City Resilience and Smartness: Interrelation and Reciprocity

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1 Introduction

The last decades of the twentieth century were characterized, among other things, by an increasing trend toward urbanism (Alqahtani et al., 2018). More than half of the inhabitants around the world live in cities, and this percentage is expected to exceed 65% by 2050 (Michelucci et al., 2016; Purnomo et al., 2016; United Nations Office for Disaster Risk Reduction (UNDRR), 2017). It is estimated that until 2030, 60% of the inhabitants will gather in cities with a population of over 500,000 (Ragia & Antoniou, 2020). This overconcentration in large urban centers, apart from development opportunities, is responsible for the emergence of new risks (Purnomo et al., 2016; United Nations Office for Disaster Risk Reduction (UNDRR), 2017; Ragia & Antoniou, 2020; Zhu et al., 2020). The city administration along with the political authorities has no other choice but to deal with them directly to secure the well-being of their citizens (ARUP, 2015; Clements-Croome, 2012; Li et al., 2017; Makhoul, 2015).

On their way to evolution, every city chooses a different path, leading to variations like sustainable city, smart city, digital city, etc. (Makhoul, 2015). The development of technology, however, was not enough to ensure a secure future for the urban areas and their inhabitants. Problems and uncertain situations existed and will continue to appear in the future, in the form of risks, crises, or disasters (Anthopoulos et al., 2013; Scholl & Patin, 2012). All these threaten the city's ability to provide the expected quality of life for its inhabitants, especially since these are dynamic such as climate change and not static phenomenon, leading to the *new normal* global situation (Scholl & Patin, 2012). To ensure the continuing operation

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P. Fitsilis (ed.), *Building on Smart Cities Skills and Competences*, Internet of Things,
https://doi.org/10.1007/978-3-030-97818-1_8

of their critical infrastructure and services, cities must demonstrate resilience against risk and disasters (Makhoul, 2015). Regarding an individual, an organization, or a system (natural or man-made), resilience is a set of competencies and skills that gives the *ability to survive* during threats, risks, or any unpredictable situation (Scholl & Patin, 2012; Chan & Zhang, 2019; Simone et al., 2021). Like any other living organization, a city must demonstrate resilience under stresses, crises, and disasters, to apply the *bounce-back ability* and secure the quality of life of its people (Cavada et al., 2017).

There has been a global tendency for cities to use ICT to improve their services provided to citizens. Smart infrastructures, solutions, and technology, along with human resources, help cities and communities achieve a better quality of life for their citizens, transforming them into "smart" (Zhu et al., 2020). But on the other hand, the more dependent is a system on innovative technologies, the larger is the risk of new and unknown vulnerabilities and danger (Alqahtani et al., 2018). Although resilience is achieved mostly in smart cities, the features of a smart city are not enough to make it resilient (Oke et al., 2020).

Literature review shows that the research on the smart city or resilient city skills and competencies is in the early stages and there are insufficient findings to compare skills and competencies for a smart or resilient city. This chapter presents the major similarities and differences between a smart and a resilient city, as a tool for officials, responsible for planning each city model, to decide and define the proper policies, strategies, and actions. Through this analysis, certain skills and competencies must be highlighted, which will be necessary to support the management along with the implementation of the strategic vision for the smart or resilient city. It is structured as follows: in Sect. 2 there is an overview of smart city and resilient city definition and aspects. In Sect. 3 models and evaluation indicators for each city are presented. Section 4 highlights the way each city should proceed with its strategic vision. In Sect. 5 there is a presentation of how major dimensions of these two cities interact and which approach should be adopted. Finally, Sect. 6 concludes and summarizes the chapter.

2 Defining the City

The reference to "intelligence" emphasizes a higher level of analysis and design that drives better decisions, conclusions, and strategies (Khatibi et al., 2021a). The overwhelming use of ICT changed the way cities managed their ecosystems, in terms of economy, development, and society, and transformed them into "smart cities" (Backhouse, 2020; Mora et al., 2018; Santinha & de Castro, 2010). Decades ago, scholars started studying the "smart city" and its applications, but there is no common definition of the "smart city" and how to "build" one, due to different perspectives and needs of each city's stakeholder and disagreements on ICT's overall contribution (Cavada et al., 2017; Mora et al., 2018; Falconer & Mitchell, 2012; Lafi Aljohani & Alenazi, 2020). Nowadays "smart" is mostly considered to

be a city where ICT and innovative solutions are used to improve the well-being of their citizens, without compromising the core subsystems of the city, like the build, natural and social environment, and information ecosystem (Michelucci et al., 2016; Purnomo et al., 2016; Backhouse, 2020; Fujinawa et al., 2015; Lopez & Castro, 2021; Nel & Nel, 2019; Stubinger & Schneider, 2020; Zhu et al., 2019).

As mentioned above, the main pillars of evolution for a smart city are the ICTs and human skills and competencies (Zhu et al., 2020). In the last decade, researchers have not limited their studies to these two factors and defined other, of equal importance, dimensions of a smart city. Most of them concluded in the following six: smart economy, smart environment, smart governance, smart living, smart mobility, and smart people (Khatibi et al., 2021a; Lopez & Castro, 2021; Anthopoulos et al., 2019). Many more dimensions have emerged in the last years like smart community, smart construction, smart development, smart energy, smart health, smart infrastructure, smart innovation, and others, highlighting all the important topics in the daily management of a smart city (Stubinger & Schneider, 2020; Zhu et al., 2019; Joss et al., 2019).

As the smart city, the resilient city is a term that has not a common definition (Nel & Nel, 2019). The resilience of a city is the overall ability to protect its citizens and continue its functionality while sudden phenomena occur (ARUP, 2015). New risks and dangers emerged over time, so resilience must be built with an innovative approach not only for the current challenges but also for the ones who come (Cavada et al., 2017; Lopez & Castro, 2021). Focusing on resilience, an urban system must face and overcome not only natural but also man-made crises and phenomena, preventing them to evolve into disasters (Chan & Zhang, 2019; Lopez & Castro, 2021; ISO, 2019a). Scholars highlighted some of the dimensions of resilience in urban systems that must be considered when planning the overall resilience management; community/social; economic, infrastructural, institutional, environmental/natural, organizational; and technical resilience (Li et al., 2017; Zhu et al., 2019; Patel & Nosal, 2016).

Many researchers identified the resilience aspect in cities and communities under a process of disaster risk reduction and sustainable development (Patel & Nosal, 2016). A resilient city must be managed in such a way that develops urban sustainability while it prepares itself to overcome not one but multiple hazards simultaneously (ARUP, 2015; Khatibi et al., 2021b). As a holistic approach, the resilient city can be considered to be the one that can absorb, adapt, and recover from multiple external pressures and threats, crises, risks, and disaster situations or mitigate the consequences; it is an interaction and co-operation of the social, technical, and ecological subsystems of the city so that it can maintain its functionality and aim at a stronger version of it (Zhu et al., 2020; ARUP, 2015; Makhoul, 2015; Oke et al., 2020; Nel & Nel, 2019; Bujones et al., 2013).

3 Measuring Performance

Various scholars and international standardization bodies have focused on defining a complete set of indicators for the smart city. Since the "smartness" of a city is approached from different points of view, evaluation is a complex procedure, so a unified model for benchmarking cannot be applied in every city (Backhouse, 2020; Anthopoulos et al., 2019; Khatibi et al., 2021b). A commonly agreed approach is for the city administration to evaluate all aspects or dimensions in a smart city that are considered to be critical. These parameters must cover all the critical dimensions of the smart city mentioned in the previous sector (smart economy, smart environment, smart governance, smart living, smart mobility, and smart people). In 2019 ISO set 19 groups of indicators to be used globally, and cover different dimensions and domains, of a smart city's management, enhancing the effectiveness of a smart city (ISO, 2019b):

- "Economy," "Energy," "Finance," "Governance," and "Safety" that can be used as indicators of policy
- "Environment and climate change," "Wastewater," and "Water" that can be related to environmental issues
- "Education," "Health," "Population and social conditions," and "Sport and culture" as social factors
- "Housing," "Recreation," "Solid waste," "Telecommunication," "Transportation," "Urban/local agriculture and food security," and "Urban planning" on urban management.

Like smart cities, resilient cities must be controlled and evaluated through specific indicators. Most of the scholars agree that resilience in a city must be measured in five critical systems: "political" since it reflects citizens' opinion about their government, "security" that covers the personal feeling and rule of law, "economic" that is related to wealth and resources, "social" that represents the quality of public services, and "environmental" for buildings and natural environment (Bujones et al., 2013). Patel and Nosal (Patel & Nosal, 2016) promoted the *PEOPLES* set of indicators, and this acronym refers to "Population and Demographics, Environmental/Ecosystem, Organized Governmental Services, Physical Infrastructure, Lifestyle, and Community Competence, Economic Development, and Social-Cultural Capital," groups that target a certain aspect of a smart city.

In 2015, the ARUP International Development summarized 12 commonly agreed and critical indicators, with 45–54 sub-indicators and 130–150 variables to measure overall resilience in a city. Since it is a complex topic and affected by many dimensions, the research team tried to cover as many aspects as possible. These 12 indicators are grouped into 4 different categories that refer to citizens, management, places, and knowledge, respectively (ARUP, 2015):

- "Minimal human vulnerability," "Diverse livelihoods and employment," and "Adequate safeguards to human life and health" in *Health and Well-being* category

- "Collective identity and mutual support," "Social stability and security," and "Availability of financial resources and contingency funds" in *Economy and Society* category
- "Reduced physical exposure and vulnerability," "Continuity of critical services," and "Reliable communications and mobility" in the *Urban Systems and Services* category
- "Effective leadership and management," "Empowered stakeholders," and "Integrated development planning" in the *Leadership and Strategy* category.

Finally, ISO chooses 19 groups of indicators to evaluate the overall resilience in a city, like the ones in smart cities: "*Economy*, *Education*, *Energy*, *Environment and climate change*, *Finance*, *Governance*, *Health*, *Housing*, *Population, and social conditions*, *Recreation*, *Solid Waste*, *Safety*, *Sport and culture*, *Telecommunication*, *Transportation*, *Urban/local agriculture and food security*, *Urban planning*, *Wastewater*, and *Water*" (ISO, 2019a). The groups are the same as the ones for smart cities, although indicators in each group are not the same – for example, the group "Economy" in smart cities has indicators like Percentage of service contracts providing city services which contain an open data policy, the Survival rate of new businesses per 100,000 population, Percentage of the labor force employed in occupations in the information and communications technology (ICT) sector, etc., while the same group in resilient cities has indicators like Historical disaster losses as a percentage of city product, Average annual disaster loss as a percentage of city product, Percentage of properties with insurance coverage for high-risk hazards, etc. Although the specific indicators are different, the fact that the categories are the same reflects that the smartness and resilience in a city's ecosystem are affected by the same dimensions.

4 City Management

Many cities tend to adopt the best practices that other smart cities have implemented. Officials need to manage a smart city and apply its strategic plan, considering that it is a "multi-sectoral, inter-organizational and intergovernmental" procedure (Michelucci et al., 2016). They must evaluate the city's current status, define the transformation plan, and check the process (Falconer & Mitchell, 2012). A smart city must be planned as holistic planning, which relates to all smart city dimensions and aspects (smart infrastructure, smart people, smart economy, smart government, smart environment, etc.), to reach the best possible outcome (Abdoullaev, 2011).

The majority of applied older strategic plans tried to improve the "smartness" level by enhancing ICT infrastructure (Nel & Nel, 2019). Since most of them target the quality of life for citizens, many cities changed their strategic plan to include the "people" parameter (Lopez & Castro, 2021; Nel & Nel, 2019). Nowadays, a complete strategic plan of a smart city must take into account all smart city dimensions (people, infrastructure, economy, government, mobility, environment)

and try to improve each and all of them, although there is no smart city that excels in all these dimensions (Purnomo et al., 2016; Anthopoulos et al., 2019; Abdoullaev, 2011).

According to Santinha and Castro (Santinha & de Castro, 2010), a smart city's administration must promote internal characteristics while establishing external connections. Internal characteristics consider being the high quality of provided services, the sustainable environmental planning, the innovative urban design, the recognition of skilled and talented citizens, and the enhanced technological solutions, among others. At the same time, highlighting comparative advantages will not only improve quality of life but also attract citizens, visitors, and enterprises. On the other hand, the external connection can be built through participation in a greater network of cities, giving access to certain information, solutions, and best practices. This will add value to the city's recognition and branding, securing funding, resources, and technology for sustainable development, through global initiatives. Of course, the first step for this endeavor must be the interaction with other cities within the region or the country.

ISO's research concluded to certain suggestions for a successful implementation of a smart city strategic plan (ISO, 2019b):

- "Respond to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how it engages society."
- "Apply collaborative leadership methods, work across disciplines and city systems."
- "Use data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors)."
- "Provide a better life environment where smart policies, practices, and technology are put to the service of citizens."
- "Achieve their sustainability and environmental goals in a more innovative way."
- "Identify the need for and benefits of smart infrastructure."
- "Facilitate innovation and growth."
- "Build a dynamic and innovative economy ready for the challenges of tomorrow."

Deciding the proper strategic plan is not an easy task, since most of the research is about technology in SC than management of SC, and this is the main reason that there are many perspectives regarding SC planning (Michelucci et al., 2016; Mora et al., 2018). Smart cities are living organizations that continuously evolve (Clements-Croome, 2012), and the position that all stakeholders must see SC through that lens is considered to be a correct approach. The complexity in operational, finance, and planning procedures along with conflicted interests of the public and private sector, parties, and communities makes a commonly accepted strategy even more difficult (Falconer & Mitchell, 2012). Smart city planners and managers must take these into account to face the less possible reactions.

Managing and planning for a resilient city is a top priority, and the city's administration develops strategies and actions toward that (AlHinai, 2020; Huck et al., 2020). Organizing its strategic plan, a city must be ready to face events

beyond 100-year frequency of happening. Even if the financial cost for this is extremely high, this is justified because the ultimate goal of each administration is to drive a safe and sustainable urban development (Alqahtani et al., 2018; United Nations Office for Disaster Risk Reduction (UNDRR), 2017). Risk reduction and implementation of resilience strategy will save lives; drive to a social, economic, and sustainable urban development; and benefit communities by strengthening their trust in their leaders and governance, enhancing citizen participation and protection of culture, promoting innovation and a safe economic environment, creating new job opportunities and balanced ecosystems, and the interconnection between cities at a national or global level (United Nations Office for Disaster Risk Reduction (UNDRR), 2017).

The main actions to build resilience are divided into two major phases, before and after the disaster occurs, without overlooking the necessary and imminent response to activate emergency plans and operations, during the disaster. In the pre-disaster period, the city must evaluate the level of resilience, through analysis of the city's strong and weak points, along with identification, understanding, evaluation of risks, and preparation against them, to mitigate potential upcoming effects. In the post-disaster period, officials must take actions for recovery and rebuild, along with the preparation and implementation of an action plan for the mitigation of consequences of future threats (United Nations Office for Disaster Risk Reduction (UNDRR), 2017; Anthopoulos et al., 2013; Oke et al., 2020; ISO, 2019a; Bujones et al., 2013; Altay & Green, 2006). The complexity of this procedure is highlighted by the United Nations (United Nations, 2015), by mobilizing and applying many different measures like "*economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures*," while in 2017 four priorities for successful disaster risk reduction were identified: "*Understanding disaster risk*; *strengthening disaster risk governance to manage disaster risk*; *investing in disaster risk reduction for resilience*, and *enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction*" (United Nations Office for Disaster Risk Reduction (UNDRR), 2017).

Research from Sendai Framework UNISDR lead to ten guidelines for city officials, planners, and decision-makers, called the "Ten Essentials." It is about a holistic approach toward more resilient cities and communities since it includes actions in all city's critical dimensions. These are (United Nations Office for Disaster Risk Reduction (UNDRR), 2017):

1. "Organize for disaster resilience."
2. "Identify, understand and use current and future risk scenarios."
3. "Strengthen financial capacity for resilience."
4. "Pursue resilient urban development and design."
5. "Safeguard natural buffer to enhance the protective functions offered by natural ecosystems."
6. "Strengthen institutional capacity for resilience."
7. "Understand and strengthen societal capacity for resilience."

8. "Increase infrastructure resilience."
9. "Ensure effective disaster response."
10. "Expedite recovery and build better."

Furthermore, resilience planners must not ignore the important role of stakeholders and adopt a people-centered approach. For a multisectoral topic like this, all the relevant stakeholders must participate and help to define and implement the strategy and policy. In that direction synergies and cooperation with cities from other regions and countries will also help, by transferring knowledge about the best practices that have been successfully implemented (United Nations Office for Disaster Risk Reduction (UNDRR), 2017; United Nations, 2015).

5 Setting Strategy

Smart cities, using ICT and innovation, aim to provide a safe, sustainable, and economically secure environment to their citizens while facing the same challenges as other cities, which can disrupt this normality (Nel & Nel, 2019). There is no other way but to enhance their level of resilience. "Smartness" and resilience are two different aspects, but both enhance sustainable development using common systems, and for this, they are both considered to be parts of the city governance model (Li et al., 2017; Khatibi et al., 2021a). Although both topics have been studied for many decades—resilience since the 1970s and smart city since the 1990s—there is limited literature on their similarities, differences, and connection, probably since there is no solid and globally accepted definition, but this seems to change (Chan & Zhang, 2019; Simone et al., 2021; Nel & Nel, 2019; Zhu et al., 2019; Khatibi et al., 2021b).

A smart city is a complex system of many dimensions that can be utilized to form a resilience status (Nel & Nel, 2019). Assets, people, communities, technology, and infrastructure can be used to overcome shocks, stresses, and disasters (Chan & Zhang, 2019; Zhu et al., 2019). After all, smart cities must be prepared and ready to face natural and man-made challenges, for a continuous provision of their services (Ragia & Antoniou, 2020; Khatibi et al., 2021a; Nel & Nel, 2019). Most scholars that studied this topic tend to agree that smart city technologies improve resilience (Zhu et al., 2020; Chan & Zhang, 2019). Smart technology and applications, along with properly educated and trained communities and individuals, will enhance responsiveness and risk management capacity and help overall management by improving aspects like risk reduction, mitigation, preparedness, response, and recovery (AlHinai, 2020; Kakderi et al., 2021).

Smart and resilient cities use the same major indicators to evaluate performance, like "*Economy, People, Governance, Mobility, Living, Environment, Society, Culture, and Infrastructure*" (Khatibi et al., 2021b), something that highlights the interconnection of these two models. According to Zhu et al. (Zhu et al., 2020), improving resilience in physical, social, and environmental dimensions enhances the overall performance of the smart city, and this is something that must be

considered during SC strategy planning. Based on their research, "effects of RC on SC are all positive." Improving the physical dimension of a smart city will enhance resilience, but the effects of the other two dimensions on resilience are not yet completely studied. Their research shows the little impact, if not negative, of social and environmental aspects on the resilience of a city.

According to ISO, a smart city must also be resilient to continuously provide the best of services to its citizens, since:

> *Smart is a city that increases the pace at which it provides social, economic and environmental sustainability outcomes and responds to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how it engages society, applies collaborative leadership methods, works across disciplines and city systems, and uses data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment* (ISO, 2019b).

On the other hand, scholars come to agree that there are also negative effects during the implementation of these two models. Many agree that the use of smart technology can cause new threats and risks, especially in environmental issues (Chan & Zhang, 2019). The ongoing production of smart technology and machines will increase wastes and pollution while threatening the sustainable use of underground resources. Furthermore, the intense use of smart devices and applications may result in social inequality that threatens social coherence and eventually urban resilience (Chan & Zhang, 2019). Especially innovative solutions may cause future risks that are unknown at present.

In 2020, Zhu et al. concluded on the most important difference between smart and resilient cities. According to them, this is the purpose: the smart city "*promotes creativity and provides better and convenient life*," while resilient city addresses the "*disaster prevention and mitigation*." The first is an active process approach, while the second is a passive one (Zhu et al., 2020). For that reason, SC studies mainly focus on ICT adoption and how to face environmental and social challenges, while RC studies mainly focus on resilience definition and infrastructures, during various natural or man-made challenges. Due to the intense and long-term research, the smart city topic is considered to be in the application phase. On the other hand, for a relevant new topic like the resilient city, research focuses on the self-awareness phase (Zhu et al., 2020). Regarding facing hazards and social problems, the resilient city is considered to be the only one that can overcome both.

In general, the current research highlights the fact that although many smart strategies and policies tend to improve the resilience level in a city, a smart city may not be resilient by default (Oke et al., 2020). There are cases where smart cities are unable to face certain types of risks, and the COVID-19 pandemic is one of them. New kinds of threats, especially if they are at a national or a global level, seem to be extremely difficult to overcome by a city alone, even a smart one, since applied solutions, applications, and projects seem to be insufficient to reduce their vulnerability against such threats.

As mentioned before both types of cities need to adapt and overcome present and future risks with all available assets like infrastructures, communities, institutions, individuals, etc., transforming their economic, social, and political aspects (Makhoul, 2015; Oke et al., 2020). The city stakeholders must agree on a common strategic plan for the city's future. To simply choose one city model over another will result not only in positive but negative outcomes since there is no specific procedure to evaluate the resilience of a smart city or the smartness of a resilient city (Khatibi et al., 2021b). It's of great importance for decision-makers to understand all dimensions and domains of these two city approaches if they want to succeed in facing all kinds of hazards and disasters while improving the quality of life of their citizens. During planning and development, a smart city must be designed to ensure resilience and a resilient city to implement and improve smart solutions and policies (Clements-Croome, 2012). This is not an easy task since the indicators, which presented in the previous sector, focus on every city model separately and there is no unified index for smart and resilient cities (Khatibi et al., 2021b).

According to many researchers, the solution seems to be the convergence of these two cities—*the smart resilient city*—applying policies and solutions from both (Zhu et al., 2020; Khatibi et al., 2021a). ICTs and innovation, along with human assets, will help improve both governance and resilience (Khatibi et al., 2021b). This approach leads to two different frameworks—the smart resilient city and the resilient smart city—with different starting points and different goals (Khatibi et al., 2021a). The first is when a smart city adopts a resilience policy, strategy, and solutions, and the second is when a resilient city chooses to use smart technology solutions (Khatibi et al., 2021a; Khatibi et al., 2021b). The common goal remains the sustainable development and prosperity of cities and communities. Since the smart and resilient city is a new approach, the few present studies tend to focus more on smart cities that want to enhance resilience and less on resilient cities that want to be smart, probably as a direct effect of the overwhelming global movement and well-known smart city development model. After all, existing studies on the resilient city are not sufficient in covering all its aspects.

Khatibi et al. (Khatibi et al., 2021a) defined the smart resilient city, as the city able:

- "To warn against disruption"
- "To predict the type of disruption"
- "To choose the best method to absorb the disruption"
- "To take the fast, economic and straightforward recovery plan"
- "To select the best technic to bounce back better".

Planning for a smart resilient city is not an easy task, since it is a new trend. Scholars, researchers, and organizations must focus their effort on this topic and provide information and the necessary guidelines to city officials and decision-makers. Further global research on this must be conducted so the strategic plan for a smart resilient city will be commonly accepted and implemented.

6 Conclusions

During the last decades, there was an increasing trend toward urbanism. To provide better services and quality of life for their citizens, cities adopted ICTs and innovation for that. This was the birth of smart cities. On the other hand, that environment is not safe against hazards and risks. City administration must face natural and man-made disasters by displaying resiliency—the ability to protect its citizens and continue its functionality during crises. The transformation to a smart or a resilient city is not a simple procedure, since it covers several different, and in many cases, conflicting systems, domains, and aspects of each city model. The first step for that is the evaluation of the current status and the formation of the strategy and policy. For that, many indicators and frameworks have been studied and proposed by scholars and researchers. The management and implementation of the strategic plan have differences and similarities between the two city models and a common purpose—the enhancing of sustainable development. Many cities might choose one model or another, based on their strategic vision. The interconnections between city dimensions cause positive and negative effects on the city's smartness and resilience on both types of cities.

This chapter highlighted key aspects of both city models on definition, performance, management, and strategy. By studying them, decision-makers will be able not only to define the proper policies, strategies, and actions for each city model but also to discover the necessary skills and competencies that professionals, employees, and city staff responsible for a smart or resilient city should possess.

Acknowledgments This work was supported by the Erasmus+ KA2 under the project "DevOps competencies for Smart Cities" (Project No.: 601015-EPP-1-2018-1-EL-EPPKA2-SSA) (SmartDevOps Project, n.d.). This paper reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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