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Reconceptualizing smart cities in a 5.0 scenario: a service ecosystems' approach. The case of Bologna

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Abstract

Purpose: The current vulnerable socio-economic context presents new challenges to be handled. The smart city arises as a concept capable of addressing these when it is analyzed according to a holistic approach. In this regard, this paper aims to detect smart cities through the 5.0 lens, a new paradigm that valorizes the combination of human and technological dimensions in achieving sustainable innovations to foster a resilient attitude.

Methodology: To explore how smart cities shape resilient behaviors, a multi-level analysis is required. To this end, a reinterpretation of smart cities through a service ecosystem view is accomplished. Particularly, an explorative qualitative approach is chosen by analyzing Bologna Smart City as a case study.

Findings: The findings enabled the development of a theoretical framework that identified the strategic drivers of city resilience, harmonized by the orchestrator role of governance that fosters sustainable innovations and, in turn, resilience. This framework could help scholars and practitioners to shed light on the key role of smart governance in the development of a resilient city.

Research limitations/implications: Reinterpreting smart cities as a service ecosystem and analyzing the trigger process to shape resilience is the main theoretical contribution. Managerially, this study can help city managers and planners design tailored strategies to foster resilience across urban actors at multiple levels. As per limitations, the case study does not allow generalization of results, therefore calling for further research in other city contexts.

Originality/Value: Existing research has started to focus on the concept of smart city, no conceptualization of holistic analysis of smart city management has been addressed, particularly investigating how resilience is shaped.

Keywords: smart cities 5.0; resilience; service ecosystems; Bologna Smart City; sustainable innovation.

Paper type: Research paper

1. Introduction

The present environmental, societal, and technological challenges have brought cities to advance reliable and sustainable solutions (de Jong et al., 2015; Neirotti et al., 2014; Yigitcanlar, 2022) for granting city livability and collective well-being. In this regard, smart cities have emerged both as a concept and a managerial solution that could address these challenges and contribute to generating sustainable innovations and city resilience. As a concept, smart cities increased their popularity in the 1990s with the emergence of information and communication technology (Alawadhi et al., 2012) for sustainable urbanization (Albino et al., 2015; Susanti et al., 2016). Nowadays, smart cities are widely discussed in academic research: computer science and information systems, environmental, and urban engineering and management scholars have focused on defining and arguing for smart cities (Albino et al., 2015; Caragliu et al., 2011; Mora et al., 2019; Yigitcanlar et al., 2021). Indeed, research zoomed in on detecting different features of smart cities, such as technological and digital infrastructure, environmental sustainability, city management, telecommunication, energy building, and transportation (Ingwersen et al., 2018). Consequently, over the years, researchers have advanced different definitions, for which there is still no agreement (Guendez et al., 2022). This is due to the fragmented research, which pushes the consideration of this topic still in its infancy (Alizadeh, 2017; Praharaj et al., 2018). Accordingly, assuming one singular perspective to detect smart cities does not allow the embracement of their inner complexity. For this reason, a holistic approach is clearly required to capture the different facets of this topic. Despite managerial research having already pointed out this need (Mora et al., 2017), no conceptualization of holistic analysis of smart city management has been addressed. This research gap is even more relevant by considering the vulnerability and complexity of current socio-economic contexts, which require a fundamental paradigm shift aimed at

- balancing economic growth with contemporary social and environmental issues;
- considering challenges proffered by human-machine interactions and the correlated skills (Breque et al., 2021).

In this regard, Society 5.0 arises as a new paradigm that lays the foundations for a wide embracement of challenges emerging in smart cities' management by addressing people, sustainability, and resilience (Breque et al., 2021; UE, 2021). Indeed, this study proposes conceptualizing smart cities through the 5.0 lens, which allows adopting a holistic perspective for smart cities. More in-depth, the 5.0 lens permits drawing the smart city as a complex socio-technical system grounded on sustainable growth in which technological tools and related devices should be negotiated through human interactions and resource integration. Consequently, this paper aims to deepen smart cities through the 5.0 approach, particularly focusing on the building of a resilient attitude.

In this regard, the leading research question is: how does resilience materialize, and which role does it play in emerging 5.0 smart cities?

From a theoretical point of view, considering the multi-layered and networked nature of urban contexts, a system perspective is embraced (Barile et al., 2016; Ciasullo et al., 2020). Thereby, smart cities are reinterpreted as a service ecosystem (Akaka et al., 2013; Vargo et al., 2015; Barile et al., 2021), which allows a deep analysis of how resilient infrastructures, processes, and behaviors are implemented by shaping a resilient attitude.

From an empirical point of view, an explorative qualitative study is conducted, focusing on the Bologna Smart City case study.

Accordingly, the contribution of this paper to the available body of knowledge on smart cities is twofold: first, it proposes a rereading of smart cities through a service ecosystem lens; second, it proposes a theoretical framework to design resilience in sustainable smart cities.

The article proceeds as follows. Section 2 contains the theoretical background on smart cities in the 5.0 context (Sect. 2.1) and on the conceptualization of smart cities as a service ecosystem (Sect. 2.2). Section 3 explains the research methodology. Sections 4 and 5 outline and discuss the research findings. Eventually, Section 6 proposes implications and conclusions.

2. Theoretical Background

2.1 Framing smart cities in a 5.0 environment

Rapid urbanization, gentrification, social exclusion, climate change and related environmental and health issues, and fierce competition due to resource scarcity are all increasing challenges for cities. It is estimated there will be an exponential growth of the global population living in cities by 2050 (UNEP, 2018). Cities' consumption of natural resources such as primary energy, raw materials, water, and food is 75% of the globally available (UNEP, 2012). At the same time, global emergencies such as Covid-19 and related socio-economic disasters have prompted scenarios characterized by high complexity and uncertainty in which the above-mentioned challenges may be even more difficult to cope with, thereby calling for renovated approaches to urban planning. Thus, also given the centrality of digital technologies, the smart city model is among the newest (Taamallah et al., 2017; Trindade et al., 2017; Wiig, 2015; Aina, 2017; Pettit et al., 2018; Yigitcanlar, 2005, 2006). Smart cities are urban systems that employ advanced computing technologies to shape their infrastructure and services (administration, education, healthcare, transportation, etc.) more intelligently (Washburn et al., 2010) and are rooted in the interplay of three dimensions, i.e., technological, human, and institutional (Nam and Pardo, 2011; Ciasullo et al., 2020), or physical, institutional, and digital (Komninos, 2013). Thus, they generally involve technical architecture (technology) managed by government (institutions) and individuals (humans) to enhance the well-being of the entire social system. According to this definition, at its first stage, smart cities have been investigated from a technocentric point of view: scholars intended the smart city as a place in which urban problems are solved thanks to digital technologies, thereby referring to almost any form of technology-based innovation in the planning and development of cities (Battarra et al., 2016; Harrison et al., 2011; Yigitcanlar et al., 2008). From this perspective, physical infrastructures were considered the unique innovative driver (Al-Hader et al., 2009; Serrano, 2018), which granted the improvement of services offered to citizens, exploiting the interconnected information that integrated devices provide (Caporuscio et al., 2022). This stream of research also refers to multiple shades of smart cities, such as digital cities, where urban problems were handled through technologically sophisticated tools and interfaces (Aurigi, 2005), and intelligent cities (Komninos, 2008), intended as a set of technologies that create a virtual innovation environment based on multimedia tools, network infrastructures, and interactive technologies, which facilitate market and technology intelligence, technology transfer, and spin-off creation (Komninos, 2008). Furthermore, as digital transformation became central in management research, scholars showed a renewed interest in smart cities by debating the importance of smartness to meet citizens economic, environmental, and social needs. Indeed, this research stream let the enabling role of people emerge, recovering social (strength of relationships among citizens), human (skills of citizens), and intellectual capital (knowledge creation) as central concepts to enhance smart cities' livability and sustainability (Michelucci et al., 2016). Examples of this trend are the so-called human cities (Nam and Pardo, 2011), grounded on multiple opportunities to exploit human potential, stimulating a creative life; sustainable cities (Munier, 2007, p. 43), based on a set of sustainability principles providing the citizenry with a good quality of life; livable cities, with affordable education, healthcare, housing, and transportation; and creative cities (Tay, 2004), as a local urban place that can be reimagined, rejuvenated, and repurposed for improving social well-being.

However, despite the wide emphasis on the social side of smart cities, two main critical points still need investigation:

- on the one hand, important technological issues are still neglected, such as security and privacy of data, digital divide (Yigitcanlar et al., 2022; Visvizi et al., 2025), and technological anxiety (i.e., users' anxiety, fear, skepticism, distrust in using smart services for their personal and professional life - Lytras et al., 2020);

- on the other hand, only a few scholars in the managerial field (Kumar et al., 2016; Ciasullo et al., 2020) focused on the digital-driven process of value creation for both citizens and users in smart cities. Consequently, an isolated discussion on technological, human, or social features does not allow the embracement of the overall complexity of smart cities.

In this regard, the need to investigate smart cities by adopting a holistic 5.0 view able to stress human, cultural, environmental, social, economic, and political facets (Ciasullo and Ferrara, 2025; Zhao et al., 2021; Deguchi, 2020) strongly arises.

Indeed, the paradigm 5.0 envisions a human-centered, resilience-oriented society able to merge the digital into the physical space by enabling technologies such as collaborative artificial intelligence to coevolve with and support humans (Deguchi, 2020) and able to bridge and coordinate among each other human and socio-technical systems (Carayannis et al., 2022).

This is becoming even truer in multiple service contexts such as medicine, research, and social welfare: smart technologies need a shared governance to be understood and led toward value co-creation (Camero and Alba, 2019), assuming a transformative role when information, know-how, personal experience, and feedback among all city stakeholders are smoothly exchanged (Polese et al., 2018; Akaka et al., 2019).

Therefore, this paper frames 5.0 smart cities as a combination of structural, socio-ecological, and socio-technical endowments dynamically interacting with each other, which develop following self-organization processes and are oriented by a resilient attitude to face sudden disturbances, allowing the city to absorb shocks while transforming its behavior (Manca et al., 2017; La Sala, 2020).

Accordingly, premised on the human-centered nature of 5.0 technologies and their configuration as proper services (Kunz et al., 2019; Opazo-Basáez et al., 2022) for supporting, integrating, and satisfying people and community needs and taking on a service ecosystem perspective (see section 2.2), this work frames a 5.0 smart city as a set of co-evolutive and intertwined socio-technical, human-centered innovations that tend toward sustainable growth and resilience. This “resilient” understanding, “the ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change and to quickly transform systems that limit future adaptive capacity” (Meerow et al., 2016, p. 39) both in terms of infrastructure planning and self-organization of communities can help configuring a smart city able to cope with continuous disruptive events, thanks to an integrated set of smart, human-centered technologies used to empower citizens through continuous and mutual interactions (Fernandez-Anez et al., 2018; Javed et al., 2022).

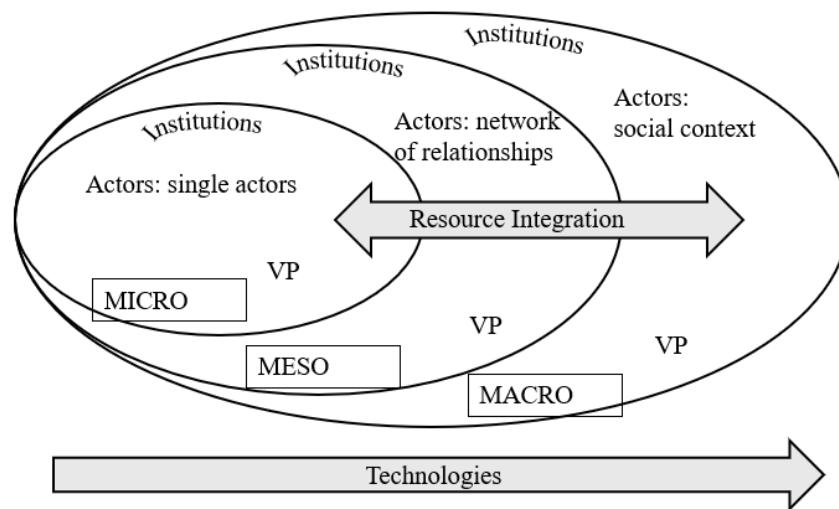
2.2 Reinterpreting smart cities 5.0 as service ecosystems

To frame smart cities in a 5.0 environment, a multi-layered analysis is needed to better embrace their inner complexity. Considering the last development in service research, the service ecosystem view (Chandler and Vargo, 2011; Akaka et al., 2013) appears to be the most appropriate theoretical framework, which detects, through a multi-level perspective, the enabling drivers for generating sustainable growth towards the emergence of resilient behaviors. It reframes social systems as embedded systems of actors that exchange resources more easily thanks to digital technologies. Thereby, it can help to conceptualize smart cities as dynamic combinations of technology, people, interactions, and resources that can give birth to the co-creation of sustainable innovations (Azoulay and Jones, 2020). More in-depth, it allows analyzing how sustainable innovative solutions can be pursued systematically using technologies that, through learning-based mechanisms and the involvement of citizens in decision-making, can encourage resilient behavior (Löbner and Lusch, 2014). Service ecosystems are defined as constantly evolving systems that continuously renew their social practices and the processes that drive the development of new knowledge and innovation (Polese et al., 2021; Vargo et al., 2017). Five key elements characterize service ecosystems, such as actors as the generic users actively engaged in the value co-creation process; institutions as norms and social rules, which act as coordination mechanisms to attain shared purposes (Akaka et al., 2013;

Vargo and Lusch, 2016); value propositions as the proposal and the sharing of common values; resource integration as dynamic exchanges of knowledge, skills, and practices that actors integrate in new and unique ways in the co-creation process (Vargo, 2016); and technology as the enabler of digital solutions that improve interactions and actors' engagement (Storbacka et al., 2016; Barile et al., 2017). The described elements are embedded across multiple levels. Particularly, the micro-level investigates interactions between single actors, the meso-level focuses on networks of relationships, and the macro-level zooms in on broader social and institutional context.

Therefore, as shown in Fig. 1, the smart city, reread as a service ecosystem, allows us to identify, at different levels, actors who exchange resources among each other through technologies by also redefining social rules that coordinate service exchanges (Vargo and Lusch, 2017). Moreover, through the dynamic combinations of resources mutually exchanged among actors, the value co-creation process to attain innovation is fostered (Azoulay and Jones, 2020). Then, value co-creation is intended as a complex process through which continuous improvement and ecosystem adaptations and transformations stimulate innovation and social change across cities multi-level contexts by encompassing economic, technological, social, and cultural dimensions.

Fig. 1. Conceptualization of the smart city as a smart service ecosystem.



3. Methodology

3.1 Research design

The exploratory nature of the research question led this paper to adopt a qualitative approach. It is appropriate when there is the need to deepen the knowledge about a contemporary phenomenon that is not well operationalized through quantitative variables (Yin, 1994). Therefore, a case study (Yin, 2003; Eisenhardt, 1989) has been chosen as the most suitable method for this analysis. Indeed, a case study is useful when the boundaries between phenomenon and context are not self-evident and when the aim is to investigate in-depth the dynamics underlying a complex context from a particular standpoint (Eisenhardt 1989; Tellis, 1997).

3.2 Research setting

The study focuses on the city of Bologna, the main city in the Emilia Romagna region (Italy). Bologna is one of the first Italian cities to invest in digital technologies with the aim to improve the livability of city stakeholders. Indeed, in 2010, Bologna's municipality promoted the project called "Bologna Smart City," aimed to better satisfy the needs of the citizens by enhancing the quality of life and also improving sociality, education, and health (Bologna Municipality website). Constantly, the

government has made efforts to develop digital platforms for boosting different urban services, such as Tourism, Mobility, Safety, Welfare (Bologna Municipality website). Particularly, Bologna Municipality, in collaboration with Bologna University, has founded the *Fondazione Innovazione Urbana*, a multidisciplinary center for research, development, and communication of urban transformation that is committed to implementing and promoting several projects. The city's efforts are reflected in numerous acknowledgements that it has gained. Indeed, *SmartCityIndex*, promoted by the Smart City Observatory (born in collaboration between the IMD World Competitiveness Center and the Singapore University of Technology and Design), awarded Bologna as the best Italian smart city in 2025 and 83rd in the world. This index evaluates both technological and human dimensions. Indeed, on the one hand, it measures technological infrastructures related to health, mobility, and safety; on the other hand, it deepens the well-being of the population regarding health, knowledge, and standard of living. Moreover, the *HumanSmartCity 2022* index, promoted by Ernst & Young, considers Bologna as the second Italian city, after Milan, in pursuing ecological and social inclusion and digital transition.

3.3 Data collection and data analysis

To answer the research question, secondary data were collected. The main data sources employed were: the strategic plan of Bologna, the smart projects handled by *Fondazione Innovazione Urbana*, the Bologna Municipality official website, the Bologna Municipality social network page. Therefore, documents that described the strategic approach of Bologna were essential to understanding the proactive behaviour of the municipality, whereas all other documentation was relevant to collect the description, objectives and impacts of the diverse smart projects on the smart city. Particularly, projects from *Fondazione Innovazione Urbana* were considered because it is a multidisciplinary center for research, development, co-production, and communication of urban transformations, serving the construction of the city's future vision, founded by the Municipality of Bologna and the University of Bologna. Indeed, all the sources were produced and maintained by Bologna Municipality and *Fondazione Innovazione Urbana*, which jointly coordinate the smart projects. For analyzing data, a qualitative content analysis was performed, which allowed the extraction of categories from texts (Krippendorff, 2004). Particularly, all the documents about the initiatives promoted by the Municipality of Bologna as well as the smart projects supported by *Fondazione Innovazione Urbana* were included in the analysis. The content analysis was conducted through the support of NVivo software by considering semantic criteria that all the researchers involved established. The semantic criteria were referred to the main enablers of value co-creation in Bologna at micro, meso, and macro contexts introduced in the previous section 2.2. This allowed the semantic interpretation of the texts from which the categories were identified and classified to detect ecosystem's elements in the micro-, meso- and macro-context until understanding resilience across the ecosystem context.

4. Findings

Bologna aims to pursue social, environmental, and economic objectives by reinforcing the principles of equity, accessibility, appreciation, and recognition of societal differences. Innovative services (i.e., smart solutions) are provided to citizens to stimulate sustainable growth, which contributes to the enhancement of their well-being.

4.1 The micro-level

At the micro level, value propositions are linked to the involvement of citizens in the co-design of innovative services by listening to and valorizing their needs and expectations. In this way, active participation in the experimentation and prototyping of city services feeds innovation processes,

where the constant and continuous citizens' involvement allows not only to satisfy their specific needs but mostly to intercept, share, and collect latent needs. This interactive process allows the valorization of citizens' role by stimulating them as enablers of service innovations aimed at sustaining individual and collective well-being. In this way, a collaborative and proactive mindset is stimulated among citizens, allowing them to share their values. Moreover, value propositions are related to a smart use of technology that facilitates citizens participation by shaping digital inclusivity. In this sense, Bologna Municipality promotes projects aimed at teaching the use of technologies for improving digital readiness. Main projects are (see Table 1): "A museum for children," "New neighborhood schools," "Activate the connection," "All Sustainable", "COMTem".

To improve service co-design and to promote digital inclusivity, an integrated set of digital platforms and related tools (such as apps, gamification-based technologies, etc.) are implemented to develop digital skills of citizens. In this way, the ability-propensity of citizens towards the use of technologies is enhanced. The projects are supported by several stakeholders equally involved in the spreading of smart values, such as local government, universities and research institutes, schools, and non-profit associations. Local government actively supports digital inclusion by promoting active participation of citizens that stimulates inclusive growth. Bologna University is involved in the scientific support for the experimentation activities linked to the project of "New Neighborhood Schools." Schools are involved in promoting children and young adults' engagement through the establishment of interactive labs. Moreover, AIAS Bologna Onlus is one of the non-profit associations that work in collaboration with Bologna Municipality to involve people with disabilities actively.

Resources exchanged at a micro-level are based on the sharing of personal experiences through different engaging platforms, easily allowing interaction and training of digital skills. Local government promotes an innovative mindset based on transparency towards a more cohesive, livable, and trustworthy city. Local education institutions and non-profit associations are embedded in citizens' involvement process.

New institutional arrangements are created at the micro-level, thanks to the resources exchanged among actors. These are related to social institutions such as new ways to include fragile people, new forms of citizen participation, and new ways to overcome digital barriers (through gamification), thereby reducing the digital divide.

Table 1—The micro-level

Bologna Smart City: the micro-level	
<i>Project</i>	<i>Aim</i>
"A museum for children"	It aims to build a new museum for children from 0 to 12 years to promote knowledge and educational games by stimulating creativity. Through two open labs, children and young adults discuss their desires, the activities they would like to practice, and the way they imagine how to interact and participate in the museum activities. In this way they are actively involved in co-designing the innovative service provided by the museum.
"New neighborhood schools"	The aim is to achieve a participative process of sharing, listening, and experimentation of students' needs for the renewal of educational practices. Students from primary and secondary schools are involved actively in proposing innovative ideas. In this sense, the project supports young adults in co-designing value propositions aimed at reinforcing social inclusion and cultural welfare against school dropout.
"Activate the connection"	This project aims at assisting fragile citizens (i.e., the elderly, people with physical or mental disabilities, etc.) via technology. The Digital Citizen Desk, as an integrated and interactive interface, allows, thanks to a group of volunteers, to solve small and large technological problems. It supports users with registration and access to online services (e.g., Digital Identity activation), or it gives advice for making more accessible digital communication tools (WhatsApp, mailbox, Skype, etc.). The project aimed at supporting people in accepting technologies and improving their digital skills to decrease their digital divide.
"All Sustainable"	It is an initiative that proposes to use serious games to raise awareness of environmental issues among citizens. More precisely, it involves users in co-designing physical and digital games. In this way, the upgrading of their digital skills is also stimulated. This project is provided by AIAS Bologna Onlus.

“COMTem”	It aims at facilitating global access to digital platforms provided by local authorities by developing clear, scalable, and standardized interfaces. In this way, common rules and methodologies in the provision of services (access levels, subscription methods, procedures, forms) are defined and managed in collaboration with citizens. Thereby, the digital divide decreases, and the possibility to actively involve more citizens arises.
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Source: our elaboration

4.2 The meso-level

At the meso-level, value propositions are related to the emergence of innovative networks with the aim to spread shared goals among city stakeholders and to foster the exchange of educational and relational resources. Then, social connections, interactions, and the sharing of knowledge are stimulated, which continuously restore and renew value co-creation, thereby enhancing co-learning mechanisms. Collaborative and open-innovation projects are put in place, in which users are considered valuable data sources. In this sense, data collection and storage are used to manage services co-delivery. The main projects implemented are “Microbe,” “New Civic Network,” “Bologna Welfare,” “Bologna Solidarity,” and “An agreement with the third sector” (cfr. Table 2).

Table 2—The meso-level

Bologna Smart City: the meso-level	
<i>Project</i>	<i>Aim</i>
“Microbe”	“Microbe” is a project promoted by Bologna Municipality in which university students and technological partners strongly collaborate with the aim to improve the response to the emerging needs arising from the Covid emergency. The project allows the network to strategically search for new ways of teaching and learning, innovating by digital solutions. It well describes the prompt response to the Covid emergency by laying the foundations for a solid preparedness in addressing any other crisis event. In this way, a proactive mindset is fostered.
“New Civic Network”	“New Civic Network” and “Bologna Welfare” are both projects based on software platforms that improve the interactions between the different public local providers, citizens, and businesses. “New Civic Network” aims at simplifying the way citizens and businesses meet public administration by providing a digital platform that collects the digitalized public services (PagoPA, Digital Identity, etc.) in standardized interfaces, taxonomies, and page templates.
“Bologna Welfare”	“Bologna Welfare” is a digital platform in the cloud where users can access their personal documents, filter resources, and interact and dialogue directly with Bologna Municipality. Users can leave comments to improve the platform functionalities and cooperate with the municipality to solve e-services problems in different areas such as health, mobility, education, culture, and leisure.
“Bologna Solidarity”	It is a solidarity initiative and an open innovation that provides free resources in digital and physical environments in which ideas and opinions are shared among citizens, local associations, volunteers, businesses, and social and health workers by creating strong and collaborative networks. Through a digital platform, both new forms of entrepreneurship and social inclusion are reinforced by searching for the fitting solutions for the economic and social needs of the local territory. For instance, elderly people are made part of the economic and social life of the city. This project responds to the value of “proximity” pursued by Bologna Municipality, which increased with Covid-19.
“An agreement with the third sector”	“An agreement with the third sector” aims to shape the creation of social businesses by stimulating an active collaboration among users, Bologna Municipality, Bologna University, research centers (AICCON), and non-profit organizations (ANCI). Through wide networks of partnerships, the development and the growth of local innovative ecosystems are supported by promoting the discussion on actual entrepreneurial challenges and innovating synergistically.

Source: our elaboration

The main digital technologies and smart tools adopted in the projects described are machine learning and artificial intelligence, which allow data collection in real time, and cloud computing, which allows the secure storage of data. These technologies support the co-delivery process by improving the possibilities for service recovery and by encouraging users to solve problems. Moreover, online information desks and mobile applications are implemented for improving users’ experience in the

city, such as the “Bologna Welfare app,” which allows users to easily access documentation, or “Pollicino,” which collects and analyzes in real time users’ information and suggestions, providing timely ecological urban solutions aimed at reducing the environmental impact.

A wide set of actors is engaged in the shaping of embedded networks for co-delivery services in the overall areas of the smart city: citizens, non-profit associations, schools, Public local providers, local institutions, businesses, universities, research centers, and technological partners. Through the synergic interactions among actors’ networks, new modalities to exchange resources are created, so new processes of value co-creation are stimulated. This generates new knowledge grounded on co-learning mechanisms. Citizens, non-profit associations, schools, public local providers, and local institutions assume a key role as innovative problem solvers: they are tightly embedded in resolution issues towards a flexible and resilient mindset. Technological partners, businesses, universities, and research centers play a leading role in the transmission of technological and technical knowledge and in the search for continuous improvement. The main resources provided at the meso-level regard knowledge, creativity, experience, and values, which are exchanged to synergistically deliver innovative service solutions through smart technologies, thereby actualizing an environmental, social, and economic transition. Lastly, institutions are linked to educational, social, and entrepreneurial dimensions. In the first case, new ways of teaching and learning are shaped. In the second case, new forms of sociality through digital technologies and new practices within Bologna city are created. Finally, new forms of doing business and creating new job roles are affirmed.

4.3 The macro-level

At the macro level, value propositions focus on shaping a cohesive smart culture that supports city co-governance for a constant tension towards sustainable growth. More in-depth, users are engaged in decision-making and policy-making processes in collaboration with the city government, embracing an open government logic. Two main projects are implemented: “Neighborhood Labs” and “Participative Balance Sheet” (cfr. Table 3).

Table 3 – The macro-level

Bologna Smart City: the macro-level	
<i>Project</i>	<i>Aim</i>
“Neighborhood labs”	“Neighborhood labs” is an initiative that promotes co-innovation and co-creation in the provision of new public services or technological platforms by involving citizens in collective decision-making processes. By activating interactive labs for each neighborhood, users are involved not only in solving issues related to mobility, energy, waste, healthcare, environment, and safety but also in proposing innovative ideas and projects for economic, social, and environmental growth of the city. In this way, citizens also contribute to policy-making development by redesigning and co-innovating government practices.
“Participative Balance sheet”	The “Participative Balance Sheet” project, as part of the Bologna Strategic Plan, actualizes interventions that the city promotes in alliance with Fondazione Innovazione Urbana. Moreover, it is directly linked to “Neighborhood Labs.” The Participatory Balance Sheet promotes direct democracy that allows citizens to propose, design, and vote for improvement projects concerning the public spaces of their neighborhood or local area. The most voted projects and ideas are then funded and implemented with the support of public institutions. Indeed, in an open government logic, different activities performed in interactive labs allow the generation of new projects aimed to, for example, transform public spaces, revitalize peripheral areas, and address environmental changes. Particularly, innovative smart projects have been realized in different areas, such as cycle paths and mobile charging systems for mobility, smart lighting for safety, and city parks for children. Besides interactive labs, a digital platform integrates the scope to shape an open government model. Thus, the platform allows the collection and the spread of knowledge in realizing participatory activities. All in all, users and end-users actively support the generation of sustainable innovations, thereby contributing to the sustainable growth of the whole city.

Source: our elaboration

The main smart tools adopted in these projects regard online information desks to provide information to users about their active participation in policymaking and to collect their opinions and feedback. The actors engaged at this level are mainly citizens, local government, research centers, non-profit associations, and private organizations. All them participate to policymaking process through the aforementioned projects that allow citizens and associations to contribute ideas and vote for local initiatives. Private organizations and research centers support the technical implementation and data management, while schools and non-profit organizations play an educational and social inclusion role.

The main exchanged resources regard institutional skills and knowledge shaping a cohesive smart culture, deriving from a sustainable-innovation orientation. Local government shares knowledge about how innovation of public services and policies works. Users, feeling like an active part of the decision-making process, share their personal knowledge and competencies. Lastly, institutions are related to the inclusiveness of all city inhabitants in policy-making processes by shaping new forms of participatory and smart governance.

5. Discussion

The key elements identified in the previous section allowed the reinterpretation of Bologna as a Smart City 5.0 in line with an ecosystem approach. The content analysis enabled the detection of the main ecosystems' variables underlying Bologna Smart City, which, due to the dynamic integration of resources and the constant renewal of value propositions enabled by digital technologies-oriented interactions, could turn the city into a smart city 5.0 built around a cohesive, human-centered smart culture at the micro, meso, and macro levels. Results obtained led to the proposition of a framework in which a meta-level synthesizing the orchestrating role of governance can be advanced. Therefore, resilience emerges along with the interplay of:

- *Micro, meso, and macro levels*: actors (decision-makers and policymakers), technologies, institutions, resources, learning, co-design, co-creation, co-innovation of Bologna Smart City services;
- *Meta level*: strategies employed by the smart governance to harmonize main ecosystems' elements into a resilient attitude.

Accordingly, by re-elaborating the findings, a framework was developed to identify two main wider dimensions for the exploration of a smart city 5.0: 1) key drivers for sustainable innovation outcomes in each level and 2) transformative mechanisms that harmonize ecosystem elements in the smart city at a meta-level, generating a resilient attitude enabled by diffused and smart multi-level governance. As shown in Fig. 2, the main strategies pursued by a multi-level governance orchestration to achieve resilience and sustainable innovation in the Bologna smart city 5.0 are

- co-design of resilience-oriented and participative services;
- co-evaluation of shared values and mutual resources exchange;
- co-innovation and definition of sustainable policies.

The strategic co-design of resilience-oriented and participative services is achieved by sharing a proactive mindset based on the spread of a positive attitude towards technology. Long-term strategies are conceived to engage stakeholders in the design of a harmonized set of smart projects in which digital technologies are integrated to achieve smart city development, supporting social innovation and change. Key stakeholders (citizens, research centers, universities, entrepreneurial texture, and local administrators) are actively engaged in the design and implementation of smart projects. The aim is to develop an integrated sociotechnical infrastructure for the smart city 5.0 based on open innovation, knowledge exchange, and harmonized relationships among actors. Moreover, users are engaged in co-creating decisions for the smart city. The co-development of smart projects is achieved through joint decision-making activities in which users' knowledge, ideas, and insights are integrated thanks to trustful relationships. Members can potentially become decision-makers by expressing their

own creative interpretation regarding a new product or service or providing a solution for a given social or environmental challenge. Knowledge exchanges among actors at each level, fostering new knowledge that stems from a synergy rising from experience. This constant regeneration of knowledge establishes an endless tension towards smart city innovation and resilience.

The integration of innovative insights from many sources should be optimized by multi-level governance through a constant search for alignment between individual goals and values with the overall ecosystem.

This alignment drives the transition from co-established decisions at the meso-level to the co-development of policies at the macro-level. To enable this switch, users' innovative ideas should be aligned with shared values in the smart city toward overall sustainability. Thus, each user can become a policymaker by turning shared decisions into common policies. Lastly, the pivotal role of policies' co-development emerges in smart city resilience emergence. Through democratic governance, new cultural and social institutions can be created, nurturing and renewing the co-innovation process over time, allowing the participatory and multi-level governance of Bologna to regenerate values and knowledge.

This allows ecosystems' resilience to emerge, which allows the continuous adaptation and response to disruptive events.

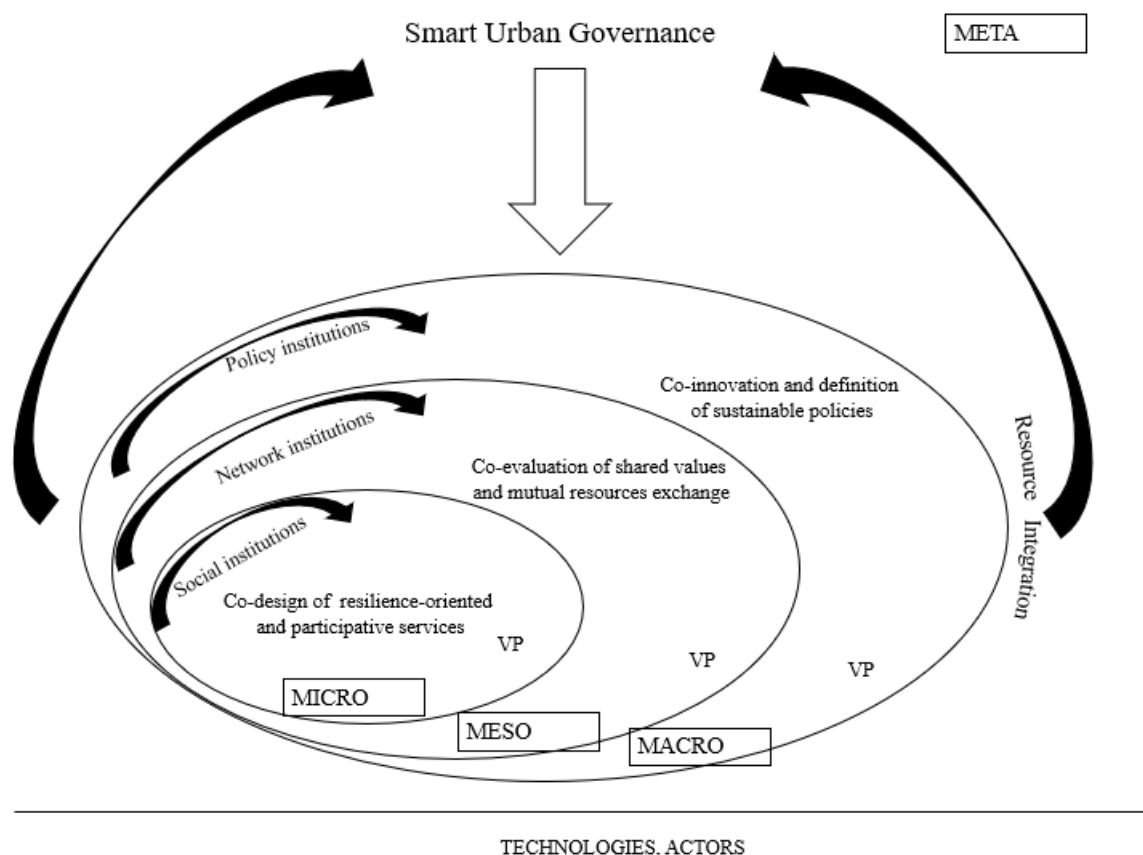
Indeed, resilience arises as the outcome of an all-encompassing process that pervades micro, meso, and macro contexts and in which the ecosystem's actors play an active and determinant role. In fact, their involvement at each level exchanging knowledge and resources contributes to the generation of further innovation. Smart governance intervenes as an orchestrator of a new mindset among actors in ecosystem contexts, which reformulates the way it readjusts to sudden events. Therefore, resilience configures an ecosystem meta-capacity driven by smart governance that supports reorganization, reconfiguration, and reinvention in response to disruptions at the micro, meso, and macro levels. Smart governance, in fact:

- 1) shapes innovative laboratories to discuss and collect new ideas from citizens that can be transformed into new products or services. Citizens are proactively involved in proposing urban solutions or social inclusion strategies. In this way, governance contributes to the emergence of a proactive mindset that enables the sharing of knowledge, experience, and opinions and uses technological innovation to shape sustainable co-innovations for city development;
- 2) promotes open innovation projects in which users act as key actors in the co-innovation process, aligning individual and collective interests for social welfare. As a result, networks of actors assume a central role in adapting, supporting, and even anticipating change;
- 3) directly involves citizens in policy and decision-making processes: citizens can behave as active policymakers, transforming shared decisions into common policies and reinforcing the smart and cohesive innovation-oriented culture shaped from the interplay of the first two levels.

Thus, this *resilient attitude* is nurtured by smart governance, understood as governance capable of harmonizing actors' objectives and aligning them with collective well-being (Ciasullo et al., 2020), aiming at sustainable development through citizen empowerment. In this sense, smart governance supports the democratic participation of citizens and, at the same time, is underpinned by a cohesive smart culture that stimulates a bottom-up legitimization process rooted in citizen engagement.

Ultimately, this process can be seen as a cycle where the tension towards co-innovation is continuously nurtured to improve the livability of the city. Indeed, this cohesive culture can be continuously revitalized through the educational, learning, and engagement activities promoted by smart governance to readily adapt to changes and nurture collective well-being through sustainable co-innovations. A resilient attitude towards innovation and the continuous development of educational, learning, and engagement activities can revitalize and strengthen the cohesive culture shared by actors over time.

Fig. 2. Resilient attitude nurturing process



Source: our elaboration

6. Implications and conclusions

This paper starts from the need to analyze smart cities through a holistic approach, able to underpin their complexity, by valorizing both technological and human/social aspects. In this regard, smart city is conceptualized in a 5.0 context, stressing how a resilience-oriented attitude is shaped by considering the role of technologies and sustainable innovations. To detect this resilience attitude, a multi-level analysis has been conducted by reinterpreting smart city as a smart service ecosystem. The key elements of the ecosystem were then outlined, and, through the content analysis of the Bologna projects, co-innovation processes leading to resilience became clear. Indeed, findings show that key ecosystem elements were dynamically organized to pursue sustainable development towards resilience: this process was strategically managed by smart governance from project co-design to co-governance and the formation of a smart, data-driven culture. Therefore, a three-level framework was developed to analyze the role of smart governance in building cities' resilient attitude. The research provides both theoretical and managerial implications. From a theoretical point of view, addressing the smart city concept through the 5.0 lens allows to fill a research gap in smart city literature. In fact, in this way, a wider view of smart cities is harnessed, which does not focus only on technological or social aspects, but it is able to embrace the complexity of smart cities. Moreover, the development of a general framework advances smart cities studies, from which the building of resilience attitude through technology and sustainable innovations can be outlined. This framework, based on the orchestration role of governance, can guide researchers in exploring resilient attitude in different contexts. Furthermore, it is theoretically confirmed the transformative role of technology in value co-creation and innovation processes, which nurtures an increasing research stream in the literature that considers technology as a means for sustainability and innovation (Visvizi et al., 2018).

From a managerial standpoint, the conceptualization of smart cities as a smart service ecosystem provides city managers and urban planners with a better understanding of how to conceive different strategies for different actors, resources, and users' engagement practices at micro, meso, and macro levels to nurture a resilient attitude throughout the city actors. At the micro-level, ad hoc strategies to strengthen involvement in the co-design of projects to boost actors' willingness to use technology could be enhanced. At the meso-level, co-delivery strategies could be employed to strengthen users' participation in urban and city problem-solving due to efficient relationships management enabled by technologies. At the macro level, strategies for actor's involvement in policymaking and decision-making (towards co-governance) could be realized to constantly ensure the attainment of social and cultural cohesion through the mediation of user's requests to pursue the regeneration of an established culture.

This study presents some limitations related to the adoption of the qualitative methodology focused on the case study. It does not allow any generalization of results; indeed, it is not possible to extend the findings obtained to other contexts. However, by adopting an exploratory approach, this research could be considered as a first step to shape resilient attitude according to the 5.0 lens in smart cities and to direct future research toward deep investigation about this topic. For example, comparative case studies can be performed to assess and confirm the process through which resilient attitude is shaped by orchestrating smart governance. Moreover, the mixed-method approach (Axinn and Pearce, 2006) could be used to address also quantitative methodology by using multiple regression or structural equation modeling to explore the statistical relationships among the key elements of smart ecosystems, the tendency towards resilience, and the role of governance. In this way, the framework proposed could be generalized. Also, quantitative methods could be employed to empirically measure resilience. This would allow a more comprehensive understanding of resilient attitude, by not only framing it in the smart city, but also giving evidence of its empirical effects. In addition, the study relied on secondary data supporting the construction of the 5.0 smart city ecosystem in order to identify the underlying resilient attitude. However, this approach does not capture the direct perceptions of the stakeholders involved. Future studies could adopt the perspectives of different actors, such as citizens, public administrators, and business organizations, and users in general, to explore their subjective experiences and evaluations of smart city initiatives. Such an approach would provide more practical and perception-based evidence to complement the present findings.

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