Competences for Resilient Smart Cities' Staff

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SCRO Curriculum

1 Document Metadata

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Abstract:

Cities worldwide are increasingly embracing smart technologies to enhance their resilience in the face of various challenges. However, this rapid urbanization also underscores the urgent need to bridge the gap between the current skillsets of municipal personnel and the future competencies required to address evolving resilience needs. The CRISIS project addresses this gap by offering a comprehensive approach to the professional development of trainees, particularly focusing on the emerging job profile of the Smart City Resilience Officer (SCRO).

The SCRO curriculum, developed as part of the CRISIS project, aims to equip professionals with the necessary skills to effectively address resilience issues in the context of smart cities. By integrating innovative pedagogical models and self-assessment tools, the curriculum identifies competency gaps and provides flexible learning paths tailored to individual needs. It targets a diverse audience, including smart city authorities, existing municipal personnel, students of public administration, self-employed individuals, and sectoral organizations.

Key objectives of the curriculum include providing a structured framework for smart cities' education on resilience, developing innovative learning tools, closing competency gaps, promoting European collaboration on smart city education, and raising awareness among stakeholders about the complexities of smart city resilience. By addressing the shortage of knowledge and experience among prospective SCROs, the curriculum aims to have a positive impact on smart city stakeholders.

The curriculum document outlines the educational intents and offers a dynamic framework for guiding teaching and learning processes to ensure quality control. It includes detailed descriptions of the SCRO job profile, objectives of the curriculum, competencies in various categories, potential learning journeys, and content design of competences.

Overall, the SCRO curriculum represents a significant step towards enhancing the resilience of smart cities by empowering professionals with the necessary skills and knowledge to navigate complex urban challenges effectively.

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2 Introduction

Cities are rapidly advancing towards smartness, presenting both challenges and opportunities for enhancing resilience. As urban landscapes evolve, there is a growing imperative to bridge the gap between the current capabilities of municipal personnel and the future competencies needed to address these dynamic challenges effectively.

The CRISIS project adopts a comprehensive approach to the professional development of trainees, aiming to enhance their competencies and employability. In response to this pressing need, the project introduces a novel job profile, the "Smart City Resilience Officer (SCRO)", which outlines the essential competences required to address resilience issues within smart city contexts.

The overarching objectives of the CRISIS project include:

a) Establishing a structured framework for educating smart city staff on resilience, recognizing its paramount importance.
b) Developing an innovative curriculum tailored specifically for SCROs.
c) Providing cutting-edge learning tools to facilitate the implementation of the curriculum.
d) Addressing competency and skills gaps among municipal officials.
e) Promoting collaboration across Europe in the field of smart cities education.
f) Enhancing awareness among Member States, Local Authorities, Municipalities, and other stakeholders about the complexity of building resilient smart cities and the challenges in acquiring relevant competencies.
g) Leveraging insights from previous ERASMUS+ projects, such as the SmartDevOps project, to inform and enrich the CRISIS initiative.

The SCRO curriculum aims to delineate the essential competencies required for the emerging job profile titled "Smart City Resilience Officer (SCRO)", focusing on resilience challenges within smart urban contexts. It integrates an innovative pedagogical model that leverages a self-assessment tool to identify gaps in SCRO competencies. These insights are then amalgamated with recommendations on learning pathways (learning journey) and educational strategies, thereby offering flexible learning avenues through a modular structure.

This curriculum is specifically tailored to bridge the knowledge and experience gaps of prospective SCROs. It targets a diverse array of stakeholders, including smart city authorities, existing municipal personnel, students of public administration-related sciences, self-employed and unemployed individuals with relevant backgrounds or experience, as well as sectoral organizations and smart city associations. With a focus on addressing imminent challenges in smart city resilience, the curriculum is anticipated to yield a positive impact among SC stakeholders, facilitating the acquisition and development of pertinent foundational skills and key competencies.

Moreover, the curriculum document aims to clarify the content and methodology of instruction required to fulfill a set of educational objectives, while also providing stakeholders with a dynamic framework to guide teaching and learning processes, ensuring a mechanism for quality control.

The rest of this document is structured as follows: Section 2 describes the SCRO Job Profile, Section 3 presents the objectives of the curriculum, Section 4 provides an outline of included competences in categories, Section 5 presents different learning journeys learners could follow and the dependencies among the modules while Section 6 describes the content design of competences.

3 SCRO Job Profile

The Europe 2020 plan acknowledges the imperative to tackle the pervasive skills gap necessary for enhancing urban resilience, alongside fostering novel learning and teaching methodologies to enhance outcomes. The designed curriculum endeavors to address the aforementioned societal and urban needs, which have become increasingly crucial, particularly in light of the ongoing COVID-19 pandemic, revealing the inadequacies of European societies. By integrating these imperatives into the SCRO job profile, the curriculum responds to the identified competencies unearthed through comprehensive research, focusing on the most competitive and highly valued relevant skills. The context of the competences revealed after the research was done for the most competitive and high valued relative skills considering:

i. a literature review in order to get an overall view of the competencies that have been developed in in the context of the resilience for several case studies (January 2021)

ii. the findings of a research study conducted among municipal officials and experts who are smart city stakeholders (March 2021)

iii. an updated literature review to incorporate new research and trends in order to develop the curriculum (April 2022)

iv. results from the observations were risen from discussion among project partners - focus groups- to decide for those that address the project's objectives (April 2022)
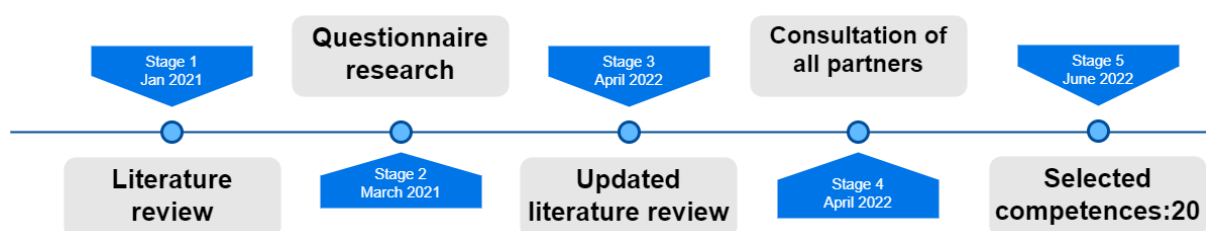

Figure 1.: Competences selection

Above all, in the first step, we had to determine the necessary skills according to the bibliography, consequently we elaborated a first literature review, aided to develop an understanding of the skills and the knowledge framework for progression to design the research. This helped in identifying and analyzing training needs, resulting in better choices for structuring a specific needs assessment.

In the subsequent phase, the project team undertook market research by administering a questionnaire to both public and private sector employees. This survey aimed to give insights into their respective roles, responsibilities, educational backgrounds, skills, and competencies deemed essential for inclusion in the SCRO job description. The collated data was then compared to relevant findings at the EU level to compile a comprehensive study on European countries' needs.

Afterwards, an updated literature review was elaborated to find recent trends and research is done in the field. Finally, the consortium, after discussing the research results, selected the 20 competences considered that should be included in the SCRO curriculum. Additionally, it was outlined the SCRO curriculum by making strategic decisions about what courses and modules the curriculum will cover and

- module's aims and objectives
- how modules connect
- criteria for successful completion
- how in-depth lessons will be taught to achieve both breadth and balance within and across subjects
- learning paths
- weekly study time
- the training plans
- the course calendar and the distribution of modules and learning units throughout the calendar

3.1 SCRO curriculum learning objectives

In accordance with the EQF framework, learning objectives are articulated as "statements delineating what a learner should comprehend, master, and demonstrate upon culmination of a learning endeavor." Broadly defined, the learning objectives of the modules encompassed in this curriculum aspire to cultivate competencies across various cognitive domains, including knowledge acquisition, comprehension, application, analysis, synthesis, and evaluation, regarding:

- Principles and fundamental concepts underpinning resilient cities and urban resilience
- Advocacy for sustainable urban development and resilience initiatives
- Utilization of tools aimed at enhancing a city's resilience
- Comprehension and assessment of risks and challenges impacting urban resilience
- Adoption of standards and performance metrics for assessing smart city resilience
- Formulation and implementation of disaster risk reduction strategies and action plans

- Preparedness and response planning within the context of smart cities
- Strategic management approaches for enhancing resilience in smart cities
- Transitioning from conventional urban frameworks to resilient smart city models

3.2 Groups of Competences

With the goal of covering all areas of the SCRO body of knowledge, the consortium endeavored to classify competencies, which resulted in four clusters. These four clusters, as they are presented in Figure 2, are the following:
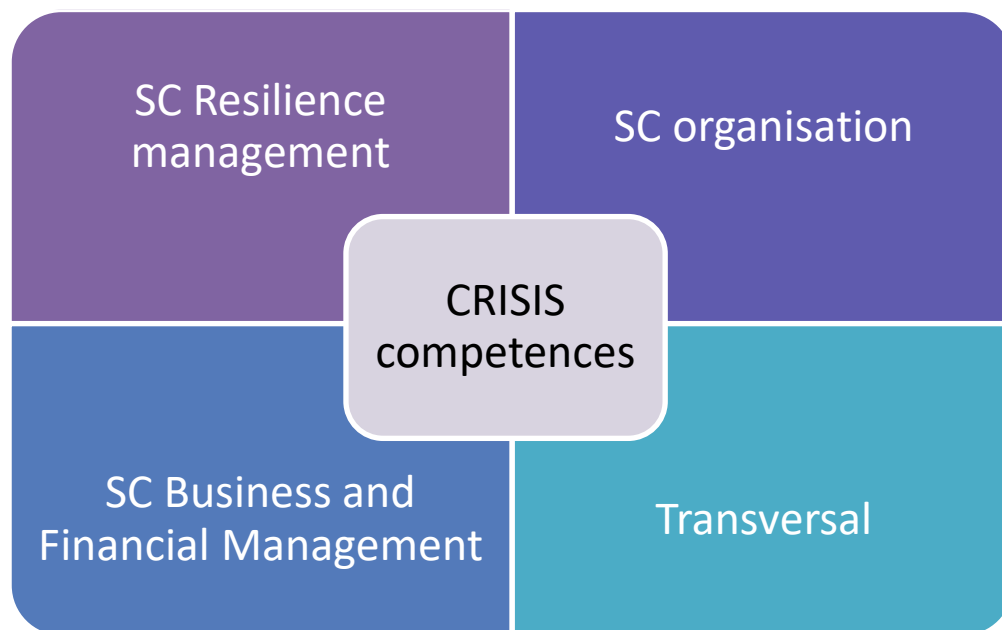
Figure 2. Four categories of skills and competences for SCO

a) Resilience management and response planning 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 Cities 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.).

4 SCRO Job Profile's Competences

4.1 SCRO Competences

4.1.1 Resilience Management competences

This group contains the competencies essential for a smart city professional's educational foundation, enabling them to adeptly navigate the sudden shifts, demands, and stresses inherent in smart city environments. It entails the orchestration, oversight, and strategic guidance of initiatives spanning multiple entities within the city's ecosystem, aimed at attaining requisite resilience levels and overcome unpleasant situations.

No	Skill	
1	Managing the transformation to a resilient SC	Managing transformation to resilient Smart Cities (SC) involves several interconnected issues. The purpose of this training is to cover the foundations of resilient SC and why resilience is so critical. Technology does not only bring benefits but also some risks. Creating a resilient SC is a multidisciplinary endeavor that requires the right leadership approach, and an understanding of what influences SC resilience. The major technologies that create both vulnerabilities and resilience for SC are presented. Lastly, the training introduces some best practices and examples of resilient SC worldwide. Different SCs face different challenges. While we cannot have a detailed example for each challenge a SC might face it is useful to explore as many as possible.
2	Identifying risks in SCs	Smart cities, despite their many benefits, provide unprecedented risks and challenges but not all these risks and concerns have been fully recognized by smart city officers. Moreover, the complexity of their dimension, the use of technology, and their integration bring the risk perspectives into the implementation of the smart city concept. If these risks are not adequately addressed and understood, they can create vital issues for the functioning of smart cities.

This module aims to help learners identify the origin, trends, and categories of risks in SC as they are categorized into main themes while discussing the technical and non-technical risk parameters related to smart cities implementation. |

3	Assessing and quantifying SC risks	The purpose of this module is to cover the most important risks a Smart City (SC) faces and how to assess and quantify them. A SC can face some significant risks such as natural disasters, climate-change, aging infrastructure and cybersecurity threats.
		Technology does not just create benefits but also vulnerabilities and cybersecurity threats. Each implementation of technology, every form of data collected, used and shared introduce risks.
		Cybersecurity risks to infrastructure, private data are introduced along with specific attacks like ransomware attacks. Various cybersecurity threats such as ransomware attacks must be assessed and mitigated. Where possible risks must be offset or prevented. This requires that they are quantified so planning can be accurate.
4	Planning for a SC resilience	One of the great challenges of this century is to find opportunities for smart environmental planning, comprehending the complexity it might entail, and approaching it from various angles, e g urban planning, sustainability, resilience, and smart cities. As cities face the dual challenges of managing everyday stresses and preparing for worst-case scenarios, they need to improve their operational capabilities and future-proof their infrastructure. With a (project) plan for SC resilience they can overcome the difficulties associated with increasing urban densification and the shortage of basic resources.
5	Monitoring and controlling SC resilience	Resilience quantification and measurement for complex ecosystems like SC, is a challenge. In fact, resilience cannot be estimated through verifications like following regulations and norms. SC's performance and its ability to track and manage that performance over time must directly relate to how resilient the city itself is measured. A system that fails can nonetheless demonstrate resilience by surviving the failure and recovering from it. On the other hand, a system's success does not guarantee that it will continue to be successful. Due to the danger of complacency, it is believed that monitoring is essential for a system to maintain resilience.
6	Assessing and coordinating SC assets and services	Smart services that are provided by fixed and digital assets in a SC represent the core of the smart city concept since they are key enablers for most activities in the world of smart cities. In this module, they will be presented different management models and indicators are used to successfully monitor, assess, and perform analysis of assets and services offered by cities (regarding their resilience). Moreover, it addresses coordination issues regarding the usage of SC assets and

No	Skill	
		services especially during the critical period of responding to hazards and disasters as well the immediate benefits and the expected progressive benefits derive e.g., guidance management that relies on the asset's intelligence.
7	Improving SC Resilience using tools	Different planning and assessment tools, utilities and frameworks for smart cities have been established and developed to deal with urban threats, being them familiar ancient threats (earthquakes, volcano eruptions, floods and fires) plus a modern set that includes terrorism, health crises, and industrial accidents. Dealing with such dangers requires new design concepts for urban spaces, foremost of which is resilience. In this context, this module will train learners in tools and frameworks for SC to support SCCRO's in coordinating and making decisions for minimizing crucial problems, especially during the critical period of responding to hazards and disasters. The main tools include information sources of a structural or event-response nature, to be used alone or together with a decision-support module. Existing tools that monitor and assess the performance and sustainability of smart city resources will also be addressed. With the aid of exploiting these tools and technologies, SC may innovate for longer-lasting value development enforcing resilience.

4.1.2 Smart City organisation competences

The set of Smart City skills comprises essential proficiencies needed by senior officials to devise and execute a roadmap encompassing projects, tasks, and initiatives crucial for transforming a city into a smart entity and achieving the desired resilience outcome.

No	Skill	
8	Developing blue-green infrastructures in SC	Literature and practice have showcased the determining role of adapting blue-green infrastructure strategies when planning for urban environment resilience, sustainability and viability. This module focuses on highlighting the benefits of engaging smart technologies in developing blue-green infrastructure and on showing that a smart city constitutes the ideal platform to apply these technologies. It will also focus on exploring proven methods and means of applying such technologies.
9	Transforming cities through digital innovation	The advancement of citizens' quality of life is a major concern of smart cities. Climate change, economic and

		social instability, demographic changes and other changes that the world has witnessed have posed complex challenges to cities that require a solid commitment to innovation.
		Cities are ideal for testing and implementing innovative, sustainable and integrated solutions to address these challenges. City governments have been developing innovative practices to engage citizens in innovation, including adopting digital platforms to promote communication and collaboration between government and citizens and/or among citizens in developing bottom-up innovations.
		Digital technologies have enabled cities to develop innovative services and products that are transforming how people live, work, collaborate and communicate. However, technology also poses privacy, security and accountability challenges that must be adequately addressed.
10	Geoservices and Digital Twins of SC	The intent of this module is to explain the connection between digital twins and smart cities, assess the traits of digital twin based smart cities, and concentrate on the key uses of such cities. It will also discuss how the digital twin can take advantage of the growing amount of geospatial data and geoservices are being created. Finally, it discusses the future development of smart cities based on digital twins. The digital image of reality makes it possible, among other things, to better visualize and also communicate planning. Different scenarios can be tried out without risk in order to make predictions about their possible effects.
11	Learning SC enabling technologies	A smart city (SC) enabling technology is used in the development of SCs to establish a holistic environment that is transparent, automated, inclusive, extensible, secured, flexible, and easily manageable. Such technologies are sensory devices, wireless sensor networks (WSNs), the Internet of Things (IoT), cloud/edge computing, and big data analytics, and play a key role in the resilience of SCs. The integration of these technologies can support the development of a connected network of devices and entities of an SC.
12	Managing SC stakeholders and developing citizen networks	Stakeholders are diverse and play a key role in the innovation and resilience of cities. They can be grouped into different areas of influence such as government and public sector, financial sector and funding system, universities and R&D entities, business sector, IT sector, NGOs and civil society, social and third sector. The complexity and diversity of the challenges faced by cities makes it essential to engage stakeholders and citizens in the development of services and applications that allow

		the city to respond quickly and sustainably to those challenges.
13	SC urban planning and critical city's infrastructures	A challenge in urban planning is to identify a complete inventory of a city's existing (critical) infrastructure and, furthermore, to design and develop resilient smart infrastructures and services. In addition to appropriate tools, cities must also be given the competence to identify critical infrastructures, analyze attack vectors against them, classify existing measures and, as a result, also plan further steps for comprehensive SC resilience. Protecting and securing the smart cities' resources and services becomes critical due to the disruptive or even potentially life-threatening nature of an outage or attack on SC infrastructures.
14	Using SC standards for resilience	Nowadays cities in Europe and all over the globe are connected through various networks that demand interoperability, security, resilience and sustainability among others. They often develop similar approaches and have comparable levels of development. These networks, collaborations and common goals provide a good basis for development of consensus-based standards.

Module 0X presents critical issues that took into account by standardisation organisations on Smart Cities (i.e. ISO, ITU, IEC, CEN CENELEC ETSI) and progress or recommendations of these pioneer organisations and other relevant initiatives that came up as results by H2020 R&I Projects and/or international workshop agreements.

Standardisation in the field of Smart City – as a holistic concept for sustainable urban planning and transformation of societies- can support a multi-sectorial integrated approach of sustainable cities and communities with a long-term vision based on the purposes of sustainability, meaning resilience, responsible resource use, preservation & improvement of environment, attractiveness, social cohesion and well-being.

Standards can provide requirements, guides, specifications, techniques and tools for cities and territories, for their critical entities (infrastructures) and for the stakeholders to plan, develop, operate, maintain, manage and govern systems and services with a long-term vision based on secure cutting-edge technologies.

Our world is changing rapidly and we have to design and implement the new world by valorising all the available resources, knowledge, data, legacy systems with an anthropocentric & holistic approach. In this |

| | | interconnected, interrelated, interdependent world we need to work smarter and efficiently to take advantage of the available tools such as digitalisation and standardisation among others, against the alarming global backdrop of climate change, energy crisis, cyber & hybrid threats, invasions and other geopolitical crises. |
| | | Both European and International Standardisation ecosystems issued an outstanding set of standards (specifically developed for SC, lateral and transversal) in order to support and enhance all the efforts done by the relevant stakeholders. |

4.1.3 Business and Financial Management competences

Business management abilities are those that a professional in charge of an organization should possess in order to ensure that the firm's objectives are realized. Financial management abilities, on the other hand, are concerned with planning, organizing, directing, and managing financial activities such as money procurement and utilization, as well as applying general management principles to the organization's financial resources.

No	Skill	
15	Data analytics for SC Decision Making	In our digital world, data-driven smart city decision making is more imperative than ever. This data is an important source of information for smart cities to effectively predict various urban phenomena and support their decisions. This module presents an introduction into the concepts of data analysis to produce useful insights and conclusions. It will consider the role of data, in an evolving smart city system, for effective decision making. Learners will also gain direct experience in using examples to analyze data and draw valuable insights.
16	SC security and safety establishment	Safety is defined as the state of being free from harm or danger. It comprises the steps taken to safeguard individuals from accidents, harm, and exposure to dangerous situations. Safety is frequently attained by following safety protocols and procedures.
		On the other hand, security can be defined as the protection from crime and violence. It contains all measures needed to protect people from life risks, theft, vandalism, terrorism, and other threats. Security is often achieved through the implementation of security procedures and protocols.
		Smart cities as complex ecosystems where millions of citizens work and leave requires both. This, of course,

		creates urgency on governments and local authorities to improve public safety and security. In many cases today we rely heavily on those new technologies and devices for achieving SC safety and security requirements. These applications are crucial to police, medical and emergency teams so to make the best decision possible when dealing with emergency situations.
17	Organizing the SC for resilience using agile principles	Agile cities display uncommon resilience throughout the crises they face because they use resilience preparation as their base and are able to adapt and innovate by adding new practices to react to the challenges. These cities adopt an adaptive planning process that allows them to adapt to change in a flexible manner in the short and medium term. Understandings and responses evolve through evolutionary development, early delivery, continuous improvement and collaboration between stakeholders in self-organizing and cross-functional teams. The agility of the resilient city is expressed in several dimensions, namely sustainable buildings, agile planning and management of land, networked energy systems, flexible infrastructures, efficient and responsive IT assets, smart policing and prevention strategies, education models based on intensive formats with quick proof-of-concept approaches and shorter time cycles, and a culture of constant transformation.
18	Establishing financial programs for resilient development and disaster recovery	Cities are continuously facing disaster risks that can materialize in various forms and levels of intensity (i.e disasters due to natural hazards (earthquakes, volcanic activity, extreme temperatures, storms, floods, drought, wildfires, etc), biological events (epidemics, insect infestation), technological or man-made disasters (industrial or nuclear incidents, terrorist or cyber-attacks). For a Smart City to be resilient and able to recover from such an event, it is important to reduce and manage these risks. A key component in order to achieve this, is the development of disaster risk management (DRM) plans, which in turn, order to be realized, a proper financial plan/strategy must be in place. In this module, we give a comprehensive introduction to the subject of DRM and subsequently focus on disaster risk financing (DRF), presenting and discussing the various steps towards establishing a suitable financial program for such a purpose, based on international standards and practices.

4.1.4 Transversal Skills

According to UNESCO the skills are those typically considered as not specifically related to a particular job, task, academic discipline or area of knowledge but as skills that can be used in a wide variety of situations and work settings. These skills are increasingly in high demand for learners to successfully adapt to changes and to lead meaningful and productive lives.

No	Skill	
19	Crisis management	A crisis is any unforeseen event which puts the operational viability and reputation of an entity or individual at risk. The course module focuses on the fundamentals of crisis management, covering 3 main areas: crisis leadership skills, crisis response plan and crisis communication skills. The module examines the steps to take before, during and after a crisis, which will help determine an outlook once the crisis has passed. In addition, it offers tools for anticipating crises and processes for developing crisis management capabilities.
20	Decision Making and Problem Solving	The course module covers decision-making processes and problem solving approaches to trainees who can first identify the basics and scope of decision-making problems as well as the fundamentals, methods, and practices of Decision theory and Problem solving. The module also emphasizes the uncertainty found in most decision-making issues, which requires special attention in the problem-solving framework. Using this approach, comprehensive studies of different Decision Making problems under uncertainty are given. The capacity to gather relevant information, collect accurate data, identify reasonable alternatives, and choose acceptable decision criteria are crucial for making suitable decisions. The capacity to determine the source of the problem and find a reasonable solution is another requirement for problem solving. It involves components of analysis, creativity, team building, and research communication. In addition, the Decision Tree Analysis is introduced to provide a proven graphical solution approach to DM problems, and the Linear Programming method's foundations and its applications are also explored.

In relation to transversal skills, learners have the opportunity to leverage pertinent open educational resources created within the DEVOPS project, focusing on the following competencies:

- Ability to work in teams
- Communication skills
- Leadership and management Skills
- Negotiation skills
- Social skills
- Teamworking
- Information and knowledge management
- Information security strategy development and management

Figure 3 displays the categories along with the competencies associated with each category.
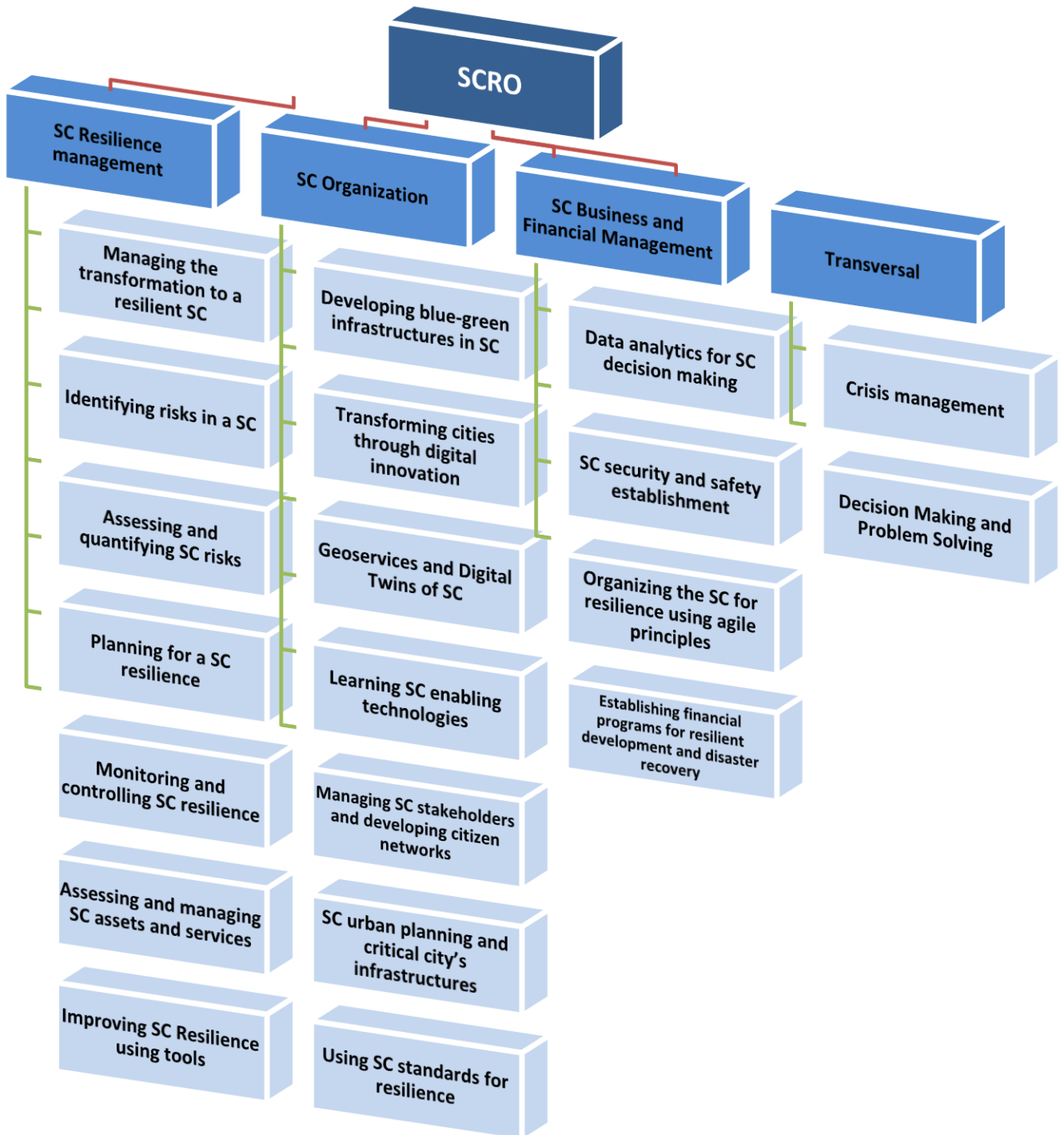
Figure 3: The set of competences that build the SCRO job profile

5 Module Learning Objectives and Learning Outcomes

Module	Learning objectives	Module learning outcomes
1 - Managing the transformation to a resilient Smart City	• The module focuses on managing the transformation to a resilient SC, and its learning objectives are: • Learn fundamental concepts of a resilient C • Challenges to resilient SC in the global context • Current approaches to resilience in cities • The main principles of resilient SC • Leadership and strategy for resilient SC • The consequences of global events with a high impact (pandemics and wars) • The contribution of recent technologies to SC resilience • 8. Learning from case studies of resilient SC	• Describe the main aspects of a resilient SC • Describe what the main challenges of a resilient SC are • Outline the typical successful models of a resilient SC • Identify the main principles of a resilient SC • Identify the typical leadership styles and strategies for a resilient SC • Describe some typical impacts of global events like pandemics and wars • Describe four technologies that are making cities more resilient and smarter • Explain the impact of different technologies on a resilient SC • Give examples from case studies of resilient SCs • Argue about the level of resilience a SC must achieve
2 - Identifying risks in Smart Cities	• The module focuses on Smart City risk identification and its learning objectives is to introduce trainees to the origin, trends and different categories of risks in smart cities.	• Define basic concepts regarding risks • Understand and explain the origin of various risks • Apply fundamentals of Risk Assessment • Categorize risks in smart cities and name fundamental risks in each category • Explain the technical and non-technical risk parameters related to smart cities implementation • Exploit the potential of new technologies for identifying risks

3 - Assessing and quantifying Smart City risks	- The module focuses on assessing and quantifying risks to a SC and the learning objectives are: - Learn fundamental risks a SC faces and how to quantify them. - Assess the cybersecurity risks to a SC. - Understand the risks to a SC from an over-reliance on technology and people losing some skills. - Understand the methods that can be used to quantify risk in a SC.	- Describe the fundamental risks a SC faces and how to quantify them - Outline the regular risks a SC faces such as risks from heat and pollution and aging infrastructure - Outline the risks to SC from natural disasters and climate change - Understand the risks to a SC from global events like disruptions to supply chains, economic instability and high inflation - Understand the cybersecurity risks to a SC - Describe the risks to SC from an over-reliance on technology and people losing other skills - Describe methods to quantify risk in a SC. - Develop a risk management plan and a risk mitigation plan. - Give examples of risk quantifying tools - Explain the different benefits of risk quantifying tools - Argue about which are the greatest risks facing a SC and how to quantify them
4 - Planning for a Smart City resilience	- Creation of a project plan for the implementation for a SC resilience - Identification of milestones - Monitoring of the implementation for a SC resilience - Evaluation of the implementation for a SC resilience - Conflict management and problem-solving skills	- Describe the creation of the project plan for the implementation for a SC resilience. - Describe what relevant milestones are and how you can identify them. - Recognize what are the challenges in planning a SC resilience. - Explain the different perspectives that stakeholders have in planning a SC resilience. - Express appropriate tools for planning and monitoring. - Analyze potential for conflicts and problems at an early stage. - Argue whether a city has the qualifications to be a SC.

5 - Monitoring and controlling Smart City	• Identify the threats of the resilience of a smart city • Explain resilience monitoring concepts • Explain resilience control concepts • Describe data acquisition and process • Choose monitoring and controlling methods to increase the resilience of a smart city	• Explain what resilience is • List the three resilience layers of smart cities • Summarize the threats of each smart city resilience layer • Outline data sources to monitor resilience • Describe the basic steps of data analysis towards smart city service deployment • Describe early warning systems • Infer the visualization strategy to be applied over specific data and needs • Explain how resilience solutions can benefit five smart city application domains
6 - Assessing and managing Smart City assets and services	• Present a holistic view of SC Infrastructures and major assets • Describe pervasive asset management Measure the Efficiency of Smart Solutions Present assessment tools and Key Performance Indicators sets for assets and services • Discuss security, coordination issues of services and Asset tracking • Explain benefits from asset and service management that relies on the evolvement of asset's intelligence	• label major assets and services; • measure the efficiency of smart solutions • apply rigorous and pervasive asset and service management • analyze security issues and asset tracking explain assessment tools and Key Performance Indicators sets • appraise benefits from asset management that relies on the evolvement of asset's intelligence.
7 - Improving Smart City Resilience using tools	• Identify the indicators capable to assess the resilience of a city to specific threats. • Develop a monitoring plan for these indicators. • Define a plan to improve the resilience of a city.	• To understand the principles of resilient systems design. • To describe the factors that influence the resilience level of a smart city • To examine the potential of IT applications to strengthen the resilience of a city • To use tools to assess and monitor the resilience of a city

		• To critique the various options to increase the resilience of a city • To design a plan to improve the resilience of a city.
8 - Developing blue-green infrastructures in Smart City	• Explain the role of blue green infrastructure for the urban ecosystem • Introduce blue green infrastructure component elements • Explore how smart technologies benefits blue green infrastructure • Present blue green infrastructure cases	• Define blue green infrastructure • Summarize the ecosystem services provided by blue green infrastructure • Summarize the benefits of blue-green infrastructure for biodiversity, the environment, the society and the economy • Outline the ecosystem services and benefits provided by each of these five (5) blue green infrastructure elements • Describe digital elevation models technologies • Outline at least six (6) smart city technologies contributing to blue green infrastructure development • Summarize the internet of nature concept • Explain what remote sensing means • Identify the risks accrued by the urban water cycle and the heat island effect • Recognize at least five (5) blue green infrastructure elements • Distinguish blue-green from grey infrastructure • Classify blue green infrastructure elements by functionality • Name at least five (5) ways a geographic information system contributes to blue green infrastructure's objectives • Order the five (5) levels of digital twins' sophistication • List at least three (3) sensor types for assessing air quality, water quality and weather conditions

9 - Transforming cities through digital innovation	• Co-Creation of innovative and sustainable solutions to resilience challenges • Citizen engagement in digital platforms supporting innovation • Addressing privacy, security and accountability issues posed by IT applications • Success stories: Digital innovation in Smart Cities	• To list enablers and barriers of urban digital transformation; • To explain proven strategies to motivate initiating and participation in urban digital transformation; • To identify the resources, including technological resources, typically involved in urban digital transformation; • To demonstrate the relevance of advanced technologies (e.g., IoT, Cloud, IA, Blockchain) for urban transformation; • To examine the privacy, security and accountability issues associated with the adoption of data technology to innovate services and products; • To compare existing frameworks guiding urban innovation; • To design an innovation process for a smart city; • To assess the effectiveness of the designed process against the processes implemented in specific cities.
10 - Geoservices and Digital Twins of Smart City	• The course module focuses on the connection between digital twins and smart cities and assessing the characteristics of digital twins. The learning objective is to introduce the trainees to the following topics: • Basic concepts of a digital twin of a SC. • Creation of a project plan for the development of a digital twin of a SC • Identification of milestones • Monitoring of the implementation development of a digital twin of a SC • Evaluation of the implementation development of a digital twin of a SC	• Describe the concept of a digital twin for SC. • Describe what relevant milestones are and how you can identify them. • Recognize what are the challenges in planning of a digital twin of a SC. • Explain the different perspectives that stakeholders have in planning of a digital twin of a SC. • Express appropriate tools for planning and monitoring. • Recognize possible problems and potential for conflicts early on. • Argue whether a city has the qualifications to develop a digital twin of a SC.

	• 6. Derive key resilience aspects from the application of different scenarios to the digital twin of the SC	
11 - Learning Smart City enabling technologies	• Introduction to SC enabling technologies • Wireless Sensor Networks and the Internet of Things • Cloud/Edge Computing technologies and Big Data Analytics	• Describe the technical and user requirements involved in a smart city. • List the categories of smart city enabling technologies. • Summarize the main tasks of the Internet of Things. • Describe the basic types of monitoring List the characteristics and advantages of a wireless sensor network. • Describe what the cloud computing paradigm offers in a smart city context. • List the drawbacks of the cloud. • Describe the advantages of edge computing in performing quick and lighter computations nearer to the Internet of Things data sources. • Describe 5 characteristics of big data • Describe the role of machine learning in big data analytics. • Explain what a clustered-based wireless sensor network is.
12 - Managing Smart City stakeholders and developing citizen networks	• Identify factors that motivate engagement and collaboration. • Identify methods and practices to manage stakeholders effectively • Identify methods and practices to develop citizen networks. • Define strategies to engage stakeholders and citizens in developing solutions to SC problems and threats.	• To list factors relevant to stakeholders and citizen engagement • To identify the key stakeholders that impact the SC sustainability • To understand strategies, platforms and techniques for effective communication and collaboration in the development of services and applications for the resilience of SC • To understand the transformative power of citizen networks as a positive social transformation tool for SC. • To articulate technologies and analytics to support innovative citizen-driven innovation

		• To explain multi-stakeholder approaches • To design co-creation initiatives with citizens and stakeholders • To assess the effectiveness of approaches to stakeholder management;
13 - SC urban planning and critical city's infrastructures	• Critical infrastructures and their role for urban resilience • Energy, Water and Health/Emergency • Government, Transportation, Communication, Finance	• Identify and name the seven central domains of critical infrastructures of SCs. • Describe the major characteristics of the various domains of critical infrastructure. • Recognize the challenges in documenting SC critical infrastructures. • Understand the mutual and manifold interdependencies between all types of critical infrastructure. • Express potential frameworks, guidelines, and measures for planning and monitoring. • Analyze potential vulnerabilities of own SC's critical infrastructure at an early stage. • Transfer guidelines and measures offered for one critical infrastructure domain to another. Argue whether a city's infrastructure is resilient against attack vectors.
14 - Using Smart City standards for resilience	• The learning objectives of this module are to: • Identify and introduce to the Standards Development. Organisations, the Forums, Technical Committees, Working Groups and SC Standards in force. • Preview and associate with the relevant EU Policies.	• To outline the need and importance of standards and standardisation generally and especially in the sphere of SC. • To distinguish the Standards Development Organisations (SDOs) and other organisations which deal with SC standards and standardisation deliverables

	• Outline pertinent FP7 and H2020 R&I Projects' outcomes with valuable contributions to the SC field. • To raise concern, elevate awareness and estimate the way forward to 2050.	• To illustrate the various Technical Committees (TCs), Working Groups (WGs) and Fora on SC at European and International level (relationships and partnerships; liaisons) • To categorise the relevant series of SC standards in force. • To relate, match and explain the series of SC standards with the relevant SDOs, TCs and WGs • To summarize the order of SC standards' content requirements • To relate SC standards with the relevant EU Policies and/or Mandates. • To value initiatives such as Society 5 and IWA 39To value results of pioneer FP7 and H2020 R&I Projects which delivered relevant SC pre-standardisation deliverables • To critique the trends in SC business/technological/social models in the way forward to 2050.
15 - Data analytics for Smart City decision making	• Definition of Data Analysis • Recognition of Data types • Understanding key characteristics of data types & Demonstration of various data collection methods • Meaning of Descriptive statistics & Determining variability measures • Description of the basic features of data & Examination of examples of different types of data • Explanation of data visualized & Calculation of central tendency measures • Understanding the contribution of data analysis to real life	• Define the concept of data collection, processing and analysis • Recognize different types of data • Summarize the basic features of data • Explain the contribution of data analysis to real life • Give applicable examples of the value of data analytics in different fields when it comes to smart city development • Compute different statistical measures for analysis • Demonstrate the purpose and necessity of data analysis for Smart Cities • Demonstrate various examples of different types of data

16 - SC security and safety establishment	• To understand key principles and concepts of smart city safety and security. To be aware on how modern technologies may improve safety and security. • To understand how modern technologies improve situational awareness and decision-making process. • To understand critical safety and security application requirements and architecture (e.g. augmented security screening, crowdsourcing security apps, data-based crime prevention)	• Define safety and security key concepts • Describe SC safety and security landscape. • Describe the key factors that affect cybersecurity • Recognize the role of technology and its influences • Being able to describe key safety and security risks • Understand the key competences for cybersecurity • Understand the holistic approach of cybersecurity • Demonstrate understanding of how technology can improve security of a SC. • Understand the process to enforce cybersecurity
17 - Organizing the Smart City for resilience using agile principles	• Apply agile principles to urban adaptation to changes. • Define adaptive planning processes. • Assess the resilience´s agility of a smart city.	• To list the 12 agility principles of software development • To descript Proof of Concept (POC) • To determine the characteristic of agile smart cities • To design agile SC frameworks • To define agile urban planning processes and governance strategies • Explore the role of Digital Transformation in improving the SC Resilience • To assess the adaptability of a smart city
18 - Establishing financial programs for resilience development and disaster recovery	• To introduce and describe the key concepts involved in disaster risk management • To familiarize trainees with international initiatives, standards and frameworks in relation to resilience and risk management • To describe the phases of disaster risk management and disaster risk reduction	• Describe the main concepts related to disaster risk • Outline the main components of disaster risk management • Distinguish between disaster risk management and disaster risk reduction • Identify resilience initiatives and frameworks • Describe the 3 key steps in designing a DRF strategy • Describe the key steps in risk assessment • List the main DRF instruments available

	• To describe the key steps in designing a DRF strategy • To get acquainted with the financial instruments available that allow the delivery of disaster risk management plans • To present the factors to consider when designing, implementing and assessing DRF programs To discuss about cities' major barriers when trying to fund resilience investments and strategies to overcome these	• Describe the key factors under consideration when designing, implementing and assessing DRF programs • Discuss major barriers that hinder SC source funding for resilience investments
19 - Crisis management	• Basic concepts of crisis management. • Challenges in developing and implementing crisis response plans. • Steps to crisis management planning. • Introduce critical crisis communication skills. • Utilizing personal and team leadership skills in crisis situations. • Introduce some best practices examples of crisis management worldwide.	• Describe main concepts related to crisis management. • Define what a crisis is and determine what constitutes a crisis. • Recognize the importance of a crisis response plan. • Implement crisis response plans to be more prepared in the case a crisis occurs. • Illustrate critical crisis communication skills. • Develop crisis response plans. • Craft key messages and media statements.
20 - Decision Making and Problem Solving	• To realize the wide scope and characteristics of Decision Making and Problem Solving processes • To understand the concept of an appropriately developed mathematical model representing a Decision Making problem and be able to formulate this model for addressing the problem	• Describe the Decision Making Process and Outline the general characteristics of the Decision Making problems • Define what a mathematical model is and what it entails and Identify a model's possible limitations • Define the Problem Solving fundamentals, process and pertinent elements and List the basic features in Decision Making under uncertainty Outline the basic features and structure of a Decision

- To become familiar with the most widely used Decision Making and Problem Solving methods and tools (such as the Decision Trees and Linear Programming techniques) - To recognize the probabilistic nature of Decision Making problems and basic characteristics of Decision Making under uncertainty - To be able to apply the concepts and applications learnt to a real-world Decision Making problem - To examine the best practices in Decision Making	Tree and Define the general structure of Linear Programming (LP) models - Outline the graphical solution approach to an LP problem and Recognize the probabilistic nature of Decision Making problems - Explain the terms of expected value, opportunity cost, payoff table and states of nature and Illustrate the Decision Tree Analysis approach - Distinguish the problems that can be solved through LP and Explain the results of an LP problem - Use the appropriate model representing a Decision Making problem to be solved and Apply the Problem Solving approach through Decision Trees in Decision Making problems - Examine the Decision Making Best practices of Fortune 500 Firm Leaders and Assess on Dangerous Judgment Errors in the workplace - Work on how to make the best Quick Decisions and Interpret Sensitivity Analysis results

6 Module designation and development

The curriculum designed to impart SCRO competencies is structured into modules. Each competency covered in the course is allocated to one or more of these modules. Furthermore, each module comprises units, which in turn consist of learning objects. In pursuit of establishing a modular curriculum that facilitates diverse learning paths, it is crucial to have a universal designation technique for all modules across the various learning paths incorporated within the curriculum.

6.3 Module Designation
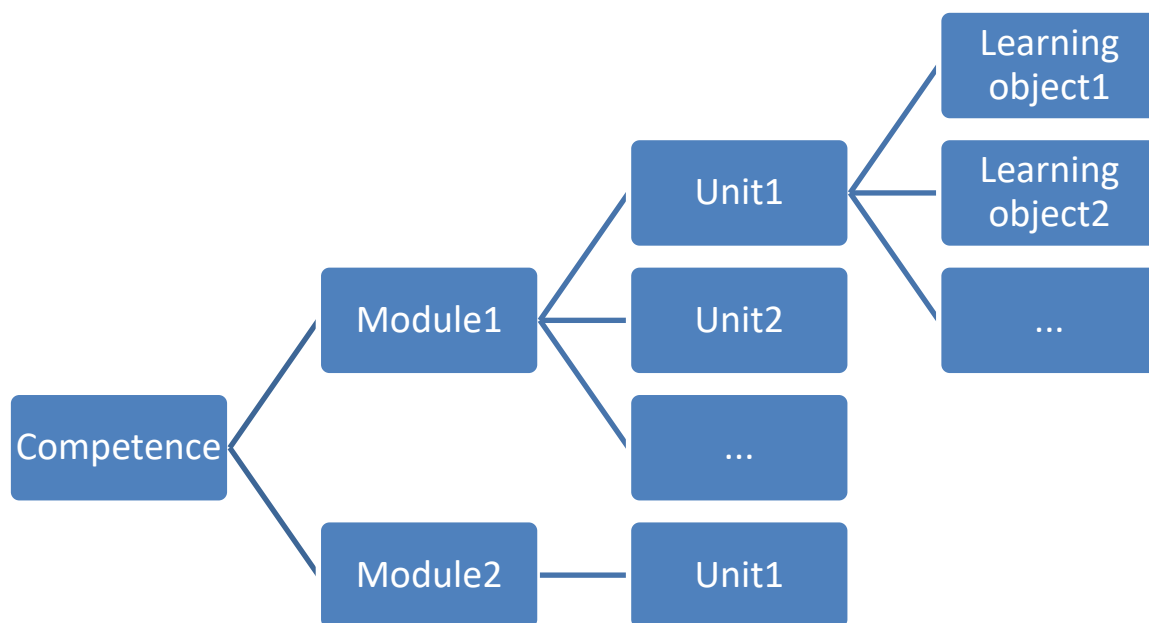
Figure 4: Competence content hierarchy

6.4 Module development

To ensure the systematic and consistent designation of all training modules during the designation stage, tables TB1, TB2, TB3, and TB4 have been defined. These tables are utilized to specify various aspects of the units, learning objects such as presentations, podcasts, white papers, and assessments within each module.
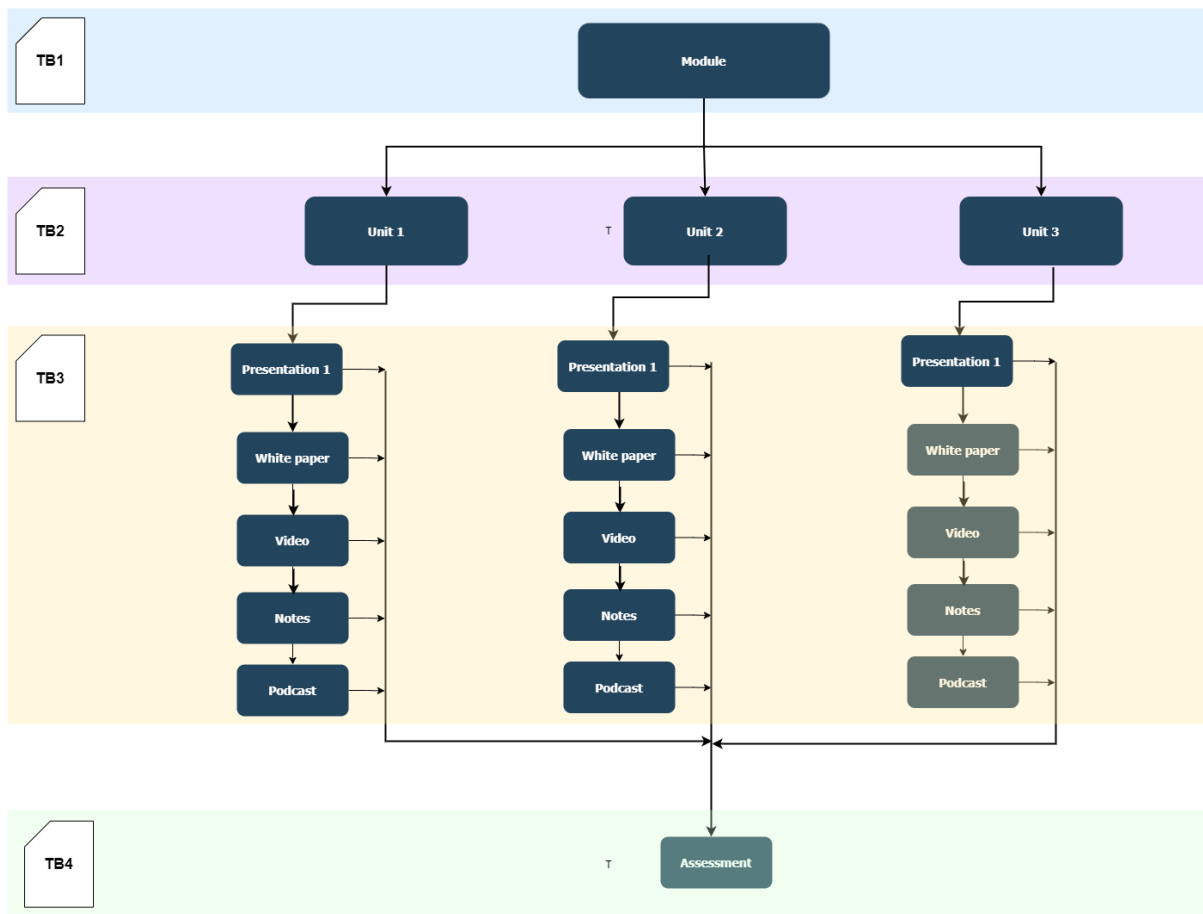
Figure 5.: TB tables for module specification

6.4.1 Module specification - TB1 template

During the designation phase of each module, the following elements are defined: (i) learning objectives, (ii) learning activities, (iii) educational techniques, and (iv) the module's units along with their respective learning outcomes. To facilitate a systematic and consistent approach to the designation of all training modules, a template named TB1 has been developed. This template encompasses the aforementioned information, in addition to supplementary details necessary for its implementation. The template is structured to include the following fields: Table filename:

mm.TB1: MODULE TITLE SPECIFICATION (mm: MODULE ID)		
1	Module ID	*Module ID, the unique ID for each module according to the curriculum*
2	Module title	*Title of the module according to the curriculum*
3	Language	English

4	Module description	*Includes the description of the module, i.e., the training problem it addresses, the context of application, the learning goals, the learning objectives and the learners' needs that the module meets. (up to 100 words)*
5	Learning objectives	*LObj1. Learning objectives (4 up to 10) for the module*

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)
{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy
please underline the verb and the concept of the knowledge domain used}
Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	(Use verbs according to bloom taxonomy)
LOut2	
2. Comprehension level	
Lout3	
3. Application level	
4. Analysis level	
5. Synthesis level	
6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION

	Unit ID*	**Unit title**
Module Units	mm-1	
	mm-2	
	mm-3	
	mm-4	

6.4.2 Unit specification – TB2 template

Each module is comprised of 3 to 4 units. Within the TB2 template, we specify the units included in the module, which correspond to learning objects.

mm-u TB2: UNIT SPECIFICATION		
Module Units	**Unit ID**	**Unit title**
	ModuleID.1	***mm-u (mm:MODULE ID, u UNIQUE UNIT ID from 1–4)***
	ModuleID.2	
	ModuleID.3	
	ModuleID.4	
	The following are repeated for each different unit is included in the module	
1	Unit ID	***mm-u (mm:MODULE ID, u UNIQUE UNIT ID)*** *This corresponds to a unit of the module*
2	Unit title	The Unit title
3	Unit description	This unit content and what it in includes, in bullets
4	Educational strategy	*presentation, video, article*
5	Unit Learning outcomes	mm.LOUT1 mm.LOUT2, etc
6	Unit core material (Learning object (LO)) (code and title)	
7	Unit additional material (code and title)	
8	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	
9	Unit schedule	

6.4.3 Leaning Object Specification – TB3 template

Regarding the development process of the learning objects, the content of each module will adhere to the design established in the preceding phases. The learning objects are

crafted in alignment with the learning outcomes delineated in the unit outlines. To systematically document all learning objects along with their respective outcomes for unit contents, an additional table template, TB3: Learning Object Description, is provided. For each distinct learning object included within a unit, the TB3 table is to be replicated.

mm-u-l - TB3: Learning Object Specification		
1	**Learning object ID**	**mm-u-l (mm:MODULE ID, u UNIQUE UNIT ID, UNIQUE LO ID)** *This corresponds to a LO of the unit (presentation, video, article, etc)*
2	Learning object title	
3	Language	*English*
4	Learning object description	Learning objects of this UNIT
5	Learning outcomes (LOut)	
6	Learning recourse type (IEEE LOM)	*Presentation, video, article, etc*
7	Technical type (IEEE LOM)	Text
8	Workload (Estimated study time) (min)	XX minutes

6.4.4 Module assessment – TB4 template

Finally, the table **TB4-Module Assessment,** which outlines the assessment methods to be employed for each unit within the module. These methods may encompass a variety of formative assessments, such as multiple-choice questions, online forms, exercises, projects, and practical assignments. From a methodological standpoint, the assessment tests will be grounded in the learning outcomes approach, reflecting the specific learning outcomes associated with each unit of the learning module. The TB4 table will be utilized repeatedly to assess each individual unit.

mm-u-A TB4: Unit Assessment Object		
1	Assessment Object ID	*mm-u-A (mm:MODULE ID, u UNIQUE UNIT ID)*

3	Language	English	
4	Learning recourse type (IEEE LOM)	Multiple Choice Questions/ Report /	
5	Technical type (IEEE LOM)	*Text*	*Document*
6	Workload (Estimated study time) (min)	30	
7	Write down the assessment object (quiz)	*Use the template below as many times as needed and modify accordingly to specific question type (1 template for each question).*	

The Question template will be repeated *as many times as needed for all questions used for the unit assessment*

Question template	
Question ID	*XX-Y-A-ZZ (XX:MODULE ID, Y UNIQUE UNIT ID, ZZ UNIQUE QUESTION ID)*
Question	Text of the question
Possible answers	
Correct answer	
Response to correct answer	e.g. Your answer is correct. Congratulations!
Response to wrong answer(s)	e.g Not quite right. The correct answer is b
Times the question can be taken	Number

7 Competences Dependencies

The assessment of competences will be conducted in three stages, encompassing the following training phases:

- Introductory modules
  - Transforming cities through digital innovation

- o Managing the transformation to a resilient SC
- o SC urban planning and critical city's infrastructures
- o Learning SC enabling technologies
- o Managing SC stakeholders and developing citizen networks
- o Identifying risks in SC

- Mandatory modules
    - o Transforming cities through digital innovation
    - o Planning for a SC resilience
    - o Assessing and quantifying SC risks
    - o Assessing and managing SC assets and services
    - o Monitoring and controlling SC resilience
    - o Improving SC Resilience using tools
    - o Crisis management
- Specialization modules
    - o Data analytics for SC decision making
    - o Developing blue-green infrastructures in SC
    - o Geoservices and Digital Twins of SC
    - o Using SC standards for resilience
    - o Organizing the SC for resilience using agile principles
    - o Organizing the SC for resilience using agile principles
    - o Establishing financial programs for resilient development and disaster recovery
    - o SC security and safety establishment
    - o Decision Making and Problem Solving

Introductory modules

- Transforming cities through digital innovation
- Managing the transformation to a resilient SC
- SC urban planning and critical city's infrastructures
- Learning SC enabling technologies
- Managing SC stakeholders and developing citizen networks
- Identifying risks in SC

Mandatory modules

- Transforming cities through digital innovation
- Planning for a SC resilience
- Assessing and quantifying SC risks
- Assessing and managing SC assets and services
- Monitoring and controlling SC resilience
- Improving SC Resilience using tools
- Crisis management

Specialization modules

- Data analytics for SC decision making
- Developing blue-green infrastructures in SC
- Geoservices and Digital Twins of SC
- Using SC standards for resilience
- Organizing the SC for resilience using agile principles
- Organizing the SC for resilience using agile principles
- Establishing financial programs for resilient development and disaster recovery
- SC security and safety establishment
- Decision Making and Problem Solving
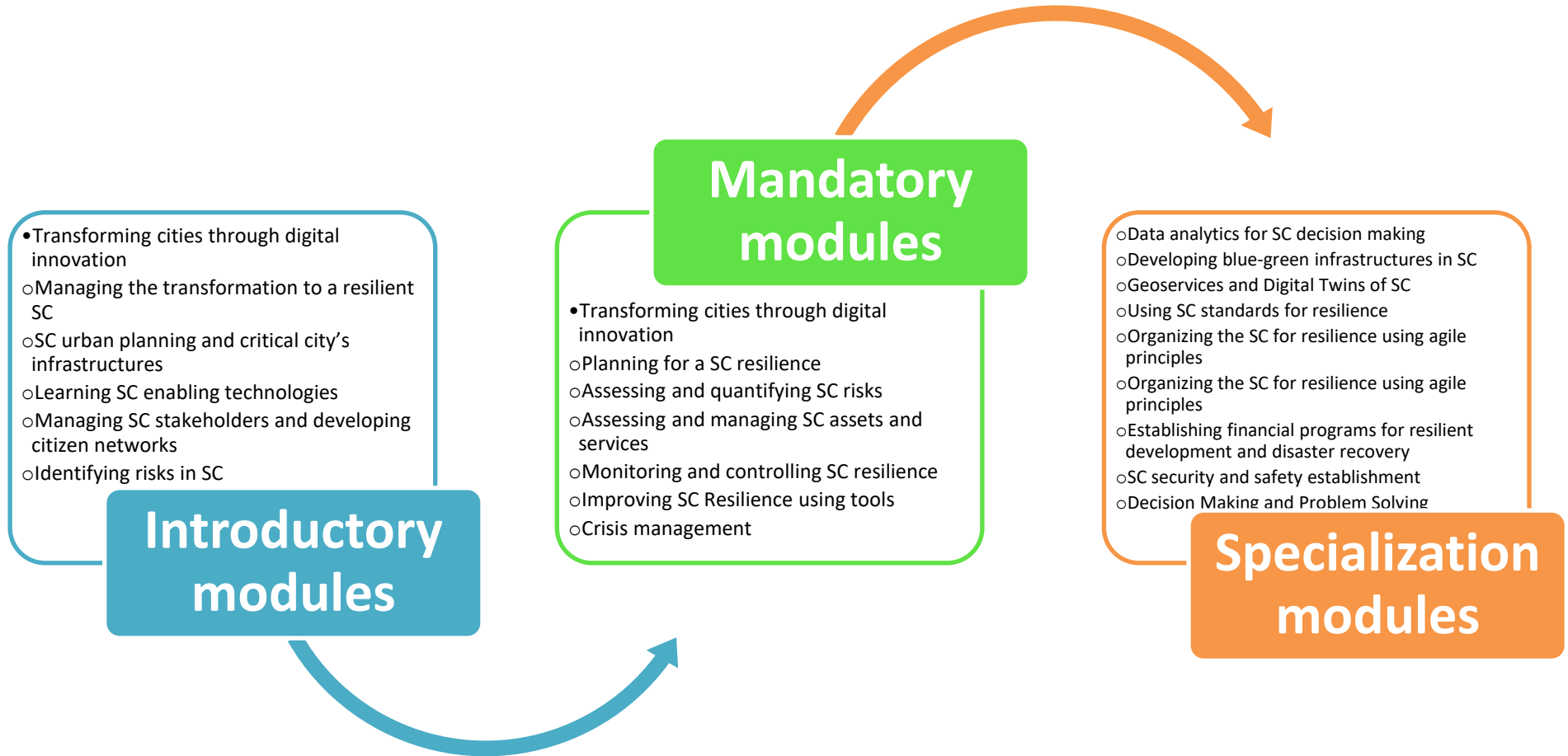
Figure 5: Competences Dependencies

ANEX I – Competences revealed from the literature review

Competence/Article	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
Communication with stakeholders during crisis		x		x	x						x				
Managing emergency smart city assets and resources		x		x		x						x	x		
Mobilizing external resources (nearby cities, governmental agencies, volunteers)					x		x			x	x				
Operating emergency control centers				x					x	x			x		
Risk management tools		x	x	x	x		x		x	x		x	x		
Risk monitoring and control		x	x	x		x			x	x	x		x		
Risk transference techniques (insuring)												x			
Smart cities risk identification		x	x	x					x	x	x	x	x		
Training stakeholders for effective disaster response		x	x		x					x	x	x			
Coordination and interoperability of critical systems and services		x		x	x		x		x	x	x				
Evaluating smart cities assets, services and resources				x	x					x	x	x	x	x	

Competence/Article	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
Risk assessment and quantification			x	x					x	x	x	x	x		
Smart city response planning			x	x						x	x	x		x	x
Citizens, Crowd Sourcing and Social Networking															
Smart city organization structure, role and accountability		x	x			x									
Smart city strategic vision and planning		x	x	x	x	x									
Blue-green infrastructures in cities											x	x			
Digital Innovation Management		x									x	x		x	x
GIS and Digital Twinning of Smart Cities										x					
Smart cities: context, policy and operation			x	x	x	x						x			
Enabling technologies for resilient SC (Smart city enabling technologies)		x	x	x			x								x
Smart City stakeholder management and citizen engagement					x										
Smart city standards for resilience		x		x							x	x	x		
Smart city urban planning and infrastructures											x	x	x		x
Agile Management						x		x							

Competence/Article	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
Creating and managing incentive schemas for non-profit organizations, businesses and citizens															
Project and portfolio management			x	x		x						x	x		
Smart cities financing and funding methods					x							x			
Data analytics and statistics		x		x		x		x	x	x			x		
Information security strategy development and management		x	x	x		x	x								
Planning financial recovery programs															

Competence/Article	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
Communication with stakeholders during crisis		x							x	x		x	x		
Managing emergency smart city assets and resources									x			x	x	x	x
Mobilizing external resources (nearby cities, governmental agencies, volunteers)											x				
Operating emergency control centers									x			x		x	x

Competence/Article	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]
Risk management tools				x					x	x				x	x
Risk monitoring and control		x		x	x				x	x		x	x	x	x
Risk transference techniques (insuring)															
Smart cities risk identification					x			x	x	x	x	x	x	x	x
Training stakeholders for effective disaster response		x							x						
Coordination and interoperability of critical systems and services	x							x	x		x	x	x	x	x
Evaluating smart cities assets, services and resources	x			x		x								x	
Risk assessment and quantification		x		x				x	x			x	x	x	
Smart city response planning		x		x	x			x	x		x	x	x		
Citizens, Crowd Sourcing and Social Networking				x							x		x		
Smart city organization structure, role and accountability													x		
Smart city strategic vision and planning		x		x		x		x	x		x			x	x
Blue-green infrastructures in cities				x		x								x	
Digital Innovation Management			x							x		x	x	x	X
Competence/Article	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]	[28]	[29]	[30]

GIS and Digital Twinning of Smart Cities									x			x		
Smart cities: context, policy and operation					x			x					x	
Enabling technologies for resilient SC (Smart city enabling technologies)									x	x	x	x	x	x
Smart City stakeholder management and citizen engagement	x				x		x		x			x		
Smart city standards for resilience														x
Smart city urban planning and infrastructures			x		x		x	x		x		x	x	x
Agile Management										x				
Creating and managing incentive schemas for non-profit organizations, businesses and citizens														
Project and portfolio management														
Smart cities financing and funding methods														
Data analytics and statistics			x			x			x	x		x	x	
Information security strategy development and management									x		x			x
Planning financial recovery programs														

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[27] Sahil; Sood, SK'Fog-Cloud centric IoT-based cyber physical framework for panic oriented disaster evacuation in smart cities'

[28] Fan, C; Jiang, YC; Mostafavi, A'Social Sensing in Disaster City Digital Twin: Integrated Textual-Visual-Geo Framework for Situational Awareness during Built Environment Disruptions'

[29] Li, JY; Nassauer, JI'Technology in support of nature-based solutions requires understanding everyday experiences'

[30] Boubakri, W; Abdallah, W; Boudriga, N'ZAO-AKA : a zero knowledge proof chaotic authentication and key agreement scheme for securing smart city cyber physical system'

ANEX II – TB1s: Module Specifications for the competences

Managing the transformation to a resilient SC

TB1: MODULE OUTLINE		
1	Module ID	**1**
2	Module title	**Managing the transformation to a resilient SC**
3	Language	**English**
4	Module description	Managing transformation to resilient Smart Cities (SC) involves several interconnected issues. The purpose of this training is to cover the foundations of resilient SC and why resilience is so critical. Technology does not only bring benefits but also some risks. Creating a resilient SC is a multidisciplinary endeavor that requires the right leadership approach, and an understanding of what influences SC resilience. The major technologies that create both vulnerabilities and resilience for SC are presented. Lastly, the training introduces some best practices and examples of resilient SC worldwide. Different SCs face different challenges (Fitsilis, 2022). While we cannot have a detailed example for each challenge a SC might face it is useful to explore as many as possible. Reference Fitsilis, P. (2022) Building on Smart Cities Skills and Competences. Edited by P. Fitsilis. Cham: Springer International Publishing (Internet of Things). doi: 10.1007/978-3-030-97818-1.

5	Learning objectives	The module focuses on managing the transformation to a resilient SC, and its learning objectives are: 1. Learn fundamental concepts of a resilient SC 2. Challenges to resilient SC in the global context 3. Current approaches to resilience in cities 4. The main principles of resilient SC 5. Leadership and strategy for resilient SC 6. The consequences of global events with a high impact (pandemics and wars) 7. The contribution of recent technologies to SC resilience 8. Learning from case studies of resilient SC

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)	
Code	**Learning Outcome** *{please underline the verb and the concept of the knowledge domain used}* Upon completion of this module, the learner will be able to:
1. Knowledge level	
Lout1	Describe the main aspects of a resilient SC
Lout2	Describe what the main challenges of a resilient SC are
Lout3	Outline the typical successful models of a resilient SC
Lout4	Identify the main principles of a resilient SC
Lout5	Identify the typical leadership styles and strategies for a resilient SC
Lout6	Describe some typical impacts of global events like pandemics and wars
Lout7	Describe four technologies that are making cities more resilient and smarter
2. Comprehension level	
Lout8	Explain the impact of different technologies on a resilient SC
Lout9	Give examples from case studies of resilient SCs
3. Application level	
4. Analysis level	
5. Synthesis level	
6. Evaluation level	
Lout10	Argue about the level of resilience a SC must achieve

Identifying risks in a SC

02.TB1: *Identifying risks in a SC*		
1	Module ID	*02*
2	Module title	*Identifying risks in SCs*
3	Language	English
4	Module description	Smart cities, despite their many benefits, provide unprecedented risks and challenges but not all these risks and concerns have been fully recognized by smart city officers. Moreover, the complexity of their dimension, the use of technology, and their integration bring the risk perspectives into the implementation of the smart city concept. If these risks are not adequately addressed and understood, they can create vital issues for the functioning of smart cities. This module aims to help learners identify the origin, trends, and categories of risks in SC as they are categorized into main themes while discussing the technical and non-technical risk parameters related to smart cities implementation.
5	Learning objectives	The learning objectives of the module is to introduce trainees to the origin, trends and different categories of risks in smart cities while discussing the technical and non-technical risk parameters related to smart cities implementation.

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)
{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy
please underline the verb and the concept of the knowledge domain used}
Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	Define basic concepts regarding risks
2. Comprehension level	
LOut2	Understand and explain the origin of various risks
3. Application level	
LOut3	Apply fundamentals of Risk Assessment
4. Analysis level	
LOut4	Categorize risks in smart cities and name fundamental risks in each category
5. Synthesis level	
LOut5	Explain the technical and non-technical risk parameters related to smart cities implementation
6. Evaluation level	
LOut6	Exploit the potential of new technologies for identifying risks

mm-u **TB2: UNIT SPECIFICATION**		

	Unit ID*	**Unit title**
Module Units	2-1	*Unit 2.1 – Risk categories*
	2-2	Unit 2.2 – Dominant technology for risk identification

Assessing and quantifying SC risks

TB1: MODULE OUTLINE		
1	Module ID	**3**
2	Module title	**Assessing and quantifying SC risks**
3	Language	**English**
4	Module description	The purpose of this module is to cover the most important risks a Smart City (SC) faces and how to assess and quantify them. A SC can face some significant risks such as natural disasters, climate-change, aging infrastructure and cybersecurity threats. Technology does not just create benefits but also vulnerabilities and cybersecurity threats. Each implementation of technology, every form of data collected, used and shared introduce risks. Cybersecurity risks to infrastructure, private data are introduced along with specific attacks like ransomware attacks. Various cybersecurity threats such as ransomware attacks must be assessed and mitigated. Where possible risks must be offset or prevented. This requires that they are quantified so planning can be accurate.
5	Learning objectives	The module focuses on assessing and quantifying risks to a SC and the learning objectives are: 1. Learn fundamental risks a SC faces and how to quantify them. 2. Assess the cybersecurity risks to a SC. Understand the risks to a SC from an over-reliance on technology and people losing some skills. 3. Understand the methods that can be used to quantify risk in a SC. 4. Learn how to use risk quantifying tools and see examples of their application.

Learning outcomes for the Cognitive domain[+] (Bloom Taxonomy)	
Code	**Learning Outcome** *{please underline the verb and the concept of the knowledge domain used}* Upon completion of this module, the learner will be able to:
1. Knowledge level	
Lout1	Describe the fundamental risks a SC faces and how to quantify them

Lout2	Outline the regular risks a SC faces such as risks from heat and pollution and aging infrastructure
Lout3	Outline the risks to SC from natural disasters and climate change
Lout4	Understand the risks to a SC from global events like disruptions to supply chains, economic instability and high inflation
Lout5	Understand the cybersecurity risks to a SC
Lout6	Describe the risks to SC from an over-reliance on technology and people losing other skills
Lout7	Describe methods to quantify risk in a SC.
Lout8	Develop a risk management plan and a risk mitigation plan.
2. Comprehension level	
Lout9	Give examples of risk quantifying tools
Lout10	Explain the different benefits of risk quantifying tools
3. Application level	
4. Analysis level	
5. Synthesis level	
6. Evaluation level	
Lout11	Argue about which are the greatest risks facing a SC and how to quantify them

Planning for a SC resilience

TB1: MODULE OUTLINE		
1	Module ID	**4**
2	Module title	**Planning for a SC resilience**
3	Language	**English**
4	Module description	One of the great challenges of this century is to find opportunities for smart environmental planning, comprehending the complexity it might entail, and approaching it from various angles, e g urban planning, sustainability, resilience, and smart cities. As cities face the dual challenges of managing everyday stresses and preparing for worst-case scenarios, they need to improve their operational capabilities and future-proof their infrastructure. With a (project) plan for SC resilience they can overcome the difficulties associated with increasing urban densification and the shortage of basic resources.
6	Learning objectives	The course module focuses on Smart City (SC) services and assets and its learning objectives is to introduce trainees to the following issues: 1. Creation of a project plan for the implementation for a SC resilience 2. Identification of milestones 3. Monitoring of the implementation for a SC resilience 4. Evaluation of the implementation for a SC resilience 5. Conflict management and problem-solving skills

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)	
Code	**Learning Outcome** {*please underline the verb and the concept of the knowledge domain used*} Upon completion of this module, the learner will be able to:
1. Knowledge level	
LOut1	Describe the creation of the project plan for the implementation for a SC resilience.
LOut2	Describe what relevant milestones are and how you can identify them.
2. Comprehension level	
LOut3	Recognize what are the challenges in planning a SC resilience.
LOut4	Explain the different perspectives that stakeholders have in planning a SC resilience.

3. Application level	
LOut5	Express appropriate tools for planning and monitoring.
4. Analysis level	
LOut6	Analyze potential for conflicts and problems at an early stage.
5. Synthesis level	
6. Evaluation level	
LOut7	Argue whether a city has the qualifications to be a SC.

Monitoring and controlling SC

05.TB1: **Monitoring and controlling SC**		
1	Module ID	**5**
2	Module title	**Monitoring and controlling SC resilience**
3	Language	English
4	Module description	Resilience quantification and measurement for complex ecosystems like SC, is a challenge. In fact, resilience cannot be estimated through verifications like following regulations and norms. SC's performance and its ability to track and manage that performance over time must directly relate to how resilient the city itself is measured. A system that fails can nonetheless demonstrate resilience by surviving the failure and recovering from it. On the other hand, a system's success does not guarantee that it will continue to be successful. Due to the danger of complacency, it is believed that monitoring is essential for a system to maintain resilience.
5	Learning objectives	LObj1. Identify the threats of the resilience of a smart city LObj2. Explain resilience monitoring concepts LObj3. Explain resilience control concepts LObj4. Describe data acquisition and process LObj5. Choose monitoring and controlling methods to increase the resilience of a smart city

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)	
{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy	
please underline the verb and the concept of the knowledge domain used}	
Upon completion of this module, the learner will be able to:	
1. Knowledge level	
LOut1	Explain what resilience is
LOut2	List the three resilience layers of smart cities
LOut3	Summarize the threats of each smart city resilience layer
LOut4	Outline data sources to monitor resilience
LOut5	Describe the basic steps of data analysis towards smart city service deployment
LOut7	Describe early warning systems
2. Comprehension level	
LOut6	Infer the visualization strategy to be applied over specific data and needs
LOut8	Explain how resilience solutions can benefit five smart city application domains
3. Application level	
4. Analysis level	
5. Synthesis level	
6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION		
Module Units	**Unit ID***	**Unit title**
	5-1	**Threats against a resilient smart city**
	5-2	**Methodologies and technologies for monitoring and controlling smart city resilience**
	5-3	**Use cases of resilient smart cities**

Assessing and managing SC assets and services

06.TB1: *Assessing and managing SC assets and services*		
1	Module ID	*06*
2	Module title	*Assessing and managing SC assets and services*
3	Language	English
4	Module description	Smart services that are provided by fixed and digital assets in a SC represent the core of the smart city concept since they are key enablers for most activities in the world of smart cities. In this module, they will be presented different management models and indicators are used to successfully monitor, assess, and perform analysis of assets and services offered by cities (regarding their resilience). Moreover, it addresses coordination issues regarding the usage of SC assets and services especially during the critical period of responding to hazards and disasters as well the immediate benefits and the expected progressive benefits derive e.g., guidance management that relies on the asset's intelligence.
5	Learning objectives	The course focuses on presenting management, assessment tools and key performance indicators to assess Smart City assets and services and its learning objectives are to: 1. Present a holistic view of SC Infrastructures and major assets 2. Describe pervasive asset management 3. Measure the Efficiency of Smart Solutions 4. Present assessment tools and Key Performance Indicators sets for assets and services 5. Discuss security, coordination issues of services and Asset tracking 6. Explain benefits from asset and service management that relies on the evolvement of asset's intelligence

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy

please underline the verb and the concept of the knowledge domain used}

Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	label major assets and services;
2. Comprehension level	
LOut2	measure the efficiency of smart solutions
3. Application level	

LOut3	apply rigorous and pervasive asset and service management
4. Analysis level	
LOut4	analyze security issues and asset tracking
5. Synthesis level	
LOut5	explain assessment tools and Key Performance Indicators sets
6. Evaluation level	
LOut6	appraise benefits from asset management that relies on the evolvement of asset's intelligence.
Module Workload (Estimated study time) (min)	

mm-u TB2: UNIT SPECIFICATION

	Unit ID*	Unit title
Module Units	mm-1	Assessing and managing SC assets
	mm-2	Assessing and managing SC services

Improving SC Resilience using tools

1	Module ID	**07**
2	Module title	**Improving SC Resilience using tools**
3	Language	English
4	Module description	Different planning and assessment tools, utilities and frameworks for smart cities have been established and developed to deal with urban threats, being them familiar ancient threats (earthquakes, volcano eruptions, floods and fires) plus a modern set that includes terrorism, health crises, and industrial accidents. Dealing with such dangers requires new design concepts for urban spaces, foremost of which is resilience. In this context, this module will train learners in tools and frameworks for SC to support SCCRO's in coordinating and making decisions for minimizing crucial problems, especially during the critical period of responding to hazards and disasters. The main tools include information sources of a structural or event-response nature, to be used alone or together with a decision-support module. Existing tools that monitor and assess the performance and sustainability of smart city resources will also be addressed. With the aid of exploiting these tools and technologies, SC may innovate for longer-lasting value development enforcing resilience.
5	Learning objectives	*LObj2. Identify the indicators capable to assess the resilience of a city to specific threats.* *LObj3. Develop a monitoring plan for these indicators.* *LObj4. Define a plan to improve the resilience of a city.*

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)
{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy
please underline the verb and the concept of the knowledge domain used}
Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	**To understand the principles of resilient systems design.**
2. Comprehension level	
LOut2	**To describe the factors that influence the resilience level of a smart city**
3. Application level	
LOut3	**To examine the potential of IT applications to strengthen the resilience of a city**
4. Analysis level	
LOut4	**To use tools to assess and monitor the resilience of a city**
5. Synthesis level	
LOut5	**To critique the various options to increase the resilience of a city**
6. Evaluation level	
LOut6	**To design a plan *to improve the resilience of a city.***

mm-u **TB2: UNIT SPECIFICATION**		
Σ **Unit ID***		**Unit title**

	mm-1	Frameworks to improve the resilience of SC
	mm-2	Integrating IT tools to promote the resilience of SC
	mm-3	Principles of information-intensive decisions and SC resilience design
	mm-4	Success Stories: Smart Cities and their development using digital tools

Developing blue-green infrastructures in SC

TB1: MODULE OUTLINE		
1	Module ID	**8**
2	Module title	**Developing blue-green infrastructures in SC**
3	Language	**English**
4	Module description	Literature and practice have showcased the determining role of adapting blue-green infrastructure strategies when planning for urban environment resilience, sustainability and viability. This module focuses on highlighting the benefits of engaging smart technologies in developing blue-green infrastructure and on showing that a smart city constitutes the ideal platform to apply these technologies. It will also focus on exploring proven methods and means of applying such technologies.
5	Learning objectives	LObj1. Explain the role of blue green infrastructure for the urban ecosystem LObj2. Introduce blue green infrastructure component elements LObj3. Explore how smart technologies benefits blue green infrastructure LObj4. Present blue green infrastructure cases

Learning outcomes for the Cognitive domain[+] (Bloom Taxonomy)	
Code	**Learning Outcome** *{please underline the verb and the concept of the knowledge domain used}* Upon completion of this module, the learner will be able to:
1. Knowledge level	
LOut1	Define blue green infrastructure
2. Comprehension level	
LOut3	Summarize the ecosystem services provided by blue green infrastructure
LOut4	Summarize the benefits of blue-green infrastructure for biodiversity, the environment, the society and the economy
LOut7	Outline the ecosystem services and benefits provided by each of these five (5) blue green infrastructure elements
LOut10	Describe digital elevation models technologies
LOut11	Outline at least six (6) smart city technologies contributing to blue green infrastructure development
LOut12	Summarize the internet of nature concept

LOut14	Explain what remote sensing means
3. Application level	
LOut2	Identify the risks accrued by the urban water cycle and the heat island effect
LOut6	Recognize at least five (5) blue green infrastructure elements
4. Analysis level	
LOut5	Distinguish blue-green from grey infrastructure
LOut8	Classify blue green infrastructure elements by functionality
LOut9	Name at least five (5) ways a geographic information system contributes to blue green infrastructure's objectives
LOut13	Order the five (5) levels of digital twins' sophistication
LOut15	List at least three (3) sensor types for assessing air quality, water quality and weather conditions
5. Synthesis level	
6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION		
	Unit ID*	**Unit title**
Module Units	**mm-1**	Introduction to Blue Green Infrastructure
	mm-2	Component Elements of Blue-Green Infrastructure
	mm-3	Smart Technologies for Blue-Green Infrastructure

Transforming cities through digital innovation

1	Module ID	*9*
2	Module title	***Transforming cities through digital innovation***
3	Language	English
4	Module description	The advancement of citizens' quality of life is a major concern of smart cities. Climate change, economic and social instability, demographic changes and other changes that the world has witnessed have posed complex challenges to cities that require a solid commitment to innovation.
		Cities are ideal for testing and implementing innovative, sustainable and integrated solutions to address these challenges. City governments have been developing innovative practices to engage citizens in innovation, including adopting digital platforms to promote communication and collaboration between government and citizens and/or among citizens in developing bottom-up innovations.
		Digital technologies have enabled cities to develop innovative services and products that are transforming how people live, work, collaborate and communicate. However, technology also poses privacy, security and accountability challenges that must be adequately addressed.
5	Learning objectives	*LObj5.* Identify the concepts and enablers that motivate digital transformation in a city*;*
		LObj6. Identify the strategic resources needed to implement digital transformation addressing the main challenges of the city;
		LObj7. Develop a plan to innovate the services and/or products that take advantage of data technology;
		LObj8. Define an innovation process for a smart city that encourages the engagement of citizens and takes into account legal and ethical constraints.

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy

please underline the verb and the concept of the knowledge domain used}

Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	To list enablers and barriers of urban digital transformation;
2. Comprehension level	
LOut2	To explain proven strategies to motivate participation in SC digital transformation;
LOut3	To identify the resources, including technological resources, typically involved in urban digital transformation;
3. Application level	
LOut4	To demonstrate the relevance of advanced technologies (e.g., IoT, Cloud, IA, Blockchain) for urban transformation;
4. Analysis level	

LOut5	To examine the privacy, security and accountability issues associated with the adoption of data technologies to innovate services and products;
LOut6	To compare existing frameworks guiding urban innovation;
5. Synthesis level	
LOut7	To design an innovation process for a smart city;
6. Evaluation level	
LOut8	To assess the effectiveness of digital innovation against the processes implemented in the cities.

mm-u TB2: UNIT SPECIFICATION

	Unit ID*	Unit title
Module Units	mm-1	Co-Creation of Innovative and Sustainable Solutions to Resilience Challenges
	mm-2	Citizen Engagement in Digital Platforms Supporting Innovation
	mm-3	Addressing privacy, security and accountability issues posed by IT applications
	mm-4	Success stories: Digital innovation in Smart Cities

Geoservices and Digital Twins of SC

TB1: MODULE OUTLINE		
1	Module ID	**10**
2	Module title	**Geoservices and Digital Twins of SC**
3	Language	**English**
4	Module description	The intent of this module is to explain the connection between digital twins and smart cities, assess the traits of digital twin based smart cities, and concentrate on the key uses of such cities. It will also discuss how the digital twin can take advantage of the growing amount of geospatial data and geoservices are being created. Finally, it discusses the future development of smart cities based on digital twins. The digital image of reality makes it possible, among other things, to better visualize and also communicate planning. Different scenarios can be tried out without risk in order to make predictions about their possible effects.
6	Learning objectives	The course module focuses on the connection between digital twins and smart cities and assessing the characteristics of digital twins. The learning objective is to introduce the trainees to the following topics: 1. Basic concepts of a digital twin of a SC. 2. Creation of a project plan for the development of a digital twin of a SC 3. Identification of milestones 4. Monitoring of the implementation development of a digital twin of a SC 5. Evaluation of the implementation development of a digital twin of a SC 6. Derive key resilience aspects from the application of different scenarios to the digital twin of the SC

Learning outcomes for the Cognitive domain[+] (Bloom Taxonomy)	
Code	**Learning Outcome** *{please underline the verb and the concept of the knowledge domain used}* Upon completion of this module, the learner will be able to:
1. Knowledge level	
LOut1	Describe the concept of a digital twin for SC.
LOut2	Describe what relevant milestones are and how you can identify them.

2. Comprehension level	
LOut3	Recognize what are the challenges in planning of a digital twin of a SC.
LOut4	Explain the different perspectives that stakeholders have in planning of a digital twin of a SC.
3. Application level	
LOut5	Express appropriate tools for planning and monitoring.
4. Analysis level	
LOut6	Recognize possible problems and potential for conflicts early on.
5. Synthesis level	
6. Evaluation level	
LOut7	Argue whether a city has the qualifications to develop a digital twin of a SC.

Learning SC enabling technologies

1	Module ID	**11**
2	Module title	**Learning SC enabling technologies**
3	Language	English
4	Module description	A smart city (SC) enabling technology is used in the development of SCs to establish a holistic environment that is transparent, automated, inclusive, extensible, secured, flexible, and easily manageable. Such technologies are sensory devices, wireless sensor networks (WSNs), the Internet of Things (IoT), cloud/edge computing, and big data analytics, and play a key role in the resilience of SCs. The integration of these technologies can support the development of a connected network of devices and entities of an SC.
5	Learning objectives	The course module focuses on smart city enabling technologies. Its learning objective is to introduce trainees to the following issues: LObj9. Describe the technical and user requirements involved in a smart city. LObj10. List the categories of SC enabling technologies. LObj11. Present the basic concepts of wireless sensor networks and Internet of Things. LObj12. Describe what the Cloud computing and Edge computing paradigms offer in a smart city context. LObj13. Describe the importance of big data analytics and the role of machine learning in big data analytics.

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy

please underline the verb and the concept of the knowledge domain used}

Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	Describe the technical and user requirements involved in a smart city.
LOut2	List the categories of smart city enabling technologies.
LOut3	Summarize the main tasks of the Internet of Things.
2. Comprehension level	
LOut4	Describe the basic types of monitoring
LOut5	List the characteristics and advantages of a wireless sensor network.
LOut6	Describe what the cloud computing paradigm offers in a smart city context.
LOut7	List the drawbacks of the cloud.
LOut8	Describe the advantages of edge computing in performing quick and lighter computations nearer to the Internet of Things data sources.
LOut9	Describe 5 characteristics of big data

LOut10	Describe the role of machine learning in big data analytics.
LOut11	Explain what a clustered-based wireless sensor network is.
3. Application level	
4. Analysis level	
5. Synthesis level	
6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION

	Unit ID*	Unit title
Module Units	11.1	Introduction to SC enabling technologies
	11.2	Wireless Sensor Networks and the Internet of Things
	11.3	Cloud/Edge Computing technologies and Big Data Analytics

Managing SC stakeholders and developing citizen networks

1	Module ID	*12*
2	Module title	***Managing SC stakeholders and developing citizen networks***
3	Language	English
4	Module description	Stakeholders are diverse and play a key role in the innovation and resilience of cities. They can be grouped into different areas of influence such as government and public sector, financial sector and funding system, universities and R&D entities, business sector, IT sector, NGOs and civil society, social and third sector. The complexity and diversity of the challenges faced by cities makes it essential to engage stakeholders and citizens in the development of services and applications that allow the city to respond quickly and sustainably to those challenges.
5	Learning objectives	LObj14. Identify factors that motivate engagement and collaboration. LObj15. Identify methods and practices to manage stakeholders effectively LObj16. Identify methods and practices to develop citizen networks. LObj17. Define strategies to engage stakeholders and citizens in developing solutions to SC problems and threats.

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)	
{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy	
please underline the verb and the concept of the knowledge domain used}	
Upon completion of this module, the learner will be able to:	
1. Knowledge level	
LOut1	To list factors relevant to stakeholders and citizen engagement
LOut2	To identify the key stakeholders that impact the SC sustainability
2. Comprehension level	
Lout3	To understand strategies, platforms and techniques for effective communication and collaboration in the development of services and applications for the resilience of SC
LOut4	To understand the transformative power of citizen networks as a positive social transformation tool for SC.
3. Application level	
LOut5	To articulate technologies and analytics to support innovative citizen-driven innovation
4. Analysis level	
LOut6	To explain multi-stakeholder approaches
5. Synthesis level	
LOut7	To design co-creation initiatives with citizens and stakeholders
6. Evaluation level	
LOut8	To assess the effectiveness of approaches to stakeholder management;
mm-u **TB2: UNIT SPECIFICATION**	

Σ c **Unit ID***	**Unit title**

	mm-1	Negotiation of diverse perspectives on the resilience of SC
	mm-2	Stakeholders' Management Approaches
	mm-3	Using technologies for civic innovations: Citizen networks
	mm-4	Success stories: Citizen participation in SC strategies

Smart cities' critical infrastructures

TB1: MODULE OUTLINE		
1	Module ID	**13**
2	Module title	**Smart cities' critical infrastructures**
3	Language	**English**
4	Module description	A challenge in urban planning is to identify a complete inventory of a city's existing (critical) infrastructure and, furthermore, to design and develop resilient smart infrastructures and services. In addition to appropriate tools, cities must also be given the competence to identify critical infrastructures, analyze attack vectors against them, classify existing measures and, as a result, also plan further steps for comprehensive SC resilience. Protecting and securing the smart cities' resources and services becomes critical due to the disruptive or even potentially life-threatening nature of an outage or attack on SC infrastructures.
6	Learning objectives	The module focuses on Smart City (SC) critical city's infrastructures and its learning objectives is to introduce trainees to the following issues: 1. Understand and explain an SCs critical infrastructures 2. Identify potential challenges and threats, and determine their urgency 3. Explain potential solutions to address threats based on selected examples in all relevant domains

Learning outcomes for the Cognitive domain[+] (Bloom Taxonomy)	
Code	**Learning Outcome** *{please underline the verb and the concept of the knowledge domain used}* Upon completion of this module, the learner will be able to:
1. Knowledge level	
LOut1	Explain the major characteristics of critical infrastructures.
LOut2	Understand, why critical infrastructure has to be protected.
2. Comprehension level	
LOut3	Name and explain the seven central fields of critical infrastructure.
LOut4	LOut4: Explain the major characteristics of each of the three domains (Energy, Water and Health/Emergency).

LOut5	Explain the major characteristics of each of the four domains (Government, Transportation, Communication, Finance).
3. Application level	
LOut6	Understand their vulnerabilities and potential threats (Energy, Water and Health/Emergency).
LOut7	Understand their vulnerabilities and potential threats (Government, Transportation, Communication, Finance).
4. Analysis level	
Lout8	Be able to identify potential countermeasures and protection opportunities (Energy, Water and Health/Emergency).
LOut9	Be able to identify potential countermeasures and protection opportunities (Government, Transportation, Communication, Finance).
5. Synthesis level	
LOut10	Transfer guidelines and measures offered for one critical infrastructure domain (Energy, Water and Health/Emergency) to another.
LOut11	Transfer guidelines and measures offered for one critical infrastructure domain (Government, Transportation, Communication, Finance) to another.
6. Evaluation level	
LOut12	Argue whether a city's infrastructure is resilient against attack vectors.

Smart Cities Standards

1	Module ID	*14*
2	Module title	***Smart Cities Standards***
3	Language	English
4	Module description	Nowadays cities in Europe and all over the globe are connected through various networks that demand interoperability, security, resilience and sustainability among others. They often develop similar approaches and have comparable levels of development. These networks, collaborations and common goals provide a good basis for development of consensus-based standards. Module 0X presents critical issues that took into account by standardisation organisations on Smart Cities (i.e. ISO, ITU, IEC, CEN CENELEC ETSI) and progress or recommendations of these pioneer organisations and other relevant initiatives that came up as results by H2020 R&I Projects and/or international workshop agreements. Standardisation in the field of Smart City – as a holistic concept for sustainable urban planning and transformation of societies- can support a multi-sectorial integrated approach of sustainable cities and communities with a long-term vision based on the purposes of sustainability, meaning resilience, responsible resource use, preservation & improvement of environment, attractiveness, social cohesion and well-being. Standards can provide requirements, guides, specifications, techniques and tools for cities and territories, for their critical entities (infrastructures) and for the stakeholders to plan, develop, operate, maintain, manage and govern systems and services with a long-term vision based on secure cutting-edge technologies. Our world is changing rapidly and we have to design and implement the new world by valorising all the available resources, knowledge, data, legacy systems with an anthropocentric & holistic approach. In this interconnected, interrelated, interdependent world we need to work smarter and efficiently to take advantage of the available tools such as digitalisation and standardisation among others, against the alarming global backdrop of climate change, energy crisis, cyber & hybrid threats, invasions and other geopolitical crises. Both European and International Standardisation ecosystems issued an outstanding set of standards (specifically developed for SC, lateral and transversal) in order to support and enhance all the efforts done by the relevant stakeholders.
5	Learning objectives	The learning objectives of this module are to: Identify and introduce to the Standards Development. Organisations, the Forums, Technical Committees, Working Groups and SC Standards in force. Preview and associate with the relevant EU Policies. Outline pertinent FP7 and H2020 R&I Projects' outcomes with valuable contributions to the SC field. To raise concern, elevate awareness and estimate the way forward to 2050.
Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)		

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy *please underline the verb and the concept of the knowledge domain used}* **Upon completion of this module, the learner will be able to:**	
1. Knowledge level	
LOut1	To outline the need and importance of standards and standardisation generally and especially in the sphere of SC.
2. Comprehension level	
LOut2	To distinguish the Standards Development Organisations (SDOs) and other organisations which deal with SC standards and standardisation deliverables
3. Application level	
LOut3	To illustrate the various Technical Committees (TCs), Working Groups (WGs) and Fora on SC at European and International level (relationships and partnerships; liaisons)
4. Analysis level	
LOut4	To categorise the relevant series of SC standards in force.
5. Synthesis level	
LOut5	To relate, match and explain the series of SC standards with the relevant SDOs, TCs and WGs
LOut6	To summarize the order of SC standards' content requirements
6. Evaluation level	
LOut7	To relate SC standards with the relevant EU Policies and/or Mandates.
LOut8	To value initiatives such as Society 5 and IWA 39
LOut9	To value results of pioneer FP7 and H2020 R&I Projects which delivered relevant SC pre-standardisation deliverables
LOut10	To critique the trends in SC business/technological/social models in the way forward to 2050.

mm-u TB2: UNIT SPECIFICATION

	Unit ID*	Unit title
Module Units	mm-1	Standards Development Organisations (SDOs) and their Technical Committees (TCs), Working Groups (WGs) and For a or Task Forces related to Smart Cities (SC)
	mm-2	Smart Cities (SC) Standards
	mm-3	Relevant Smart Cities global initiatives, EU Policies and pioneer FP7 and H2020 Smart Cities R&I Projects

Data analytics for SC decision making

1	Module ID	*15*
2	Module title	*Data analytics for SC decision making*
3	Language	English
4	Module description	In our digital world, data-driven smart city decision making is more imperative than ever. This data is an important source of information for smart cities to effectively predict various urban phenomena and support their decisions. This module presents an introduction into the concepts of data analysis to produce useful insights and conclusions. It will consider the role of data, in an evolving smart city system, for effective decision making. Learners will also gain direct experience in using examples to analyze data and draw valuable insights.
5	Learning objectives	The learning objectives of this module are the following: • Definition of Data Analysis • Recognition of Data types • Understanding key characteristics of data types • Demonstration of various data collection methods • Meaning of Descriptive statistics • Description of the basic features of data • Examination of examples of different types of data • Explanation of data visualized • Calculation of central tendency measures • Determining variability measures • Understanding the contribution of data analysis to real life

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy

please underline the verb and the concept of the knowledge domain used}

Upon completion of this module, the learner will be able to:

1. Knowledge level

Lout1	<u>Define</u> the concept of data collection, processing and analysis

Lout2	Recognize different types of data
2. Comprehension level	
Lout3	Summarize the basic features of data
Lout4	Explain the contribution of data analysis to real life
Lout5	Give applicable examples of the value of data analytics in different fields when it comes to smart city development
3. Application level	
Lout6	Compute different statistical measures for analysis
Lout7	Demonstrate the purpose and necessity of data analysis for Smart Cities
4. Analysis level	
Lout8	Demonstrate various examples of different types of data
5. Synthesis level	
6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION

Module	Unit ID*	Unit title
	15-1	Introduction to Data Analysis
	15-2	Analyzing Data: examples in the context of smart cities

SC security and safety establishment

1	Module ID	*16*
2	Module title	*SC security and safety establishment*
3	Language	English
4	Module description	*Safety is defined as the state of being free from harm or danger. It comprises the steps taken to safeguard individuals from accidents, harm, and exposure to dangerous situations. Safety is frequently attained by following safety protocols and procedures.*
		On the other hand, security can be defined as the protection from crime and violence. It contains all measures needed to protect people from life risks, theft, vandalism, terrorism, and other threats. Security is often achieved through the implementation of security procedures and protocols.
		Smart cities as complex ecosystems where millions of citizens work and leave requires both. This, of course, creates urgency on governments and local authorities to improve public safety and security. In many cases today we rely heavily on those new technologies and devices for achieving SC safety and security requirements. These applications are crucial to police, medical and emergency teams so to make the best decision possible when dealing with emergency situations.
5	Learning objectives	*The learning objectives of this module are the following:*
		• *To understand key principles and concepts of smart city safety and security.*
		• *To be aware on how modern technologies may improve safety and security.*
		• *To understand how modern technologies improve situational awareness and decision-making process.*
		• *To understand critical safety and security application requirements and architecture (e.g. augmented security screening, crowdsourcing security apps, data-based crime prevention)*

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy

please underline the verb and the concept of the knowledge domain used}

Upon completion of this module, the learner will be able to:

1. Knowledge level

LOut1	Define safety and security key concepts
LOut2	Describe SC safety and security landscape.
LOut3	Describe the key factors that affect cybersecurity

2. Comprehension level

LOut4	Recognize the role of technology and its influences

LOut5	Being able to describe key safety and security risks
LOut6	Understand the key competences for cybersecurity
LOut7	Understand the holistic approach of cybersecurity

3. Application level	
LOut8	Demonstrate understanding of how technology can improve security of a SC.

4. Analysis level	
Lout9	Understand the process to enforce cybersecurity
5. Synthesis level	

6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION

	Unit ID*	Unit title
Module Units	16-1	*Introduction to safety and security key concepts.*
	16-2	*SC safety and security*

Organizing the SC for resilience using agile principles

1	Module ID	*17*
2	Module title	*Organizing the SC for resilience using agile principles*
3	Language	English
4	Module description	Agile cities display uncommon resilience throughout the crises they face because they use resilience preparation as their base and are able to adapt and innovate by adding new practices to react to the challenges. These cities adopt an adaptive planning process that allows them to adapt to change in a flexible manner in the short and medium term. Understandings and responses evolve through evolutionary development, early delivery, continuous improvement and collaboration between stakeholders in self-organizing and cross-functional teams. The agility of the resilient city is expressed in several dimensions, namely sustainable buildings, agile planning and management of land, networked energy systems, flexible infrastructures, efficient and responsive IT assets, smart policing and prevention strategies, education models based on intensive formats with quick proof-of-concept approaches and shorter time cycles, and a culture of constant transformation.
5	Learning objectives	LObj18. Apply agile principles to urban adaptation to changes. LObj19. Define adaptive planning processes. *LObj20. Assess the resilience´s agility of a smart city.*

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)
{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy
please underline the verb and the concept of the knowledge domain used}
Upon completion of this module, the learner will be able to:

1. Knowledge level	
LOut1	**To list the 12 agility principles of software development**
2. Comprehension level	
LOut2	**To descript Proof of Concept (POC)**
3. Application level	
LOut3	**To determine the characteristic of agile smart cities**
4. Analysis level	
LOut4	**To design agile SC frameworks**
5. Synthesis level	
LOut5	**To define agile urban planning processes and governance strategies**
LOut6	***Explore the role of Digital Transformation in improving the SC Resilience***
6. Evaluation level	
LOut7	**To assess the adaptability of a smart city**

***mm-u* TB2: UNIT SPECIFICATION**

	Unit ID*	Unit title
Module Units	mm-1	*Agile Principles in Designing Resilience*
	mm-2	*Urban Adaptive Planning*
	mm-3	*Proof of Concept Approaches for Constant Transformation*
	mm-4	*Success Stories: Agile SC*

Establishing financial programs for resilience development and disaster recovery

1	Module ID	*18*
2	Module title	*Establishing financial programs for resilience development and disaster recovery*
3	Language	English
4	Module description	Cities are continuously facing disaster risks that can materialize in various forms and levels of intensity (i.e disasters due to natural hazards (earthquakes, volcanic activity, extreme temperatures, storms, floods, drought, wildfires, etc), biological events (epidemics, insect infestation), technological or man-made disasters (industrial or nuclear incidents, terrorist or cyber-attacks). For a Smart City to be resilient and able to recover from such an event, it is important to reduce and manage these risks. A key component in order to achieve this, is the development of disaster risk management (DRM) plans, which in turn, order to be realized, a proper financial plan/strategy must be in place. In this module, we give a comprehensive introduction to the subject of DRM and subsequently focus on disaster risk financing (DRF), presenting and discussing the various steps towards establishing a suitable financial program for such a purpose, based on international standards and practices.
5	Learning objectives	*The learning objectives of this module are the following:* • *To introduce and describe the key concepts involved in disaster risk management* • *To familiarize trainees with international initiatives, standards and frameworks in relation to resilience and risk management* • *To describe the phases of disaster risk management and disaster risk reduction* • *To describe the key steps in designing a DRF strategy* • *To get acquainted with the financial instruments available that allow the delivery of disaster risk management plans* • *To present the factors to consider when designing, implementing and assessing DRF programs* • *To discuss about cities' major barriers when trying to fund resilience investments and strategies to overcome these*

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)

{The learning outcomes of the module assigned to Comprehension, Application, Analysis, Synthesis and Evaluation level according to the Bloom taxonomy

please underline the verb and the concept of the knowledge domain used}

Upon completion of this module, the learner will be able to:

1. Knowledge level

LOut1	<u>Describe</u> the main concepts related to disaster risk
LOut2	<u>Outline</u> the main components of disaster risk management
LOut3	<u>Distinguish</u> between disaster risk management and disaster risk reduction
LOut4	<u>Identify</u> resilience initiatives and frameworks

LOut5	<u>Describe</u> the 3 key steps in designing a DRF strategy
LOut6	<u>Describe</u> the key steps in risk assessment
LOut7	<u>List</u> the main DRF instruments available
LOut9	<u>Discuss</u> major barriers that hinder SC source funding for resilience investments

2. Comprehension level	
LOut8	<u>Describe</u> the key factors under consideration when designing, implementing and assessing DRF programs

3. Application level	

4. Analysis level	

5. Synthesis level	

6. Evaluation level	

18 TB2: UNIT SPECIFICATION

	Unit ID*	Unit title
Module Units	18-1	*Disaster Risk Management*
	18-2	*Disaster Risk Financing*

Crisis Management

TB1: MODULE OUTLINE		
1	Module ID	**19**
2	Module title	**Crisis Management**
3	Language	**English**
4	Module description	A crisis is any unforeseen event which puts the operational viability and reputation of an entity or individual at risk. The course module focuses on the fundamentals of crisis management, covering 3 main areas: crisis leadership skills, crisis response plan and crisis communication skills. The module examines the steps to take before, during and after a crisis, which will help determine an outlook once the crisis has passed. In addition, it offers tools for anticipating crises and processes for developing crisis management capabilities.
5	Learning objectives	The learning objectives of this module introduce trainees to the following issues: LObj 1. Basic concepts of crisis management. LObj 2. Challenges in developing and implementing crisis response plans. LObj 3. Steps to crisis management planning. LObj 4. Introduce critical crisis communication skills. LObj 5. Utilizing personal and team leadership skills in crisis situations. LObj 6. Introduce some best practices examples of crisis management worldwide.

Learning outcomes for the Cognitive domain⁺ (Bloom Taxonomy)	
Code	**Learning Outcome** {*please underline the verb and the concept of the knowledge domain used*} Upon completion of this module, the learner will be able to:
1. Knowledge level	
Lout1	Describe main concepts related to crisis management.
Lout2	Define what a crisis is and determine what constitutes a crisis.
2. Comprehension level	
Lout3	Recognize the importance of a crisis response plan.
3. Application level	
Lout5	Implement crisis response plans to be more prepared in the case a crisis occurs.
Lout6	Illustrate critical crisis communication skills.
4. Analysis level	

5. Synthesis level	
Lout4	Develop crisis response plans.
Lout7	Craft key messages and media statements.
6. Evaluation level	

Decision Making and Problem Solving

TB1: MODULE OUTLINE		
1	Module ID	**20**
2	Module title	**Decision Making and Problem Solving**
3	Language	**English**
4	Module description	The course module covers decision-making processes and problem solving approaches to trainees who can first identify the basics and scope of decision-making problems as well as the fundamentals, methods, and practices of Decision theory and Problem solving. The module also emphasizes the uncertainty found in most decision-making issues, which requires special attention in the problem-solving framework. Using this approach, comprehensive studies of different Decision Making problems under uncertainty are given. The capacity to gather relevant information, collect accurate data, identify reasonable alternatives, and choose acceptable decision criteria are crucial for making suitable decisions. The capacity to determine the source of the problem and find a reasonable solution is another requirement for problem solving. It involves components of analysis, creativity, team building, and research communication. In addition, the Decision Tree Analysis is introduced to provide a proven graphical solution approach to DM problems, and the Linear Programming method's foundations and its applications are also explored.

| 5 | Learning objectives | *The learning objectives of this module are the following:*
 • *To realize the wide scope and characteristics of Decision Making and Problem Solving processes*
 • *To understand the concept of an appropriately developed mathematical model representing a Decision Making problem and be able to formulate this model for addressing the problem*
 • *To become familiar with the most widely used Decision Making and Problem Solving methods and tools (such as the Decision Trees and Linear Programming techniques)*
 • *To recognize the probabilistic nature of Decision Making problems and basic characteristics of Decision Making under uncertainty* |

		• To be able to apply the concepts and applications learnt to a real-world Decision Making problem • To examine the best practices in Decision Making

Learning outcomes for the Cognitive domain+ (Bloom Taxonomy)	
Code	**Learning Outcome** *{please underline the verb and the concept of the knowledge domain used}* Upon completion of this module, the learner will be able to:
1. Knowledge level	
Lout1	*Describe the Decision Making Process*
Lout2	*Outline the general characteristics of the Decision Making problems*
Lout3	*Define what a mathematical model is and what it entails*
Lout4	*Identify a model's possible limitations*
Lout5	*Define the Problem Solving fundamentals, process and pertinent elements*
Lout6	*List the basic features in Decision Making under uncertainty*
Lout7	*Outline the basic features and structure of a Decision Tree*
Lout8	*Define the general structure of Linear Programming (LP) models*
Lout9	*Outline the graphical solution approach to an LP problem*
2. Comprehension level	
Lout10	*Recognize the probabilistic nature of Decision Making problems*
Lout11	*Explain the terms of expected value, opportunity cost, payoff table and states of nature*
LOut12	*Illustrate the Decision Tree Analysis approach*
LOut13	*Distinguish the problems that can be solved through LP*
LOut14	*Explain the results of an LP problem*

3. Application level	
LOut15	*Use the appropriate model representing a Decision Making problem to be solved*
LOut16	*Apply the Problem Solving approach through Decision Trees in Decision Making problems*
Lout17	*Examine the Decision Making Best practices of Fortune 500 Firm Leaders*
Lout18	*Assess on Dangerous Judgment Errors in the workplace*
Lout19	*Work on how to make the best Quick Decisions*
4. Analysis level	
Lout20	*Interpret Sensitivity Analysis results*
5. Synthesis level	
6. Evaluation level	

mm-u TB2: UNIT SPECIFICATION		
Module Units	**Unit ID***	**Unit title**
	20-1	Unit 20.1 – Introduction to Decision Making and Problem Solving
	20-2	Unit 20.2 – Decision Making under Uncertainty
	20-3	Unit 20.3 – Decision Trees
	20-4	Unit 20.4 – Linear Programming for Addressing DM Problems
	20-5	Unit 20.5 – Decision Making Best Practices of Fortune 50 Firm Leaders

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CRISIS is a consortium of five European Universities working together with esteemed colleagues on Smart City resilience, a topic that is of great interest to each of us and to our communities.

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