Smart city in Europe: comparative analysis between Italy and Germany development

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Abstract: The upward trend of urbanisation characterised by a rapidly growing number of city dwellers and an increasing population density is exacerbating sustainability issues such as air and water pollution, insufficient public waste management and relying on non-renewable energies, but also issues affecting the quality of citizens' life such as congestion, inadequate development of public transport systems and the lack of digitalisation of public services. The state-of-art of the smart city understanding and term definition stated by authors at different development stages of the smart city paradigm as well as a critical reflection of the approach of the smart city idea as an urban growth model is presented. A smart city multi-dimensional framework based on an input-process-output-impact model was chosen as a methodological approach to analyse the smart city best practices of Italian and German pioneering cities in the core dimensions of technology, community and policy.

Keywords: smart city model; sustainability; European environmental policy; technology management; urban metabolism.

Reference to this paper should be made as follows: Arcese, G., Schabel, L., Elmo, G.C. and Risso, M. (2019) 'Smart city in Europe: comparative analysis between Italy and Germany development', *Int. J. Environmental Policy and Decision Making*, Vol. 2, No. 4, pp.330–359.

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1 Introduction

Urbanisation is one of the four demographic mega-trends alongside the growth of the global population, population ageing, and international migration and is characterised by an increasing number of city dwellers (UN, 2019). The emerge of urban agglomeration areas is intensified by the growing number of multi-million-resident megacities such as Tokyo, Shanghai, and Mexico City with an incontestable effect on the environment (Folberth et al., 2015). Despite the fact that cities take in a neglect able amount of the global land area, the final urban energy use has a share of up to almost 80% of the total global final energy use and urban areas account for a major share of worldwide greenhouse gas emissions (Seto et al., 2014). While by 2018 more than 50% of the world's population already lived in urban settlements, by 2030 the share of city dwellers is predicted to grow up to 60% while one in three residents will live in a city with at least half a million inhabitants (UN, 2018). The degree of urbanisation depends on the geographical location: Northern America's urbanisation rate added up to 82% of the population in 2018, Europe's to a total of 74% and Oceania's accounted to 68%, while only half of the population of Asia agglomerates in urban areas and Africa is remaining

predominantly rural with only 43% of the population living urban. Between 2018 and 2050, the global urban population is expected to grow by 2.5 billion urban dwellers, with Africa and Asia expected to generate up to 90% of the increase (UN, 2019). Furthermore, not only the number of city dwellers living in urban areas is increasing, but also the number and size of cities conditioned to birth rate in urban areas exceeding the mortality rate and the migration of new city dwellers from rural areas (Lerch, 2017). Especially in the low-income and lower-middle-income countries, for which the fastest urbanisation rate from 32% to 50% and from 41% to 59% of the population living in urban areas till 2050 is expected, the requirements on a targeted and comprehensive management of urban growth are increasing in order to ensure sustainable urban development (UN, 2019). On the one hand, urbanisation contributes positively to economic growth, entrepreneurship and technical innovation due to a high concentration of businesses, skilled labour force, knowledge and information exchange enabled by an infrastructure provided by the interaction and proximity of government, commerce, and transportation. In comparison, urban areas have a positive effect on the reduction of poverty and human development, offering more opportunities for cultural and political participation, social services, finding decent employment, and housing (Cohen, 2006). Cities can be identified "as centers of modern living, where female labor force participation is greatest and where indicators of general health and wellbeing, literacy, women's status, and social mobility are typically highest" [Cohen, (2006), p.64]. Furthermore, city dwellers have typically better access to education and personal healthcare, are more highly educated, and enjoy the majority of paid employment opportunities. The fact that cities are characterised by a high population density even reduces the influence of humans on the local ecosystem since the per capita cost of providing infrastructure and basic services such as electricity, water, and sanitation is lower compared to the costs for inhabitants of rural areas (Cohen, 2006).

On the other hand, the speed and the scale of the urbanisation movement arise various challenges and risks, in particular "to the immediate and surrounding environment, to natural resources, to health conditions, to social cohesion, and to individual rights" [Cohen, (2006), p.64]. The ongoing number of migrants moving to cities together with a growing native population lead to an increasing urban poverty rate especially in urban areas in the world's poorest countries whereas the local authorities are struggling to provide basic services and infrastructure to their citizens which leads to the emerge of shanty towns and squatter settlements (Cohen, 2006). Next to challenges affecting the quality of life of city dwellers such as congestions, non-digitalised public services and a lack of efficient public infrastructure, issues with negative impact for the environment intensify such as the unsustainable choice and insufficient use of resources alongside with an increasing production capacity, water and air pollution, and an oftentimes inadequate public waste and recycling system (Kalhor and Mahdisoltani, 2015). The metabolism of cities can be described as the input of goods and the output of waste impaired with the rely on mostly external resources and the consumption of resources which leads to economic, social, and ecological issues (Albino et al., 2015). Inadequately planned urbanisation processes conditioned to a lack of public capacity for the management of sustainable urban development in combination with unsustainable production and over-consumption of resources "can impair sustainability due to urban sprawl, pollution and environmental degradation" [UN, (2019), p.1].

In the last two decades, the idea of smart cities emerged as an approach to meet the challenges arising from the urbanism "to tackle urban prosperity, livability, and

sustainability issues mostly through the means of technology solutions" [Yigitcanlar et al., (2019), p.1]. While the conceptualism and framework of smart cities are more comprehensive than only the technological dimension, especially in the initial period smart city approaches mainly targeted on implementing the newest technologies with main focus on ICT to the infrastructure of cities (Albino et al., 2015). Examples of technological smart city solutions are smart streetlights, environmental monitoring tools, optimised waste collection, garbage surveillance, autonomous vehicles using smart sensors, massive data centres, and automated grids. Contrarily to the mainly technology-focused approach of the initial period, later arising citizen-centred smart city models focus on benefiting the citizens themselves by offering a smarter way of living and engaging them to use smart city solutions instead of introducing the smart city approach top-bottom only (Woetzel and Kuznetsova, 2018). This search is aiming at advancing a comprehensive understanding of the smart city approach to support the development of smart city models and frameworks which engage multiple stakeholders in the urban development process and use technology in the most benefiting way to achieve desired social, economic, and ecological outcomes.

2 Current state-of-the-art of the smart city conceptualism

According to the challenges arising from the urbanisation movement, Albino et al. (2015, p.4) describe a rising need for the development of urban growth concepts with "solutions which enable transportation linkages, mixed land uses, and high-quality urban services with long-term positive effects on the economy" as well as a "high-quality and more efficient public transport that responds to economic needs and connects labor with employment". Kalhor and Mahdisoltani (2015, Chapter 4)state as the key factors of sustainable urban development the improvement of the quality of life of city dwellers and the addressing of environmental issues while "fulfilling requirements of current generation without causing limitation for next generation's facilities and capabilities to fulfil their requirements". As the key concepts for urban sustainable development are stated the "prevention of environmental urban pollution, decreasing production capacity and supporting recycling, discouraging non-profit development and fading poor and rich differences" [Kalhor and Mahdisoltani, (2015), Chapter 4]. Furthermore, the principles are stated that sustainable urbanism is not based on the concept that natural resources can be replaced with technologies, and democratic principles should be applied instead of a domineering approach. The following requirements have to be fulfilled to achieve sustainable urban development: "Developing social equality for citizenry, improving communion and social correlation of citizens, improving social and familial basis, strategic approach for urban sustainable development, developing urban culture for urbanized societies, increasing efficiency of urban policies, developing citizen rights and urban legislation, developing urban education for citizens, requesting citizenry for continuous evaluation of urban management systems [and] paying careful attention to environmental concerns" [Kalhor and Mahdisoltani, (2015), Chapter 4].

One conceptualism coming up to meet the requirements for a sustainable urban development is the smart city approach, whereas the term 'smart' prevailing the current state of art over alternative adjectives because smartness is associated with being more user-friendly and appealing to stakeholders than for example the term 'intelligent' which simply describes the ability of quick processing and responsiveness to feedback. Smart

cities have added the capability to adapt to customers' needs with the use of customised interfaces (Marsa-Maestre et al., 2008). After the definition approach of the Centre on Governance (2003, Chapter 1, p.5) "the 'smart' adjective has come to signify innovation, creativity, or attractiveness in products, services or in new ways of doing business". In the smart city and urban planning context, the use of the term "smartness in smart growth is treated as a normative claim and ideological dimension" [Nam and Pardo, (2011), p.283, referring to Centre on Governance (2003)]. In this context, smartness is closely connected with strategic directions as the government and all levels of public administration include the notion of smartness in their policy-making and program development to advance sustainable urban development and support economic growth. For governmental and public organisations "'smartness' is most likely to imply a strategy to achieve more efficiency, integration and transparency in their program solutions, often with the aid of technology" [Centre on Governance, (2003), Chapter 1, p.5]. Smart technology including thinking machines and the use of artificial intelligence contribute to offering city dwellers smart solutions and "reduce the cost of gathering information about usage patterns – and with an unprecedented volume of data points in hand, city governments, employers, and residents can find new ways to optimise existing systems" [Woetzel et al., (2018), p.2]. Offering smart solutions and technologies goes above of adding digital interfaces to traditional infrastructure, but being citizen-focused and improving the quality of life of city dwellers and allow them better informed and efficient decision-making using real-time data (Woetzel et al., 2018).

In the current state of the art, there is no uniform definition of the term 'smart city', which leads to various definition approaches, which are mostly conform in certain parts. The literature mainly agrees on the use of technologies and the pursuit of resource protection, improvement of the life quality of city dwellers, and sustainability in the urban transformation process (Gorynski et al., 2019). After Caragliu et al. (2011, pp.67–68), a city is smart when the following requirements are fulfilled: The "utilization of networked infrastructure to improve economic and political efficiency and enable social, cultural, and urban development" [referring to Hollands, (2008), p.308], an "underlying emphasis on business-led urban development" (referring to Hollands), a "strong focus on the aim of achieving the social inclusion of various urban residents in public services", a "stress on the crucial role of high-tech and creative industries in long-run urban growth", "profound attention to the role of social and relational capital in urban development", and "social and environmental sustainability as a major strategic component of smart cities". The current frameworks trying to illustrate the smart city approach are mostly characterised by a lack of consecutiveness of development drivers and desired outcomes (Yigitcanlar et al., 2019) and a lack of integration of sustainability in the urban growth conceptualism (Ioppolo at al., 2019), which leads to the development of more consolidated conceptual frameworks as the input-process-output-impact model by Yigitcanlar et al. (2018).

The model bases itself on the assumption that the smart city transformation can be approached by the impact resulting from desired outcomes, which are based on outputs realised by the successful operationalisation of assets and processes including key drivers. The assets as main inputs result from the smart city transformation pursuit initiated by the city itself, which are put into use by various processes including key drivers of the domains policy, community, and technology. By the successful operationalisation of the city's assets and the key drivers "sustainable and knowledge-based development outputs-i.e., in the economic, societal, environmental,

institutional development domains [are generated]- to achieve desired outcomes" [Yigitcanlar et al., (2019), p.3]. The desired outcomes are "i.e., productivity, innovation, livability, wellbeing, sustainability, accessibility, governance [and] planning", whereas the resulting impacts from the outcomes are able to put the smart city transformation process into effect. Contrary to currently available frameworks limited in their theorisation of the smart city conceptualism, the model after Yigitcanlar (2018) is presenting a system of system view (McLoughlin, 1969), includes sustainable development as a key factor into the smart city notion and technology is regarded only as an enabler next to community and policy for achieving the desired outcomes. The conceptual framework implies "a consolidated notion of smart cities, and seeks ways for achieving desired urban outcomes for an effective and efficient smart city transformation" [Yigitcanlar et al., (2019), p.3]. The following definitions underlie the conceptual framework: A "smart and sustainable city is an urban locality functioning as a healthy system of systems with sustainable and balanced practices of economic, societal, environmental and governance activities generating desired outcomes and futures for all humans and non-humans" [Yigitcanlar, (2018), p.108].

Contrarily to the smart city model evolution stated before, in another literature source the smart city 2.0 period is described to still pursue a technology-driven and not citizen-centred approach, whereas the communities themselves instead of tech-companies take actively the initiative of introducing and making targeted use of technologies to improve the quality of life and prosperity of citizens. Differently to that, the previous smart city 1.0 model is defined as technology-driven mainly enhanced by tech-companies promising efficiency and innovation to communities with a low focus on the actual benefit for citizens. The point of view that technology is only a mean for addressing issues and realising opportunities for urban development was introduced as the smart city 3.0 evolved model, whereas city dwellers and other stakeholders are actively engaged and put in the centre of focus. Only if they are convinced and willed to use offered technological solutions to satisfy their needs, the implementation of the technological infrastructure and applications can be evaluated as sustainable and successful. While the authors state that the smart city 3.0 model describes the current stage of the smart city conceptualism evolution, the 4.0 model provides an outlook on the future and describes an increasing engagement with various groups of stakeholders. The concept of a smart city is extended to an understanding of smart cities as a measurable ecosystem for a targeted and needs-oriented improvement of processes and the increase of the attractiveness of the commune. The municipality introduces itself as a platform that relies on the collective intelligence of stakeholders for its further development in order to create an ecosystem, which is developable under the participation of multiple actors (Gorynski et al., 2019).

The centuries ago found metaphor of the invisible hand by philosopher and economist Adam Smith can be applied to the modern smart city approach as well. After Smith, the self-interested actions of many parties can lead to larger benefits for economy and society, which can be observed as an outcome of the smart city notion as well for example when companies offer mobility services for the purpose of profit-generating while the quality of life for citizens improves at the same time as congestion, emission rates and the commute times decrease due to a more efficient mobility concept. Also, individual decisions and actions of residents can lead to a more significant benefit for the collectivity making cities more responsive and efficient; for example, when residents use smart devices based on real-time data to identify less busy travel times, which minimises

the volume of traffic and congestion for everyone affected. A requirement for the successful urban development is that the municipal governance must ensure to minimise potentially negative effects of the smart city transformation process so that all residents and not only single groups receive benefit. To ensure equity when it comes to smart solutions, city dwellers of all demographics should be encouraged to engage online as a majority of smart solution applications work best with a smartphone or other mobile devices. The smart city approach can be initiated by adding specialists, new roles such as a chief digital officer, and cross-disciplinary units oriented towards urban and technological transformation with the respective skills to as many areas of the municipal government as possible. The smart city approach also sets new requirements for not only tech-companies to adapt their products to new market opportunities and customers' needs; for example, in real estate, properties are increasingly equipped with sensors, automation systems, and security applications. While implementing the infrastructure and applications falls mainly into the responsibility of the public sector, the initial investments are not only made by the city government but increasingly by private-sector companies focusing on revenue-generating investments. Private-sector companies, universities, state-owned utilities, and non-profit organisations can participate in the smart city transformation process adding new points of view and creativity. For enhancing public-private partnerships, cities should function as a platform bringing together multiple actors from the private and public areas, while the role of the municipal government is mainly to regulate, providing subsidies, and connecting stakeholders (Woetzel et al., 2018).

Woetzel et al. (2018, p.1)primarily focus on the impact of smart solutions for the urban development and state, that smart technologies used in comprehensively smarter cities contribute to "understand how demand patterns are changing, and respond with faster and lower-cost solutions". A three-layer model is presented as a smart city concept which states the interaction of correlating layers as a requirement for the smart city transformation: The first layer is given by a technology base which equips the given traditional physical and social infrastructure with high-speed communication networks and open data portals connecting sensors and devices such as smartphones to record and exchange data about variables as traffic flow, air quality, and energy consumption. Smart applications using data analysis capabilities build up the second layer and translate raw data into alerts, pattern, and insights whereas tools and apps are already available in multiple domains affecting urban life such as energy, security, mobility, waste, housing, economic development as well as in social areas like the community and its engagement. As the authors approach a citizen-centred understanding of the smart city notion, the critical success factor of smart technologies in urban areas is characterized by the actual adoption and usage of the offered smart solutions by stakeholders and the community in order to make better decisions, which builds up the third layer of the model (Woetzel et al., 2018). High-income cities are ahead of developing cities in building the underlying technology base while "even the most advanced cities are only about two-thirds of the way toward achieving what constitutes a fully comprehensive technology base today in terms of the extent of sensors and devices, the quality of communication networks, and the presence of open data portals" [Woetzel et al., (2018), p.9]. In general, the technology base is stronger developed for cities located in North America, China, Europe, and East Asia diversely to cities in Africa, Latin America, and India, which lack especially in capital-intensive infrastructure investments like the installation and connection of sensors (Woetzel et al., 2018). The comparison of 50 cities worldwide shows that the smart city

transformation process takes place faster in wealthier urban areas while the awareness and usage of offered smart solutions remain still critical and technological advances are not fully accepted and used on a regular basis in many of the examples. The highest adoption of smart cities can be found in Asian megacities as urban problems are extraordinarily high, and especially young citizens tend to be digital natives. Even the leading cities in the smart city development are not exploiting the full potential of available smart city solutions, and many cities have not implemented yet the applications that would potentially have the most significant impact on their urban development (Woetzel et al., 2018).

Kymäläinen et al. (2014) state science fiction storyboarding as a mean for the development of technology and design innovation, advancing an experience-centred design concept of future technologies to centralise the user experience instead of only the usability of technological advances. An elementary finding of the research of Woetzel et al. (2018) states that smart city applications can have a positive effect of 10%–30% improvement rate on quality-of-life indicators as health, safety, environmental quality, social connectedness and civic participation, time and convenience, and the cost of living. Smart technologies are often characterised by the fact that they affect more than one quality-of-life aspect of urban development as smart traffic lights, for example, have a positive effect on mobility, emission rate, and safety. The outcome of smart applications varies from city to city depending on the given requirements for their implementation and the legacy infrastructure. In the considered study, digital or data-based technologies with a high adoption rate and best-in-class effectiveness were considered, which are commercially available, used and proven in practice and targeted to solve public issues with the city playing at least a passive role in their application and implementation. Smart applications can improve public safety by 8%–10% preventing road traffic, fatalities from homicide and fires and in terms of crime prevention incidents of burglary, robbery and assault could be decreased by 30%–40% using real-time crime mapping for highlighting patterns, predictive policing and home security systems while deaths can be prevented by gunshot protection and smart surveillance. A faster emergency response is possible with optimised call centres and field operations, while traffic signal preemption can minimise the time taken to arrive to the scene of emergencies. Especially in megacities, the quality of life for citizens is affected by insufficient public transport systems, while by 2025 the commuting times for cities using smart mobility applications could decrease by 15%–20%, and real-time information can be used to enable riders to adapt their routes to delays and breakdowns. Installing IoT sensors can support predictive maintenance and fixing problems before they occur and affect the efficiency of the public transport, and collected data can support the optimisation of the traffic flow by improving bus routes, adding bike lanes, and install traffic signals. Congestion can be mitigated by syncing traffic lights, smart parking-apps, and real-time navigation for preventing delays and selecting the fastest route. Digital devices play an increasingly important role in the healthcare field using digital devices as remote patient monitoring systems, which take vital readings to pursuit required treatment proactively and monitor conditions sending data to doctors for assessment. So-called mHealth notification to educate citizens after data-based risk profiles for example about sanitation and child health, infectious disease surveillance systems, and telemedicine are examples for fields of applications for technological advances in healthcare, which can be lifesaving (Woetzel et al., 2018).

With growing consumption patterns and the upward trend of urbanisation and industrialisation, technological advances can support sustainability by cutting of

emissions up to 10%–15% using automation systems applied in commercial buildings and homes, intelligent traffic signals and dynamic electricity pricing, reduce water consumption by 20%–30% using water consumption tracking, and lower the volume of unrecycled solid waste with initiatives as digital tracking and payment for waste disposal. Especially megacities in Asia benefit from real-time air quality information provided by air quality sensors which analyse data to the sources for air pollution and give city dwellers real-time information for taking protective measures. In terms of social connectedness, digital applications such as digital apps and platforms can make citizens feel more connected to their local government and community, while local officials can act more responsive about concerns and comments of citizens using social networks and interactive citizen apps. Critics claim that especially big cities can feel anonymous and unipersonal, which can be enforced by technology, but on the other side technological advances properly initiated can support building up online communities with common interests and hobbies which come together also offline. Despite the fact that jobs in the administrative field might be cut, smart city technologies are expected to have a positive impact on the employment as new work fields as tech-related, maintenance and temporary installation jobs are created and a more efficient mechanism of employment is introduced with e-career centres and digital hiring platforms. The skillset of a city's workforce can be advanced with online retraining and education programs, and the digitalisation of tax filing, business licensing, and permitting can reduce bureaucracy and lead to more entrepreneurial efficiency. A consequence of urbanisation, especially for high in-demand cities, are housing shortages, inflating rents and home prices while the supply of housing can offset prices and can be enhanced by digitalising processes susceptible to risks and delays as land acquisition, design approvals, and environmental studies. Smart technologies can lower the cost of living for citizens with savings resulting from: a more efficient use of utilities, lifestyle wearables that can contribute to the quality of life of citizens, and the use of mobility applications as e-hailing which are an alternative to the ownership of private vehicles (Woetzel et al., 2018). A concern of some residents might be to be exploited by high prices for smart technology advances, but the study shows that "the average person could save as much as 3% on current annual expenditures" [Woetzel et al., (2018), p.9].

Additionally to what has been carried out before, O'Grady and O'Hare (2012, p. 1581) state Ambient Intelligence, shortly AmI, state as one key factor of the smart city transformation "an intrinsic link between individuals and their environment, enabling individuals to access and interact with computing artifacts in ways that are intuitive and do not disrupt everyday activities". AmI may contribute to a safer and less energy-consuming environment and be realisable conditioned to advances in robotics, embedded systems, and sensor technology with the requirement to address fundamental privacy and security concerns. While the potential of AmI can be found in multiple domains and proof-of-concept services, the challenge is still to turn this potential into practical implementation in terms of intelligence, scalability, and robustness. Another challenge is the deployment of more sophisticated software using complex software algorithms in order to meet high requirements demanded from pioneering AmI services. In what way AmI services will be part of future smart city concepts, and how people will accept and adopt them, will be shown while the authors expect high potential for smart grid and energy efficiency applications. As AmI is closely connected with all areas of urban life, O'Grady and O'Hare (2012, p.1581) expect AmI services in many domains to "emerge organically, though it terms of governance and administration, a top-down

approach may be anticipated". As soon as AmI will assert themselves as a solid component of the smart city conceptualism, issues of security, privacy, and ethics have to be publicly discussed (O'Grady and O'Hare, 2012).

As a main aspect of the smart city conceptualism is the collection of sensitive data by governments and private-sector companies, next to opportunities for sustainable and targeted urban development also critical issues and concerns came up. While the use of measured and collected data can have a positive impact on social interaction and informed decision-making, the evaluation, especially of real-time data, induces short-term thinking and management while urban development should be based on long-term planning (Batty, 2013). Relying on the Internet of Things, shortly IoT, smart cities can be affected in a severe way by cybersecurity vulnerabilities as hacker attacks, because "compromised security systems, medical monitors, and self-driving cars could pose life-and-death risks, and the consequences could be severe if bad actors shut down a city's power grid or water supply" [Woetzel et al., (2018), p.16]. Especially sensitive assets have to be protected with high standards of security, sufficient security standards have to be adopted to critical IoT applications before they are applied on a large scale, and the city government should constantly update its cybersecurity expertise while being aware of the steadily evolving threat environment(Woetzel et al., 2008). Another concern raising is the dependence on technologies and their providers and the potential cutback on the personal freedom conditioned to governmental surveillance and economic data usage (Günthner, 2017). The Internet of Things development is criticised to not pursue a human-centred approach, but instead treating humans as data-producing objects which are controllable by their data and are powerless against non-transparent automatism. According to Meixner (2016), the Internet of Things concept is promoting the gradual expropriation of private data and the invasion of privacy of individuals. Within the privacy of humans, a source for value creation in the form of human decisions that reflect the behaviour of people can be found which is of great interest for companies using data for profit-generation. Human decision-making is especially interesting for the IT-industry because machines themselves cannot make decisions and interpret or explain data because they are not capable of causal relationships. Therefore, the approach is that machines imitate human performance and decisions by statistically evaluating received measurement data, called Big-Data. By observing the decision-making behaviour of people in various situations, machines are progressively able to increasingly simulate human performance. This is important for industrial development because robots can be developed that can replace human labour in multiple working fields (Meixner, 2016).

3 Methods

The research is implying a fourfold methodological approach inspired by Yigitcanlar et al. (2019): Firstly, the current state of the art of the smart city term definition and conceptualism is pointed out whereas a lack of a comprehensive understanding of the smart city approach can be identified. The evolution of the smart city definition from a technology to a citizens-centred approach is shown, and smart city models with changing focus and main initiators over time are presented. A model of the smart city notion showing an example of components and layers building up smart cities to support sustainable urban development, the correlation between stakeholders and technology, and success factor for the sustainable implementation of the smart city notion is introduced.

Furthermore, drivers and key aspects of the smart city approach stated in the literature are shown, and points of criticism on the smart city conceptualism are highlighted. Moreover, the significance of the technology in the smart city approach is evaluated, and the opportunities and benefits, especially for citizens and environment, are discussed. Secondly, the conceptual smart city framework by Yigitcanlar et al. (2018) giving a comprehensive view of smart cities from an input-process-output-impact model perspective is specified, which combines how inputs provided by the city itself and processes including key drivers can operationalise to desired outcomes which support the smart city transformation. Contrary to concepts with an insufficient understanding of the smart city notion, the presented framework includes sustainable urban development in the smart city conceptualism and shows further dimensions besides technology that contribute to the smart city transformation. Thirdly, the presented smart city conceptual framework is used as a lens to analyse the smart city best practices of pioneering cities in Germany and Italy with a focus on the core part of the framework built up by dimensions of technology, community, and policy. In order to present the case studies of the pioneering cities in the background of the current state of development of the smart city transformation of both countries, Italian and German government programs and initiatives, as well as the current state of development, are presented. Lastly, an analysis of the findings of the case studies of the best smart city practices is conducted, and an outlook for further research is given.

4 The best practice of Italian and German Smart Cities

4.1 The current state of Italian smart city transformation process

In this section, we provide an overview of the concept of urban metabolism, recently applied in the context of sustainable urban planning and design and policy analysis. Below we highlight the importance of the use of information and communication technologies (ICT) to collect, analyse and provide feedback on the flows of materials and energy, caused by the actions of planners, industries and citizens, in real time, to optimise the energy and material flows of a city, through more informed decisions. The next paragraph begins with an analysis of the Italian political and economic context in which the first smart city strategies emerged; the analysis continues by emphasising the role of the European Union in spreading the concept of ‘smart city’ in Italy and its first implementations. The section ends with the case studies of the three pioneering cities in Italy: Milan, Florence and Bologna. In order to decide which Italian cities are at the forefront of the transformation of smart cities, the annual report of FPA, ICity Rank 2019 was used, which photographed the situation of 107 municipalities, which contribute to becoming intelligent and sustainable. The evaluation of the Italian cities was carried out on the basis of six dimensions: environmental protection, social quality, economic solidity, social transformation and governance capacity.

4.1.1 The Smart city strategies in Italy

Yigitcanlar

A political approach centred on the idea of smart city represents an innovative scenario for Italian development policies; development strategies in Italy are implemented at the

municipal level, characterised by a high degree of freedom, and extensive coordination at the sub-regional level (Crivello, 2015). The smart city strategy was introduced at national level by article 20 'Intelligent communities' of the Cresci Italia law decree (179/2012 converted into law 221/2012). In order to coordinate this new political strategy, a technical agency of the Council Presidency was set up, the Agency for Digital Italy that "defines strategies and objectives, coordinates the implementation process and prepares the technological and economic tools for the advancement of intelligent communities" (art.20, 179/201). A strategy at national level was developed in the Italian Digital Agenda in order to achieve the objectives of the European Agenda. Furthermore, the aforementioned law defines smart cities "as a technical and measurable form of defining and policies based on standards and statistics" (Smigiel, 2018). The Italian government has highlighted how the idea of an intelligent city represented one of the pillars of the Italian digital agenda, providing financing plans for smart city projects for almost a total of one billion euros. The so-called "Smart cities and communities and social innovation program" of the Ministry of Education, University and Research included two calls for proposals; the first invitation addressed exclusively to the cities of southern Italy (Ministerial Decree n. 84 / Ric. Del 2 marzo 2012) with the aim of reducing the economic and technological gap between north and south; the second (Ministerial Decree No. 391 / Ric. of 5 July 2012) has been extended to the whole country (Crivello, 2015). The smart city program is thus also conceived as a policy of cohesion, which is used to correct and improve the current existing competitiveness in southern Italy (Crivello, 2015). Furthermore, it is important to underline how smart cities represent an essential aspect of metropolitan cities as indicated in the national metropolitan cities operational program (Pon Metro). The Pon Metro program is part of the national urban and urban development agenda, and focuses on the sustainability of services and mobility, on the digital metropolitan agenda and aims at improving energy efficiency. The metropolitan cities concerned are those established by the Delrio Law in 2014 (Turin, Genoa, Milan, Venice, Bologna, Florence, Rome, Naples, Bari, Reggio Calabria, Cagliari, Catania, Messina and Palermo) leading to an important change, installing a new level of strategic planning (Smigiel, 2018). In Italy, smart cities represent a state-led political strategy, but there is no shortage of interventions by different actors that play an important role (including regions, cities, businesses and more Association of Italian national common (ANCI). In fact, ANCI has made an observation for smart city activity centre (Osservatorio National Smart City) with the aim to collect, map and monitor all types of activities in smart city Italy (ANCI, 2017).

4.2 Case of Milan, Italy

4.2.1 Background

The metropolitan city of Milan covers an area of approximately 1,575.65 km^2 and includes 133 metropolitan municipalities, with a population of over 3 million inhabitants. In the spring of 2013 the Milan smart City path was started by signing a protocol between the Municipality of Milan and the Milan Chamber of Commerce. The public hearing instrument was used. The first city forum on the topic was created, with the aim of involving the main actors in the development of the city, around the creation of a consultation and governance system. All this has led to the creation of thematic working groups that correspond to the traditional pillars of Smart Cities: Smart Economy, Smart

Living, Smart Environment, Smart Mobility, Smart People (Milan Smart City – guiding lines). By participating in the European Sharing City project, Milan faces important environmental challenges, such as the reduction of carbon emissions and means of transport, as well as how to regenerate air quality.

4.2.2 Technology

It should be emphasised that the starting point for the creation of an 'intelligent' Milan exists and is represented by the 'digital Milan' characterised by infrastructures, such as the dense fibre optic network, wifi hot spots and on a series of interventions such as digital islands, portals and open data. They were created with the aim of creating a hospitable and attractive city and having the right to adapt to multiple changes, thanks also to the policies put in place such as temporal ones and the analysis of big data. Environmental quality and energy efficiency are the pillars on which the construction of intelligent public and private buildings is concerned. The goal of Milano Smart City, to improve the quality of the environment, translates into an improvement in the quality of its citizens, through the reduction of pollution, innovative public lighting (installation of intelligent street lamps equipped with sensors) and efficiency measures energy in buildings, in waste management, and in the creation of an intelligent network to manage energy in the city. In addition, Milano Smart City has brought about an efficient reorganisation in the management of the demand for mobility through an improvement in the use of public transport and parking and parking systems. Milan becomes the leading city in the experimentation of sharing and peer-to-peer mobility, promoting competition and the dissemination of enabling platforms.

4.2.3 Community

"Milano Smart is a city where each individual is unique" and where each type of 'intelligence' and diversity creates value (Milan Smart City-guidelines), allowing each citizen to offer their own conscious contribution. A mapping of the Stakeholders was carried out with the aim of identifying the subjects interested in the implementation of a smart process, who can contribute through research and innovative ideas, or even through real investments in the creation of an 'intelligent' Milan. The goal is to create an inclusive and intelligent city through the use of new technologies that allow a social rebuilding between public and private resources, cooperation among stakeholders and promote multiculturalism. The existence of Milano Smart City is closely linked to smart Citizens, i.e. active and aware citizens who take part in the public life of the city (Milan Smart City-guidelines). For this purpose it is necessary to eliminate some barriers, such as overcoming the digital divide, and at the same time to promote a culture of well-being, as well as respect for and improvement of the environment and public places. Management of greenery and public places includes the participation of stakeholders in the process of achieving well-being, in the dissemination of new interactive forms and digital culture.

4.2.4 Policy

Milan Smart City, through the streamlining of measures and the simplification of bureaucracy, wants to facilitate the relationship between institution and private

individuals. The Municipality of Milan identifies in the Open Government paradigm the way to create an open Public Administration, which gives value to innovation in relation to businesses and citizens. One of the pillars of this strategy is represented by open data, a central element to guide transparency and innovation in the Public Administration. Open Data are a tool that allows citizens to access public information and data through innovative apps and platforms. Therefore, the way is to use the technological lever, to extend access and quality of services, through the creation of an information system suitable for the development of online services addressed to the citizen. The e-Government project supported by Assolombarda made it possible to sign a memorandum of understanding with the INPS to stimulate the s tangle of e-Government services. A cooperation has also been activated with the PIM (Metropolitan City Studies Center) to encourage the drafting of a strategic plan related to digital and e-Government issues. The agreement with the Milan Chamber of Commerce will lead to a rethinking and redesigning of the one-stop shop for productive activities (SUAP).

4.3 Case of Florence, Italy

The metropolitan city of Florence covers an area of approximately 3,514 km^2, and includes 41 metropolitan municipalities, with a population of over 1 million inhabitants. Smart cities are sustainable cities, and the city of Florence takes the opportunity to become an 'intelligent' city starting from the Sustainable Energy Action Plan (SEAP), approved following the city's accession to the pact of Mayors in 2010. The Plan provides for a 21% reduction in CO_2 emissions into the atmosphere by 2020, and aims to look further: 40% reduction by 2030, going as far as 2050 with a target of 70% reduction. The analysis of CO_2 emissions in the atmosphere, carried out on the occasion of the drafting of the Plan for Action for Sustainable Energy in Florence, showed us how mobility is the most responsible sector, with its 34%. Therefore, the city has prepared the realisation of a project integrated with technology and info mobility, which incorporates all the interventions aimed at achieving the goal of Florence eco-city, also through the realisation of the Urban Mobility Plan (PUM). In addition, the city has recently equipped itself with new urban planning tools: Structural Plan (approved in 2011) and Urban Planning Regulations (operational since 3 June 2015) based on 'zero volume' urban regeneration (Firenze Smart City Plan, 2019).

4.3.1 Technology

For digital cultural progress in the city and the economic development linked to innovation in Florence, a strategic element is represented by ICT. The objective of Florence, to be extended to all neighbouring municipalities as it is a wider territorial context, the metropolitan one, is to encourage new digital services, and to encourage citizens and businesses to use them in order to ensure an improvement in the quality of life of the city. A success factor of the city is represented by the possibility of using a public wireless network, as well as the use and distribution of sensor networks, such as traffic monitoring and surveillance, monitoring of tourist traffic, urban safety and high applications of the Internet of Things that will be gradually made accessible to 2050. also in relation to social care services can play lot experiments aimed at elderly people with diseases efficient , thanks to a post-hospital monitoring focusing on the l' use of sensors and highly trained specialised personnel. As regards access to public sector information,

an open data project is envisaged with a gradual improvement in the quality and number of published data. Florence has also promoted open data experiments created by citizens. A user generated the 'Florence sound map', published as a data set. Other technology-related interventions are represented by the development of the traffic management centr, smart parking and the sensor system. Specifically, an integrated traffic management platform is created , consisting of a traffic supervisor who performs its functions through systems located within the city of Florence: camera system, UTC (traffic light control), AVM to track traffic in real time, traffic detection sensors, CITYWORKS (management system for mobility ordinances), information systems on the percentage of occupation of parking lots, PMV (variable message panels), and ZTL (telematics access portals in the traffic area limited (Florence Smart City Plan).

4.3.2 Community

The Municipality of Florence has considered communicating and sharing them with the partners as an essential factor, already in the preparation of the SEAP/Action Plan for Sustainable Energy, and later also for the preparation of the Structural Plan and the Urban Planning Regulations Stakeholders. More generally, including citizens in decision-making processes, making them involved, means making an administration transparent, which provides adequate information on the actions it intends to plan, and which is predisposed and capable of listening and communication. By providing the necessary tools and information, it allows you to create spaces for listening and gathering ideas from the neighbouring cities ('listening marathons'), and then disseminating the results obtained and letting you know the decisions taken and policies implemented (Florence Smart City Plan). All this in a dimension not only strictly urban, but in a wider dimension, that of the Metropolitan City. The Municipality of Florence implements a Communication Plan, as an integral part of the Smart City Plan, which includes not only unilateral actions by the body promoting the plan towards citizens, but continuous interactions, with the aim of keeping the citizen informed throughout the existence of the Plan. In addition, the municipality of Florence is also reviewing the infrastructure of its digital communication channels also in the dialogue between the Public Administration and citizens. A significant example is represented by the digital signage network that has led to the creation of a synergy between several subjects (Municipality, Theatres, hospital, University) who contribute to the production of content , and to the management of digital schedules of over 40 digital systems present in the metropolitan area (Firenze Smart City Plan, 2019).

4.3.3 Policy

A Smart City is characterised by the quality of life offered to citizens and by greater attention to the environment. Within this context, the Public Administration must become 'exemplary', making its pre-established objectives its own, involving the participation of citizens, tourists and other public bodies (Firenze Smart City Plan, 2019). Having to be an example, the Municipality, after joining the Covenant of Mayors, has implemented annual monitoring of its consumption. The first monitoring shows that the Public Administration already reduced the required minimum threshold by 20% in 2012 compared to 2005. Therefore, a priority of the Municipality of Florence was to make the Public Administration efficient, and managerial and operational methods were used to

achieve this objective. In addition to the figure of the Energy Manager, appointed in compliance with current regulations, and with the role of monitoring and implementing the existing planning systems, the figure of Mobility Manager was established as a reference figure, in the field of mobility, in relation to the CO_2 emissions throughout the territory. In particular, the figure of the municipal Mobility Manager has the task of coordinating the implementation of the home-work travel plans (PSCL) of the entities and companies in the Florence area, with the aim of optimising interventions on mobility; and to this end a "Memorandum of Understanding was signed to promote the use of local public transport (LPT) and sustainable mobility in the Florentine metropolitan area" (Florence Smart City Plan), in collaboration with the Tuscany Region, the carriers of public transport and the Metropolitan City. A sharing service has been activated on vehicles, where there are electric vehicles powered by certified green electricity at the Municipal Administration of Florence. Since 2005, several thermal power stations have also been transformed from diesel to methane, and old generators have been replaced with efficient boilers, leading to a benefit in economic and environmental terms. While in many public buildings and sports facilities, thermal and photovoltaic solar panels have been installed, r inspectively for the production of hot water and electricity. Within this framework, we can affirm that in a Smart City perspective, the Public Administration must be as efficient, inclusive and innovative as possible.

4.4 Case of Bologna, Italy

4.4.1 Background

The metropolitan city of Bologna covers an area of approximately 3,700 km^2 and includes 55 metropolitan municipalities, with a population of over 1 million inhabitants. On 30 July 2012 the Municipality of Bologna in collaboration with the University of Bologna and Aster (from May 2019 ART-ER) signs a memorandum of understanding for the creation of the Bologna Smart City platform, in order to rethink the city through the use of ICT, and favouring a green footprint for its inhabitants. The Bologna Smart City platform has identified seven thematic priorities on which to implement its actions and to collect adhesions from entities and companies interested in developing partnerships for specific actions. The seven Bologna Smart city themes were: Cultural heritage, that is, enhancing and requalifying the historic center and its cultural heritage; Iperbole 2020 Cloud & Crowd, i.e. redesigning the Iperbole Civic Network, founded on cloud technology and an integrated digital identity; Smart networks, i.e. Smart grid, Ultra broadband fibre to the home (FFTH) and smart lightning; sustainable mobility, i.e. the development of an intelligent electric mobility network; Sustainable and safe neighbourhoods, for example through the reform of public and private heritage in terms of efficiency and energy production, monitoring the safety of buildings, co-working, waste management; health and welfare, through process optimisation and business intelligence, e-care, e-health; education and technical education, through the development of projects in these areas.

4.4.2 Technology

In December 2009, the Smart Services Cooperation Lab was born in Bologna, from the collaboration between the Ministry of Public Administration and Innovation, the CNR

(National Research Council) and Telecom Italia SpA, in order to implement synergic actions to make the e-government plan, and to encourage the spread of the use of ICT technologies, as well as innovative tools and services with the aim of improving the quality of public administration services. The mission of the 'Smart Services Cooperation Lab' centre is 'from technology to service', with the aim of transforming the most advanced technologies into innovative services that can be used by public bodies, businesses and citizens (OICE, 2017). The projects are characterised by the digitisation of cities through the creation of power lines (smart towns) and the intelligent control of buildings (smart buildings). Particular attention has been directed towards issues, such as smart green grid (energy management intelligently) and smart environment (the development of sensor networks). The city of Bologna on 2 October 2013 in Brest was awarded by the European Commission in the context of the CIVITAS Awards 2013, thanks to the initiatives to encourage the use of bicycles and sustainable mobility (Bologna Smart City, 2019). The Municipality has also started collaborations with the company Enel Sole, with a view to an energy reform and to an integrated management of public lighting systems, activating a control system on over 60% of the luminaires in the city, to monitor and regulate operation of the bright centre.

4.4.3 Community

With regard to citizen involvement, the Municipality of Bologna has activated the Iperbole 2020 project, a platform dedicated to citizen inclusion practices, through the use of social media. The platform presents all the projects, which promote the territory on the basis of Bologna's vision of itself. Iperbole wants to aggregate all the initiatives carried out by users in the various areas, involving new interactions between the administration and the citizens, the latter also becoming protagonists, not only consumers, of services, ideas and solutions. Another project that aims to create new relational approaches between the city, citizens and its public and private bodies, is represented by the 'BazzAPP' initiative, a system that is based on two elements: the BazzAPP, ie temporary mobile apps which represent the unmissable opportunities that institutions and companies make available to users; and BazzaaR, consists of a platform that has the task of directing BazzAPPs to users also through the use of Augmented Reality (Smart City Bologna). A project characterised by the participation of citizens is represented by Im-possible living, a project aimed at managing the marriage of abandoned buildings throughout the territory. This makes it possible to view buildings in the area, to report other buildings and to suggest new ideas. The multi-partner ICity project, co-financed by the European Commission, on the other hand, aims to create services that are of public interest, and that actively involve the citizen, and the other actors, through the innovative approach of crowdsourcing and co-design in relations with the community. These services created through the use of ICT infrastructures will be integrated with the services offered by the Administration, increasing the offer aimed at digital and non-end user needs.

4.4.4 Policy

In 2012 the Municipality of Bologna adopted its own SEAP, representing the tool with which the Municipality, in collaboration with other public and private subjects of the city, intends to reduce CO_2 emissions. 20% by 2020, as required by the Covenant of Mayors promoted by the European Commission, to which Bologna joined in 2008. The actions

envisaged by the Plan for the reduction of 20% of CO_2 emissions by 2020 concern six areas: tertiary and production sector, local energy production, interventions on residential buildings, interventions on municipal energy consumption, urban forestry, mobility and transport (OICE, 2017). The same year, exactly on January 14, 2012, the City Council approved an act that proposed the adoption of a Digital Agenda, with the aim of setting the lines of action in the digital field in order to enhance the rate of sustainability and innovation. in the Bolognese urban system. On October 29, 2012, the Municipality of Bologna adopted this strategy by allocating funds for a value of € 100.000, for the development of objectives and actions proposed in the Digital Agenda. For the evaluation of the participants' proposals, a specific Scientific Committee and a Participation Guarantor have been appointed, a figure external to the Municipality of Bologna. The Municipality of Bologna also adheres to the Open Municipal project, a platform that aims to provide official data of the Public Administration, in open formats (open data), with the aim of offering free information to citizens and encouraging their active participation (Agenda Digital Bologna). The city of Bologna is characterised by an important propensity to the network and technology, taking fast steps towards the creation of an information society and the global market; in this context, the Public Administration has adopted an infrastructure investment policy, aimed at reducing the digital divide and creating a broadband network linking public buildings and schools. All this made possible thanks to the strong predisposition of Bolognese citizens towards the web and technologies, creating a growing demand for services and products.

4.5 Case studies of pioneering German smart cities

4.5.1 Case study of Hamburg, Germany

4.5.1.1 Background

Hamburg is a city in the north of Germany with over 1.8 million citizens and an area of about 760 km^2 (Fraunhofer IESE and Bitkom, 2019). Additionally to the previous e-government and IT-strategy, which focused mainly on increasing the efficiency of administrative processes (Senate Chancellor, n.d.,a), the 'Digital City' strategy was implemented by the Senate in 2015 and requires the active participation of all city authorities, instructing them to develop digital strategies for their specialist tasks. The aim of the strategy is to make technical innovations usable for the urban development and to transform Hamburg into a digital city, whereby industry, science, and administration work together in close exchange with each other, and required structures must be provided (Fraunhofer IESE and Bitkom, 2019). The strategy addresses challenges such as the digitalisation of value chains of economic activities and the daily lives of citizens, promoting economic strength, prosperity, and innovation. Emphasis is laid on developing a digital infrastructure, the setup of digital communication channels between the Senate and the citizens, digitalisation of public transport networks and infrastructures, and promoting partnerships, networks, and cooperation, especially with private companies and organisations (Senate Chancellor, n.d.,a).To advance the digital transformation, the 'City Science Lab' was founded, which is a cooperation between the HafenCity University and the research institute MIT Media Lab. The City Science Lap uses urban data to develop digital city models so-called 'City Scopes' that help understand complex urban development processes and support actors in different positions in decision making. Furthermore, projects on digital participation, urban platforms, and e-culture in

the context of the digitalisation of cities are promoted, and the city of Hamburg itself is serving as a 'Living Lab', where urban processes are closely researched, and useful digital applications for urban transformation are developed (HafenCity University Hamburg, n.d.).

4.5.1.2 Technology

The City of Hamburg is committed to offer well-developed broadband networks in cooperation with private companies and to set up public Wi-Fi hotspots at many locations in the city, which will benefit citizens as well as tourists and business travellers. In the field of education, intelligent educational networks and digital services are available to schools and universities facilitating access to education. Digital applications are used to save energy and reduce greenhouse gas emissions, and the Internet of Things movement will continue to be driven forward supported by partnerships with private companies such as Cisco and Microsoft (Senate Chancellor, n.d.,a).Urban data management will be driven forward by the implementation of the 'urban data hub' online platform, which supports the identification of areas with innovation potential and enables the real-time analysis of traffic, environmental, and economic data available to citizens and other stakeholders. The city is implementing in terms of 'intelligent transport systems' around 60 smart mobility projects to advance the state of autonomous bus transport, intelligent parking or construction site coordination to ensure the safety, efficiency and environmental friendliness of the urban transport system and to offer citizens more comfort (Fraunhofer IESE and Bitkom, 2019).A pioneering digital project is the port of Hamburg, the so-called 'SmartPort', which uses the current state-of-the-art digital intelligence with world-leading control systems, which puts Hamburg's harbor into a pioneering role in Europe. "The interaction between sensor technology and analysis, forecasting and information systems delivers huge efficiency improvements" (Hamburg Port Authority, n.d.), which also have a positive effect on aspects of environmental protection to promote sustainable economic growth. The philosophy of the Hamburg Port Authority is aiming at minimising the negative impacts on the environment while maximising the benefits of all stakeholders, especially customers and Hamburg's city dwellers, while processes and technologies are stately advanced and improved. Led by a PortTraffic centre the smartPORT logistics use smart solutions for optimising infrastructure, traffic flows, and the flow of goods enabling smart networking of traffic and operations as "optimum data capture and rapid information sharing allow logistics managers, carriers and agents to select the most efficient means of transport for their goods" (Hamburg Port Authority, n.d.). The flow of traffic is improved by providing real-time navigation, infrastructure information, and the current traffic volume, as well as free parking spaces and the closure of moveable bridges. Sensors placed at frequently used sections of the harbour railway transmit real-time data about the condition and possibly upcoming maintenance work, which allows preventive repairs and decreases downtime. A mobile GPS sensor sending data about the location of vehicles and machines to the IT system of the harbour contributes to intelligent fleet management and provides information about weather conditions and the flow of the Elbe. Mobile end devices are used to monitor the infrastructure, including bridges, roads, and plants, sending data and measurements to the harbour's IT system in order to optimise maintenance processes. A smart application for trucks allows to identify the nearest free parking spot and offers the opportunity to reserve them to advance smart parking management and optimised use of parking spaces

to relieve neighbouring city districts of Hamburg. A software called 'Port Monitor' is implemented, which centralises information about vessel-positions, bridge heights, and water level data to keep stakeholders updated and which can be accessed remotely on land and water. In terms of sustainability, the smartPORT focuses on the efficient use of existing infrastructure and networks and increasingly promoting renewable energy as wind and solar power while research is done on new opportunities provided by bioenergy as huge amounts of biomass are accumulating at the harbour area (Hamburg Port Authority, n.d.). The energy consumption is reduced by decreasing the dependency on non-renewable energy sources and reducing emissions while increasing energy efficiency and sustainable means of mobility. E-mobility is promoted by using electric vehicles in road transport and increasingly in passenger and freight traffic, while the charging infrastructure is extended "in collaboration with the operators of public charging pillars [and a]t the cruise ship terminal, [it is planned] to use preferential e-Taxis" (Hamburg Port Authority, n.d.).

4.5.1.3 Community

The main stakeholders in the digital transformation process include citizens and businesses whose interests are taken into consideration by promoting user-centric urban development processes with IT-security and data protection playing a particularly important role. Methods such as design Thinking are used to bring stakeholders from businesses, administrations, and citizens into the digital transformation process (Fraunhofer IESE and Bitkom, 2019). The city administration has set up the online platform 'Transparenzportal', which is an information register that gives citizens access to current data and information such as messages from the Senate to the citizens, official statistics, activity reports, studies, geo-data, and information about subventions (Senate Chancellor, n.d.,b). The Senate does not aim for an exclusively top-down approach, but a smart city transformation needs to involve multiple stakeholders as citizens in both strategy development and project implementation, and national and international partnerships are promoted with actors of economy and research (Senate Chancellor, n.d.,a). An example of a project initiated by the city that demands the participation of citizens is the 'finding places' project, which is a cooperation project between HafenCity University Hamburg and the city of Hamburg. Using interactive city models, a total of 400 participants proposed areas that could be used for the construction of refugee accommodations, and the most promising suggestions were taken into practice after both advantages and disadvantages were widely discussed (HafenCity University Hamburg and the City of Hamburg, 2016).

4.5.1.4 Policy

Under the leadership of the Chief Digital Officer, the Department for IT and Digitalisation as a part of the Senate Chancellery is in charge of the digital transformation process of Hamburg with regard to the overall strategic direction of the city and the digitalisation of city's administration. In addition to cross-authority strategic planning, coordination of cross-authority processes and topics, and monitoring of progress, the department is also responsible for communicating the digital transformation to stakeholders. The city administration aims at using smart technologies and digital applications to improve the quality of life of citizens and enhance the economic

attractiveness of the city. In order to benefit from the full potential of digital innovation within the framework of the 'Digital City' strategy, the infrastructural requirements for the development of innovation have to be provided, and cooperation between business, science, and administration has to be promoted. The city administration attempts to meet the upcoming socio-demographic challenges such as the effects of demographic change on the labour market and the increasing number of residents, which enhances the need for intelligent solutions for meeting the growing volume of traffic, consumption of resources and the rising demand of residents for the digitalisation of administrative services whereas the automation of administrative tasks and optimisation of the provision of resources present possible solutions. In order to involve citizens in the digital transformation, the city administration is aiming to uphold a multi-channel communication to inform about upcoming initiatives and projects and convince skeptical citizens of the benefit of using innovative technologies for their everyday life. By 2022, the city's citizens should be able to conduct government procedures and services online, with the 'Digital First' program supporting the administration to make online service delivery as user-friendly as possible by automating procedures, promoting digital communication and making use of the once-only-principle to input data (Fraunhofer IESE and Bitkom, 2019).

4.6 Case study of Karlsruhe, Germany

4.6.1 Background

Karlsruhe is a city in the southwest of Germany with over 300,000 citizens and an area of about 180 km². The city describes itself as one of the leading digital locations in Europe characterised by a high number of IT students and an extensive IT-related research landscape driving innovation forward and increasing the economic attractiveness of the city. The city is actively working on shaping its digital future and pursues the vision of establishing Karlsruhe as a centre of technology. In 2014, the city's Science Office was assigned by the City Council to develop a communication concept in order to establish the city of Karlsruhe under the title 'internet capital'. In the following representatives from politics, science, administration, and economy decided to implement a comprehensive concept instead of exclusively a communication concept, based on a project report including the definition of success factors, the specification of the current and target state of development as well as measures and initiatives to achieve the target status (Fraunhofer IESE and Bitkom, 2019). The initiative was presented to the public in 2016, and in 2017 Karlsruhe selected to participate in the Digital Hub Initiative of the Federal Ministry of Economic Affairs and Energy in the core area for applied artificial intelligence (Federal Ministry for Economic Affairs and Energy, n.d.,b). Karlsruhe is already stated as one of the leading digital locations in Europe while the digital transformation is essentially being driven forward by the initiative karlsruhe.digitalin order to engage with experts of the domains administration, economy, science, and society as well as to promote networks and partnerships to advance innovation and knowledge exchange (Fraunhofer IESE and Bitkom, 2019).

4.6.2 Technology

The city establishes itself as a centre for technological progress and development with 4,400 IT-companies, 10,000 computer science students, 30,000 IT-workplaces, and 25 research and development facilities. For example, the FZI IT Research Centre deals with autonomous driving and robotics, the Karlsruhe Institute of Technology focuses on technology, environment, and computer science and the FIZ Karlsruhe-Leibniz Institute researches on information-infrastructure and electronic data archives. The companies based in Karlsruhe cover sectors such as research in the ICT-sector, business software, and IT security, whereas a wide range of offers for professional development and retraining are offered. Karlsruhe is an attractive economic location, especially for start-ups as the city offers a unique start-up scene, and IT and high-tech incubators support companies in different phases of business development (Karlsruhe.digital, n.d.,a). The city supports the innovative start-up scene initiated network 'Gründerallianz Karlsruhe', which connects start-ups with established companies, institutions, universities, research centres and experts, organises events for networking, and provides advice and useful information to founders (Gründerallianz Karlsruhe, 2017). In order to offer the necessary infrastructural requirements for the digital transformation, the city is working on the expansion of broadband networks, the digitalisation of public services (Karlsruhe.digital, n.d.,b) and an area-wide IT infrastructure using digital applications as parking lot sensors and hygrometers to build up an energy-saving and cost-effective intelligent network of technology. Additionally, a test field for autonomous driving was introduced in Karlsruhe where companies and research institutions have the opportunity to test new technologies and services in the field of autonomous and networked mobility for future-oriented solutions in the fields of individual and public transport (Fraunhofer IESE and Bitkom, 2019).

4.6.3 Community

The city describes itself as a living lab enabling new opportunities to integrate innovations advanced by the city's network consisting of research institutions, companies, and start-ups into the daily lives of its citizens (karlsruhe.digital, n.d.,b).The network 'CyberForum', with its 1200 members, including start-ups, companies, and universities, is the largest regionally active network of its kind in Europe and has been awarded as the best IT-cluster in Europe (Karlsruhe.digital, n.d.,c). Additionally to the 'CyberForum', the 'karlsruhe.digital' initiative, networks as the 'K3- Kultur- und Kreativwirtschaftsbüro Karlsruhe', 'EnergieForum Karlsruhe' and 'automotive engineering network' have been found to initiate communication and exchange between experts on topics such as cultural industries, energy and mobility (Fraunhofer IESE and Bitkom, 2019). The 'CyberLab' initiated by the 'CyberForum' was funded as the IT accelerator of the state of Baden-Württemberg, where promising IT start-ups can get support, mentoring from experienced entrepreneurs and a start-up workspace where founders can exchange advice and develop their business ideas further (CyberLab, 2018). Another state-funded initiative is the 'Lernfabrik 4.0', which rebuilds the production plants used in the industry 4.0 sector exemplarity's cooperation project between two vocational schools as a competence centre for industry 4.0 with focus on automatisation and information technology (Lernfabrik 4.0 Karlsruhe, 2019). In the area of ICT education, a broad variety of interdisciplinary degree courses and extracurricular learning

opportunities is offered to raise citizens' awareness of digital change and to include citizens of all ages in the process (Karlsruhe.digital, n.d.,b). Among the stakeholders of the city are the urban society, specialists, students, companies and founders, which are offered digital citizen services, an administration office equipped with technical applications to provide citizen services digitally, the Augmented History App 'Stadtgeist' and public Wi-Fi Hotspots. In order to advance the communication with stakeholders the City of Karlsruhe offers workshops, events, and citizen surveys and is working on the development of a multi-functional app for citizens, which is part of the federal state program 'Digitale Zukunftskommune@bw' which funds projects and concepts implementing innovative technologies to advance the digital transformation of German cities and to improve the quality of life their citizens (Fraunhofer IESE and Bitkom, 2019).

4.6.4 Policy

The city administration uses digital applications and technologies to connect the areas of administration, smart government, and the interest of citizens to digitalise and simplify citizen services and to provide the highest quality of life possible for citizens (Karlsruhe.digital, n.d.). Since 2017, the Office for Information Technology and Digitalisation in responsibility for the topics e-government, open data and IT security implements IT projects such as a multifunctional app for citizens, the digital optimisation of the city website, and the establishment of the research centre 'DigitalLab' in the town hall. The city's digitalisation efforts are mainly driven forward by the Karlsruhe. Digital initiative, which consists of a leading committee made up of actors from the fields of science, economy, culture, and administration, and 11 working groups dealing with digital aspects and success criteria critical for the digital transformation process. An office was established as a medium between the members, for the implementation of projects, as a contact point for external requests which is built up by representatives of the Science Office of the city and the earlier mentioned business network 'CyberForum'. The initiative crosses disciplinary and hierarchical barriers and advances the digital transformation of the city through an innovative way of working (Fraunhofer IESE and Bitkom, 2019). Furthermore, several ICT security institutions are located in the city in order to maintain the digital sovereignty of the actors and to expand security standards (Karlsruhe.digital, n.d.,b).

4.7 Case study of Leipzig, Germany

4.7.1 Background

Leipzig is a city with nearly 600,000 inhabitants and an area of 300 km^2 in the east of Germany. In 2015 the city started with the digitalisation of the administration processes, and the smart city transformation of the city was mainly pushed forward, especially in the areas energy, mobility, and IT-infrastructure with the participation in the European Union funded project 'Triangulum' (Fraunhofer IESE and Bitkom, 2019). 'Triangulum' is one of the lighthouse projects initiated by the European Union to develop and test smart city solutions and frameworks in so-called lighthouse cities which then are introduced to follower cities to advance the smart city conceptualism and transformation of European cities and communities. The lighthouse projects will be tested in Manchester, Eindhoven,

and Stavanger, whilst the selected follower cities are Leipzig, Prague, and Sabadell. These projects will genuinely benefit from the "interdisciplinary experience and expertise of 22 partners from industry, research and municipalities" and the focus of the innovative projects has been mainly laid on "sustainable mobility, energy, ICT and business opportunities" (Fraunhofer IAO, 2018). The project is funded with a total of 30 million Euros in the period of 2015 till 2020 with the target to develop flexible smart city solutions and a smart city framework adaptable to European cities which take characteristics and individual challenges faced by the cities into consideration. The city of Tianjin, located in China, is currently implementing a smart infrastructure and applications to engage with its citizens and functions as a so-called observer city in the 'Triangulum' project to contribute with critical policy development work in exchange of best practices developed in the project. The metropolitan area has a major economic importance due to an economic output twice as high as the national average, and its participation brings actors in the private and industrial sector of the involved cities in the project, providing them with the opportunity to enter the Chinese smart city market by knowledge transfer and partnerships (Fraunhofer IAO, 2018).

Furthermore, the city is represented in the European Union initiated program 'Central Europe' with the funding projects 'LOW-CARB' and 'EfficienCE' which both aim at advancing low-carbon mobility services and infrastructure to reduce emissions (Fraunhofer IESE and Bitkom, 2019). At the federal level, Leipzig was chosen in the digital hub initiative of the Federal Ministry for Economic Affairs and Energy as the digital hub in the domains smart systems and smart infrastructure with focus on smart cities, e-health, and energy(Federal Ministry for Economic Affairs and Energy, n.d.,b) and was funded as part of the 'Sofortprogramm Saubere Luft 2017-2020', which aims to achieve short-term improvements of air quality of German cities (Fraunhofer IESE and Bitkom, 2019). Especially the western part of the city plays a pioneering role in the smart city transformation process and serves as a laboratory for the development of ideas and objectives as the challenges for the development of the district are particularly diverse. As the western parts of the city have undergone a transformation from an industrial to a residential area, facing challenges in the urban areas of living, economy, and mobility, the district is well placed on testing alternative concepts for energy, water, and sanitation. With residents showing a special commitment to proactively share suggestions and ideas for improvements, that part of the city has a high potential to take a pioneering role in the overall transformation process of the city (City of Leipzig, 2019).

4.7.2 Technology

Technological solutions in the fields of energy, transport, and economy have not yet been sufficiently developed, but the transformation process has been initiated by the implementation of pilot projects and initiatives. A particular challenge lies in the digital transformation of administrative services since the automation of processes replaces human work and leads to the reduction of workplaces in specific employment fields, which is faced by the city administration with professional training of the affected employees. In order to convince the citizens of the benefits of the driven digital transformation, the advantage of facilitating and simplifying administrative processes by automation is emphasised by the city administration. Sustainability opportunities in the context of a possible exit of coal-fired power generation are advanced by the further development of smart grids, together with the municipal services provider of the city

promoting the development of regenerative and intelligent energy systems by in real-time controlling ICT infrastructure, decentralised storage solutions, block chain technology for carrying out micro transactions, and algorithms with artificial intelligence to forecast energy demands. An urban data platform was created, which collects and analyses urban data from the areas of environment, mobility, energy, and economy and evaluates them in real-time to identify potential for improvements and optimisation (Fraunhofer IESE and Bitkom, 2019).

4.7.3 Community

As stakeholders, the city counts local businesses, representatives of the 'Leipzig Group', which consists of city's transport companies, municipal waterworks, public services, and public swimming pool provider, the citizens and the fields of science and research. The smart city transformation in Leipzig is unique because not only a top-down approach of the city administration for the implementation of projects and initiatives can be observed, but also citizens and companies proactively advance urban transformation and seek dialogue with the city (Fraunhofer IESE and Bitkom, 2019). In order to enable stakeholders from urban society, economy, and science to participate in the urban transformation, events called 'Zukunftslabore' were organised to develop potential solution concept addressing challenges of the smart city topics intelligent living, mobility, and the digitalisation of administration processes. Additionally, the 'Zukunftsforum' decision-making committee was introduced, which consists of the city's mayor, the managing directors of the 'Leipzig Group', as well as interested members of the city councils to discuss topics like smart grids and intelligent mobility, and to agree on interdisciplinary projects. In this way, the overall strategic direction of the city can be discussed with representatives from politics, business, and administration, and strategic decisions can be made in the alignment of economic and urban development goals. Citizens have the opportunity to inform themselves about the current state of the art of the 'Triangulum' project and to contribute their own ideas and points of critics at events organised in the western part of the city. Workshops and discussions are held with a focus on climate-friendly living, sustainable mobility, intelligent living, and engagement of stakeholders, whereas suggestions of the participants contribute to recommendations for action for the city administration (City of Leipzig, 2017). Additionally, a series of expert lectures called 'Hotspots der Stadtentwicklung' were organised by the city of Leipzig and the city of Leipzig planes to increase the participation with stakeholders in the future by the expansion of workshops and discussions and the involvement of more stakeholder groups. Another platform for creating long-term partnerships and connecting local businesses of all sizes with financial resources and innovative ideas is the association 'Netzwerk Energie & Umwelt'. Additionally, the City of Leipzig is actively engaging on the nationwide smart city platform called 'Dialogplattform smart cities', initiated by the Federal Ministry of the Interior, Building, and Community, and is in intensive exchange with the members of the 'Triangulum' project. The city administration primarily communicates with stakeholders over the aforementioned workshops, events, and platforms as well as projects and city websites, whereby a communication strategy including press work and social media communication is planned (Fraunhofer IESE and Bitkom, 2019).

4.7.4 Policy

The topics of digitalisation and smart city transformation are not centralised in the city's administrative organisation, but are distributed among various departments and offices: The Department of General Administration deals with IT coordination and administrative digitalisation, the Department of Urban Development and Construction with the urban geo-information system, and the Department of Economics, Labor and Digital Affairs established a separate Digital City office, which leads and coordinates the digital transformation process of the city. In addition, the department seeks conversations with stakeholders such as citizens and companies on digital topics and passes on suggestions and proposals for improvements to the city administration. The city administration faces upcoming challenges against the growing traffic volume and energy demand, conditioned to the increasing number of citizens with digitalised processes and services, to mitigate issues alongside promoting sustainable urban growth. The City of Leipzig wants the digital transformation to benefit citizens and companies, and therefore engages its citizens to participate in the urban development process and promotes the diversity of enterprises located in Leipzig by increasing its attractiveness as a business location with benefits for start-ups and new businesses. In 2019 the program 'Digitale Werkstatt' has been found, where representatives from the city administration and the city's sub company LECOS developed an adaptable organisation and process model for developing innovative solutions in the field of e-government and services (Fraunhofer IESE and Bitkom, 2019).

5 Discussion and conclusions

The urban development of the City of Leipzig is characterised by a high level of commitment from citizens and other stakeholders, which is further met by workshops and events initiated by the city administration. In addition, the knowledge transfer and stakeholder cooperation are driven forward by numerous networks, organisations, and platforms, which promotes the communication and exchange between city, economy, and citizens. The participation in the EU-funded project 'Triangulum' points the way of the smart city transformation of the city with a smart city framework and digital solutions, which were tested in the lighthouse cities and will be implemented in the City of Leipzig. While the citizen engagement, the participation in several projects, initiatives and programs, as well as initiatives founded by the city administration are key drivers, the City of Leipzig is still in the initial stage of the smart city transformation process and is staying behind in terms of technological infrastructure and implemented digital applications. On the one hand, the city shows high potential with networks of stakeholders and a diverse business landscape while, on the other hand, basic infrastructural and technological framework conditions have to be met, and the digital transformation has to be advanced.

In summary, it can be concluded that the City of Hamburg is playing a pioneering role in the smart city transformation approach of German cities conditioned to projects as the 'smartPort', the 'Finding Places' initiative and the provision of online platforms such as the 'Transparenzportal' in order to introduce the current-state-of-the-art technologies to the city's infrastructure and engage with stakeholders. Similar in Italy is the Milan situation for the Smart city program implemented.

Although the City of Hamburg is recording large-scale progress in implementing digital application and the dimensions policy, technology and community presented in the smart city framework by Yigitcanlar et al. (2018) are considered in the smart city approach, the interaction and collaboration between key drivers and stakeholders could be improved. Remarkable is that the city administration approaches the smart city transformation nearly exclusively with digitally transforming the main areas of the city, which indicates that a mainly technology-focused view on the smart city notion is followed.

Bologna for the Italy situation is the most complete case analysed with the seven Bologna Smart city themes were: Cultural Heritage, Hyperbole 2020 Cloud & Crowd, Hyperbole Civic Network; Smart grid, Ultra broadband Fiber to the Home (FFTH) and Smart Lightning; Sustainable mobility.

In some ways the situation is similar to the city of Florence, where the technologies implemented (especially ICT), are mainly linked to the cultural and museum industry.

The city of Karlsruhe is characterised by a high technological standard and promising innovation potential due to the wide range of companies and a large number of IT students and research institutes contributing to the digital transformation. Especially in the IT and high-tech sector, the city is highly attractive as a business location and supports the start-up scene with numerous networks and an IT and high-tech incubator which provides support and expertise from specialists. Furthermore, the city's technological infrastructure is highly developed and the 'karlsruhe.digital' initiative is advancing the digital transformation process.

Sustainable and safe neighbourhoods, building safety, co-working, waste management; health and welfare, through the optimisation of processes and business intelligence, e-care, e-health; education and technical education, through the development of smart city projects should be included in the development model.

The research landscape is very extensive, and educational opportunities, especially in the IT sector, support the qualification of specialists and promote the exchange of knowledge.

Despite the city's pioneering role, especially in the digital field, it can be criticised that representatives from industry, research, and educational institutions are mainly involved as stakeholders, while more opportunities for participation should be offered to all citizens.

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