Technical Report - TR2

Smart City Resilient Officer Competences Inventory

P. Fitsilis, L. Anthopoulos, P. Tsoutsa, C. Ziozias, V. Kyriatzis
University of Thessaly, Greece

T. Panagiotakopoulos, A. Kameas
Hellenic Open University, Greece

Introduction

The work presented in this Technical Report aims to provide an *Inventory of Competences for Smart City Resilient Officer* and it is partially based on the results of the preliminary analysis described in TR1 that were combined with the findings derived from the extensive literature review on resilience needs in smart cities we have done. This study was conducted by University of Thessaly and Hellenic Open University during the last months, as a preparatory task for the proposal development.

Covid-19 epidemic has created new challenges for the development of Smart and Sustainable Cities. It has proven that it is not anymore sufficient just to focus on providing services for quality of life, or for a better business ecosystem, but we need to prepare cities, so that they are able to manage, adapt, maintain and ensure city services and enhance quality of life in the face of hazards, shocks and stresses. According to this definition, resilience does not include only earthquakes, fires, floods, etc. but also whatever disrupts significantly the operation of a city either occasionally or periodically as well. Examples include high unemployment; endemic violence; health epidemics and chronic food and water shortages.

Even though some standards and projects exist in this area, we have not yet reached consensus on a common city resilience model that will able to describe what exactly constitutes resilience and what a resilient city. Furthermore, up to now little emphasis has been given to the way municipalities are organized for addressing hazards; and even less on training their personnel to the new skills required.

Currently, these new required job profiles do not exist, they are overlooked, or they are partially described.

Rockefeller Foundation, founded in 2013 the "100 Resilient Cities (100RC)" project, having as objective to help cities face three major threats and challenges: urbanization, globalization, and climate change. In the context of this project, a job profile named "City Chief Resilience Officer" was defined, but without sufficiently describing the required skills. In parallel, other projects e.g. "Smart DevOps competencies for smart cities" (devops.uth.gr) are attempting to define the required skills and job profiles needed for Smart and Sustainable Cities professionals. Obviously, we need to address the skills' gap between today's and future's skills demand of municipal workforce by emphasizing on these emerging needs and by combining the needs for smart and resilient cities development. Exactly on this subject area, this paper presents the results of a survey that attempts to define the required skills for a "Smart and Resilience City Officers".

Resilience and City Resilience

City challenges are among the United Nations priorities, as it is illustrated in the 2030 Sustainable Development Agenda envisioned in 2015, and detailed into 17 development goals (SDGs). These goals seek to address crucial issues including poverty, public health, individual rights, social cohesion, climate action, gender equality, and the promotion of peace. Cities are at the core of achieving these goals, especially SDG 11 that stresses the importance of "making cities and human settlements inclusive, safe, resilient and sustainable". The city's ability to *keep on operating in means that can ensure that its community (and especially its most vulnerable members) to survive and prosper regardless the crisis (economic, health, environmental etc.) that it experiences* (Susetyo and Sasono, 2018; Patel and Nosal, 2016; Vale and Campanella, 2005). Resilience, on one hand, refers to a key feature, or a state or quality (Collins Dictionary). More specifically it is *the ability of an ecosystem to return to its original state after being disturbed; the amount of potential energy stored in an elastic material when deformed. O*n the other, resilience defines a process, manifested by the *ability of people or things to feel better quickly after something unpleasant, such as shock, injury, etc.* or *the ability of a substance to return to its original shape after it has been bent, stretched, or pressed (Oxford Learner's*

Dictionary). In fact, the ability to recover and adapt, or resilience, underlies many of the 2030 SDG goals. For instance, ending poverty as called for by SDG1 is expected to be achieved by building resilience of *the poor and the most vulnerable community members against extreme events* (economic, social, environmental and disasters). Closely linked to this goal is SDG 2, which is concerned with the promotion of good health and well-being for all ages, including providing health coverage and tackling health emergencies.

Some indicative frameworks for city resilience concern:

Sendai Framework (Sendai Framework for Disaster Risk Reduction 2015-2030)	Priority 1: Understanding disaster risk. Priority 2: Strengthening disaster risk governance to manage disaster risk. Priority 3: Investing in disaster risk reduction for resilience. Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.	United Nations (2015b)
Operational Risk Management (ORM) model	1. Identifying Threats/Targets/Hazard 2. Assess Threats Risk(s) 3. Make Threat (Risk) Control Decisions 4. Implement Threat (Risk) Controls 5. Supervise-Monitor the Effect(s) of Control Implementation	Bellenkes (2004)
Model for city resilience based on Arup/ Rockfeller (2014) and Bujones/USAID (2013) frameworks	1. Resilience dimensions' definition 2. Resilience indicators' definition 3. Resilience goals' definition 4. Indicators' and goals' justification 5. Indicators' measurement and monitoring 6. Strategic alignment to goals	Patel and Nosal (2016); Bujones et al. (2013); Arup (2014)

A crisis management/emergency framework, such as the one that is presented in (Fig. 1) considers the pre-event and the post-event phases of a crisis. In anticipation, preparedness planning engages the social, natural and physical systems of a place and prepares response processes. During a crisis, mitigation is focused on understanding the impact and issuing immediate assistance and relief.

Moreover, longer term relief measures, better known as *adaptive resilience,* are considered for adoption by the community to improve its local characteristics, learn and adapt to the transformation brought about by the disaster.

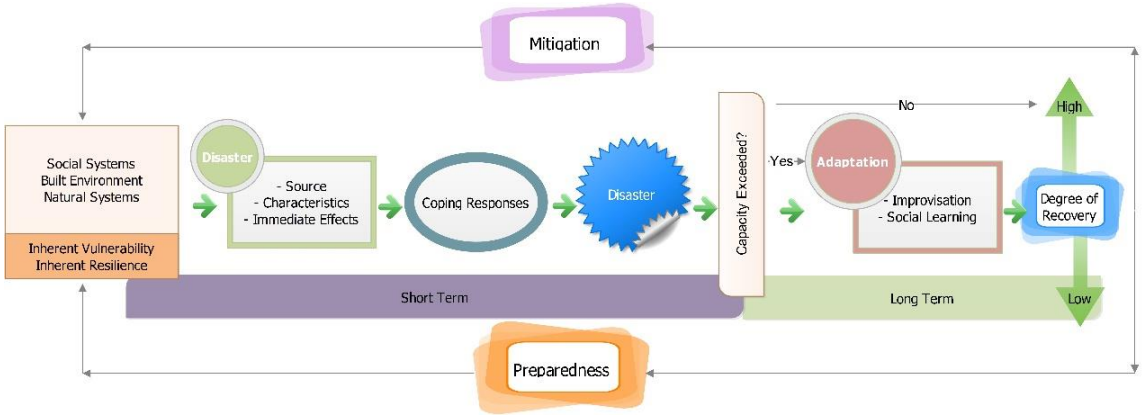

Figure 1. *Disaster Resilience of Place Model (Patel and Nosal, 2016)*

The examined models of Figure 1 (Patel and Nosal, 2016; Arup, 2014) measure city resilience by relying on the performance of key indicators focusing on the *social, economic, institutional, physical and natural dimensions*. The social dimension addresses health and well-being issues, designed to minimize human vulnerability, and effectively safeguard health and life. In this regard, a standard of living which goes beyond mere survival is necessary to be achieved, accompanied by the existence of integrated health facilities and services, and responsive emergency services. These frameworks recognize the importance of learning and future planning to ensure that public health practices, such as prevention through education, are appropriate for the social and physical context of a given city. Additionally, the existence of a diverse network of medical practitioners and facilities, in addition to the availability of additional resources (redundancy) in cities that can be deployed immediately in the case of a public health emergency (Arup, 2014). As such, indicators that measure the resilience of a city's health are public health systems, quality healthcare, medical care, and emergency response.

Inventory of Resilience Job Skills

Drawing from the literature review we conducted, a list of 38 competencies was compiled, considered crucial for inclusion in the evaluation survey. All the 38 competences revealed from the literature review are presented in Table 1. This effort aims to ensure a comprehensive coverage of the skill sets and expertise areas necessary for the Smart City Resilient Officer (SCRO) role, as follows:

	Required Skill	**Literature**
1	Communication with stakeholders during crisis	(Tonmoy, 2020; Marana, 2019; Galle, 2019)
2	Managing emergency smart city assets and resources	(Tonmoy, 2020; Moglia,2021)
3	Mobilizing external resources (nearby cities, agencies, volunteers)	(Marana, 2019; Kim, 2021; Galle, 2019)
4	Operating emergency control centers	
5	Risk management tools	(Tonmoy, 2020; Shayan, 2020; Marana, 2019)
6	Risk monitoring and control	(Tonmoy, 2020; Shayan, 2020; Kim, 2021)
7	Risk transference techniques	(Kim, 2021; Moglia,2021)
8	Smart cities risk identification	(Tonmoy, 2020; Shayan, 2020; Moglia,2021)
9	Training stakeholders for effective disaster response	(Tonmoy, 2020; Shayan, 2020; Marana, 2019)
10	Coordination and interoperability of critical systems and services	(Tonmoy, 2020; Marana, 2019; Galle, 2019)
11	Evaluating smart cities assets, services and resources	(Marana, 2019; Galle, 2019; Moglia,2021)
12	Risk assessment and quantification	Shayan, 2020; Kim, 2021; Galle, 2019)
13	Smart city response planning	Shayan, 2020; Motta, 2021; Kim, 2021)
14	Citizens, Crowd Sourcing and Social Networking	(Elvas, 2021; Galle, 2019; Moglia,2021)
15	Smart city organization structure, role and accountability	(Tonmoy, 2020; Konstantinou, 2021; Elvas, 2021)
16	Smart city strategic vision and planning	(Tonmoy, 2020; Marana, 2019; Konstantinou, 2021)
17	Smart city enabling technologies	(Tonmoy, 2020; Shayan, 2020; Elvas, 2021)
18	City stakeholder management and citizen engagement	(Marana, 2019; Wilk, 2018; 21
19	Smart city standards for resilience	(Tonmoy, 2020; Shao,2021; 30
20	Smart city urban planning	(Wang, 2018; Monstadt, 2019; Moraci, 2020)
21	Creating and managing incentive schemas for non-profit organizations, businesses and citizens	(Wang, 2018)
22	Project and portfolio management	(Elvas, 2021; Konstantinou, 2021; Moglia,2021)
23	Smart cities financing and funding methods	(Marana, 2019; Moglia,2021)
24	Data analytics as SC risk management tool	(Tonmoy, 2020; Konstantinou, 2021; Kim, 2021)
25	Planning financial recovery programs	(Marana, 2019; Konstantinou, 2021)

26	Ability to work in virtual teams	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
27	Communication skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
28	Leadership & Management skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
29	Teamworking	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
30	Crisis management	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
31	Decision Making and Problem Solving	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
32	Negotiation skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
33	Social skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
34	Management skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
35	Leadership skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
36	Agile Management skills	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
37	Understanding and Managing SC	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)
38	Smart city urban infrastructures	(Lepeley, 2021; Adiego, 2021; Krpálek, 2021)

Table 1. Competencies Identified through Literature Review

Following the approach outlined in TR1 - Competences for Resilient Smart Cities Staff, we solicited evaluations from professionals in smart cities, encompassing both public and private sectors. By integrating these assessments with the insights gained from our comprehensive literature review, we compiled a detailed inventory of competencies. This inventory is designed to be utilized for the development of targeted training programs, ensuring that the training material comprehensively addresses the essential competencies required for resilience in smart city contexts.

Aiming to cover all necessary aspects of the SCRO body of knowledge the authors attempt to form a classification of skills and competences revealed in to four clusters emerged. These four areas that are presented in Figure 2, are the following:

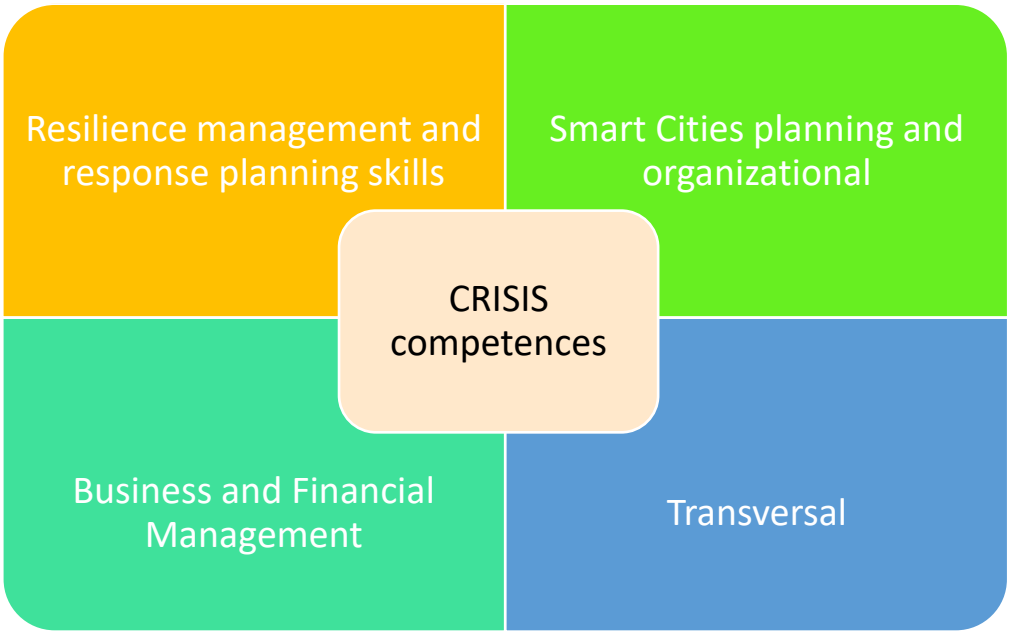

Figure 2. Four categories of skills and competences for SCO

a) resilient management skills (e.g., risk assessment and quantification, evaluating smart city assets etc.) including in risk response planning and effective disaster response (e.g., smart city response planning, coordination of critical systems, etc.),

b) smart city planning and organizational skills (e.g., smart city stakeholder management and citizen engagement, smart city standards for resilience, etc.),

c) business and financial management skills (e.g., planning financial recovery programs), and

d) transversal skills (e.g., crisis management, decision making and problem solving, etc.).

The contents of each category and a short description for the skills and competences revealed is following:

A. Resilience Management and Response Planning Skills

In this group are the skills and competences that a smart city professional's educational background, to deal effectively with all the sudden changes, pressure and stresses a smart city will face. It's about defining, managing, coordinating and controlling actions across various organization, withing city's ecosystem, to reach the desired level of resilience and overcome any unpleasant situation.

1. Coordination and interoperability of critical systems and services.

   Coordination and interoperability requires that elements share common awareness of the situation and are able to coordinate to their potential partner as well as sharing information with other stakeholders. In this context, it will have presented how to implement new standards to support SC systems for minimizing crucial problems, especially during the critical period of responding to hazards and disasters.

2. Evaluating smart cities assets, services and resources.

   Skills on how to identify, engage and operate city's critical assets, services and resources. It will be presented existing frameworks of currently available smart city indicators to monitor and assess the performance and sustainability of smart cities resources.

3. Risk assessment and quantification.

   Quantitative Risk Management represents the discipline which deals with the ability of an organization to quantify and manage its risk. This scientific approach to smart cities is becoming increasingly critical in today's world as they need to satisfy stakeholders who demand it.

4. Risk management tools.

   An e-CF Competence that is a very important in identifying, prioritizing and developing responses to various risks. Technology is critical to helping smart cities become more efficient, while technology adoption presents novel opportunities, there are challenges and inherent risks that must be understood and managed for all smart city projects.

5. Smart city response planning.

   The necessary skills and competences to plan and implement the strategy on recovery after a crisis.

B. Smart City Planning and Organizational Skills

Smart City Planning skills are the skills and competences that a higher-level official must have in order to form and utilize a roadmap of all project, task and activities to transform a city to a smart one. Organizational skills are the ones that help someone stay focused on different tasks, by managing his time, energy, strength, mental capacity, physical space, and his resources in general in order to achieve the desired outcome.

1. Blue-green infrastructures in cities. A topic that covers both the blue (water elements) and the green (trees, parks, etc.) infrastructure management that will introduce trainees to models and

strategies that enhance blue-green infrastructure & social performance in urban environments to strengthen blue-green infrastructure in their cities contents

2. Digital Innovation Management.

   Digital Innovation Management aims to provide trainees with the opportunity to combine knowledge of digital innovation with management insights and strategies related to smart city, enabling them to stay ahead of one of the fastest evolving trends in the world.

3. GIS and Digital Twinning of Smart Cities.

   Technologies of these two scientific areas, i.e. geographic information system (GIS) and Digital Twinning, will be introduced to trainees and how these are utilized with monitoring systems by pairing the virtual and the physical world to prevent problems.

4. Smart cities: context, policy and operation.

   The core knowledge on what is a smart city, how it is working and what is the strategic vision of it.

5. Smart city enabling technologies.

   It covers the wider area of cutting-edge technologies that are used by smart cities to enhance city's' infrastructures and provide smart services to citizens.

6. Smart City stakeholder management and citizen engagement.

   The major sectors of stakeholders of Smart Cities will be presented and explain the different perspective that different stakeholders have about services and resources of a smart city. It will be also described the procedure by which the relationship with the smart city stakeholders is organized, planned and controlled, in order for them to be fully motivated to engage.

7. Smart city standards for resilience.

   Identification and implementation of the recognized standards to build resilience in smart cities.

8. Smart city urban planning and infrastructures.

   It will be presented the key knowledge domains and competences required for effectively managing smart cities characterized by rapid urbanization triggering the need to cope with increased complexity. In addition, it will analyze cases that is necessary to combine the best possible way the land, the houses and buildings and transportation utilities for a balanced perspective in the given context.

C. Business and Financial Management Skills

Business management skills are the ones a professional running an organization should have to ensure its business goals are met. On the other hand, the Financial management skills are about planning, organizing, directing and controlling the financial activities such as procurement and utilization of funds of the organization and applying general management principles to its financial resources.

1. Data analytics and statistics.

   Data analytics, which is a e-CF competence, has a crucial role to play in helping cities improve urban mobility, and better manage their infrastructure in a secure, resilient, sustainable and cost-effective manner.

2. Information security strategy development and management.

   One more of the e-CF Competences that it's about identification and management of controls that need to be implemented in order to secure assets from various threats.

3. Planning financial recovery programs.

   A necessary area of expertise in order to minimize the lag between the effect of a disaster and the beginning of the recovery procedure. A financial recovery plan help stakeholders determine strategic ways to set financial goals, organize, monitor, evaluate and reevaluate their progress.

D. Transversal Skills

According to UNESCO transversal skills are *"skills that are typically considered as not specifically related to a particular job, task, academic discipline or area of knowledge and that can be used in a wide variety of situations and work settings (for example, organisational skills)."*

1. Crisis management.

   The procedure that ensures that the city will face unexpected events and threats the best possible way.

2. Decision Making and Problem Solving.

   It will introduce the Decision Making process and Problem Solving approaches to trainees that will be able to first realize the general characteristics and scope of Decision Making problems, as well as the fundamentals, methods and techniques of Decision Theory. Furthermore, it focuses on the uncertainty nature of Decision Making problems in the context of smart city, for which special consideration in the problem solving approach need to be given.

3. Information and knowledge management.

   An important e-CF Competence about the management of the procedure that includes gathering the right information from various sources and distribute them to those who need it.

4. Management skills.

   The set of skills in order a leader like the SCRO be able to organize, plan, and deliver the desired recovery strategy of a Smart City.

5. Information security strategy development and management.

   One more of the e-CF Competences that will introduce trainees to the tools for identification and management of controls that need to be implemented in order to secure assets from various threats. It will describe how to build a security strategic plan, an entire IT security policy, and lead in the execution of the plan.

According to our point of view, the aforementioned skills will enable SCRO to perform his duties, as he has a holistic approach of his responsibilities and the challenges such a job role will face. To cover even more scientific areas, a number of selected skills are considered to be part in more than one groups. Furthermore, some of the e-CF Competences, were adopted in order for the selection to be comprehensive.

Common skills in categories

- Stakeholder and communication management, and citizen engagement.
- Evaluating smart cities assets, services and resources.
- Smart city response planning.
- Smart city standards for resilience.

This forms the first version for the inventory of competences and it will be more elaborated and exploited to derive the learning outcomes that the desired curriculum will have. Our intention is to provide a larger set and give trainees the ability to choose from a wider pool with skills and competences, those that best fit to their educational and working background, through a predefined process.

The larger pool of skills and competences, that enable possible alternatives for additional knowledge and experience will also be considered for the final form of the curriculum. The list of additional skills includes:

A. **Resilience Management**

1. Communicating with stakeholders during crisis
2. Managing emergency smart city assets and resources
3. Mobilizing external resources (nearby cities, governmental agencies, volunteers)
4. Operating emergency control centers
5. Risk monitoring and control
6. Risk transference techniques (insuring)
7. Smart cities risk identification
8. Training stakeholders for effective disaster response

B. **Smart City Planning and Organizational skills**

1. Citizens, Crowd Sourcing and Social Networking
2. Smart city organization structure, role and accountability
3. Smart city strategic vision and planning

C. **Business and Financial Management skills**

1. Agile Management
2. Creating and managing incentive schemas for non-profit organizations, businesses and citizens
3. Project and portfolio management
4. Smart cities financing and funding methods

D. **Transversal Skills**

1. Ability to work in virtual teams
2. Communication skills
3. Leadership and management Skills
4. Negotiation skills
5. Social skills, and
6. Teamworking

References

Adiego, J., & Martín-Cruz, N. (2021). Training competences in smart cities: an online program for higher education students. International Journal of Sustainability in Higher Education, 22(7), 1630-1645.

Bellenkes, A.H. (2004). Effective Risk Management in the Human Factors Assessment of Chemical/Biological Threats. In Kocik, Janiak and Negut (Eds) Preparedness Against Bioterrorism and Re-Emerging Infectious Diseases, NATO Science Series I: Life and Behavioural Sciences - Vol. 357. IOS Press: Amsterdam.

Bujones, A.K., Jaskiewicz, K., Linakis, L. and McGirr M. (2013). A Framework for Analyzing Resilience In Fragile and Conflict-Affected Situations. Retrieved, August 2020 from https://www.sipa.columbia.edu/academics/capstone-projects/framework-analyzing-resilience-fragile-and-conflict-affected-situations

Deloitte, 2020. Smart cities acing COVID-19 response using smart technology and data governance solutions https://www2.deloitte.com/content/dam/Deloitte/in/Documents/about-deloitte/in-about-deloitte-WEF-report-noexp.pdf

Elvas, L. B., Mataloto, B. M., Martins, A. L., & Ferreira, J. C. (2021). Disaster management in smart cities. Smart Cities, 4(2), 819-839.

Galle, N. J., Nitoslawski, S. A., & Pilla, F. (2019). The Internet of Nature: How taking nature online can shape urban ecosystems. The Anthropocene Review, 6(3), 279-287.

Kim, J., Park, J., Kim, K., & Kim, M. (2021). RnR-SMART: Resilient smart city evacuation plan based on road network reconfiguration in outbreak response. Sustainable Cities and Society, 75, 103386.

Krpálek, P., Berková, K., Kubišová, A., Krelová, K. K., Frendlovská, D., & Spiesová, D. (2021). Formation of professional competences and soft skills of public administration employees for sustainable professional development. Sustainability, 13(10), 5533.

Konstantinou, C. (2021). Toward a secure and resilient all-renewable energy grid for smart cities. IEEE Consumer Electronics Magazine, 11(1), 33-41.

Lepeley, M. T., Beutell, N. J., Abarca, N., & Majluf, N. (Eds.). (2021). Soft skills for human centered management and global sustainability. Routledge.

Marana, P., Eden, C., Eriksson, H., Grimes, C., Hernantes, J., Howick, S., ... & Serrano, N. (2019). Towards a resilience management guideline—Cities as a starting point for societal resilience. Sustainable Cities and Society, 48, 101531.

P. Fitsilis et. All (2021). Workforce Competences for Resilient Smart Cities: A survey, Technical Report, University of Thessaly, Greece

Patel, R. and Nosal, L. (2016). Defining the Resilient City. United Nations University Centre for Policy Research, working paper 6. Retrieved, July 2020 from https://i.unu.edu/media/cpr.unu.edu/attachment/2331/Defining-the-Resilient-City-24-Jan.pdf

Marana, P., Eden, C., Eriksson, H., Grimes, C., Hernantes, J., Howick, S., ... & Serrano, N. (2019). Towards a resilience management guideline—Cities as a starting point for societal resilience. Sustainable Cities and Society, 48, 101531.

Moglia, M., Frantzeskaki, N., Newton, P., Pineda-Pinto, M., Witheridge, J., Cook, S., & Glackin, S. (2021). Accelerating a green recovery of cities: Lessons from a scoping review and a proposal for mission-oriented recovery towards post-pandemic urban resilience. Developments in the Built Environment, 7, 100052.

Monstadt, J., & Coutard, O. (2019). Cities in an era of interfacing infrastructures: Politics and spatialities of the urban nexus. Urban studies, 56(11), 2191-2206.
Moraci, F., Errigo, M. F., Fazia, C., Campisi, T., & Castelli, F. (2020). Cities under pressure: Strategies and tools to face climate change and pandemic. Sustainability, 12(18), 7743.

Motta, M., de Castro Neto, M., & Sarmento, P. (2021). A mixed approach for urban flood prediction using Machine Learning and GIS. International journal of disaster risk reduction, 56, 102154.

Shao, W., Su, X., Lu, J., Liu, J., Yang, Z., Mei, C., ... & Lu, J. (2021). Urban resilience of Shenzhen city under climate change. Atmosphere, 12(5), 537.

Shayan, S., Kim, K. P., Ma, T., & Nguyen, T. H. D. (2020). The first two decades of smart city research from a risk perspective. Sustainability, 12(21), 9280.

Tonmoy, F. N., Hasan, S., & Tomlinson, R. (2020). Increasing coastal disaster resilience using smart city frameworks: Current state, challenges, and opportunities. Frontiers in Water, 2, 3.
Wang, Z., Deng, X., Wong, C., Li, Z., & Chen, J. (2018). Learning urban resilience from a social-economic-ecological system perspective: A case study of Beijing from 1978 to 2015. Journal of Cleaner Production, 183, 343-357.

Wilk, J., Jonsson, A. C., Rydhagen, B., del Callejo, I., Cerruto, N., Chila, G., ... & Rani, A. (2018). Assessing vulnerability in Cochabamba, Bolivia and Kota, India: how do stakeholder processes affect suggested climate adaptation interventions?. International Journal of Urban Sustainable Development, 10(1), 32-48.