the government management and their focus on innovative related aspects which is often merged with ICT technology (as smart governance, sharing practices, open city government, etc. . . .).

Moreover, the SC model finds full implementation typically in advanced communities; so therefore there are cities that are more ready than others to become smart [17]. And this fact is homogeneous in Europe as well as in Asian countries.

Other definitions of SC are more focused on the digital-technological aspect as "Cities (should be seen as) systems of systems, and that there are emerging opportunities to introduce digital nervous systems, intelligent responsiveness, and optimization at every level of system integration" [18].

Citizens however are important actors of this innovative process, because they are *active* players/users of cities transformations. "But cities must also have a soul: this is why buildings and smart services need smart citizens *active citizens*. A smart city isn't made by people just responding to inputs, but by citizen performing an essential role: the leading role in the process of data collection and sharing. Connected citizens are the engine of urban change in the city of the future" as Carlo Ratti says.

The notion of the "smart city" thus refers to urban environments with "pervasive and ubiquitous computing and digitally instrumented devices" [19]. These definitions highlight the digital character by referring to specific initiatives undertaken by international technological players [20].

The Internet of Things/Internet of Everything [12], coupled with Artificial Intelligence and Human Machine interactions, is another asset of the SC. In fact, most of the pilot smart cities have rolled out or are in the process of rolling out an overlay of ICT that connects things, people and organizations—the Internet of Everything—to deliver services to their citizens. These services are built on top of the concepts of open data [21] where Municipal ICT assets and public data are made available across a municipal network. Among developing countries, China has the most developed IoT industry and infrastructures. Some of the major IoT players are working on SC issues. "Overall coverage" represents platform features of IoT in the field of urban management and consumption management: here, IoT is the primary feature of SC application system [22]. These considerations, derived from some recurring interpretations of the SC concept appearing in the reviewed literature, show two different approaches: the digital-technological approach [23,24]—more widespread in China- and the social-comprehensive holistic approach, that we commonly find in the European area [25–27]. Such digital-technological approach in China will may gain control over citizen's actions, regardless the private data protection issues, that have been instead, since May 2018, strictly ruled in Europe (General Data Protection Rules, GDPR).

1.1. Ranking Tools and Indicators on SC

To measure the urban smartness, research centers or international companies and society have developed different ranking tools and indicators, among which: the *Ranking of European medium-sized city* [13] (first ranking tool developed in 2007 by the University of Lubjana and the Deft Polytechnic University together with the University of Wien. 70 European cities were classified on the basis of six above defined dimensions) and the ISO TC 268 Sustainable cities and communities (The International Organization for Standardization in February 2012, has established a technical committee, ISO TC 268 Sustainable Cities and Communities, for the definition of standards for measuring the performance of Smart Communities and for their efficient management, also in terms of infrastructures. The mentioned standards introduce the concept of Smart Communities Infrastructures schematized through a hierarchical structure arranged in layers where hard infrastructures constitute the basis. The ISO standard is the only integrated indicator system supporting reliable progress-monitoring in all fields relevant to smart cities).

The synergy between the various fields of interest and the various actors reflects the many aspects that are at the base of a multi-dimensional integrated approach, "These six axes connect with traditional regional and neoclassical theories of urban growth and development. In particular, these axes are based—respectively—on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of societies in cities" [11]. As a subordinate analysis, we can find, all over the world, other classification tools based on a technological approach supported by IT companies: for example, the Between (Italian Company leader in strategic technology consulting operating in the ICT field) company, earlier (2014), and the Ernst and Young, later (2016), have carried out a monitoring in the Italian context on 116 provincial capitals about the spread of ICT technologies ranging from broadband to digital services platforms using the SC index.

The cited Smart City index allows:

- for Cities: to carry out a digital mapping assessment, to position themselves in relation to other cities and to support their candidacy for SC funding;

- for Regions: to benchmark cities in their territory, to evaluate the digital road map for the creation of a Smart Region;
- for Nations: to define city innovation policies, to define a method for identifying best practices, and useful guidelines for SC.

The ranking above is based on the idea of SC dominated by IT logistics structure and based on four fundamental layers:

- Basic infrastructure, enabling element for the construction of a smart logic of urban functions;
- Network of technological sensors interoperable, to collect big data and remote management;
- Delivery platform for the development and exploitation of *big data* and land management;
- Network of applications and facilities to create added value in the city.

This ranking list is based on the use of digital services in cities for many aspects: smart culture and travel, smart urban security, smart justice are only some of them.

However, such kind of ranking measure reduces the SC concept to technology widespread, ICT infrastructure implementation and commercial interests.

Besides, this ranking based on ICT technology deployment prizes rich areas and global cities. This fact widens the differences between different areas of the same country, the less and the most developed ones. In Italy, the Southern and Northern Italian cities show these differences. The latter being always in first positions of SC ranking due to ultra-wideband, open data and app deployment, the human and cultural integration components not being considered at all.

Another study to measure the level of smartness of cities was conducted in Italy by FORUM PA (Rome, Italy) (Forum PA is an established company that has been working for years on the SC topics taking care of relevant studies, events and exhibitions). This company proposed the index iCity rate, which compares Italian cities on the basis of 150 indicators developed on six recurrent drivers (smart people, living, governance, economy, environment, mobility).

In the last editions (2016 and 2017), the *iCity rate index* measured, within the quality of urban living, also the ability of cities to put long-term goals by making the right choices and investments while focusing on new development drivers. In this ranking it is considered that the SC paradigm has shifted the emphasis from technological innovation to social innovation, co-design and management of common goods. This evolution of the concept of SC and its translation into new urban policies has introduced—for the construction of the iCity rate Index—new variables and indicators that measure the capacity of cities in Italy to accommodate and manage new migratory flows, while attracting global talents, creating innovative businesses, putting systems of tools for the production of objects and knowledge, making public data available, facilitating and sharing the use of public spaces, activating networks and relationships for sustainability, declaring at local level the national digital growth strategy.

Also Chinese cities are working on different indicators and on a selected number of pilot cities as we can observe in the *Chinese Cities of Opportunities* 2016 [28] document and in the recent edition implemented of 2017, made by CDRF—China Development Research Foundation and PwC-China: the idea of a good balance between technological innovation and development is the key of success of those smart cities.

It is evident that the analysis of urban systems cannot rely on a static analysis of the different phenomena: new indicators must always be found that can also explain emerging phenomena.

Such as already introduced in 2016, different aspects of the SC concept are included in these indicators: (1) intellectual capital, (2) technology readiness, (3) important regional cities, (4) healthcare, safety and security (5) transportation and urban planning (6) sustainability and natural environment (7) culture and lifestyle (8) economic cloud (9) cost and (10) easy to do business.

The ten indicators contain in turn different variables: for example in the technology readiness field, four variables can be found: internet penetration, broadband speed, digital economy, software

development and multimedia design. The lack of statistical homogeneous data has mostly driven the choice of the cities that year by year PWC China selects for the analysis.

Moreover, while in Europe the cities development is connected to the advent of capitalism driven by market, in China the status of a community and pace of development is largely dependent on its administrative level which has affected in turn the availability of statistical data for comparison. For this reason in China the analysis is restricted only to one typology of cities.

Nonetheless, most observers predict a market growth in Smart city initiatives in Europe from 19 billion US dollars to 31 billion in 2021, while in China it will reach 28 billion US dollars by 2020 [29].

1.2. Smart People & Smart Living: Experiencing Community Platforms

Smart technologies and SCs development in China have been bridged from a technology-oriented phase based on hardware and technology infrastructure to the SC development, which locates the analysis within a human-centered approach to digital government [30]. This vision actually applies, also at worldwide level, to the New Urban Agenda (The United Nations Conference on Housing and Sustainable Urban Development (Habitat III) held in 2016 in Quito, Ecuador, was concluded with the adoption of the New Urban Agenda, an action-oriented document). The latter aims to adopt sustainable, people-centered approach and by developing integrated policies at the appropriate level, including local-national and multi-stakeholder partnerships and building integrated systems of cities and human settlements [31].

In regard to the above considerations for a global aim of sustainability it becomes evident to the Chinese decision makers that the present urban situation in China is characterized by increasing environmental and social pressures which gives a fundamental role to contexts basically people-oriented.

The commitment to sustainable urban development as a critical step for realizing the construction of SCs as targeted by the Guiding Opinions (2013) asserts the inevitable choice between smart and harmonious urbanization development of China and the national economic growth [32]. These goals are typically mutually exclusive in the short term.

The 13th Five-Year Plan, formulated on the basis of the Recommendations of the Central Committee of the Communist Party of China (CPC), puts great emphasis on the Implementation of the 2030 Agenda connected to domestic midandlong term development strategies [33]. The latter are aiming at CO_2 emissions reduction and at energy efficiency increase through renewable energies. This was basically China's Basic Position on the Paris 2015 UN Climate Change Conference to strengthen actions on climate change after 2020, even though China's economic transition will continue to be complex and challenging China's policies towards climate change and low-carbon urban development processes, as well as the freedom in treating private data and widespread of Artificial Intelligence, are turning pilot SCs programs in China to interesting laboratory tests, providing important lessons to Europe [34,35].

It is reported that by 2025, 300 million EU citizens will be served by Urban Platforms infrastructures within their cities and its predicted that in the shorter term, the adoption of these platforms through an easy-to-implement approach and cross-sector collaboration will have many positive effects.

Through the European Innovation Partnership for Smart Cities & Communities (EIP_SCC) the Urban Platform initiative represents the way by which European cities foster better society outcomes, through an interaction designed to improve a knowledge and management within the large volumes of city data making a further connection with the sharing of this data and the improvement of the city services.

Just to report on efficient European activities, the CAPSELLA project (Collective Awareness PlatformS for Environmentally-sound Land management) [36] developing between 01/01/2016 and 30/06/2018, is an evolutionary ICT application of smart cities urban management based on data technologies and sustainable agri-food systems.

This project is using participatory processes throughout scientific and local knowledge, bottom-up data collection and top-down data integration to develop solutions for agro-biodiversity and the food supply chain adding a social value to grassroots communities' applications of ICT innovations. The formation of a city's physical environment can be regarded as the spatial outcome of certain urban development processes under the manipulation of certain urban policies and this could be the case of grassroots communities' platforms that can bridge on the urban soil accessible concepts of urbanization and space identity. On the European urban scenario, these sets of actions have been called Collective Awareness Platforms for Sustainability and Social Innovation (CAPSSI) (CAPSSI is an EU project).

In Europe, the cities themselves have become laboratories for collective experiments in which all citizens are called to participate actively creating opportunities for self-directed life and job [37] by replacing the vertical rigid organization model with an experimental continuous learning one [38]. This is the case of Farm Cultural Park which is an independent Cultural Centre in the city of Favara in Sicily. Through a set of actions this resilient community has seen the re-birth of its social economic and entrepreneurial activities mainly promoting cultural activities that have revitalized the entire urban tissue.

On the other hand, understanding and re-thinking the structural behavior of Chinese cities could actually lead towards a more effective design of city platforms to create awareness on sustainability problems and to put in place collective solutions.

The management of an innovation–led economy as part of the 13th Five-Year Plan could be implemented by a highly participatory process at the local level where the grassroots democratic communities can effectively establish new forms of collaboration between the government and the economic, social and entrepreneurial tissue.

Based on an exploration of these features, as well as of new stakeholders interests, new social and economic values, the design of strategies for SC development unprecedented challenges, [4] that can support experiments and activate collective awareness adding a better social and economic link between cities and enterprises' networking processes. This is the case of Shenzhen where new cultural landscapes and community platforms address alternative trajectories for city development. More recently, the city's local authorities are trying to make sure that the citizen is the focus of the high-tech facilities and systems that are implemented. And indeed, in November 2008 the Director General of UNESCO, Koïchiro Matsuura, has nominated the two cities of Iowa City in the USA and Shenzhen in China as "City of Literature" and "City of Design" of UNESCO's Creative Cities Network.

The main outward expression of the city's high level of connectivity are the millions of Wi-Fi terminals that have been installed in Shenzhen, enabling the locals to carry out their purchases, travel, bookings, waste disposal and communications with public administration in a dematerialized way.

A collective and collaborative innovation based Chinese urban reality) [39,40] and mass amateurization of invention as well as innovative product development within the peripheral urban districts [39], has brought to the experimentation of projects like 'Shanzhai innovation'. Established early 2015, Shanzhai City is a social enterprise promoting community self-agency through technology development, community building, and value co-creation that synergizes and integrates into sustainable markets.

In this case, the ICT platform collects millions of innovators and originated from simple manufacturing activities in developing regions throughout the grassroots community. In this way, Chinese collective innovation and distributed creativity has brought high added value to community development.

2. Looking at Smart Planning in China from a European Perspective

2.1. SC Projects Management and Financing

The recent Urban EU-China kick off meeting held in Putian city in China in march 2017 for the joint Innovation Platform on sustainable urbanization has set out the main drivers of a wide educational

initiative on urban innovation. The expected basic impact of Urban EU-China project is to create a strong and experimental approach to support sustainable urbanization. This will be implemented through a set of actions such as brokerage events for city-industry-science cooperation or nursery of collaborative projects. The challenge addressed by Urban EU-China is the disconnection between strategic visions and targets and operational realities of time/resource constraints, language and cultural barriers, differences in planning/policy/governance framework conditions within European and Chinese cities, and the lack of effective bi-directional transmission mechanisms of transferable planning and policy instruments for sustainable urbanization.

The idea is to efficiently start an EU-China Innovation Platform on Sustainable Urbanization. Creating such a platform is complex and intrinsically cross-sectoral, pointing at the policy makers engagement, as well as national authorities, industries, cities, academia, civil society and other stakeholders, in the aim to design sustainable cities. The partnership is composed of 12 experienced European and Chinese partners that will support the European Commission in its aim to make EU-China sustainable urbanization cooperation more accessible, attractive, and rewarding for a broader set of stakeholders. The EU financial contribution is not high (below 0.5 million euros), but the aim of the cooperation is to create an educational system for exchanging knowledge and create human resources to face the urbanization challenge in EU and in China.

An investment analysis carried out based on recent available documents [41] shows that both in China and in Europe, SC projects are largely financed from public institutions.

From the analysis of many project reports and the experience from Companies supporting the SC development in China [42] and in Europe, the authors have synthetized the framework for the implementation of SC projects in China and in Europe in Figures 2 and 3.

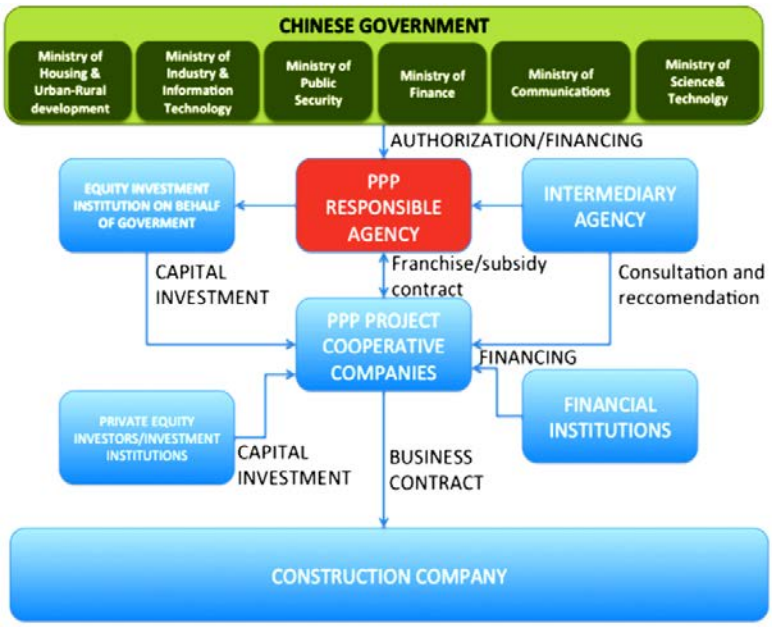

Figure 2. Chinese framework for National SC projects.

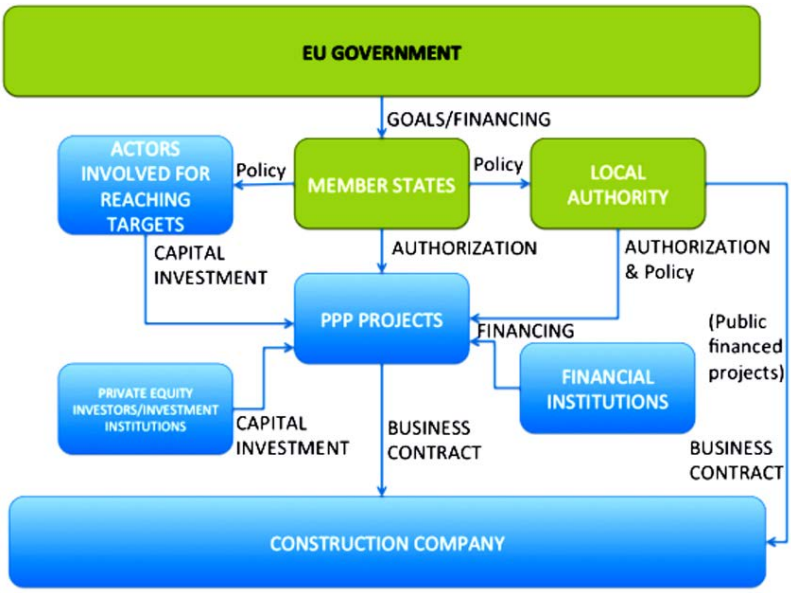

Figure 3. European framework for smart city (SC) projects.

It appears that in China there is a direct management and funding from the government, while local authorities execute a mandate from higher levels with a top-down approach. Europe instead through the involvement of member states and local authorities catches the feelings and feedbacks from people about the projects, trying to raise awareness and social acceptance. The other side of the coin of such large sharing of ideas and responsibilities is the projects implementation time that in Europe is much larger than in China.

Moreover, in Europe, the fragmentation deriving from the wide variety of funding measures does not show clearly the real amount of EU funds available for smart city initiatives. As an example, the Covenant of Mayors [43] (launched in 2008 in Europe with the ambition to gather local government voluntarily committed to achieving and exceeding the EU climate and energy targets) currently engages with sustainability action plans around 6487 municipalities of different sizes in Europe and is supported by different EU measures, specifically designed for local authorities. The EU governance else than the H2020 funds under the Smart City and Communities (SCC) calls indeed sets different measures targeted to urban renewal projects.

An example of financing framework for bottom up EU approaches is the deployment of the European Jessica funds supported by the European Investment Bank (EIB).

Integrated, sustainable urban innovation projects can be funded by the Joint European Support for Sustainable Investment in City Areas, Jessica, see Figure 4. A range of complex financial tools are used in this aim, including loans, equity investments and guarantees, delivering novel opportunities for the employment of EU Structural Funds.

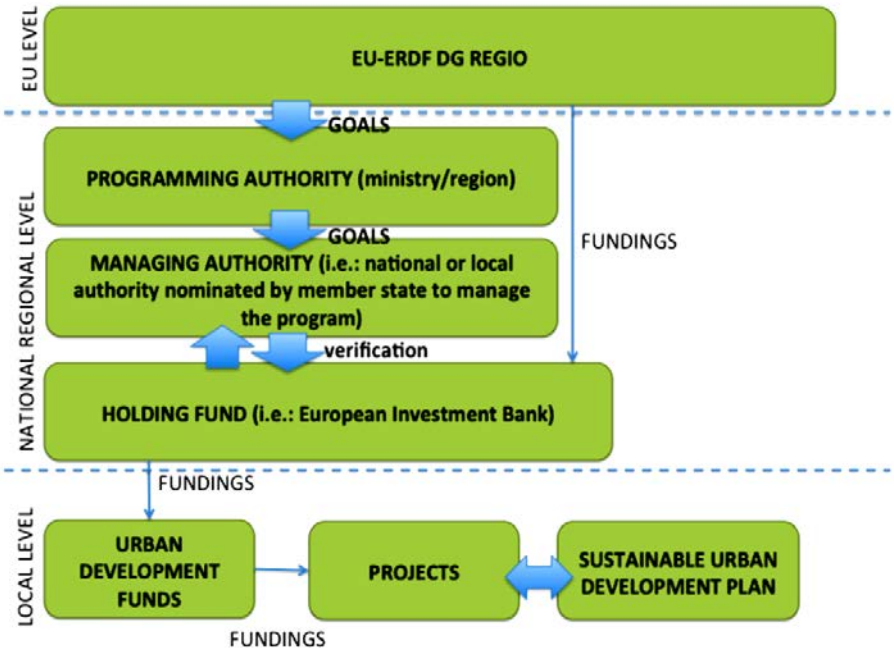

Figure 4. European framework for Urban regeneration projects (Jessica).

Jessica and other similar successful supporting measures were designed to make Structural Funds more efficient and effective for supporting local actions by "non-grant" financial tools, creating stronger incentives for successful projects deployment. The possibility to mobilize additional financial resources deriving from public-private partnerships and other urban development projects with a focus on sustainability/recyclability appears strategic for reaching medium and longer term EU goals. Finally, the architecture proposed in Figure 4 capitalizes the financial and managerial expertise from international financial institutions such as the EIB for

- advising and assisting national, regional and local authorities;
- promoting the use of Urban Development Funds and best practice across Europe;
- acting as a Holding Fund, when requested by Member States or managing authorities.

In the end, these financial supports are delivered to projects through the urban development funds and, if requested, through holding funds. They must be in line with Structural Funds operational programs agreed for the current programming period.

In Europe, a lot of measures like Jessica are put in place, while the calls H2020 Smart cities and communities have created several clusters of cities working together, some as lighthouse cities, other as followers thus creating know-how exchange, replicability and scalability of results. In the following Figure 5, an outline of the budget is given for all projects of the SCC calls in H2020 and the most recent FP7 projects on SCs.

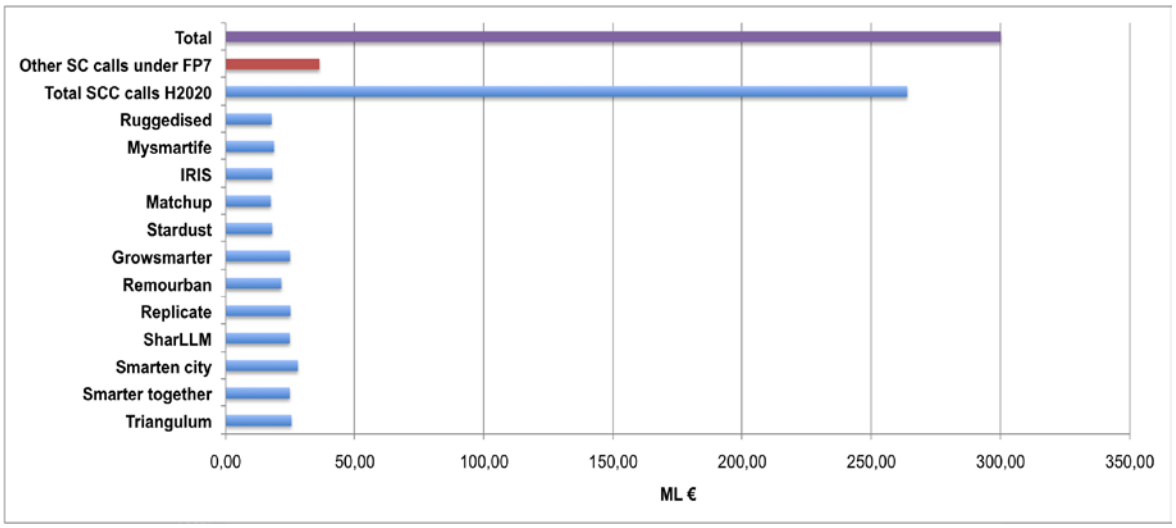

Figure 5. European projects under the H2020 SCC calls and more recent FP7 calls (since 2010).

Based on Figure 5, Europe, up to 2018, has invested almost 0,350 billion euros for the H2020 SCC calls. However this graph does not account for the European Stabilization Mechanism (ESFM), the EU multiannual Financial Framework that has allocated itself more than 1000 billion euros and the other smaller measures, still under H2020, like Jessica and that are listed in (EU funding opportunities for SC projects, 2017). Another funding opportunity in Europe is the European Regional Development Fund, ERDF, that aims to strengthen economic and social cohesion in the European Union by correcting imbalances between regions. The key priorities of such programs are: innovation and research; digital agenda; support to SMEs and low carbon economy.

Funding is allocated with different percentages in relation to the category of the region (less developed and transition regions, more developed). The ERDF gives particular attention to specific territorial characteristics. ERDF action is designed to reduce economic, environmental and social problems in urban areas with a special focus on sustainable urban development. At least 5% of the ERDF are set aside for this field, through integrated actions managed by cities. For this reason this European Regional Development Fund program intercepts many of the themes of the intelligent city.

A drawback of the EU approach resides in the inability of many local authorities to manage these funding opportunities. A lot of money from EU originally destined to support infrastructure deployment are often sent back, thus enlarging the gap between the different areas of Europe showing different development levels.

China government has already planned investments for 173 billion euros for the National SC Projects comprising 277 smart city projects in China [41]. And further money are set apart for further SC projects. Also in China 32 clusters of cities were created for exchanging knowledge and scale smart solutions. The smart cities are part of a largely ambitious global project of China. They should indeed become part of the so-called 'silk road economic belt', Figure 6, for commercial development of the Asian region and of China in particular. Up to 60 countries shall be involved through the new Eurasian Land Bridge running across developing China-Mongolia-Russia, China-Central Asia-West Asia, and China-Indochina Peninsula. In this way, economic corridors will be created by taking advantage of international transport routes, relying on core cities along the Belt and using key economic industrial parks as cooperation platforms.

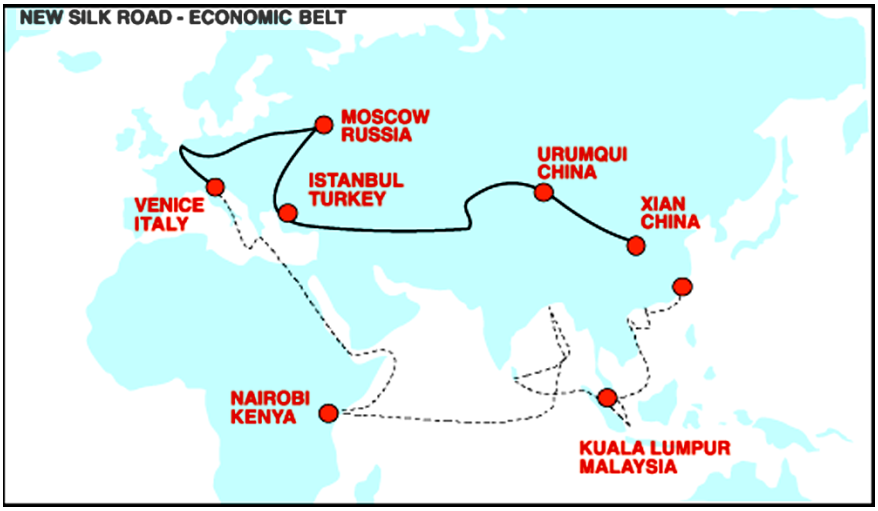

Figure 6. The global Chinese commercial development project.

2.2. Enabling a Successful Implementation of SCs

As described in the introduction, according to most definitions, the SC holistic vision is based on ICT infrastructures to support sustainable economic growth and high quality of life, while human and social capital are fully developed by a large participation of citizens to the city governance and mobility as well as energy infrastructures that are fully sustainable. For these reasons in the following paragraphs the issues of Governance, ICT infrastructures, Energy and sustainable mobility infrastructures are developed.

2.2.1. Enabling Smart Governance System: Top down and Bottom up Approaches in SC Initiatives

In the EU context, we find SC initiatives both in metropolitan cities and in smaller urban centers. This is due to the fact that in most cases, such as in Italy, urban planning is demanded to local authorities. As an example, Italian cities aim to be "smart" in certain areas (smart environment, smart mobility. Smart people etc.), depending on territorial features [44], following a bottom-up approach rather than a strategic program [45].

In China, the administrative power is centralized: the Central government defines a precise strategy in the field of urban planning. For this reason, in China, Smart Cities are born predominantly on the margins of suburbs of the major metropolitan areas, following the decision of the Chinese Government to invest in the implementation of several pilot cases of SCs [46]. In this regard, it can be said that the Chinese SC development follows a sort of strategic planning defined by the central government following a top-down approach [47]. In both cases, EU and China, the SC concept implies the need of a well-organized governance system [45]. EU pilot smart cities have indeed adopted, in recent years, a more open approach to SC governance. Even though European territories and cities have since long time experienced democratic, participatory and multilevel open governance models, now they need to be joint with sustainable development issues. The concept of governance, indeed, refers to patterns of interaction in which the coherence and effectiveness of the government of territorial processes depends not only on political-administrative activity, but also on horizontal and vertical coordination between several actors, both institutional and social, and their ability to share goals, negotiate agreements and cooperate to reach them [48].

Differently, most of the Chinese pilot SCs have a top-down vertical approach with a leadership group. Moreover, the multi-stakeholder aspect of smart cities is recently stressed upon also in China, and requires that governance system at municipal level ensures that political leaders, service operators, investors, solution providers and citizens will all have a relevant impact on the implementation of SC initiatives.

Horizontal (or local) governance and multi-stakeholder systems are now considered better than the traditional vertical hierarchy as some authors refer. Horizontal governance contrasts with the "vertical" or "ministerial" [45] authority where all decisions are made in a centralized hierarchical manner. In a horizontal governance approach actors collaborate and share power and responsibility. The SC ecosystem indeed comprises public sector, private sector, civil society, academia and social entrepreneurs, according to the Penta Helix Frame [47]. The horizontal European governance system in the SC field is being tested recently in the European projects funded in Horizon 2020. As an example, the EU project Replicate-Renaissance of places with Innovative Citizenship and Technology funded in H2020 SCC call is testing (2016–2020) his actions in three leader-cities (Bristol, San Sebastian, Florence) and three follower cities (Essen, Nilufer, Lausanne) [49]. Here, cities have the opportunity to test the multiple aspects of the governance system, which requires:

1. Interdependencies among stakeholders;
2. Democratic mechanism to manage data;
3. Different urban solutions to various city levels;
4. Comparative evidence-based data;
5. Not only quantitative but also qualitative rankings.

Inside European projects, cities have developed co-productive approach strategies to engage citizens for building a co-creative environment [49]. In addition to this, making connections between cities (lighthouse and followers for example in the Smart Cities Communities call in H2020 EU program) [50] is central in order to reinforce the city-to-city learning, while ensuring that project results are applicable throughout the cities that want to evolve towards the 'smart city' concept respecting the different features of individual cities and their communities.

In the European context (Figure 7) the bottom-up approach could be a sort of urban strategy to implement city power, to intercept competitive funding opportunities, to achieve city goals: the city/land features and the infrastructural frame determine the smart actions to be taken in each case differently.

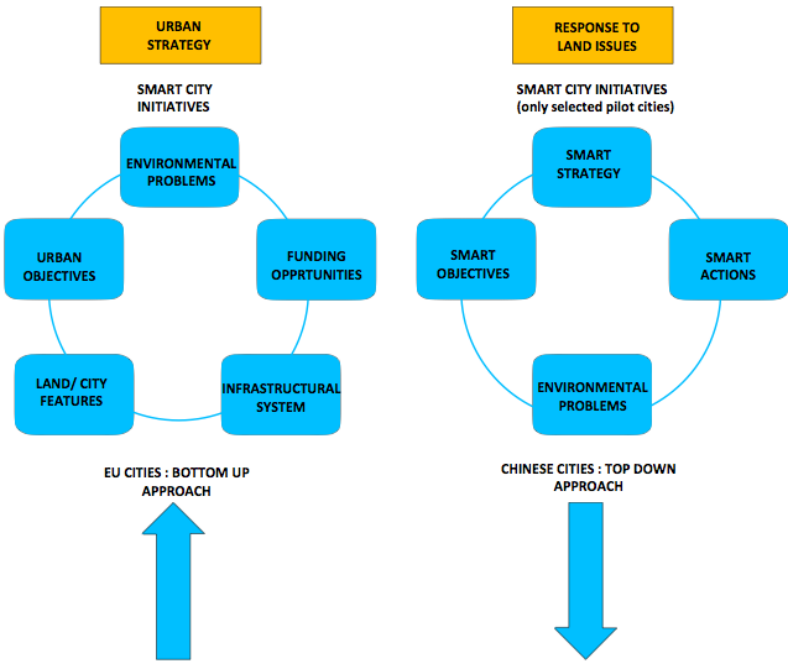

Figure 7. Comparing different SC visions: top-down (EU cities) and bottom-up (Chinese cities) approach.

The two enabling pillars, on which a comprehensive governance system in SCs is based, are citizens engagement and open data infrastructures [51].

2.2.2. Citizens Engagement

Many SCs, especially in the EU, have implemented mechanisms, such as developing a "public, private and people partnership" approaches to engage and empower citizens in being involved in the development of their city innovation and SC plans. In this way, ordinary citizens can affect their city to a degree they never thought possible by becoming informed participants and stakeholders, willing to take on political, financial, or design decisions that will change their city for the better. According to Jane Jacobs (1961), "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody." Actually by making city processes more transparent and engaging, we can finally bring that notion to fruition.

The work *Rethinking Smart Cities: ICT for New Type of Urbanization* [30] takes a closer look at one of the few bottom-up elements of Chinese smart cities: the ways in which city government use technology for citizens engagement and public participation. Through some important development documents such as the *the Guidance on Promoting Healthy Smart City Development*. issued in 2014, it can be argued that SCs development in China is in a transitional period. The Guidance is aiming to coordinate the SC development work among different ministries and agencies, the National Development and Reform Commission (NDRC) and seven other ministries. The Guidance explains the basic principles, objectives, strengths, weaknesses and action plans for SC development in China.

But it can also be said that urban processes are run at a different speed in China as compared to European countries. The Guidance above emphasized the principles of human-centered vision and demand–driven development. In the mentioned document, bottom-up and citizens engagement elements like strengthening public services via smart technologies and establishing platforms for expressing opinions, is also present.

However, going from policies (and intentions) to implementation of proposals coming from citizens, in China, is at the moment a reality only in isolated cases: as an example, the Xiamen Municipal Government backed down from building a chemical factory near a residential area in 2007. Citizens were mobilized via text messages, email and social media to protest against the project. China's public online service development is still largely providing information services, rather than connected services, focusing on providing information to citizens, instead of encouraging their participation in decision-making processes.

2.2.3. Open Data Infrastructure

Most EU pilot smart cities have implemented open data infrastructure projects, which enable businesses and citizens free access to city data. Open Cities [52], for example is a project co-founded by the European Union (2013) that aims to validate how to approach Open & User Driven Innovation methodologies for the Public Sector in a scenario of Future Internet Services for Smart Cities. The validation is based on leveraging existing tools, trials and platforms in Crowdsourcing, Open Data, Fiber to the Home and Open Sensor Networks in seven major European cities: Helsinki, Berlin, Amsterdam, Paris, Rome, Barcelona and Bologna.

The recent General Data Protection Regulation (GDPR) that came into force on 25 May 2018 in Europe focuses on the right of personally identifiable information to be forgotten. This legislation is issued when SCs worldwide are embracing the Internet of Things (IoT) to collect massive amounts of data and, through Artificial Intelligence and data analysis algorithms, deliver automatically efficient services. The question is now if it will still be possible to manage SCs with GDPR in place. The new regulations indeed change the owner of data. They are now of property of individuals, therefore to put in place any SC project, the basic prerequisite will be trust in public institutions that are willing to implement the SC actions. As a consequence, bottom-up approaches will have to be realistically

implemented with a level of awareness from citizens that can be triggered by digital education and civic sense.

The major difference that appears, thus, between EU and China with respect to the Open Data in urban contexts is that in China data is not open. Data is property of the Chinese government or of big IT companies. Moreover, in most cases, there is no compatibility among data deriving from different departments, making data sharing quite hard [7]. Finally data are not publicly available, creating a problem to citizen participation in using data to deploy novel products and services.

Therefore in this dimension, Chinese pilot cities are at an earlier stage as compared to EU SCs, but many are in the process of establishing such open data systems and portals. Information sharing is the key to successful application of big data, and in this case, "smart data" is the trademark of a smart city. For data to become "smart", specialized expertise and quantitative analyses [53] must be combined with empirical skills, understanding, common sense, insights and good judgement, which requires critical thinking in data interpretation. Decision-making should be based on data availability and the key data generated by core systems of city operation should be measured, analyzed and integrated, leveraging various information and communication techniques. In doing so, the ultimate goal is to make cities more enjoyable for people. On the other hand, open data is a guarantee for citizen, when data driven decisions are taken at political level. Therefore standardized modes to process data and to use them for political decisions should be elaborated in order to avoid any kind of arbitrary or, worst, manipulated interpretation.

2.3. Enabling ICT Infrastructures

Else than the governance system, also the enabling of ICT infrastructures is based on Open Data and citizens engagement, although the latter is being carried out consciously or unconsciously through IoT and Artificial Intelligence. Recently, the State council on Artificial Intelligence document of July 2017, considers indeed AI, among the others, as a tool to improve social governance [54]. In what follows, a brief description of the status of fixed broadband infrastructure in EU and China is provided. In recent years, China has pursued prominent goals in the field of Internet accessibility for citizens and for companies. There is no doubt about the potential of supporting economic growth through new business models of new ICT technologies and in particular the most recent 5G wireless technology largely backed up by optical fiber and an extensive deployment of small field antennas.

While in China the deployment of optical fiber is continuously growing [35], with an exponential increase of Fiber To The Home (FTTH) subscribers, the broadband access on average according to the ITU and UNESCO is still limited [31], since only 47% of Chinese households has access to the Internet. The same report however shows that in cities like Hong Kong and Macao, this percentage reaches 82.4% and 84.3% respectively. Europe has now on average 80% households with Internet access (according to "Digital Agenda for Europe Performance Indicators for Broadband Supply and Take-up") and fixed broadband subscriptions are 26.89 every 100 inhabitants. Fixed wired broadband subscriptions include the total number of subscriptions to the following broadband technologies with download speeds of 256 kbit/s or greater: DSL, cable modem, fibre-to-the-home and other fixed technologies (such as broadband over power lines and leased lines). This indicator is measured in number of subscriptions per 100 inhabitants and in total number of subscriptions.

In China, broadband subscriptions every 100 inhabitants is limited to 18.56. This means that although it is advisable to have governance, economy and other SC dimensions backed up by digital services, China is not everywhere ready for such revolution.

Figure 8 shows the increasing trend of penetration of household broadband fixed connection in China, showing that it is expected to reach 50% next year. Eurostat shows that in Europe almost 80% of households have fixed broadband access to the Internet in 2016.

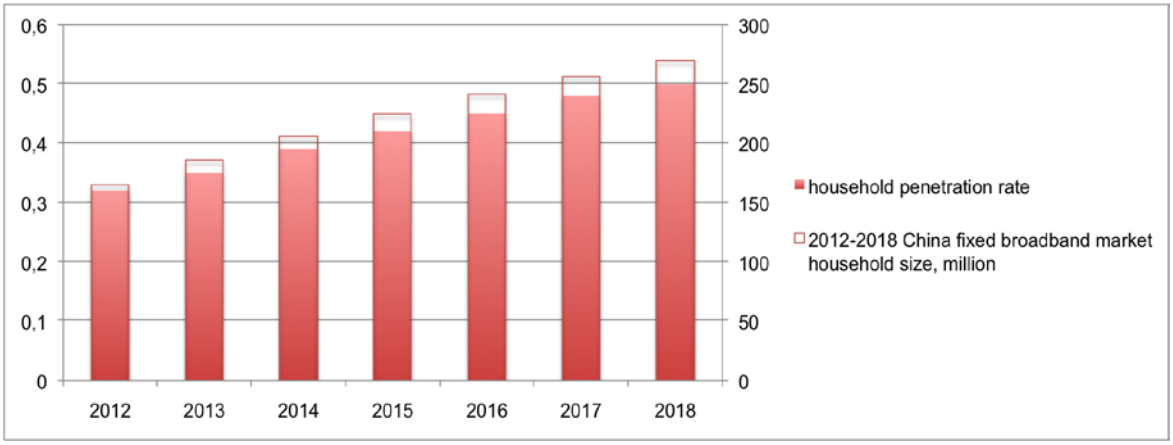

Figure 8. Household fixed broadband penetration rate in China (Source: MIIT, Value Partners). Values from 2013 to 2018 are expected.

Urban areas in China have far more infrastructure than other non-urbanized areas, while in Europe the difference is decidedly limited to some percent. Based on urban TLC infrastructures, the collection and analysis of urban big data generated from transactional, operational, planning and social activities that are not specifically designed for research has a large potential of improving life of people and operation of technical infrastructures. This recent scientific area is named 'urban informatics'.

Different elements are positively affected by the big data technology and 'urban informatics' [55]: (1) improved strategy for dynamic urban resource management; (2) theoretical insights and knowledge discovery of urban patterns and processes; (3) strategies for urban engagement and civic participation; (4) innovations in urban management. To understand the importance of ICT infrastructures for big data exploitation, we here report a list of sources of urban big data: sensor systems; user generated contents; administrative data (open and confidential micro-data); private sector transactions data; data from arts and humanities, and hybrid data sources, comprising linked data and synthetic data.

While European cities are getting to digitalization after the development of industrialization and urbanization dimensions, Chinese cities are running fast towards digitalization, together with industrialization and urbanization [9].

In Europe, indeed, most administrations are becoming skeptical about the real possibility to integrate big data into the decision making process, due to the institutional complexity underlying big data integration. Local government capacity is indeed limited, for many reasons, to arrange data management structures that would allow proper use of big data [10]. One of these reasons is certainly the privacy preserving issue, the integration of new stakeholders and privates into the decision making process, with all the deriving regulatory implications.

Due to the disruptive innovations in the IT field, Eurocities is only recently (2018) creating focus groups on the most recent technological advances that could change citizens everyday life. The focus groups "Blockchain 4 Cities" and "The Impact of Frontier Technologies on Cities" will review the advent of Distributed Ledger Technologies, Artificial Intelligence, IoT and data processing in cities. Although still perceived as far from us, the most disrupting technology in man-to-man interaction and in man-environment interaction will be Artificial Intelligence, AI. It can be defined as "machines that respond to stimulation consistent with traditional responses from humans, given the human capacity for contemplation, judgment and intention" [56] or software systems that "make decisions which normally require human level of expertise" and support people in anticipating problems [56]. In this way, these artificial systems *operate in an intentional, intelligent, and adaptive manner* [57].

In China, a lot of resources have been invested for hardware and infrastructures although still soft services are not fully deployed on top of existing infrastructures. For this reason, and in the light of

disruptive advancement in Artificial Intelligence technology, the State Council document about AI [54] rules the advent of AI in all sectors and puts the basis for being China a world leader in this technology.

The Chinese national SC pilot program initially involved 277 Chinese cities and districts that have now reached the number of 500 [58]. The project shows a large penetration of ICT solutions and platforms for local administrations monitoring and managing a lot of data collected from either open or private sources, when possible. Moreover the inexistence of privacy preserving regulations makes the deploying of very advanced SC experimental projects on citizens involvement as well as behavioral control.

As an example, ZTE soft is the Communication Service Provider in the city of Yinchuan, defined by the same ZTE company a 'truly data driven city'. The City of Yinchuan wants to serve as a model for other cities on a global scale, to show how to transform into "smart," not only the urban infrastructures, but also services creation and delivery. In this way, through innovative business models, a strong economic development comes along. It emerges that the main driver for turning a Chinese city into a SC is technology and a top down vision that covers all areas of urban living. It is thus hard to understand how ICT truly enables citizens' participation to governance and strategic choices. On the other hand, it is well known that when there is no real sharing of goals among citizens, environmental and other SC objectives can hardly be reached.

Yinchuan's big data cloud platform can be seen as the brain of the city is an urban database that stores information of the city's population, economy, buildings and infrastructure, and spatial geographic information. Yinchuan has also created an urban industry application database and subject library that looks at transportation, education and government public services. Data sharing between different active platforms and from the big data cloud platform has transformed the city from a passive and reactive government to one which utilizes, processes, and analyses big data to make informed decisions and has turned the mode of government to one which is active and can provide smart and intelligent services for its citizens. An inventory of applications of the China's National Pilot Smart City can be found in the TM Forum's Framework™ suite of digital business best practices and standards, used to enable innovation through intelligent data analytics.

2.4. Smart Environment: Enabling Energy Infrastructures in Chinese Smart Cities

2.4.1. Energy Strategy in China

The recently published "13th five-year plan for economic and social development of the people's republic of China" (2016–2020) [35] several times talks about 'smartness'. Smart health care dimension, smart manufacturing alliances, smart energy systems, smart transportation, smart materials; all these and others are considered to be smart when somehow 'organized' and planned efficiently. When planning future research, smart electrical grids play a central role, such as smart manufacturing and robotics, smart mobile terminals and 5G technology. When talking about developing urban and rural infrastructure networks, the document describes smart cities as: "making full use of modern information technology and big data to develop a number of exemplary new-style smart cities, focusing on developing smart infrastructure, convenient public services, and refined social governance." Besides that, an entire chapter entitled: "Develop Harmonious and Pleasant Cities" is devoted to urbanization. The idea proposed in this section is about restoring a relation between urbanization and ecosystems. When it comes to talk about the idea of 'smart cities', the notion is largely related to modern information infrastructure and promotion of development of big data and the Internet of Things. What however appears largely different from the European approach in the energy and ICT fields is the total absence of numeric indicators, goals and targets for the different areas of the country. At a closer look, China is still in a development phase that it calls a tough infrastructuring. This fast run towards development, however, is being done in a decidedly not 'smart' way. Planning and long term views seem undefined and the absence of clear goals affects the lack of harmonization of obtained results. As already mentioned in the above paragraph, the possibility to provide intangible services to end-users seems

currently far from be reached. Therefore, as an example, de-carbonization measures at distribution level brought by Demand Response policies can effectively be deployed only in some parts of the country. However, China strategy does not seem to be currently able to run for deep de-carbonization through solar and wind especially at distribution level, since according to the Department Of Energy no project of electrochemical storage is currently being run in China. This storage technology (especially Li-Ion) seems to be the most suitable for deploying renewable energy sources in cities thanks to the high energy density. According to the largest electric company in China, which is also the world largest electricity distributor (State Grid Chinese Corporation, SGCC, Beijing, China), there will be a fuel shift from carbon to hydroelectric, wind and geothermal resources and future Ultra High voltage Direct Current, HVDC, projects will connect Xinjiang and Tibet, rich of geothermal and hydropower, to its central and eastern provinces. Moreover, China will likely continue to build HVDC projects that will service its major urban centers (e.g., Shanghai, Guangzhou), so as to keep up with the dramatic increase of energy demand in these areas [55]. The same High voltage DC technology will support large corridors implementing the recently announced Global Energy Interconnection (GEI), plan of SGCC that implies transcontinental and intercontinental interconnections. In this frame, Europe should receive energy from the western borders from Chinese wind power plants.

2.4.2. Energy Infrastructures

Looking the energy supply dimension in cities, the following aspects are here considered for comparison between EU and China:

- Electricity
- Heat
- EVs mobility.

The energy consumption in European and Chinese cities by sector is depicted in Figure 9.

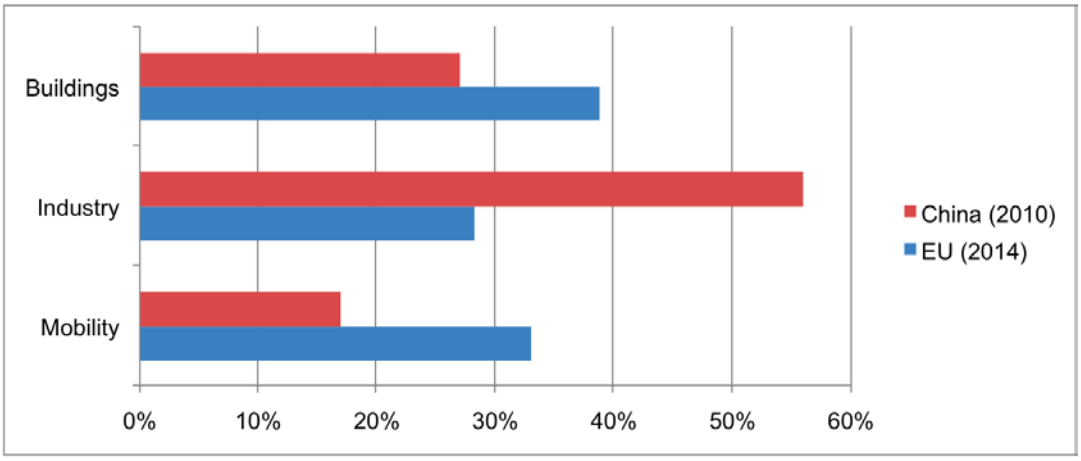

Figure 9. Energy consumption by sector in cities—Sources: (Ohshita S. et al., 2015; EU transports, Pocketbook, 2016).

In both cases, the buildings energy needs are largely related to heating and electricity, the different incidence [59] of one or the other comes for the geographical location of cities, since colder cities have larger consumptions related to heating and hotter cities show higher electricity consumptions. While in EU the buildings sector appears as the main source of consumption in cities accounting for almost 40% of overall consumptions, in China the most energy intensive activity is industry, for which the 13th five year plan pursues a large reduction of emission related activities.

2.4.3. Electricity and Renewable Sources in Cities in EU and China

China's cities are currently strongly reliant on fossil fuels to power and heat residential and industrial buildings in cities, fuel mobility, and supply urban manufacturing [60]. Also electricity, covering about 20% of cities' final energy, is largely produced by fossil fuels (75% by coal and 1% by natural gas). Non-fossil sources for city needs electricity are 20% hydropower, 2% nuclear, and 2% other renewables like solar and wind. Most of the coal and coke consumed by China's cities is used by the industrial urban area that is responsible for 56% of urban primary energy consumption. China's urban residential and commercial buildings account for 27% of urban primary energy use, which is mostly heat and electricity, both of which are predominately produced by coal. Urban mobility covers 17% of primary energy use, the large part of which is oil consumption. Going to a comparison with European Urban context the following Figure 10 shows large differences.

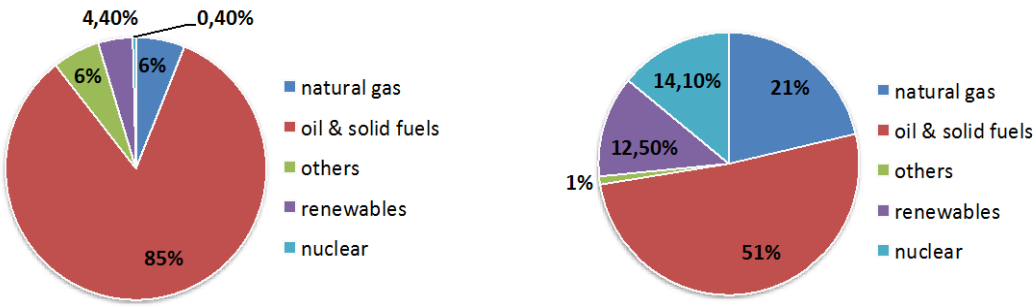

Figure 10. Primary urban energy share EU (**right**)-China (**left**). Data from EU are available in 2014 and data from China in 2010—Data from (Ohshita S., 2015) and Eurostat.

Although the pictures taken refer to different years, the corrections brought by the Chinese policies on renewable energy penetration have brought on the whole an increase of 30% between 2010 and 2014, thus getting to around 5.7% from 4.4%. Oil and solid fuels cover almost same percentage such as natural gas, while nuclear seems to cover a smaller percentage, below 1%. Decarbonization in EU cities in general seems largely at a higher stage as compared to China. In Europe, the situation is different. Urban areas account for 60 to 80% of global energy consumption in EU and around the same share of CO_2 emissions.

2.4.4. Smart Mobility: Electric Vehicles

According to the last trends, it can be decidedly claimed that decarbonization in China seems to be strongly supported by EV penetration. China is indeed the largest market for Electric Vehicles. The 2016 Global EV Outlook shows that the number of vehicles in the electric car stock (BEV and PHEV) by country, is the highest in China, as the world largest with an exponential increasing trend. However, at a closer look, the market penetration is still around 1% against almost 23.3% of Norway and an average in EU that is still quite limited around some percent, mostly due to policy framework and lack of recharging infrastructures. Some European countries indeed, for example The Netherlands and Norway, implement range of measures favoring consumers that buy electric cars. In both EU countries, as well as in others, electric cars enjoy very significant reduction on registration and circulation taxes as well as privileged access to some portions of the transport network restricted for others cars. Financial incentives as well as the availability of charging infrastructure emerged as elements that were positively correlated with the growth of electric vehicle market shares [61]. Another element strongly pushing the market is certainly the widened offer. Besides, battery capacities in mass-market EVs are expected to increase over the next several years from the 20–33 kWh range of today's vehicles to 60–100 kWh. In the same way, to guarantee affordable recharging times Direct Current Fast Chargers (DCFC), are expected to spread. DCFC with power levels ranging today from 50 kW to 145 kW are expected to

reach 400 kW. In late November 2016, Volkswagen group, BMW, Ford, and Daimler announced the development of a 400-site European high-power DC charging network starting in 2017 [62]. This will put serious questions about the possibility of the existing power infrastructure to supply such high power peaks.

As already said, the EV market in China is growing fast, supported by subsidies and other incentives like free license plates and free parking places and public charging stations appearing everywhere.

The main issues in Chinese cities are about air pollution and traffic and the local administrations tackle these issues by restricting opportunities to own conventional Internal Combustion Engines, ICE, cars and favoring the adoption of EVs. As a result, in 2015 sales of New-Energy Vehicles (electric and plug-in hybrids), NEV, stood at 188,700 units, up to 223% compared to 2015. Right now the growth pace of NEV market in China is twice the US growth pace observed and China is currently the largest NEV market in the world by sales of new energy vehicles.

Such as it happens in Europe, but also in the US, also Chinese cities are implementing since some years strong supporting policies for those citizens buying a NEV. In Table 1 below the supporting policies are summarized.

Table 1. Supporting policies for EV purchase in Chinese cities—Source: China Youth Daily (2014), Xinhua (2013), Xinhua (2011) [30], Beijing Municipal Government (2010) [52], Dongfang (2013), Colorful Guizhou (2015) [53], MIIT (2009) [54] and Jun (2015) [55].

Chinese Cities	Since	Details	Waiver for New EV	Details
Beijing	2010	Lottery	2013	Quota exists, but odds are better for new energy vehicles
Guiyang	2012	Lottery	2014	New energy vehicles allowed license plate
Hangzhou	2011	Lottery and auction	2015	New energy vehicles allowed license plate
Shanghai	1994	Auction	2014	Quota on new energy vehicles allowed license plate
Shenzhen	2014	Lottery and Auction	2014	Quota exists, but odds are better for new energy vehicles
Tianjin	2013	Lottery and Auction	2014	New energy vehicles allowed license plate

The national 'dual credit policy' took effect since April 2018. It imposed compulsory targets for vehicle manufacturers starting from 2019. Vehicle manufacturers are now evaluated in terms of fuel consumption of vehicles they produce and EVs production and as a reward they get new energy credits. The number of credits they get is based on EV features such as weight and driving range. The policy imposes that 10% of total credits of a vehicle manufacturer must be composed of these new energy credits in 2019 growing to 12% in 2020. Manufacturers (those selling more than 3000 conventional vehicles a year) that do not meet this requirements are fined or must buy credits from other manufacturers. Over the past decades indeed, China adopted policies restricting the availability of license plates in its major agglomerations. These "increment control" measures on motor vehicles consist primarily of lotteries and/or auctions issuing new license plates up to a certain annual quota. Cities listed in Table 2 implemented these policies. Between 2013 and 2014, they also introduced specific waivers for electric vehicles. The city of Guiyang adopted polices restricting access to certain areas of the city for vehicles not having specific plates (issued via lottery systems and/or auctions). Subsidies can be as high as $13,800, making electric vehicles attractive for a large audience, and that in turn attracts more automakers. China has indeed also a remarkable recent production

of competitive EVs, both in terms of price and in terms of range that goes up to 350 km. Chinese cities are also going for EV based taxis transportation. The city of Beijing is substituting almost 70,000 ICE taxis with Electric Vehicles. This boom of EVs calls for new infrastructure for EV recharging infrastructures that will may be supplied by dedicated specifically MVDC cable lines, with a possible integration with PhotoVoltaic generation and storage systems. China is indeed planning to build an entire dedicated infrastructure for 800,000 vehicle recharging points in cities across the whole country. This will be a further incentive pushing the EV market growth in China. Nonetheless, to have a real decarbonization effect at global level, it would be advisable to couple EV mobility with Renewable Energy Sources. A recent Italian study shows the impact in terms of avoided emissions hypothesizing different penetration rates of EVs [63]. Other studies from TU Delft [64] within a joint project with ABB propose full DC infrastructures including PV and recharging points to be created in parking lots. However, if the deployment of EVs will be so large as it appears, it is also arguable the need for smart management of recharging, in order to limit power peaking and schedule reservations for recharging. It is well known that fast recharging plugs are deployed in DC. They ensure recharging times that can be several times lower than AC recharging, thus enabling electric mobility.

Table 2. EU-China cross-reading findings.

	CHINA	EU
Ranking Analysis for SCs	Limited to cities whose statistical data are available (Depending on administrative status)	Wide and differentiated, carried out for small and larger cities by different entities even at national level
Smart city projects implementation and financing	Top-down approach Large availability of funds for SC projects implementation	Bottom-up approach Discrete availability of funds for SC projects implementation–bureaucracy—too dispersed information and difficulty to accessing to funds for less developed municipalities
Successful implementation of SCs		
Governance	Limited Citizenship engagement—PPP is controlled by government by own agencies No availability of Open Data Difficulty in implementation of horizontal and multi-stakeholder projects	Wide Citizenship engagement through PPP measures Availability of Open Data City-to-city learning feature by Lighthouse H2020 projects
ICT infrastructures	Fixed broadband subscriptions are growing fast Large non uniformity of infrastructures between urban and non-urban areas Many projects are starting for urban data driven cities Extensive use of Artificial Intelligence for decision making	High penetration of fixed broadband subscriptions Uniformity of wide band (OF) infrastructures in non-urban and urban areas Concern in using big data for policy decisions and GDPR Issuing regulations about AI
Energy and mobility	Buildings are less energy intensive than industrial sites. Primary urban energy share is still based on non-renewable. China is world largest NEV market and is building suitable infrastructures for EVs recharging. Policies are set up since many years for encouraging the ownership of EVs, mostly pushed by cities air pollution.	Industrial sites are less energy intensive than buildings. Primary urban energy share is covered by more than 30% by renewables and natural gas. In Europe only some member states are on the frontline of EVs penetration.

2.4.5. Comparing Smart Mobility in Europe and China

European cities are launching different initiatives in the field of smart mobility: for example Hammarby Sjostad is an eco-friendly district in Stockholm and its sustainable transport model is a mix features a tramline, bicycle and pedestrian networks, carpooling and a ferry. Infrastructure here was planned as "closed loop" systems for water, waste and energy, all feeding each other.

The whole city has an integrated mobility system: public transport are very efficient and very used, the capillary networks are integrated and, 90% of the population live less than 300 m from a bus stop [65].

With Chinese cities suffering from congestion and pollution, smart mobility becomes a central part of the concept of smart city as an approach to improve the quality of transportation and thus of citizens' life. Over the last few years, a number of smart mobility initiatives have been rolled out across the country. With large investments, it is an area of opportunities but also risks for companies spanning equipment suppliers, system integrators, platform providers, and content suppliers. New mobility services in China are oriented to a user-centric city: on-demand mobility that would allow customers to choose among public and private transport providers and assemble the fastest or cheapest way of going anywhere they need to go at any time.

In June 2012 the Chinese government promulgated the Planning for the Development of the Energy Saving and New Energy Automobile Industry, explicitly advocating the replacement of fuel oils with natural gas and developing Liquified Natural Gas, LNG, buses. Then the Ministry of Transport issued the Key Points in Energy Conservation and Emission Reduction of the Transport Industry in Year 2013 and proposed the priority in advancing the development of natural gas for vehicles and LNG initiative and encouraged the use of New Energy Vehicles. Now over 100 cities are implementing the clean vehicles initiative and a comprehensive picture of the current situation about NEV spread is reported in the preceding section.

As a measure to solve the difficulty in finding a taxi for the morning and night rush hours and cope with bad weather, cities of Beijing, Nanchang, Chongqing, Qiqihar, Nanjing, Jinan initiated the pilot project of taxi sharing in 2013. Beijing stipulated that the two persons sharing the same taxi should each pay 60% of the total taxi fare; Qiqihar stipulated that each of the people sharing the taxi shall pay 70% of the taxi fare based on the actual vehicle mileage; and Sharing Meters were installed on taxies for separate metering in Nanchang.

Public bicycle system symbolizes the transformation of bicycles from individual transport to quasi-public transport and it is an important measure to construct the green urban transport system and implement the public transport priority strategy.

Based on its convenience and zero consumption of energy, the public bicycle system has been implemented and developed in over 60 cities including Beijing, Shanghai, Hangzhou, Suzhou, Shenzhen and Nanjing as a part of the urban livelihood program. As the first city in China to integrate public bicycle system into the urban public transport system, Hangzhou had over 2000 services stations and over 60000 public bicycles in 2012, with the average daily amount of bicycles rented reaching 230000 person times. The red public bicycles have become a new city logo of Hangzhou.

More recently, a different smart mobility enabler, the Vehicular Social Networks (VSN), is strongly changing the scenario in both EU and Chinese cities. VSN deeply integrates social networks and the Internet of Vehicles (IoVs). This technology strongly relies on efficient ICT infrastructure and digital education of citizens. A common application of this service is Uber [66] and is present worldwide. On top of this technology, trajectory data-analysis-based traffic anomaly detection systems can be implemented for VSNs.

Several initiatives for smart mobility are launched by big companies such as Bosch, which in April 2017, established a partnerships for automated driving with largest Chinese high definition map providers, such as Baidu. The "Bosch Road Signature" is going to be the most accurate localization service in China. This service will combine high-definition maps with on board Bosch's advanced camera and sensors to ensure the stable positioning and localization of autonomous vehicles even in bad weather conditions. All this of course will be supported by the wide-spread of the 5G technology.

3. Concluding Remarks

In this paper, the SC development model is described both in EU and in China considering the most important areas to be developed and namely: the governance system, ICT infrastructures,

energy and sustainable mobility infrastructures. Table 2 shows a summary of the most important elements arising from this study. What appears is that the required integration between tangible and intangible urban infrastructures, see Figure 11, happens in China mostly through a top-down approach guaranteeing a fast process but at the same time a scarce inclusion of citizen in decision processes.

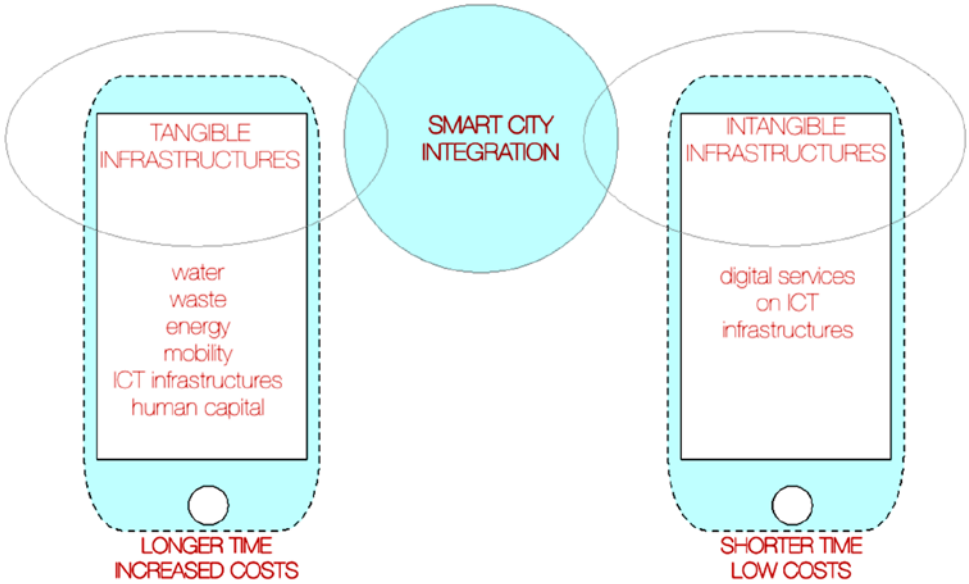

Figure 11. SC integration: tangible and intangible infrastructures must be integrated in a smart urban scenario (Source: authors image).

In a recent interview Bruce Sterling [67] talking about urban intelligence affirms that "Smart cities are not so smart": smart city should be more human and less technological, underlining the main function of citizens in the construction of the urban smartness.

In this context urban platforms can represent harmonic speakers of cities, where citizens can democratically represent their own istances, both fisically and digitally, for the construction of the future city. The city should be tailored for each kind of latitude, so that each of them will have its proper shape in future time.

In Europe, longer times have allowed the creation of a well-developed system of city infrastructures and services for citizens.

Another big difference relates to the fact that EU cities have had time for experimentation through several city oriented projects for all dimensions of the SC concept at the scale of the district/city or even of the building, while in China this was not possible.

Some other interesting findings of this work can be summarized in the following. When regulations for data protection exist (i.e., GDPR), citizens' awareness rises and through a positive loop data are shared more and more and the use of community platforms is encouraged. On the other hand, extensive AI deployment, as well as ownership of personal data under Government or private companies may bring to the reduction of citizens awareness thus producing a negative feedback loop on all SC processes. Another interesting issue that is evident from all SC projects is the fact that citizens' engagement is the key to their successful application. Finally, since pollution in cities reduces the level of citizens' engagement [3], this will in turn affect all SC dimensions, as an example, the increase of EVs in urban energy transition will reduce pollution and, in turn, this will affect citizens engagement positively.

Finally, there is no doubt that the maximum efficiency from digitalization can be gained if intangible services, triggered by citizens engagement and awareness, can be deployed over tangible efficient infrastructures. Future outcomes of this study concern numerical evaluations and the

deployment of a Systems Dynamics model [68] for the specific case studies in China and in Europe, in order to deduce numerical dependencies among the highlighted topics and provide a model for Smart Cities development in China.

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Abbreviations

DCFC	Direct Current Fast Chargers
EU	Europe
PPP	Public-private Partnership
SC	Smart City
AC	Alternate Current
DC	Direct Current
EV	Electric Vehicle
NEV	New Energy Vehicle
HVDC	High Voltage Direct Current

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