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LIST OF TERMS AND ABBREVIATIONS

Term/Abbreviation	Definition
GIS	Geographic Information Systems
ICT	Information and Communication Technology
IT	Information Technology
ITU	International Telecommunication Union
LAN	Local Area Network
MOOC	Massive Open Online Courseware
SDG	Sustainable Development Goal
SSC	Smart Sustainable Cities
WP	Work Package

1. INTRODUCTION

1.1 Purpose and Scope

This report is the first deliverable of Work Package 4 (WP4). The aim of WP4 is threefold. First, to develop training on the development and delivery of Smart Sustainable City-related courses and on packaging such courses for online delivery through the MOOC platform. Second, to deliver such training to faculty members in four partner countries in Latin America. Third, to support the incorporation of the developed courses into the regular education programs run by partner universities. As such, WP4 directly succeeds and builds upon WP1 with its focus on best practices, competencies, education and databases; WP2 with its focus on the roadmap, library and courses; and WP3 with its focus on online courses.

Towards this aim, the work package has four tasks with four main deliverables. T4.1 develops training for educators on the use and development of SSC-related teaching and learning tools, including the SSC-related education database created under WP1, for developing SSC-related courses. T4.2 develops training for educators on how to package SSC-related courses for online delivery via the MOOC platform created under WP3, and on how to use this platform for delivering such courses. T4.3 delivers both types of training to selected faculty members in four partner countries via university partner institutions, and offer mentoring support to such faculty members as they embark on developing and delivering such courses. T4.4 supports university partner institutions in the incorporation of the developed SSC-related courses into existing or new education programmes run by such institutions, and in the initial implementation period of such programmes.

This report is the main deliverable, D4.1, of the first task, i.e. a methodological course which comprises training on the development of SSC-related courses using SSC-related teaching and learning tools developed by the project. The scope of this course comprises: introducing teaching and learning objectives associated with general and role-specific competencies for SSC, presenting the landscape of existing SSC education programs represented by the SSC education databases developed under WP1, introducing the roadmap and training modules developed under WP2, and presenting methods of developing and delivering SSC-relevant courses suitable for different target SSC audiences from such modules. The training also covers opportunities and lessons on how to design new ICT-based teaching and learning tools for SSC.

The course is intended to help train potential instructors, or less experienced instructors, on the best ways to develop and deliver training materials to others, covering different modes of classroom, online and blended training. The general approach is to create a pool of trainers, rather than to have to rely on only one instructor who manages all training within a program.

However, subject matter expertise is necessary but insufficient to train other trainers. The instruction in such training must answer not only the questions “what” and “how” but also “why”. For learners to accept and retain the information taught, they should feel like it is coming from an authority figure. Training leaders should understand the most effective ways to engage the audience – not just supply the right answers, but get everyone thinking on a deeper level. Most types of training incorporate interactivity and discussion, allowing the trainers to make the most of interactivity: asking the right questions, fostering thought-provoking conversations, and getting everyone to participate. To this end, elements of learning theory and human psychology should be taught along with substantive knowledge: how to appeal to a diverse audience, how to make content “stick” to trainees, how to prepare trainees to develop content by themselves.

There are some principles for training trainers. Reality grounding means that the trainers need to feel that they are engaging in training that has merit regarding the real-life situations they will face when training their colleagues. Assessment should cover not just overall knowledge, but also learning theory and instructional design. Self-assessments can help trainers clarify where they are lagging in delivering the best training possible. It is important to introduce trainers to the concepts that prepare them for a variety of challenging situations and how to best overcome them. Preparing less experienced trainers for what they will face should leave some degree of flexibility – providing theoretical foundations, but ensuring enough freedom to make it their own decisions. Videos can be used strategically: to track progress, have videos taken before, during and after training, such videos can be used to provide feedback on the trainers’ performance.

1.2 Methodology for WP4 and relation to other WPs

This WP represents the intersection between the development and implementation phases of the project by following a curriculum development approach. The train-the-trainers programme uses the outputs of the previous tasks as a foundation for the training, as well as develops new modules that will guide the future implementation of the courses by the trainees. Besides WP1, which consisted of the baseline deliverables for the project, WP4 has a bilateral relation to the other WPs that can use the content delivered in the training to improve the ongoing activities. The Figure 1 presents the WP4 methodology and its relation to other WPs.

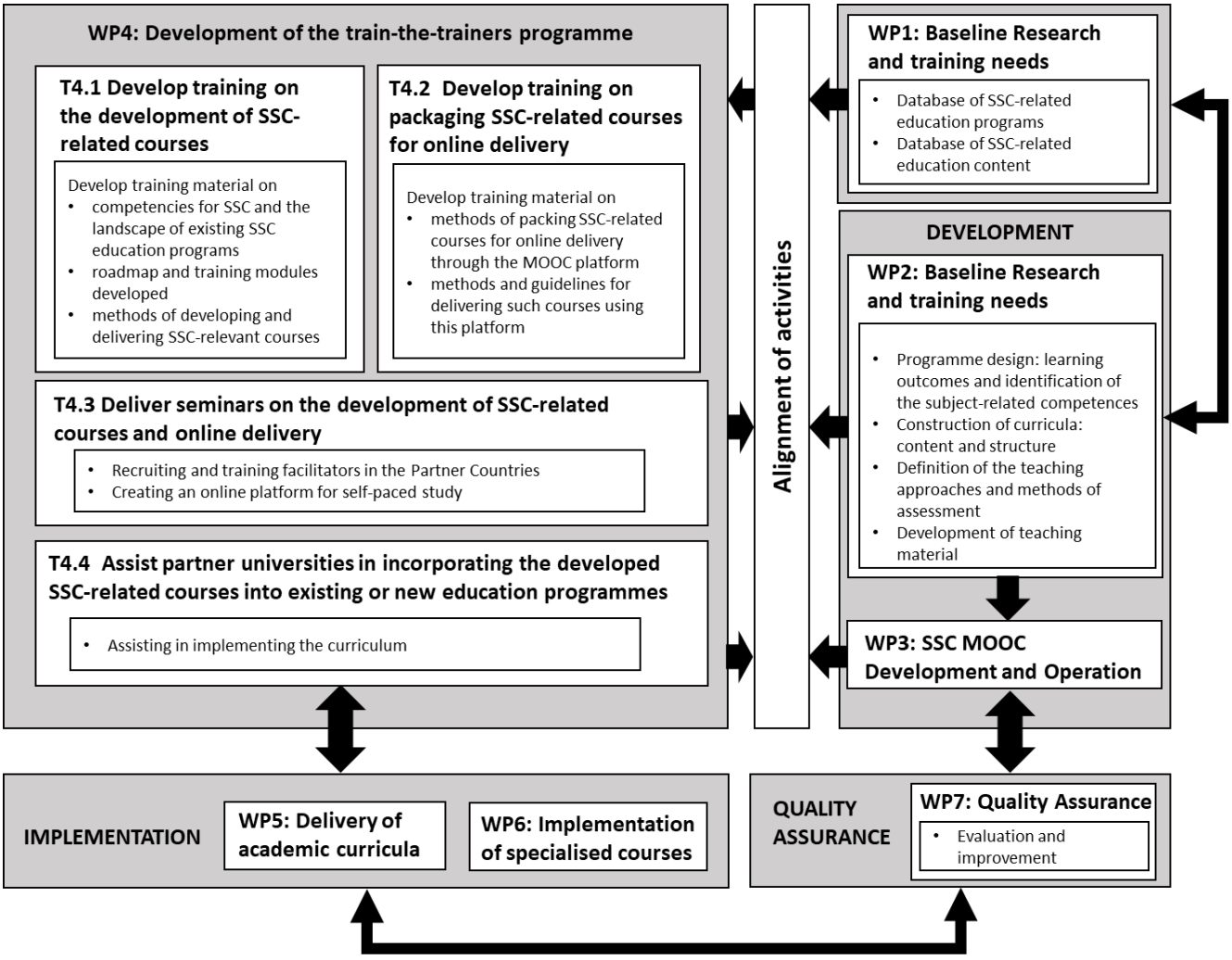


Figure 1. WP4 Methodology

The project methodology for curriculum development follows the Tuning model[1] including the phases of planning and programme design, construction of curricula, definition of the teaching approaches and methods of assessment and development of an evaluation system. We also adapted the proposed model, by adding an implementation phase including the activities of developing the content (WP2), recruiting and training facilitators (WP4), and implementing the curriculum in partner universities (WP5 and WP6). This WP (WP4) activities follow under the design phase, supporting the activities done in WP2 on stating the intended learning outcomes of the courses and related competencies to be developed; the translation into curricula, supporting the activities on WP2 for selecting the content of the courses (topics to be covered); under the definition of the teaching approaches and methods of assessment, also supporting WP2; and recruiting and training facilitators to implement the curriculum in their universities (WP4).

The current deliverable, as the main output of T4.1, is strong related to WP1 and WP2 and has the aim of developing the training material on:

- competencies for SSC and the landscape of existing SSC education programs (background and resources from WP1);
- roadmap and training modules developed (resources developed by WP2); and
- methods of developing and delivering SSC-relevant courses (support the development of the teaching material in WP2).

The next tasks of WP4 are described as follows: T4.2 uses the outputs of WP2 to provide the basis for the MOOC implementation in WP3. T4.3 includes recruiting and training facilitators from the Partner Countries, who will reproduce the training in their institutions with support of WP leaders and creating an online platform for self-paced study. T4.4 consists of assisting the partner universities in incorporating the developed SSC-related courses into existing or new education programmes.

1.3 Structure of the Deliverable

The rest of this report is structured as follows. Section 2 provides learning materials concerning the background to Smart Sustainable Cities. Section 3 describes the resources produced by the project and how they could be used in developing new courses on Smart Sustainable Cities. Section 4 provides some resources and guidelines for developing new courses that can help build competencies for planning, implementing and managing Smart Sustainable Cities. Section 5 focuses on theories, methods and approaches of delivering Smart Sustainable City courses.

[1] https://www.unideusto.org/tuningeu/tuning-methodology.html

2. LEARNING MATERIALS – BACKGROUND

This section aims to provide learning materials concerning the background to Smart Sustainable Cities. The subsequent text covers definition (Section 2.1), concepts (Section 2.2), roles (Section 2.3), responsibilities (Section 2.4), and competencies (Section 2.5) for Smart Sustainable Cities. Besides, Section 2.6 provides the references used.

2.1 Smart Sustainable City – Definition

Smart Sustainable City is regarded as a new discipline that integrates two points of view: urban and technological (Bibri and Krogstie 2017). International Telecommunication Union (ITU) defines Smart Sustainable City (SSC) as "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency or urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects"(ISO/IEC 2015). Following the model of digital government evolution (Janowski, 2015), Estevez et al. (2016a) point out that Smart Sustainable Cities are the most advanced form of digital city transformation, primarily based on collaboration and engagement of various stakeholders to improve quality of life and pursue sustainable development goals.

Smart Sustainable City is a territory (urban and rural) in continuous transformation, enabled by digital technology and innovation, stakeholder engagement and collaboration, constructing human, institutional and technical capacities to solve problems and create new development opportunities, to raise and maintain the quality of life in communities, and pursuing sustainable development (Azambuja and Pereira 2019).

The concept of Smart Sustainable City developed by the Cap4City project consists of five dimensions: social, economic, environmental, governance, and urban infrastructure, presented in Figure 1.

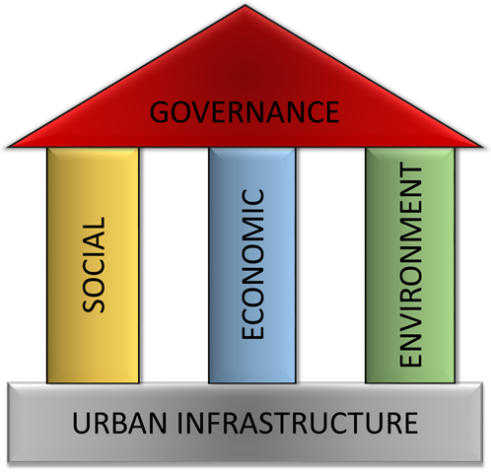


Figure 2. Smart Sustainable City (Azambuja and Pereira 2019)

According to Figure 1, Smart Sustainable City is built upon the urban infrastructure – the physical infrastructure comprising roads, transportation, factories, buildings, subways and more, and ICT infrastructure – urban ICT assets comprising Local Area Networks (LAN), servers, databases, software, open-source software, Geographic Information Systems (GIS) and more. Three pillars of SSC represent the concept of sustainability understood as balancing the social, economic, and environmental dimensions to improve the quality of life. The presented concept of SSC incorporates the institutional aspect into the governance dimension (Estevez et al., 2016a), indicating institutionalism (Tolbert and Zucker 1983) to be a part of governance (Pereira et al. 2018; UN Habitat 2016).

The first (social) dimension refers to the social aspects of SSC. This includes the provision of city services to citizens, guaranteeing the quality of life, enhancing social participation, communication with citizens, education, decreasing the digital divide for reaching sustainability, etc. (Chourabi et al. 2012; Estevez, Lopes, and Janowski 2016b; Azambuja and

Pereira 2019). The second (economic) dimension addresses challenges to the economic sustainability understood as "a city with a healthy, dynamic and responsible economy" (Estevez, Lopes, and Janowski 2016b). The third (environmental) dimension covers issues related to the protection and restoration of the natural environment, green buildings, energy savings, creating better space to live, and the adoption of ecological practices to protect the environment (Estevez 2016, Chourabi et al. 2012, Alawadhi et al. 2012, Yigitcanlar et al. 2018). Above all mentioned dimensions, the governance dimension addresses the administrative capability to manage the cities' resources, people, policies and stakeholders, design and implement legal regulations as well as provide compliance mechanisms and processes in a standardized and continuous manner.

Literature also distinguishes two domains of SSC projects: hard – the essential role of digital technology, and soft – technology understood as an enabler in education, culture, policy, and innovation (Al-Nasrawi, El-Zaart, and Adams 2017). According to Grimaldi and Fernandez (2017), effective management of human capital leads to developing the "knowledge city" where the education sector substantially supports urban development, and policy implementation. Zait (2017) stresses the equal importance of human and purely technical components of SSCs.

2.2 Smart Sustainable City – Concepts

The development of SSCs is the result of scientific exploration and practical implementation of solutions to challenges faced by modern municipalities, cities, agglomerations, regions, and countries. The basic concepts that significantly influence the development of SSCs are:

1. the global approach to environmental problems and sustainable development,
2. urbanization and urban growth,
3. sustainable urban development and sustainable cities,
4. digital technologies, and
5. smart cities.

As a result of the development of digital technologies, the expectations of the citizenry towards local governments have changed. Currently, citizenry expects the local government to understand and address their need in a fast, secure, and responsive way using modern Information and Communication Technologies (ICT).

Due to globalization, the catalogue of matters belonging to the competence and needed continuous monitoring by the local governments have expanded. Pandemic, an increase of air and water pollution, or climate changes are examples of issues that have to be addressed by the joint effort of many governments and agencies. Scott (2015) presents the categorization of problems that cities face according to their concentration: infrastructure, health, climate change, and social instability. Zhang (2016) analyzed urbanization premised in comparison to urbanization challenges. The author showed a clear imbalance between urbanization premises, such as enabling the global economy and stimulation of economic growth, and multiple urban challenges. The latter include urbanization of poverty, high living costs, poor infrastructure and management of urban areas, poor financial capacity, higher unemployment, and more.

Sustainable Development Goals (SDGs) have a huge impact on the functioning of many countries and cities. Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987). With the objective of "no one will be left behind," inclusive urbanization can be regarded as an indispensable condition of the sustainable development goals agenda (McGranahan, Schensul, and Singh 2016). The rapid development of technologies and the benefits of their use in everyday city management practices bring local governments closer to achieving SDGs than ever before. There are three evolutionary stages of urban smartness: digital city, intelligent city, and smart city. Digital city calls for the integration of technology and city infrastructure. The intelligent city comprises intelligent urban systems and services. The smart city enables social progress using intelligent urban systems (Estevez, Lopes, and Janowski 2016b). See Figure 2.

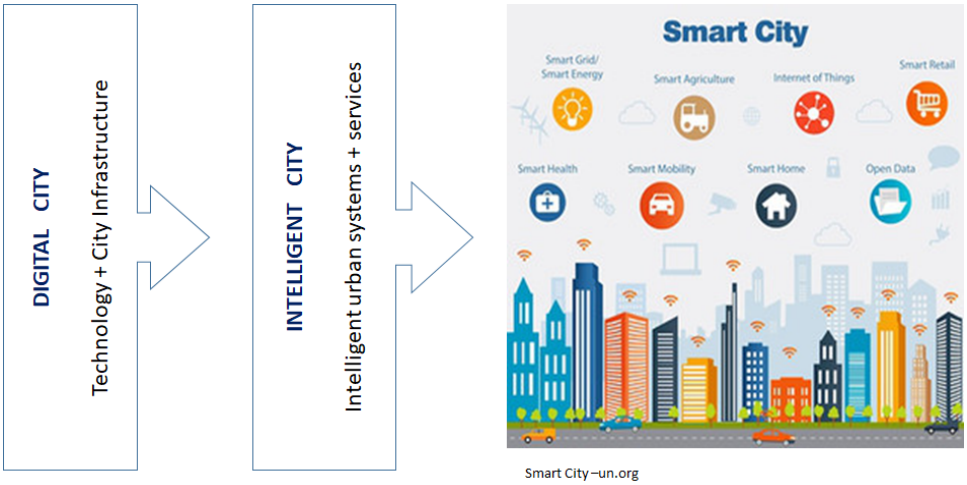


Figure 3. Three stages of Smart City Development

Over time, cities gain in importance. Currently, about a third of the world's population are city dwellers. As expected, by 2050, in as many as 89 countries, around 80% of the total population will constitute an urban population (6.3 billion), while the rural population will decrease to 3.2 billion (United Nations 2014). According to the World Bank, the urbanization rate has exceeded 55% (The World Bank 2018) and is forecast to reach 68% in 2050 (United Nations 2018). Large cities are increasing the number of inhabitants, reaching the size of a small country, e.g., Tokyo is forecast to have 37 million inhabitants by the end of 2020 (UNDESA, 2011). On the other hand, it should be noted that the largest cities are emerging in developing countries, and the richest are localized in the developed ones, not reaching any impressive sizes (City Mayors 2018a). And yet, despite 90% of urban development in developing countries, an impressive number of billion city dwellers live in slums, and in sub-Saharan Africa, this figure reaches 59% (UN Habitat, 2016). According to WHO (2016), 80% of the urban population is exposed to air pollution that exceeds set limits. By 2050, the world is expected to generate 3.40 billion tons of waste annually, from today's 2.01 billion tons (Kaza et al. 2018).

Maes et al. (2019) identified 102 targets (99 synergies and 51 trade-offs) with published evidence of relationships with urban ecosystems, where decisions about urban ecosystems affect humanities ability to realise greater welfare and well-being and build physical and social infrastructure. This falls in line with (Estevez, Lopes, and Janowski 2016b) that point out that sustainable urban development crosses the economic, social, environmental, and institutional dimensions. The United Nations (2015) revealed a set of objectives for sustainable urban development, e.g., safe and affordable transport systems, protection of cultural heritage, reduction of impact on the urban environment, etc. With current urbanization models considered unbalanced (UN-Habitat, 2016b), sustainability action should include, among others, resource management, waste reduction, and equal access to digital technologies (ITU and UNECE 2016).

The remainder of this section introduces five concepts related to SSCs: smartness (Section 2.2.1), sustainability (Section 2.2.1), governance (Section 2.2.3), stakeholders (Section 2.2.4), and partnership (Section 2.2.5).

2.2.1 Smartness

The increase in the urban population, the rapid development of technology, and the changing needs of citizens, businesses, and communities force cities to undergo continuous development of digital systems and the creation of digital public services. Only digital technologies allow faster response to disasters, improve resource planning, and implement continuity plans (Chourabi et al. 2012; Scholl and Scholl 2014). Thus, digital technologies in the context of SSCs enable smart urban innovation (Pereira et al. 2018). Five dimensions of smartness are: smart economy, smart environment, smart living, smart mobility, and smart people. Full descriptions of each dimension are presented in Table 1.

Table 1. Characteristics of smartness for Smart Sustainable Cities

Dimensions	Thematic scope	SSC context
Smart economy	• Entrepreneurship and innovation • Productivity • Local and global interconnectedness • Innovative spirit • Economic image and trademarks • The flexibility of the labour market • International embeddedness • Ability to transform	Economy, Investment, Business, Technology hub, Inventory management, Telemetry, Transport, Logistics, Planning and allocating resources, Waste
Smart environment	• Green buildings, • Green energy, • Green urban planning, • The attraction of the natural conditions, • Pollution, • Environmental protection, • Sustainable resource management	Waste, waste analysis, drainage, recycling, zero waste, sustainable food, education, soil, Buildings, Green buildings, Constructions, sustainable building, Clean energy, water, electricity, climate-carbon reduction, eco-friendly infrastructure, pollution reduction, clean and renewable energy, clean water, urban biodiversity, green technology, air quality, metering, air pollution, indoor air pollution, outdoor air pollution, Manufacturing, eco-labelling, material products, Parking, street lighting control, traffic analysis, sustainable transport, Innovation, resources, pollen data, solar energy, procurement, environmental management, gas, wind, plant energy, architecture, ecology, telecommunication, audit, LEED, design, sales
Smart governance	• Enabling supply & demand side policy • Transparency & open data • ICT & e-government • Participation in decision-making • Public and social services • Political strategies & perspectives	Governance, administration, citizens services, standardization, employment, economic development, risk management, strategy building, voting, co-creation, private sector involvement, urban planning, participation, business planning, strategy, services, product, law regulation, public information, data collection, tourism, infrastructure, technology
Smart living	• Health conditions • Individual safety • Cultural facilities • Housing quality • Education facilities • Touristic attractivity • Social cohesion	Health care, safety & security, sports facilities, communication network, retail, entertainment, green spaces, an urban model of living, urban mobility, street lighting, home automation, IoT, buildings, save lives, natural disasters, healthcare, power, food, shelter, real estate, mass media, green technology, audit, energy supply, property, eco-city, finance, eco-design, energy supply, standardization, LEED, services design, travel,
Smart mobility	• Integrated ICT • Prioritized clean & non-motorized options • Integrated ICT • Mixed - modal access • Availability of ICT-infrastructure • Sustainable, innovative and safe transport systems	ICT, technology, communication, systems, e-commerce, telecommunication, geo-informatics, web services, sensor networks, grids, big data, cloud services, satellite, networks, IoT, internet services, virtual reality, 3d printing, open data, robotics, drones, logistic, electric vehicle, noise, pollution, emission, time-saving, mobility data, ITS, web programming, automotive application, mobility, project management, retail, city, deep learning, machine learning, research, reinforcement learning, algorithm, text understanding, semantic analysis, robotics, automotive drive, intelligent application, intelligent platform, cloud platform, UX, UI, automotive applications, sensor, monitoring, industry 4.0, retail, city, design, security, sales, software, programming, carbon reduction
Smart people	• Embrace activity • Inclusive society • 21st-century educations • Level of qualification • Affinity to lifelong learning • The social and ethnic plurality • Flexibility • Creativity	Society, participation, integration, education, e-education accessibility, fairness, living labs, knowledge transfer, responsible action, digital competencies, training, facility management, building, standards, energy, medicine, biotechnology, crowd simulation, pedestrian, crowded events, 3d render

	• Participation in public life	

2.2.2 Sustainability

Smart sustainable city "contributes to improving the quality of life of its citizens by pursuing socio-economic development and protecting natural resources among other locally-defined priorities" (Estevez, Lopes, and Janowski 2016b).

According to Bruntdland's report (United Nations 1987), sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The primary objective of SSCs is to provide quality of life to its citizens focusing on the present and future generations. Thus, for cities to be smart and sustainable, they need to focus on: the quality of life issues for both present and future generations; on managing long-term relationships with the stakeholders within and across government, business and societal sectors; on citizen participation and co-decision-making in public affairs; on defining and realizing locally-appropriated paths to urban development; and on ensuring strong institutional support for environmental initiatives. Digital technologies and digital innovation are essential tools to enable smart sustainable cities.

2.2.3 Governance

Stakeholder theory defines governance as the interaction and collaboration of different stakeholders in the decision-making process (Garcia Alonso and Lippez-De Castro 2015; Albino, Berardi, and Dangelico 2015). UN Habitat (2009) points out the necessity of legal frameworks and efficient processes to ensure the satisfaction of citizens' needs. Bergh and Viaene (2015) define governance as the way cities organize internally over administration boundaries. Authors stress that transformed city governance should: balance control with empowerment, adopt an open form of teamwork and collaboration, co-construct business processes with the community outside organizational endorsements, involve experimentation and continuous improvement, influence cultural stance toward uptake and adoption of the solution, and manage motivational issues of smart city stakeholders (Bergh and Viaene 2015). Anthopoulos and Fitsilis (2014) point out smart cities' evolution towards eco or green cities enabling sustainable urban growth. Pereira et al. (2018) define smart governance as "the ability of governments to make better decisions through the combination of ICT-based tools and collaborative governance". Nam and Pardo (2011) identify enablers of communication and interaction amongst smart city stakeholders: collaboration, cooperation, partnership, citizen engagement, or participation. The governance of an SSC encompasses social norms, people, policies, partnerships, practices, data and information, and technologies for:

- balancing the social, economic and environmental dimensions making use of urban infrastructure and digital technologies to connect the elements of a region;
- managing long-term relationships with stakeholders within and across government, business and societal sectors including citizen participation and co-decision-making in public affairs;
- defining and realizing locally appropriated paths to the development of smart territories; and
- ensuring strong institutional support for environmental initiatives (Azambuja and Pereira 2019).

Azambuja and Pereira (2019) identified SSC key governance enablers and challenges presented in Table 2.

Table 2. Smart Sustainable City key governance enablers and challenges

Enablers	Challenges
• transparency and openness, • citizen empowerment; interactive and participatory services; co-production and co-creation; bottom-up approaches, • information and knowledge sharing; good communication and feedback channels, • supportive government policies; political will and synergy, • urban planning: strategy and vision definition, and shared vision with stakeholders,	• lack of planning (Resources/HR Capacity); Lack of vision and strategy, • lack of project management (team, size, skills, risk management), • lack of capacity (HR), • lack of IT knowledge among city planners; the need for IT adaptation and IT management, • lack of operational capability (operational IT skills, AI, big data, networks, security),

• context adaptation; analysis of the current situation, flexibility, adaptive governance, • capacity planning (infrastructure, cost, and human resources), • clear definition of roles and responsibilities, • leader/champion: dedicated organization/person for promoting and supervising initiatives, • use of compliance and monitoring tools/assessments; KPIs definition, • collaborative decision-making processes; network and participatory governance, • multiple stakeholders' engagement: internal (cross-sector), and external (public and private sectors, academia, and citizens), • align and manage conflicts of interests, • data-driven decision and real-time data, • urban proactiveness (service provision), • data governance (ensure data quality, sharing, data privacy).	• lack of capacity building (training), • structure: Isolated silos; Lack of internal coordination and cooperation, • the complexity of organizational structures; the need to balance centralized/decentralized mechanisms, • lack of alignment/engagement; no shared vision; conflicts of interests; lack of synergy; lack of coordination, • lack of knowledge and information sharing, • lack of engagement opportunities (citizens and others), • poor public-private partnership (monopoly), • centralized decision-making top-down approach, • political instability and complexity, • lack of political will/support, • lack of transparency and trust (internal and external), • lack of regulation and legislation (norms, laws, directions), • the inability of policies, • the multiplicity of policies and programs (local, regional, national), • lack of standards and KPIs for measuring performance, • lack of data governance (quality of data, data privacy regulations), • lack of open data; issues for opening data (Open data vs Privacy)

2.2.4 Stakeholders

Sustainable smart cities is a set of partnerships of different stakeholders, under various conditions and in the different form. The smart city stakeholders include city, state government, national government, technology vendors, universities, schools, investors, banks, insurance companies, research institutions, public housing associations, start-up incubators, energy, logistics, transportation, and health care providers, digital agencies, retailers, manufacturers, and construction companies, hotels, museums, restaurants, theatres, stadiums (Deloitte 2015). No matter the number of stakeholders, SSCs adopt a citizen-centric approach, putting a citizen at the heart of all city's actions.

2.2.5 Partnership

A partnership is the essence of the SSC's existence. Due to the limited financial resources, municipalities cannot develop and implement innovative public services to the citizenry by themselves. Municipalities, to provide quality of life through public services, need to collaborate with three main partners: citizens, industry, and universities. The involvement of universities, industries, and government in SSC planning, development, and management respond to the triple helix model (Etzkowitz and Leydesdorff 1995). The model represents the academia-industry-government collaboration that characterizes the knowledge society (Dameri, Negre, and Rosenthal-Sabroux 2016). See Figure 3.

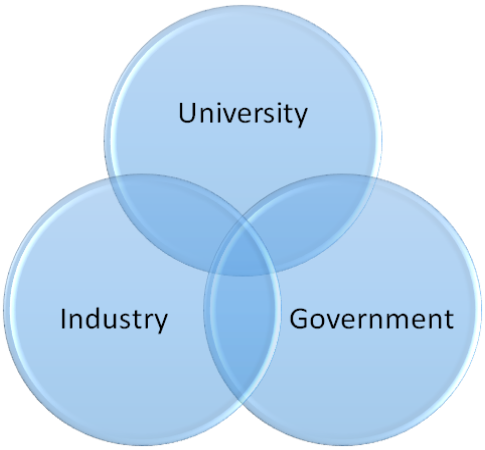


Figure 4. Triple helix model (Etzkowitz 2003)

Partnership with citizens is associated with terms such as citizen involvement and citizen engagement. Municipalities, to satisfy public needs, need to establish communication with citizens and facilitate collaboration with citizens to engage them in the process of public services co-creation. On the other hand, citizens tend to express their needs to the local government via established communication channels. Municipalities are limited with their access to knowledge about citizen's needs and optimal ways of enhancing citizen satisfaction. We can only gain such knowledge through citizen engagement and participation in events stimulated by the local governments. Thus, we can observe twofold approaches toward the smart city, the top-down, government-led approach and bottom-up, citizen-driven approach (Dameri, Negre, and Rosenthal-Sabroux 2016; Bouton et al. 2013; Washburn et al. 2010).

The other type of partnership vital to successful SSC development is the partnership with the industry. Industries are usually the product owners of the technological solutions delivered to the municipalities. ICT industry characterizes a high level of expertise on the delivered solutions to the public services market, as well as human capital ready to design and deliver digital solutions. We usually realize the collaboration with public administration through a public-private partnership with the key role played by the private sector (Huston, Rahimzad, and Parsa 2015). (Górka and Szyja 2015) state legal innovations are the basis for public-private partnerships. Many smart sustainable city projects are the results of private companies' investments in revenue-based solutions.

Universities, regarded as structurally aligned pools of human resources necessary for the creation of "knowledge cities", take part in the third type of partnership. They create a pool of ICTs engineers, big data experts, IT project managers that directly benefit to SSC projects development and implementation (Grimaldi and Fernandez 2017; Mayer-Schonberger and Cukier 2013; Dameri, Negre, and Rosenthal-Sabroux 2016).

The outcome of a successful partnership is individual and organizational learning. Organizational learning is the process of change in thinking and action affecting individuals, groups, and the entire organization (Crossan, Lane, and White 1999). The effective functioning of the triple helix model in the context of the smart city result in knowledge creation (Broman and Robèrt 2017). Combining the stakeholder knowledge with knowledge introduced by communities, researchers, governmental representatives, and businesses enable the discovery of new ideas and ways of their delivery to the users. This, in turn, influences social learning and information sharing between SSC partners (Dyer and Dyer 2017; Neuvonen and Ache 2017; De Oliveira Musse et al. 2018).

SSC emerges as a member of a larger innovation ecosystem under the public-private partnership form (Lee, Hancock, and Hu 2014). It exploits social and economic development thanks to the integration of universities, industry, and government to generate a creative renewal in the knowledge economy and society (Dameri, Negre, and Rosenthal-Sabroux 2016).

2.3 Smart Sustainable City – Roles

Smart sustainable cities are working in a constantly changing environment leading to continuous adoption and transformation to these changes. Such transformation requires a deep understanding of processes and structure design suitable to challenges the local governments face. The organizational change leads to the redefinition of roles that the local government requires to deliver public value to the citizenry successfully. These roles include political leaders, government leaders, project managers, technical staff, service staff, business managers, and citizens (Janowski, Estevez, and Ojo 2012). Whenever local governments develop a new strategy, create a new organization structure, introduce new projects, create new project teams, assign team leaders, implement a new IT system or a new process, change the organizational culture, etc. it has to work on changing to roles. The consequences of not doing a role definition as a part of government transformation create many problems for employees, leaders who become overloaded, confused, underperforming, and stressed. Table 3 presents the key roles for smart sustainable cities.

Table 3. Key roles for Smart Sustainable Cities

Role	Description
Political leaders	articulate public needs define development priorities perform visionary and strategic decisions
Government leaders	perform sectoral planning secure resources develop and motivate staff coordinate across government and between public and private sectors
Public managers	plan, design and execute SSC projects between government, private and non-profit partners oversee the running of public agencies to carry out SSC projects manage the impact of SSC projects on such agencies act as senior responsible owners for such projects
Technical staff	plan, design, implement and manage technical systems underpinning SSC operations ensure the provision of technological infrastructure for such operations
Service staff	interacts with citizens carry out the day-by-day business of SSCs rely on the city's organizational and technical environment
Business managers	take part in the development and management of SSCs bring knowhow, enable innovation, share risks and costs of technological solutions help integrate public and private services
Citizens	participate in formulating the SSC vision and defining priorities co-create and receive city services interact with the city's service staff when requesting such services

Source: own deliberation based on (Janowski, Estevez, and Ojo 2012)

A particular government leader role for SSC transformation is the city's Chief Information Officer (CIO). This role is responsible for the smooth operation of the city's digital platforms and services, and for building and managing city-business-people partnerships to address the city's needs using its digital platforms and innovations. CIOs play an important role in urban transitions; in authentic deliberation between disparate stakeholders and interests, particularly in highly polarized societies; in maintaining distinction and linkage between deliberation and implementation; and in applying creative approaches to managing ambiguity and conflict (Hamann and April, 2013).

According to the Cap4City project's research, the roles associated with planning, developing, and managing SSC, identified through the review of 143 vacancy announcements, can be categorized into five areas: computer science, environment, industry, management, and urban planning. Table 4 presents the roles identified in SSC vacancy announcements.

Table 4. Smart Sustainable City roles identified from vacancy announcements

Computer science	Android Tech Lead C++ Developer Cloud Data Architect Computer Vision Researcher Data Scientist Development Manager Digital Marketing Specialist Hardware Production Technician Hardware Technician Intelligent Platform And Application Software Engineer Intelligent Platform And Application Software Project/Product Manager Intelligent Platform Senior Architect Intern for Front End Development IoT Solution Manager: Smart City and Smart Building IT Project Manager Junior / Senior Backend (Fullstack) Developer Junior Hardware/Embedded Developer Machine Learning and Deep Learning Algorithm Engineer Machine Learning and Deep Learning Researcher Natural Language Processing Researcher Product Manager/Operations Manager Program Analyst Project Technician Senior Cyber Security Analyst Senior Data Analyst / UI Designer Senior Java Engineer Senior Software Engineer - Central Systems Smart City IoT Project Manager Smart Grid Specialist Software Developer Software Engineer Support Technician Test & Support Developer Test Engineer
Environment	Acoustic Measurement Engineer – Propulsion Earthquake Data Scientist Energy Auditor Energy Management Analyst Environmental Specialist Field Service Engineer Fleet Engineer - Wind Turbine Blades Flood Data Scientist: Coastal/Storm Surge

	Flood Data Scientist: Urban Flooding Maintenance Planner Mechanical Engineer - Energy Systems Senior Director Sustainability Consulting Sustainability Manage Sustainability Program Coordinator Wind Commissioning Technician Wind Technician Wind Turbine Inspector
Industry	Content Marketer Deployment Engineer Design Engineer Electrical Design Engineer Electrical Motor Engineer Engineer for Autonomous Flight Systems Engineer-Product Stewardship Field Tech Loads Engineer Product Engineering Intern Product Manager Product Stream Autonomous Drive Senior Mechanic Senior Product Designer Technical Designer Emerging Technologies Visual Designer
Management	Account Manager Account Manager IoT Smart Cities Account Manager of Smart City products Accounting Officer Associate Director Business Analyst Business Development and Sales professional Business Development Manager Chief Representative Commercial Markets Lead Commissioning Manager Contract Data Management Specialist CRM Specialist Customer Success Manager Customer Support & Community Manager – Liquid Customer Support Lead - Manager Service Client Deployment Project Manager Director Director of Business Development Director of Operations Sales Head of Sales International Chief Technical Advisor on Sustainable Cities

	Management Consultant Manager of Engineering Partnerships & Business Development Manager Policy/Public Affairs Programme Manager Safety & Reliability Engineer Sales & Marketing Intern Sales Agent Sales Engineer Sales Executive Senior Director of Smart City Solutions Senior Key Account Manager Senior Procurement Officer Service Manager Smart City Sales Manager Solar Energy Strategy and Business Development Manager Vertical sales engineer (VSE - Smart City) Volunteer Admin & HR Team Leader Works Manager Head of R & D Projects Director of R&D Treasury Manager Talent Acquisition Trainee Talent Acquisition Specialist Europe
Urban planning	LEED Project Manager LEED Reviewer Project Assistant Structural Design Specialist - CAD & BIM Urban Planner

Source: (Janowski et al. 2019).

SSC processes are multi-sectoral, inter-organizational, and intergovernmental (Alawadhi et al. 2012). As the SSC initiatives are realized through public-private partnership projects, this makes it necessary to establish teams of people from different entities, characterized by different backgrounds, competencies, and skills that are assigned to different roles within SSC initiatives. Assigning these roles within SSC dimensions, as seen in Table 5, indicate the highest demand for the roles associated with the environmental and social dimension of smartness. The most popular combinations are environmental sustainability and smart environment, as well as social sustainability and smart mobility.

Concerning sustainability, the most significant number of vacancies exist for environmental sustainability (66) followed by social (55), economic (15), and institutional (8) sustainability. Concerning smartness, the most significant number of vacancies exist for smart mobility (71), followed by the smart environment (42), smart living (17), smart economy (8), and smart governance (2).

Among the combinations, the most significant number is environmental sustainability and smart environment (40), followed by social sustainability and smart mobility (38), environmental sustainability and smart mobility (17), social sustainability and smart living (11), and economic sustainability and smart mobility (9). The least number of jobs is offered for institutional sustainability (8) and smart governance (2).

Table 5. Examples of roles concerning sustainability and smartness

Sustainability				Roles	Smartness					
Environmental	Economic	Institutional	Social		Smart economy	Smart environment	Smart living	Smart mobility	Smart people	Smart governance
x				Contract Data Management Specialist, Sr. Key Account Manager, Treasury Manager	x					
x				Software Engineer, Account Manager, Business Development Manager, Chief Representative, Client Solutions Manager, Commissioning Manager, Content Marketer, Customer Success Manager, Customer Support Lead - Manager Service Client, Data Scientist, Director of Business Development, Director of R&D, Director - Solar Energy, Energy Management Analyst, Environmental Specialist, Field Service Engineer, Fleet Engineer - Wind Turbine Blades, IT Project Manager, LEED Project Manager, LEED Reviewer I, Product Engineering Intern, Product Manager, Product manager/Operations manager, Project Assistant, Sales & Marketing Intern, Senior Director, Sustainability Consulting, Senior Software Engineer- Central Systems, Smart City Sales Manager, Software Developer , Sustainability Program Coordinator, Sustainability Project Coordinator, Test Engineer, Vendor Relations Analyst, Visual Designer, Volunteer Admin & HR Team Leader, Wind Commissioning Technician, Wind Technician III, Wind Turbine Inspector, Works Manager, Development Manager		x				
x				Works Manager, Development Manager, Accounting Officer, Design Engineer,Developing a Strategic Plan for a Smart, Connected City, Electrical Design Engineer, Energy Auditor, Sales Executive			x			
x				Acoustic Measurement Engineer - Propulsion, C++ Developer, Deployment Engineer, Deployment Project Manager, Electrical Motor Engineer, Engineer for Autonomous Flight Systems, Field Tech, Intern for front end development, Loads Engineer, Maintenance Planner, Mechanical Engineer, Energy Systems Aircraft Integration, Safety & Reliability Engineer, Sales Engineer, Senior Frontend, Developer, Senior Mechanic, Software Engineer, Strategy and Business Development Manager				x		
x				Development Manager					x	
	x			Principal Optical Sol Architect-Webscale, Senior Data Analyst, Senior Product Designer, Talent Acquisition Specialist Europe, Talent Acquisition Trainee	x					
	x			International Chief Technical Advisor on Sustainable Cities						x
	x			International Chief Technical Advisor on Sustainable Cities			x			
	x			International Chief Technical Advisor on Sustainable Cities		x				
	x			Android Tech Lead, Customer Support & Community Manager - liquid, Head of Sales, IoT Solution Manager: Smart City and Smart Building, Partnerships & Business Development Manager, Sales Agent, Senior Director of Smart City Solutions, UX / UI Designer, Vertical sales engineer (VSE - Smart City)				x		
	x			Sustainability Manager					x	
		x		Programme Analyst						x
		x		Business Development and Sales professional, Computer Vision Researcher, Intelligent Platform and Application Software Engineer, Intelligent Platform and Application Software Project/Product Manager, Intelligent Platform Senior Architect, Machine Learning and Deep Learning Algorithm Engineer, Machine Learning and Deep Learning Researcher, Natural Language Processing Researcher				x		
			x	Senior Director, Sustainability Consulting, Works Manager		x				
			x	Management Consultant, Programme Analyst, Urban Planner, International Chief Technical Advisor on Sustainable Cities						x
			x	Works Manager, Digital Marketing Specialist, Junior/ Senior Backend (Fullstack) Developer, Junior Hardware/Embedded Developer, Business Analyst, Commercial Markets Lead, Developing a Strategic Plan for a Smart, Connected City, Digital Anthropologist (IoT Data Operations Specialist), Earthquake Data Scientist, Flood Data Scientist: Coastal/Storm Surge, Flood Data, Scientist: Urban Flooding, Engineer-Product Stewardship, Smartdties Media Sales-OOH/DOOH/Experiential, Software Developer			x			
			x	Business Development and Sales professional, Account Manager IoT Smart Cities , Account Manager of Smart City products , Business Development, Chief of Staff, City Operations , CRM Specialist, Director of Operations , Director Operations Sales, Electrical Motor Engineer, Engineer for Autonomous Flight Systems, Enterprise Account Executive, Front End Engineer, Hardware Production Technician, Hardware Technician, Head of R & D Projects , Manager of Engineering, Operations & Fulfillment Specialist , Operations Associate, Policy/Public Affairs Programme Manager, Product Designer (UX/UI), Product Manager, Project Technician, Safety & Reliability Engineer, Senior Cyber Security Analyst - SOC, Senior Procurement Officer, Senior Product Manager, Senior Manager, Site Reliability Engineering, Smart Grid Specialist, Smart City IoT Project Manager, Software Developer, Software Developer for the Smart, Community Unit, Software Engineer, Support Technician, Technical Designer Emerging Technologies,, Product Stream Autonomous Drive, Test & Support Developer, User Support				x		
			x	Associate Director, Engineer frontend, R&D Engineer					x	

According to (Michelucci, De Marco, and Tanda 2016), working teams on SSC initiatives shall also be cross-organizational and interdisciplinary to deal with shared resources and solutions-oriented to diverse social groups. The analysis of 12 case studies in Latin America identified 30 roles within the organizations involved in the initiatives. The roles were classified into individual, collective, intra-organizational, and inter-organizational, and if the organization hosting the roles are leaders or partners. From the total of 30 identified roles, 18 are individual, and five are collective, divided into lead and partner organizations. The remaining roles consist of 5 inter-organizational that are shared between the leading and partner organizations, and two are intra-organizational developed by lead organizations.

Table 6. SSC roles and their type identified from Latin American case studies

TYPE	ORGANIZATION	ROLES
Collective	Lead	Social inclusion techniques
Collective	Lead	Lead the formulation and monitoring of policies and strategies on digital government
Collective	Lead	Promote agreements and strategic alliances other territorial entities, the private sector
Collective	Partner	Design a monitoring system to prevent accidents and crimes
Collective	Lead	Public-Private partnership management
Individual	Lead	Strategy management
Individual	Lead	ICT Coordination
Individual	Partner	Dissemination of initiatives
Individual	Partner	Investor advising
Individual	Partner	Urban and regional planner
Individual	Lead	Digital convergence coordination
Individual	Lead	Attendance and modernization of public services
Individual	Lead	Innovation Platform Coordination
Individual	Lead	Management and Financial Coordination
Individual	Lead	Risk and disasters management
Individual	Lead	Environment, mobility, infrastructure and sustainability coordination
Individual	Partner	Microcomputing
Individual	Partner	Informatics Security
Individual	Lead	Data Analyst
Individual	Lead	Communication specialist
Individual	Lead	Programmers
Individual	Lead	Graphic designers
Individual	Partner	Coordination of workflow during an urban crisis
Inter-organizational	All	Stakeholder coordination
Inter-organizational	All	Relationship and identification of opportunities
Inter-organizational	All	Strategic guidance
Inter-organizational	All	Promotion of initiatives
Inter-organizational	All	Monitoring the progress
Intra-organizational	Lead	Share the challenges, achievements, and risks of the system with other municipalities
Intra-organizational	Lead	Identify opportunities to apply ICT to support interaction with other organizations

Source: (Ribeiro et al. 2019)

The list of keywords characterizing the students' future roles is presented in Table 7. The content of this table allows one to draw the following conclusions: technical and engineering positions, and environmental protection, are highlighted as individual roles; collective roles mainly related to management, government, marketing, and global design, presuppose the realization of static forms of cooperation among organizations; intra-organizational roles involve the implementation of consulting, management, design and other professional roles that apart from individual competencies require the ability to work in teams and in synch with organizational objectives; inter-organizational roles refer to business model creation,

collocation activity planning and management, and implementation of agile professional activities which not bound to any single organization but to networks of organizations.

Table 7. Keywords characterizing future Smart Sustainable City roles

Individual	Collective	Intra-organizational	Inter-organizational
Design engineering	Citizen design	Private/public sector engineering design	Sustainable business model development
Engineering consultancy	Urban design	Development of the energy conversion projects	Environmental management systems building
Engineering standards regulations	Chain management	Design control	Environmental urban consultancy
Engineer-scientist	Consumers engagement	Change the organization's policy	Infrastructure sustainability consulting
Technical managers	Changing the environment	Business support	Local authorities and academics
Environmental advocacy	Social governance	Specialist project manager	Policy analysis and development
Environmental protection	Sustainability marketing	Chief of sustainability officer	Urban planning
Work independent	Work in the public and private sector	Consultancy in project and risk management	Entrepreneur business

2.4 Smart Sustainable City – Responsibilities

The vacancy announcements have also been reviewed to identify key responsibilities associated with different dimensions of Smart Sustainable Cities. The results are presented in Table 8.

Table 8. Responsibilities for Smart Sustainable City roles according to dimensions

SSC Dimension	Responsibilities
Smart economy	• working closely with account teams and business users to develop and execute technical account strategies • creating candidate profiles and supporting talent Acquisition Partners with accurately tracking candidate profiles through the relevant application steps • developing and implementing robust quality assurance processes to include assurance for contract data completeness and accuracy • customer signatures for contracts • addendums • pricing letters, and contract management controls • managing daily cash positions across all bank accounts and preparing monthly cash management reports • monitoring performance of existing technology and building business cases for technology enhancement • develop the company and departmental policies and procedures that will lead to enhanced cash management
Smart living	• creating commercial go-to-market strategies • working closely with the product team to understand and influence product roadmap while moving into the commercial vertical markets • interacting with stakeholders in government, academia, and the private sector to negotiate data acquisition agreements

	• collaborating with data science and engineering teams to ensure data sufficiency and quality control • building models to improve damage prediction of structures due to earthquakes • designing new software components and systems and re-designing existing software components and systems • coordinating junior developers • developing designs in BIM, Revit, and AutoCAD under the guidance of the engineering team and project manager • end-to-end design of IoT devices, board designs and production and testing procedures • coordinating with network and hardware specialists to solve challenging problems cutting across various domains of technology and exposing efficient and robust APIs • making intuitive, beautiful and performant mobile apps to expose exciting and challenging new use cases • participating in all stages of product planning, right from envisioning to execution to delivery • designing and executing inbound and outbound marketing campaign strategies for brand visibility and lead generation • setting project governance, managing risks, and variations in project scopes, managing internal and external stakeholders, overseeing project financials • maintaining regular customer contact and following up in order to anticipate project, support or training needs, while keeping customer satisfaction • developing specialized knowledge surrounding water management systems - sewers, storm drains, flood control, and more
Smart environment	• IoT connectivity management • writing good quality test specifications in the test management tools • designing and implementing RESTful API servers and consumers to integrate platforms with other data providers/consumers • assessing the privacy impact and shape what can and cannot be done taking into account the ethics policy and relevant legislation • identifying suitable partners that will contribute to realizing the potential of application domains • contributing to the development of new strategic areas that complement the Urban Data Project vision • delivering software to agreed time and quality targets whilst working in Agile/SCRUM • designing and producing communication assets for banners • social media ads and other visual or motion products • developing leading-edge strategies to expand the reach, impact, and quality of customer engagement including responding to and resolving customer queries through chat, email and social media • building and executing a territory plan to sell the technology in Europe • providing LEED documentation management and support to project teams on green building projects • installing, commissioning and testing AMCS hardware and software products including all wiring and mechanical work on refuse collection vehicles and recording and reporting all service and repair visits using an ERP system to meet and/or exceed the expectations of customers
Smart people	• organizing funds, researching new opportunities, managing projects • developing, implementing, maintaining and monitoring a range of KPIs for each centre in respect of energy use, waste volumes, recycling targets, carbon reduction • ensuring the development of effective internal relationships with procurement, development, design and construction, facilities management, shopping centre retailers, waste teams, cleaning teams, centre teams, to enable their effective participation in environmental and sustainable requirements • creating the kite energy and sustainability program • creating a cost-benefit analysis for financial investments • designing and developing 3D rendering components and virtual humanoid animations
Smart mobility	• performing noise measurements of propulsion systems • developing and prototyping basic technology and systems for autonomous flights

	• managing and performing system safety assessments • performing system reliability assessments, including failure modes and effects analysis • in the end-to-end design process, developing brand identity and building high-fidelity digital products ready to launch in the market • solving the full-spectrum of customer problems, focusing on delivering the type of thoughtful detail that premium customers expect • generating new business opportunities outside of existing core business and pipeline • writing reusable and clean code and delivering high-quality Android applications • providing strategic and technical oversight to a team responsible for incident management, technology implementation, ITIL process management and, performance management and customer service • writing client and server code to provide successful and ergonomic web applications • participating in major systems design and programming projects, managing all phases of the development of the information technology project including project design, implementation, hardware and software integration, initial operation and continuing performance evaluation and improvement • theoretical and technological research into machine learning, deep learning, and reinforcement learning • research into intelligent application technologies related to image, video, text, speech, health, precision medicine, robot, automatic drive, smart city, business finance, education, etc. • architectural design and development of general and domain-intelligent platforms • designing and developing innovative solutions of the company's products using real-time data visualization, Big Data, ML, IoT, etc.
Smart governance	• providing client-centric, value-added management consulting services to a variety of strategic and operational opportunities and practice areas • supporting respective City Program and Service Leads in the development and implementation of smart city initiatives from an I&T and smart city framework perspective • consulting with relevant municipal, provincial, federal and international subject matter experts to conduct required research and sharing relevant research materials

Source: (Janowski et al., 2019)

2.5 Smart Sustainable City – Competencies

Smart sustainable cities require strong competencies for public governance in the digital world. The concept of competency (Blanchard and Thacker 2004) comprises knowledge, skills, and attitudes that allow employees to discharge the responsibilities associated with their assigned roles. Knowledge is the cognizance of facts, truths, and principles gained from formal training and/or experience. The application and sharing of knowledge are critical to individual and organizational success. A skill is a developed proficiency or dexterity in mental operations or physical processes acquired through specialized training. The execution of skills results in a successful performance. An attitude is a kind of soft skill to perform in physical or mental activities affiliated with a given profession.

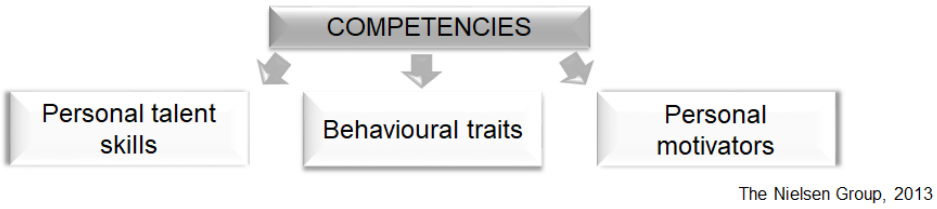


Figure 5. Basic competency components (The Nielson Group, 2003)

According to The Nielson Group (2003), competencies can also be divided into personal talent skills, behavioural traits, and personal motivators. Behavioural traits are analysis of data, competitiveness, customer orientation, frequent change,

frequent interactions with others, organized workplace, urgency, and versatility. Personal motivators include aesthetic, individual, political, social, theoretical, traditional, regulatory, utilitarian, and economic motivators.

Competencies cover not only traditional roles played by political and government leaders acting vertically top-down, but they also require collaboration between different roles acting horizontally and vertically bottom-up. An example is a bottom-up collaboration between political leaders and citizens or horizontal between public managers and business managers.

Competencies for governing SSCs target individuals, teams, organizations, or organization networks. The corresponding typology includes four types of competencies:

- Individual competencies comprise knowledge, skills, and attitudes, which are required and which empower relevant staff to play specific smart sustainable city roles. The concerned staff may already play these roles, they may aspire to play such roles in the future, or they may plan a transition from one role to another.
- Collective competencies entail the ability to collaborate within and among teams that have to work together in the performance of their smart sustainable city roles. Before building competencies for cross-role collaboration, the team members should possess competencies required to play individual roles.
- Intra-organizational competencies entail the existence of capabilities, rules, regulations, processes, and other structures within the organization concerned that empower individuals and teams in the performance of their respective individual or collective smart sustainable city roles.
- Inter-organizational competencies entail the existence of capabilities, rules, regulations, agreements, and other structures within different organizations comprising the smart sustainable city ecosystem to work together, in particular, to form and empower collective roles for inter-organizational teams.

In Janowski et al. (2019), 21 soft skills and attitudes expressed in vacancy announcements required for SSCs are identified. The results indicate that the most wanted soft skill is oral communication (45%). The results are presented in Figure 5.

Figure 6. Soft skills and attitudes in Smart Sustainable City vacancy announcements

The most common soft skill is oral communication (45%), followed by written communication (36%), analytical thinking (36%), teamwork (31%), technical expertise (29%), customer orientation (25%), collaboration (20%), flexibility (16%), attention (15%), result orientation (14%), performance management (14%) and innovation (13%). As a result, potential employees are required to possess skills and attitudes related to both logical thinking and communication.

As can be seen in Figure 6, some skills and attitudes repeat in every dimension. These are oral communication, written communication, analytical thinking, and fostering teamwork. However, most skills and attitudes are dimension-specific. These include attention to communication for Smart Economy; technical expertise, customer orientation, flexibility and building collaborative relationships for Smart Environment; establishing focus, managing performance, results in orientation, strategic thinking, and stress management for Smart Governance; flexibility, attention to communication, results from orientation and fostering innovations for Smart Living; technical expertise, customer orientation, building collaborative relationships, flexibility, results from orientation and fostering innovation for Smart Mobility; and technical expertise, building collaborative relationships, and fostering innovation for Smart People

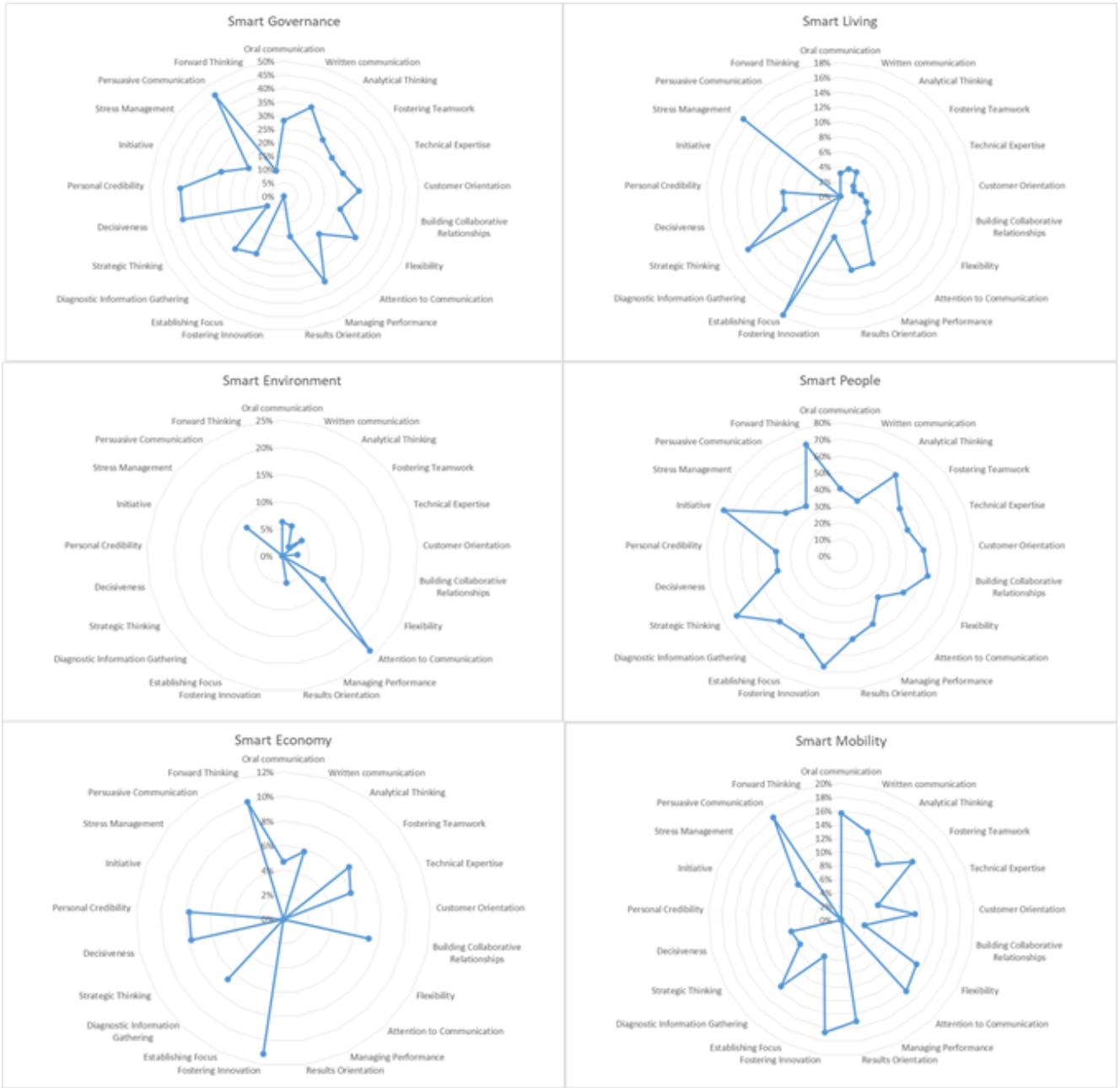


Figure 7. Soft skills and attitudes in relation to smartness

A skill that is relatively common in all areas of sustainability is analytical thinking, followed by oral and written communication. The skills characteristic to different dimensions are: fostering teamwork, technical expertise, customer orientation, building collaborative relationships and orientation on results for environmental sustainability; customer orientation and attention to communication for economic sustainability; technical expertise and initiative for institutional sustainability; and fostering teamwork, technical expertise, customer orientation, building collaborative relationships, managing performance, fostering innovation, focus and strategic thinking for social sustainability. See Figure 7.

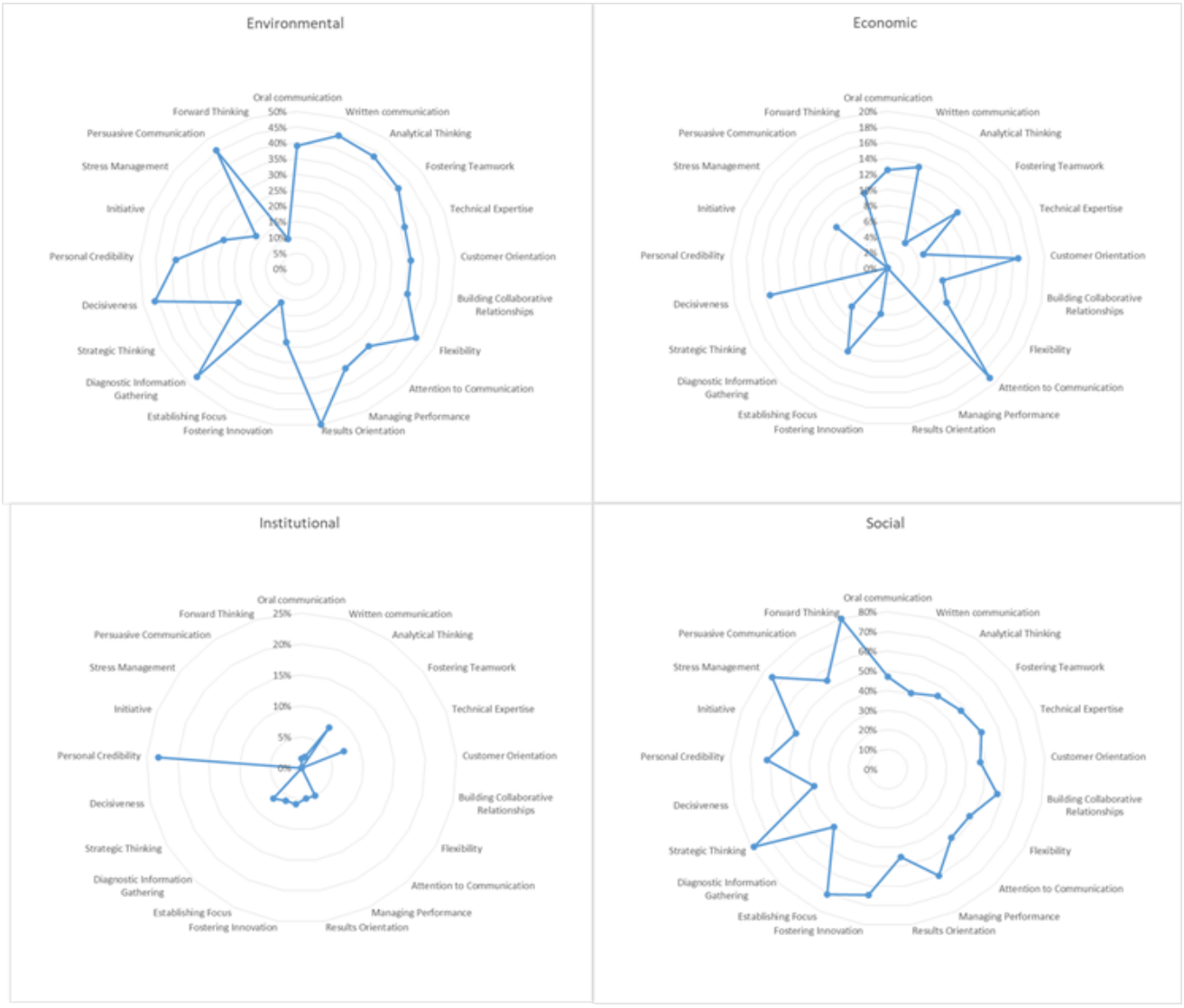


Figure 8. Soft skills and attitudes in relation to sustainability

The analysis of vacancy announcements also identified knowledge of subject areas, tools, and languages sought by employers for SSC positions and roles. The most desired knowledge concerns smart environment and mobility and the areas include knowledge of the law, rules and standards; knowledge of new technologies and related systems and programs; knowledge of new forms of mobility; knowledge of low-or-zero carbon energy production; knowledge of new business models and start-up coordination and management; and knowledge of new products, buildings, and urban solutions. Knowledge of the most desired tools includes staff and customer management; office management; programming, testing, applications, systems, servers, and the web; and urban and architectural planning. Language

requirements in vacancy announcements prioritize English, Spanish, French, and occasionally Mandarin, basic, or proficiency levels.

Concerning education levels, 73 vacancy announcements asked for higher education, 4 for high school education, and 55 did not specify education requirements. Among higher education degrees, Bachelor, Master or PhD degrees are needed, and occasionally MBA. Table 9 Expectations of educational degrees in vacancy announcements presents degree requirements divided into six smartness dimensions.

Table 9. Expectations of educational degrees in vacancy announcements

Dimension of Smartness	Degree							Field of the study
	Bachelor	Bachelor of Science	Master	Master of Science	Post-secondary	MBA	PhD	
Smart Economy		x		x		x		accounting computer networking economics finance
Smart Environment	x	x	x	x		x		aerospace engineering architecture business business administration computer science ecology economics education electrical engineering electronics engineering engineering environmental management environmental science ICT international relations journalism management marketing material science math's science mechanical engineering media physics policy public health sales science sociology software engineering sustainability
Smart Living		x		x		x	x	architecture chemical engineering civil engineering engineering environmental science geophysics

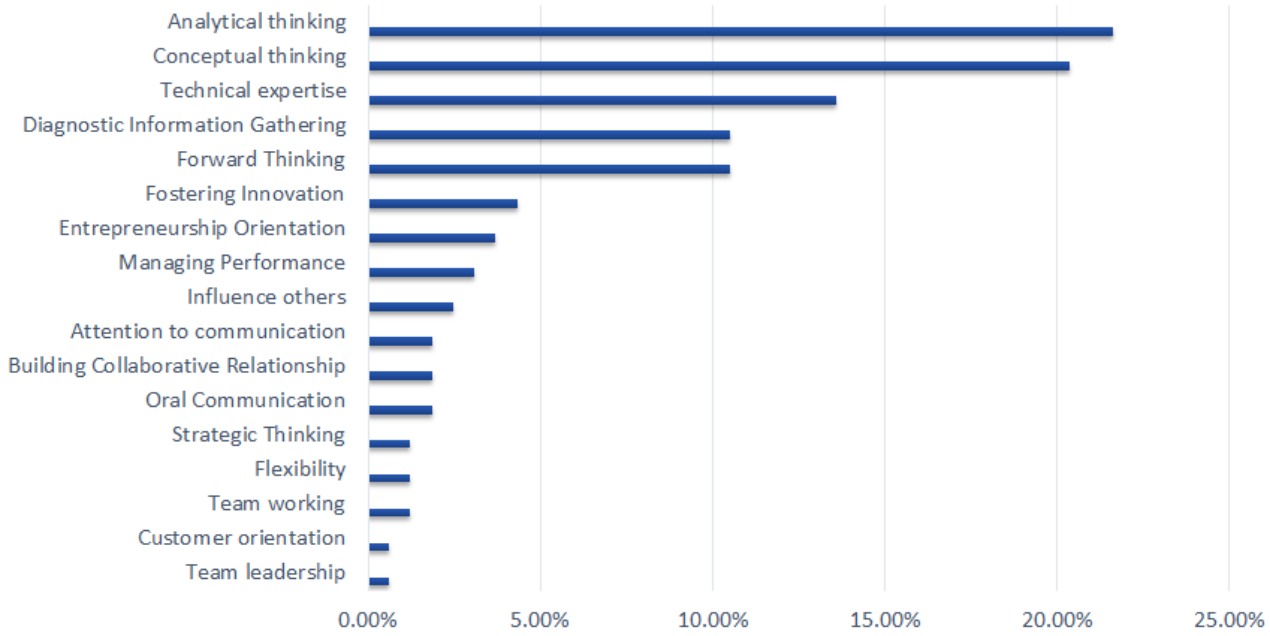
								material science natural resource management planning structural engineering technology
Smart People			x					architecture engineering informatics mathematics meta programming sustainability
Smart Mobility	x	x	x	x		x	x	administration aerospace engineering business computer engineering computer science economics electrical engineering electrical engineering electronics information systems IT management marketing mathematics mechanics mechatronics public administration robotics statistics telecommunications
Smart Governance			x		x	x		business administration business technology energy environmental sciences managing information systems public communication transport urban economics urbanization waste management

Janowski et al. (2019) examined competencies acquired by students of the analyzed education programs, required to fulfil professional roles in SSC initiatives. We proceed with soft skills and attitudes, then with other skills and knowledge. Seventeen soft skills and attitudes were identified as the most common among education programs in SSCs. The most common soft skill and attitude is analytical thinking (22%), followed by conceptual thinking (20%), technical expertise (14%), diagnostic information gathering (10%), and forward-thinking (10%). The remaining skills and attitudes occur at rates of less than 5%.

These observations do not contradict the analysis of the soft skills in vacancy announcements. The most popular competencies presented in this table could be interpreted as an expanded version of the competencies delivered by the education programs. The main reason is the specificity of the documentation being studied – in vacancy announcements, the requirements for soft skills and attitudes are usually stated in detail and then in the education programs' curricula. One

of the main competencies both required by employers and delivered by education programs is analytical thinking and technical expertise. The full catalogue of the most popular competencies built through SSC training is in Table 8.

Figure 9. The most popular competencies built through Smart Sustainable City training



The analysis of the educational program identified a set of skills and knowledge built through SSC training. Four groups of skills have been distinguished through the study of the sustainability program group, the smartness group, the specific smartness, and sustainability group, and data science in smart sustainable cities group. The skills trained by the sustainability programs consist of realizing the co-creation in the sociotechnical policy context, designing processes within the built environment, enabling strategic feasibility design, build the newest entrepreneurship thinking, combine theoretical and practical research, realize the comparison of different real-life cases, etc. The smartness programs develop entrepreneurial and executive management skills, open analytical and problem-solving mindset, ability to communicate with technical and nontechnical audiences, ability to gather new insights independently, ability to present ideas and innovative solutions, and ability to analyze urban theory. The third group of programs educates in the field of specific smartness and sustainability group. The following skills are developed by this training: discovering the collected geospatial data, predictive analysis, and big data tools, aimed at discovering new possibilities, develop and implement the behaviour control algorithms, applying smart technology-driven on the framework of IoT, and develop the model of complex system behaviours. The last group of programs refers to data science in SSCs and builds the skill in assessing the quality of urban planning, reducing the cybersecurity challenges, improving the liveability and governance of cities, learning online, solving the issues surrounding urban environment, and awareness of smart automation products.

3. LEARNING MATERIALS – RESOURCES

This section describes the resources produced by the project and how they could be used in developing new courses on Smart Sustainable Cities. First, we discuss the Smart Sustainably City Roadmap, which constitutes the deliverable D2.1 – how it was created, what are its main phases, and how it could be used. Second, we elaborate on the database of the SSC-related content, which constitutes the deliverable D1.5, which may be a useful reference for those seeking a fast and efficient way of finding SSC content relevant to new SSC courses. Third, we present and discuss SSC-related educational programs that were identified in the deliverable D1.2 and aggregated in D1.5. Fourth, we preview and describe the portfolio of SSC-related courses, i.e., the training modules prepared by the project, and discuss how the assembly of these courses could offer a comprehensive SSC education that satisfies the identified educational needs. These four parts are covered by the respective sections 3.1, 3.2, 3.3, and 3.4, before providing a list of references used in this section.

3.1 Smart Sustainable City – Roadmap

A roadmap is a tool to guide or plan (map) actions to achieve something. Roadmapping is the process of creating the roadmap, which can be used to support different types of strategic aims as, for instance, planning, supporting communication, and assessing projects (Phaal, Farrukh, & Probert, 2004). Considering the benefits of roadmaps, we decided to create a roadmap for SSC to serve as input to the development of the SSC training. The guideline for developing Smart Sustainable Cities (SSC roadmap) is the starting point for identifying the content of the training modules (training needs). In other words, the suggested steps of the roadmap are mapped to potential competencies that should be taken into consideration when developing educational programs. The remainder of this section presents the development, phases, and potential uses of the SSC roadmap in Sections 3.1.1, 3.1.2 and 3.1.3 respectively.

3.1.1 Roadmap – Development

To achieve the goal of developing a guideline for SSC development, we performed a literature review to identify governance enablers (positive aspects) and challenges (barriers and obstacles) for Smart Sustainable City development, which were used as the basis for describing the steps for the SSC roadmap. Besides, best practices were identified in Europe and Latin America through case studies developed by the project. Based on the results and considering insights from the real SSC initiatives, we conceived the roadmap for Smart Sustainable City development.

Figure 9 illustrates the process of developing the SSC roadmap. The process consists of three main phases, which are elaborated in the following sections: literature background in Section 3.1.1.1, data collection and analysis in Section 3.1.1.2, and findings and roadmap development in Section 3.1.1.3.

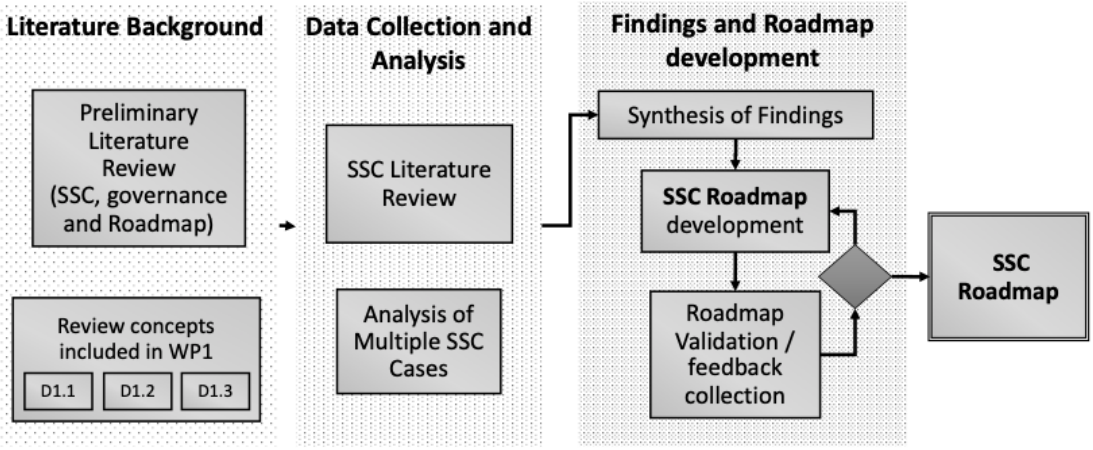


Figure 10. Roadmap development steps

3.1.1.1 Literature Background

First, a preliminary literature review on SSC, governance, and roadmap development was performed. The deliverables of the WP1 Baseline Research and preparation, particularly deliverables D1.1, D1.2 and D1.3, were used as sources of information and collections of important terms and definitions.

3.1.1.2 Data Collection and Analysis

Data collection and analysis consists of the SSC Literature Review and the analysis of SSC initiatives performed in earlier stages of the project. The SSC literature review used the search term:

("smart sustainable cit*") OR
("sustainable smart cit*") OR
("smart and sustainable cit*") OR
("sustainable and smart cit*") OR
("smart sustainability")

The search was performed on the Scopus and Web of Science databases, considering article titles, abstracts, and keywords. Since SSC is a multi-disciplinary field, the journals were not limited to one specific area. The search resulted in a total of 414 records, 221 in Scopus, and 193 in Web of Science. After removing the duplicates, 271 unique records were verified whether they presented governance enablers or challenges for SSC development. A total of 118 references were included in the review, as they were mentioning a governance enabler or a governance challenge. The governance challenges and enablers identified by the literature review are as following:

Governance Enablers

- Adaptive governance
- Align and manage conflicts of interests
- Analysis of the current situation
- Bottom-up approaches
- Capacity planning (infrastructure, cost, and human resources)
- Citizen empowerment
- Clear definition of roles and responsibilities
- Collaborative decision-making processes
- Context adaptation
- Co-production and co-creation
- Data governance (ensure data quality, sharing, data privacy)
- Data-driven decision making and real-time data
- Flexibility
- Good communication and feedback channels
- Information and knowledge sharing
- Key performance indicators
- Interactive and participatory services
- Leader/champion: dedicated organization/person for promoting and supervising initiatives
- Multiple stakeholders' engagement: internal (cross-sector), and external (public, business, academia, citizens)
- Network and participatory governance
- Political will and synergy
- Supportive government policies
- Transparency and openness
- Urban planning: strategy and vision definition, and shared vision with stakeholders;
- Urban proactiveness (service provision)
- Use of compliance and monitoring tools/assessments

Governance Challenges

- Centralized decision-making process
- Conflicts of interests
- Inability of policies
- Issues for opening data, e.g., open data versus privacy
- Lack of alignment and engagement
- Lack of capacity building (training)
- Lack of coordination
- Lack of data governance (quality of data, data privacy regulations)
- Lack of human capacity
- Lack of internal coordination and cooperation
- Lack of IT knowledge among city planners
- Lack of knowledge and information sharing
- Lack of operational capability (operational IT skills, AI, big data, networks, security)
- Lack of planning (resources/HR capacity)
- Lack of political will/support
- Lack of project management (team, size, skills, risk management)
- Lack of regulation and legislation (norms, laws, directions)
- Lack of standards and KPIs for measuring performance
- Lack of synergy
- Lack of transparency and trust (internal and external)
- Lack of vision and strategy
- The multiplicity of policies and programs (local, regional, national)
- Need to balance centralized/decentralized mechanisms
- No shared vision
- Political instability and complexity
- Poor public-private partnership (monopoly)
- Structure: isolated silos
- The complexity of organizational structures
- Top-down approach

Also, 12 cases were analyzed – six from Europe:

1. Barcelona, Spain,
2. Copenhagen, Denmark,
3. Gdansk, Poland,
4. Helsinki, Finland,
5. Tallinn, Estonia, and
6. Vienna, Austria

and six from Latin America:

7. Buenos Aires, Argentina,
8. Curitiba, Brazil,
9. Santiago, Chile,
10. Bogotá, Colombia,
11. Panama City, Panama, and
12. Montevideo, Uruguay.

3.1.1.3 Findings and Roadmap Development

After data collection, the findings were synthesized, and the roadmap was proposed and validated as follows:

- The first step in the synthesis of findings was the identification of governance enablers and challenges, which were described in the format of tables that list the enablers, challenges, and the respective references. In addition, key aspects of the SSC initiatives were analyzed.
- The roadmap was based on the research findings from the literature review, including governance enablers and challenges, and on the complementary data gathered from the SSC initiatives. The key governance factors were identified and described as "phases" and "steps" to develop Smart Sustainable Cities.
- The roadmap validation was another step. To this end, an online form was created, and the link was sent to project members to collect feedback, in addition to the feedback received from the first workshop of T2.2 in Bogota and Medellin. In total, 15 participants provided feedback through the online form. Afterwards, a new version of the roadmap was proposed, which was presented and discussed in two workshops at international conferences (DG.O in June 2019 in Dubai and EGOV-CeDEM-ePart in September 2019 in San Benedetto del Tronto) attended by 15 and 10 participants respectively (Azambuja, Pereira & Krimmer, 2020).

3.1.2 Roadmap – Phases

The suggested SSC Roadmap is generic. It contains non-specific stages that can be adapted according to the city context. Besides, the model suggests a continuous approach to follow the dynamism of cities. Figure 10 presents the roadmap. The visual form of the roadmap is useful in understanding the relations within each phase and communicating the necessary actions to be undertaken.

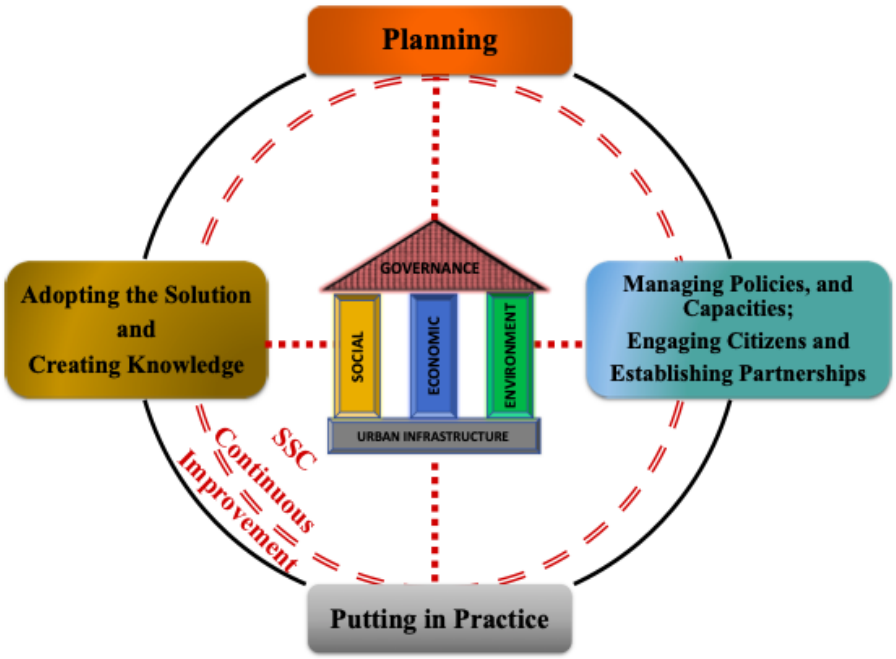


Figure 11. Smart Sustainable City Roadmap

In the middle of the circle in Figure 10 is Smart Sustainable City illustrated through five main dimensions corresponding to the three pillars of sustainability: Social, Economic, and Environmental, jointly with the Governance dimension at the top and the urban infrastructure at the bottom. This SSC model in the centre of the figure aims to guide all stages of the roadmap towards SSC development.

Five phases of the roadmap are described in the following sections: planning in Section 3.1.2.1, managing strategies and engaging citizens in Section 3.1.2.2, putting in practice in Section 3.1.2.3, adopting solutions, and creating knowledge in Section 3.1.2.4 and continuous improvement through monitoring in Section 3.1.2.5.

3.1.2.1 Phase 1 – Planning

The roadmapping phases vary according to the approach used, but two of them are distinctive and recommended: the identification of the current position (AS-IS situation) and the definition of the 'desired situation' (TO-BE state).

When implementing a project, it is always necessary to understand the context and the current situation to draw the action plan. The first aim of the planning phase is to perform a preliminary GAP analysis to identify what is necessary to do in order to achieve the TO-BE state. The GAP analysis serves as an input for planning actions. In addition, in the planning phase, it is important to define the stakeholders (multidisciplinary background) that will be involved in the initiative, both internal and external.

As seen, one of the findings of this study was the importance of developing strategic planning for Smart Sustainable City implementation. Taking the examples of the cases of Barcelona and Vienna, these cities have a defined Smart City Strategy, containing city vision, plan of actions, assessment criteria, etc. Included in the planning phase are the activities of defining medium- and long-term visions and planning activities.

Another step under the planning phase is planning capacity. Projects should be analyzed thoroughly before initiation. Initiatives should have roles and responsibilities defined and documented in order to set expectations. Likewise, it is recommended to define a leader responsible for promoting and monitoring the project performance; and the achievement of stakeholders' commitment (political, societal, business, etc.). Partnerships should be planned since the early stages; a step is dedicated to this. Finally, under the planning phase, cities should define the assessment criteria to be used in the monitoring phase.

The steps included in this phase can be summarized as follows:

- **Identifying Stakeholders** (internal and external)
- **GAP Analysis**: Preliminary verification of the situation and what is necessary to achieve the desired situation
    - **AS-IS analysis** (Critically understand the context)
        - The political situation, societal problems
        - Solutions and capabilities in place
        - Understanding organizational structure, processes, and interactions
        - External environmental scanning with stakeholders
    - **TO-BE definition**
        - Brainstorm of necessary actions
        - Preliminary definition of city vision (what the city wants to achieve)
- **Setting a map**
    - Cities should create forums and workshops to discuss problems and possible solutions
    - Vision definition (medium and long term)
    - Plan what needs to be done according to the defined vision
- **Needs Assessment**: Prioritizing aims and values
- **Risk Assessment and Management**
    - Learn from previous errors and assess possible risks
- **Planning Capacities** (HR, infrastructure and financial)
    - Defining **who** is going to be involved / reviewing who is involved

        - Definition of Roles and Responsibilities (internal and external)
        - Champion (leader) definition to promote, check, communicate and motivate
    - Analysing **Infrastructure** needs (according to the context analysis)
        - Developed cities tend to have the basic infrastructure
        - Developing cities may need to invest more in technology in order to implement smart systems
        - Planning strategies to integrate existing technologies
    - **Financial** planning
        - Prioritizing investments
- **Planning Partnerships**
- **Achieving approval and commitment** (political, entrepreneurs and society)
- **Defining assessment criterion** (what, how, who, when)
    - Define KPIs (important targets, indicators)
    - Define which assessment tools to use
    - Define who and when the performance is going to be checked

3.1.2.2 Phase 2 – Managing Strategies, Engaging Citizens

Whereas the previous phase planned capacities, this phase has the purpose of managing them. Capacities here include infrastructure, human resources and financial aspects. In addition, this phase aim to manage policies, meaning analysing existing policies, creating new policies if necessary, and integrating them. This step was also recommended by experts in the validation process. Policies should include all SSC dimensions and should encourage stakeholder's engagement (including citizens). One of the findings of the case analysis is the risk of discontinuity of initiatives in next municipal administration; in this context, citizen engagement remains essential for the SSC initiative continuity after changes in government. Furthermore, other steps refer to the engagement of internal and external stakeholders. Cities should establish (and manage) partnerships, and avoid isolated silos (structures), promoting cooperation and coordination between organizations. In brief, the steps included in this phase are:

- **Managing Policies (identification, creation, review and integration and evaluation)**
    - Identification of existing policies
    - Review / update / create / integrate / evaluate policies
- **Managing Capacities** (HR, Infrastructure and financial)
    - HR management
        - Check skills needed
        - Roles and responsibilities management
        - Promote collaboration
        - Providing training and capacity development
        - Ensure a flexible and open workspace (to retain work force and foster innovation)
    - Infrastructure management (checking what is needed and compare with what the city has)
    - Financial management
- **Engaging internal stakeholders** (cross-sector collaboration)
    - Make use of coordination mechanisms
    - Establish horizontal structures, in order to foster collaboration
- **Engaging Citizens** (online and offline)

- Create mechanisms to allow citizen participation and co-creation
- Communication plan

- **Establishing / Managing Partnerships** (engaging external stakeholders)
  - Partnerships overview
  - Managing legal issues (legal framework)
  - Strategic alignment

3.1.2.3 Phase 3 – Putting in Practice

This phase aims to put the plan in practice, with the cooperation of stakeholders, who are already engaged and aligned. As a first step, experts recommended the analysis of existing solutions and initiatives. It was also suggested the creation of multiple projects, as one might not work, so the city should count with more than one option. The implementation should be followed by the integration with existing solutions and architecture; thus, is recommended the creation of a migration plan. In terms of technology, network infrastructure and connectivity are main aspects to consider. In addition, it is important to use open sources, to facilitate the interoperability within systems and to avoid vendor locker. Last, but equally important is the step of "governing data". The steps included in this phase can be summarized as following:

- **Verifying existing solutions**
  - Smart technologies and services identification, set standards
- **Creating SSC solutions / services / initiatives**
  - Initiatives for all city areas and basic community needs
  - Solutions for Smart Education, Smart Health, Smart Energy, Smart Water, Smart Waste management, Smart mobility, Smart Buildings and constructions, etc. according to the city needs
- **Setting / Adjusting the SSC infrastructure**
  - The SSC Infrastructure must be interconnected, scalable, flexible, open and secure
- **Implementing SSC solutions / initiatives / services**
  - Migration plan
  - Implementation
- **Testing developed solutions**
- **Integrating new solutions/initiatives to the "city system"**
  - Ensuring interoperability and systems integration
- **Governing Data**
  - Data management to ensure data quality, and to tackle privacy concerns
  - Cybersecurity

3.1.2.4 Phase 4 – Adopting Solutions, Creating Knowledge

After project implementation and integration with the environment, this phase has the purpose of delivering the project and communicating the new/updated solutions to ensure adoption. During the validation process, one of the experts suggested that this phase should be focused on the "appropriation" of the solution, in order to obtain benefits. Cities should communicate initiatives using different channels to ensure social inclusion. In addition, if necessary, training should be provided to avoid digital divide. Knowledge creation is also part of this phase, as the idea is to collect user feedback, and to document the lessons learnt from the solution implementation. However, it is worthy to mention that if the city makes use of feedback channels, public administrations should be able to reply and attend requests under a predefined service level agreements. Here are the steps:

- **Delivering and Communicating initiatives**
  - Communication for all (using different channels)
- **User Training**
  - Education and training for all
- **Collecting Feedback**
  - Establish different feedback channels (ensuring inclusion)
- **Creating Knowledge**
  - Document lessons learned
- **Planning improvements**
  - Feedback analysis and improvements planning

3.1.2.5 Phase 5 – Monitoring

The continuous improvement is delivered through the monitoring phase, illustrated in the centre of the roadmap as connected to all other phases. The idea is to monitor the progress of all phases, collecting and sharing information within the phases during the implementation cycle. The assessment criteria used here is the one defined in the planning phase. Considering the importance of citizen engagement in SSC, they should be included in this phase. One expert mentioned that this phase "looks like a correction phase". Indeed, the idea is to monitor all aspects of SSC in order to ensure continuous improvement. Cities should have a dedicated team or organization responsible for the "monitoring" of SSC initiatives as the previous mentioned "leader" or "champion". Good practices can be taken from the Barcelona and Vienna cases, as both cities have an organization responsible for Smart Sustainable City related initiatives and projects.

- **Monitoring and assessment** (different aspects)
  - Performance assessment according to the defined KPIs
- **Ensuring stakeholder alignment with SSC goals** (internal and external)
- **Managing conflicts** (internal and external)
- **Managing education and training** (external and internal)
  - Check the adoption of programs
  - Check the need of new education programs
- **Managing Communication** (internal and external)
  - Feedback management
- **Continuous Improvement:** learning from errors and improving

3.1.3 Roadmap – Potential Uses

A roadmap is an important tool to support the planning, resource allocation and coordination of activities to "transform" a city into a Smart Sustainable City. The roadmap intends to facilitate the identification of the key governance elements, e.g. stakeholders, partnerships, structures, competencies and roles that should be considered when planning, implementing, managing, maintaining and evaluating SSC initiatives.

The roadmap is generic, aiming to guarantee flexibility for it to be used by different cities in different contexts. Accordingly, the roadmap presents non-specific actions, addressing different aspects and not focusing on one specific objective. This roadmap can be used by different SSC stakeholders and can help in the identification of important steps to develop SSC initiatives. A city does not need to perform all phases and there is no fixed starting point, it will depend on the context and maturity level of each initiative/city, but the roadmap is to serve as a guideline.

3.2 Smart Sustainable City – Database

The database of SSC-related content is one of the project's deliverables (D1.5). It contains a set of data collected as a basis for the report (D1.2). Due to the largely unstructured character of the datasets, it is kept in the MS Excel format. However, if needed, it is perfectly possible to export its selected fragments to more specialized forms, e.g. MS Access.

Each worksheet of the database, except for the first two ones, contains data on a certain research entity and is thus respectively named, e.g. "Education offers". The rows represent data entries (records), the records apply to relevant research objects e.g. a city or a paper, while the columns represent data attributes. The exception is the "Cities – case studies" worksheet, where such order is reversed for to technical reasons, i.e. rows represent attributes and groups of columns represent objects.

The section covers usage, users and structure of the database in respective Sections 3.2.1, 3.2.2 and 3.2.3.

3.2.1 Content Database – Usage

The objectives and potential use scenarios of the database include:

- Synthesis of the knowledge acquired within the D1.2 report
- Enhancement and addendum to the topics that were treated aggregately in the report
- Quick and handy reference to the data entities
- Organized data collection for future analyses
- Guide and reference to further data resources, e.g. papers, books, videos, etc.

3.2.2 Content Database – Users

Among the target groups and potential beneficiaries of the database we identify:

- Political leaders responsible for translating public needs into visions and priorities for SSCs
- Policy makers responsible for designing, implementing and monitoring policy instruments for SSCs
- Public managers responsible for planning, implementing and managing SSC projects and programs
- Public managers responsible for hiring, training and managing human resources for SSCs
- Municipal employees responsible for day-to-day routines of SSCs
- Service and infrastructure providers for SSCs
- Educators and education managers from partner education institutions responsible for planning and implementing education programs targeting various stakeholders of SSCs
- Researchers and analysts studying the design, performance and impact of SSCs

3.2.3 Content Database – Structure

The Excel workbook is organized into the following worksheets:

1. **Front page**

   The first worksheet in the workbook contains mainly the necessary metadata about the database. Here, a user can find the formal details of the project and the version history. There is also information on the structure of the file, areas of use and intended audience.

2. **Tables – schemas**

   This worksheet includes descriptions of the contents and detailed schemas for all remaining worksheets. For each of the data worksheets, its title and general content description are included. The above is accompanied by a schema, i.e. a list of all data categories (technically columns or rows) for a respective data worksheet.

3. **Cities – case studies**

This worksheet includes the data collected within the SSC case studies, mirroring the research schema introduced in the D1.2 report. It should be noted that the dataset contains not only the case studies included in the deliverable D1.2 but also a number of studies included in different deliverables. Given that the output of the case studies was strongly diversified in terms of size and complexity, the structure of this worksheet is relatively most complex. This datasheet is meant to aggregate the information supplied within the case studies proceeded, taking it „as-is", hence not all the rows for each of the cases are filled. The subsequent data rows are organized according to the predefined policy of case examination, i.e. into the following higher order categories:

I. CASE – basic information about the case
II. WHAT – the fundamental information about the examined SSC initiative
III. WHO – participants of the initiative
IV. WHY – the rationale behind its undertaking
V. HOW – details of the implementation
VI. SUSTAIN – mapping of the initiative to the domain of sustainability

4. Education offers

This worksheet includes the discovered education offers. Each offer is examined through the theoretical lens of SSC concepts. Beginning with the declared attitudes of competency, the „smart" and „sustainable" dimensions are explored. Further, the technical and organizational details are collected, e.g. partners, learners.

5. Job vacancies

This worksheet includes the discovered job offers in a range of countries representing various parts of the world. The offers are thoroughly described and further examined according to the research data categories: competencies, roles, smartness, sustainability, etc. Also, URLs of the respective websites are supplied, along with additional video materials, if available.

6. Materials – readings

This worksheet includes a rich selection of readings relevant to the report's topics. The included types of readings are: journal papers, conference proceedings, books, reports, working papers. Each entry is described, both in relation to its bibliographic details and its content, including keywords for the sake of search facilitation.

7. Materials – WWW

This worksheet includes a selection of Internet-based sources useful for SSC-related topics. The included types of materials are: articles, courses, reports, videos, websites. Each entry is described and assigned a set of keywords.

8. SSC competencies

This worksheet includes a review of the competencies discovered through the studies. Further information on the logic of their selection can be found in the D1.2 (2.2.14 and Appendix). Each entry is further explained.

9. SSC dimensions

This worksheet includes a preview of the discovered smartness dimensions. Further information on the logic of their selection can be found in the Report D1.2 (2.2.1 and Appendix). The dimensions are introduced along with their thematic focus and their respective sub-dimensions, both in general and a more detailed conceptualization.

3.3 Smart Sustainable City – Education

3.3.1 Smart Sustainable City Education – Research

Those who creatively participate in turning their city into Smart Sustainable City should be equipped with a right set of competences. Beyond acquiring them in arguably the most natural way, i.e. "learning by doing", it is highly advisable to at least grasp the basics of the topic with support of some SSC-dedicated educational programs.

Within the project, the issue of SSC education has been thoroughly addressed. In fact, the involved authors have prepared a decent amount of learning and analytical material dedicated solely to this topic. Section 4.3 of D1.2 ("Competency Building in Smart Sustainable Cities") provides a deep insight into the trends and tendencies occurring in educational programs offered by various institutions in many of the world's countries. The results are further summarized and aggregated in the database D1.5. This research focuses mainly on the courses carried out in English. On the other side, there is also report D1.3 ("Report of SSC related education programs in the HEI in Latin America"), accompanied by its database D1.4, focused solely on the educational offers in Latin American countries, i.e. where Spanish and Portuguese are the dominating languages.

While in principle sharing the same goals, the approaches and designs differ significantly between these two endeavours. In the following table the two research efforts are compared in terms of their objectives and methods harnessed.

Table 10. Two research endeavours on the educational programs within the project

Aspect	Deliverable 1.2	Deliverable 1.3
Title	Competency Building in Smart Sustainable Cities	Report of SSC related educational programs in the HEI in Latin America
Declared objectives	To identify the trends, advantages, and disadvantages of existing educational programs for building and maintaining the competencies required for planning, developing, and managing SSCs.	To identify and classify using a uniform instrument (template) the SSC-related education programs offered by higher education institutions in Latin America, and to develop a database of SSC-related education programs offered by higher education institutions, including those associated with SSC initiatives and best practices, to build general and roles-specific competencies for SSCs.
Approach to selection	Internet queries containing the combinations of the keywords: • "smart city" or "smart sustainable city" or "sustainable" or "eco-design" or "data science" or "big data" • in conjunction with the keywords "study" or "university" or "master" or "MBA" or "course" or "study" or "program" or "workshop"	Internet querying (Google): • subjects: Smart Sustainable City, Digital City, Sustainable City, Smart City, Digital Governance, Electronic Government (e-Government, eGovernment), Public Administration, Information Systems, Digital Transformation, Public Sector Innovation, Digital Government Transformation, Public Sector Digital Transformation • educational degrees: Bachelor, MBA, Capacity Building, Certificate, Continuing Professional Education, Diploma, Education, Executive Masters, Graduate, Higher Education, Masters, MSc, Ph.D., Program, Specialization, Training, Undergraduate, Joint Master, MOOC
Supporting tools, engaged frameworks	Latent semantic data analysis	Instrument and framework built upon Estevez, E., Janowski, T. (2013). Landscaping Government Chief Information Officer Education.
Objects of research	50 programs including certificate, master or master of research	36 educational programs held by higher education institutions

	programs, as well as online courses, short courses, and workshops	
Countries	Various countries, in principle non-Latin American, e.g., USA, UK, Germany, Sweden, Switzerland	6 Latin American countries: Argentina, Brazil, Chile, Colombia, Mexico, Peru
Examined properties of a course	• Competencies – attitudes, skills, knowledge • Dimensions of sustainability and smartness • Roles within SSC • Formal properties, e.g., language, tools, partners	A thematically focused group of properties: • Program (general information) • Where (institution) • Who (students) • When (prerequisites) • What (competencies, subjects) • How (organization, administration) • Further details

In the further course of this subsection, these two research initiatives will be referred to as, respectively – "GLOBAL" and "AMERICA". Below, the important findings and conclusions coming from these studies are elaborated – the included data is taken directly from the deliverables listed above (D1.2, D1.3, D1.4, and D1.5).

3.3.2 Smart Sustainable City Education – Course Categories

In the case of GLOBAL research, the authors first classified the courses according to the categorization designed to reflect various aspects of SSCs. The categories are Smartness of Sustainable Cities, Sustainability of Smart Cities, Data Science in Smart Sustainable Cities, and Specific Smartness and Sustainability, i.e., more specialized areas of interest. On the other side, the grouping in AMERICA is much different – the authors state that "programs that are entirely related to SSC are limited, it has been considered suitable to include programs that are related to the theme and characteristics of SSC". Thus the following categories of courses were discerned: Governance-related, Business-related, Engineering-related, and Technology-related. Table x depicts these groups along with their share within a respective set.

Table 11. Primary categorization of the educational courses

Research	Group	No. of courses	Share
GLOBAL	Smartness of Sustainable Cities	9	18%
	Sustainability of Smart Cities	25	50%
	Data Science in Smart Sustainable Cities	5	10%
	Specific Smartness and Sustainability	11	22%
AMERICA	Technology	5	14%
	Governance	6	17%
	Business	7	19%
	Engineering	18	50%

The most obvious observation here is that in each research theme, there is one dominating group that half of the courses belong to. In the case of GLOBAL, it is Sustainability of Smart Cities, in the case of AMERICA, it is Engineering.

3.3.3 Smart Sustainable City Education – Course Analysis

First, it should be noticed that the authors of both pieces of research adopted different strategies of data exploration. In the case of GLOBAL, it was directly driven by the earlier findings on smartness and sustainability, as included in the

respective deliverable. The authors of AMERICA apparently focused on the exploration of domains more external to these topics.

In GLOBAL, there is an assignment of each of the analyzed courses to a certain dimension of sustainability and smartness. Table 12 is a contingency table, where a number in a cell represents the number of courses assigned to an intersection between a dimension of smartness and a dimension of sustainability. Some courses are assigned to several categories.

Table 12. Assignment of courses to dimensions of smartness and sustainability, the GLOBAL research

Dimensions of sustainability	Dimensions of smartness					
	Smart Environment	Smart Mobility	Smart Economy	Smart Governance	Smart People	Smart Living
Environmental	31	1	0	1	0	0
Social	2	17	0	0	5	1
Economic	0	4	13	1	0	0
Institutional	0	0	0	9	0	1

Source: Table 13, Deliverable D1.2.

A few numbers should be particularly noted here. There are 31 courses that are classified as focused on Smart Environment and Environmental Sustainability. Also, 17 courses belong to Smart Mobility and Social Sustainability. Thirteen courses teach Smart Economy and Economic Sustainability. These numbers can be explained by thematic consistency within the respective intersections. In fact, the GLOBAL's authors notice that "the dependence between the distribution of programs across the smartness and sustainability dimensions can be projected from each other". However, designers of the courses apparently do not believe in the possibility of raising smart people, since there are only five courses within this dimension. Smart living is even more neglected, with only two courses.

An equivalent analysis in AMERICA is the construction of the "word cloud" of the program names, where it is noticed that: 11 courses refer to "Smart City or Cities", 12 to "Sustainable", 7 to "Development", and 6 to "Management".

Concerning the formal academic status of the courses, Figures 11 and 12 below depict such insights for GLOBAL and AMERICA studies, respectively.

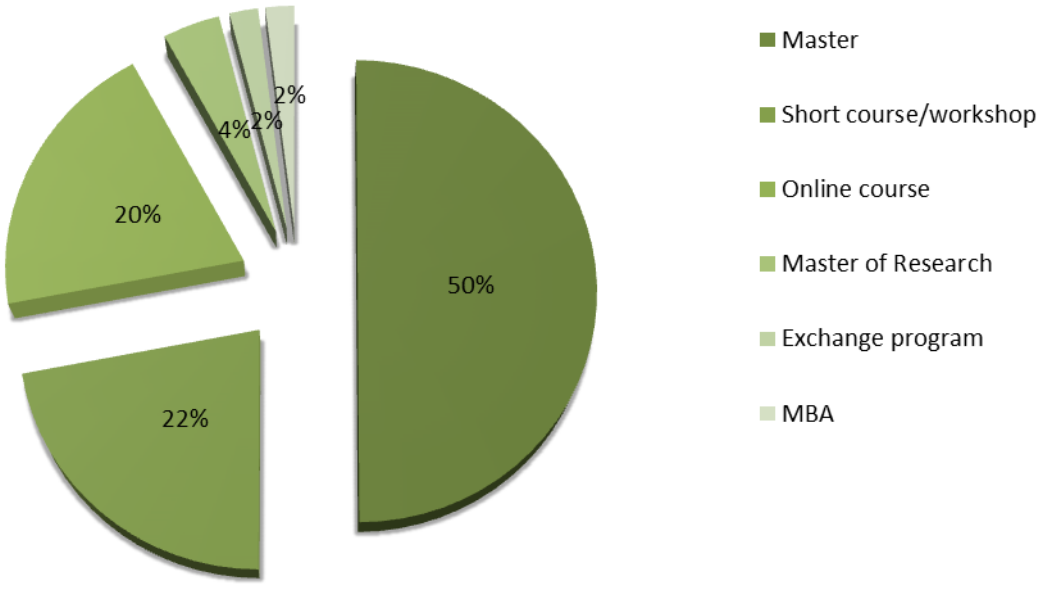


Figure 12. Academic levels of the courses – GLOBAL study

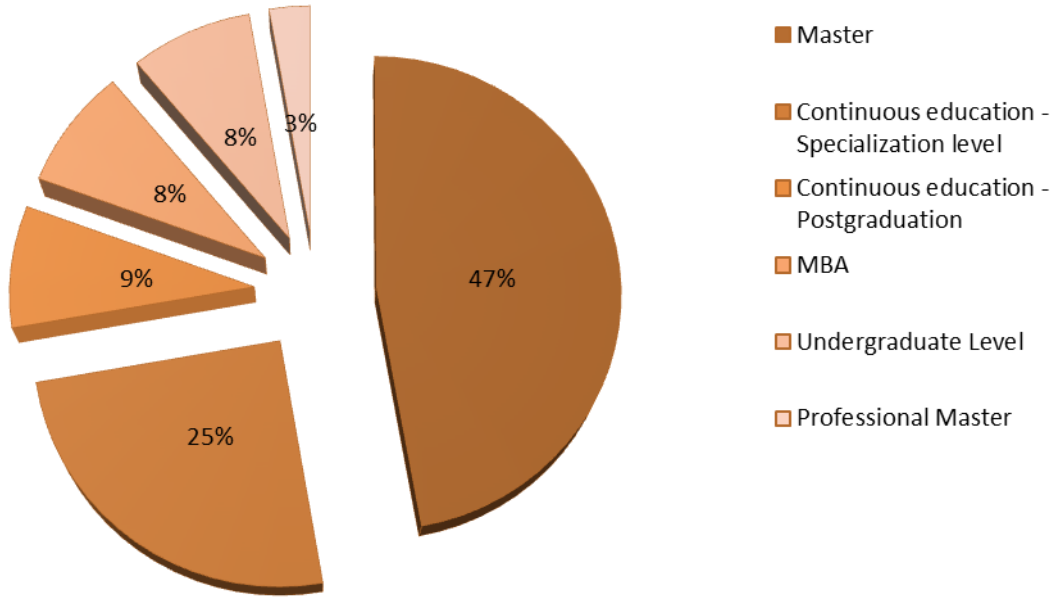
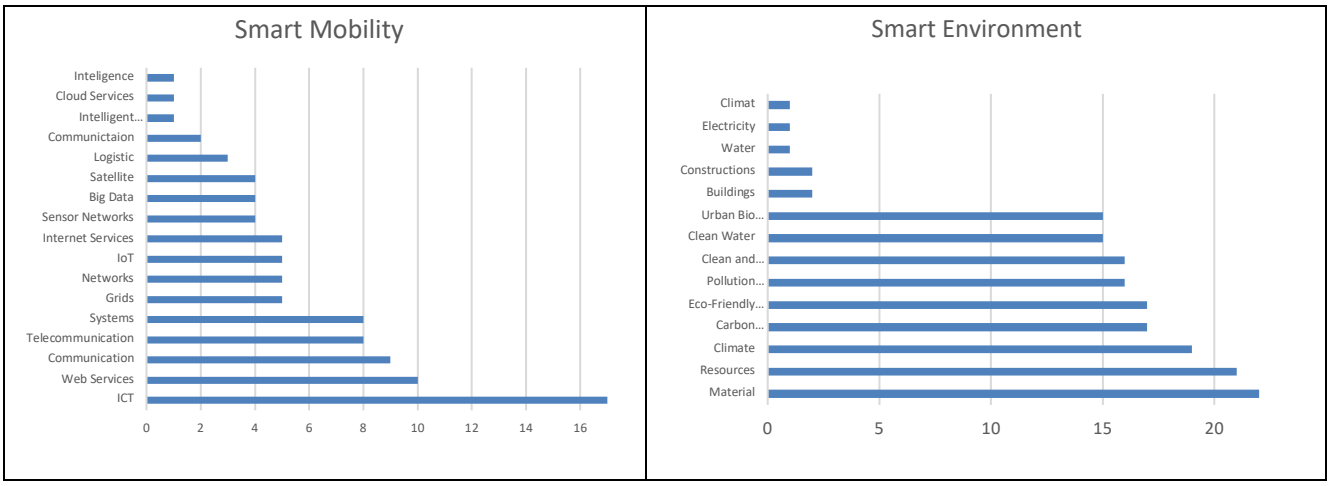


Figure 13. Academic levels of the courses – AMERICA study

These two classifications do not entirely correspond to each other. However, some common observations can be made. First, in both cases, there is apparent domination, up to a half, of Master-level courses. Also, it should be noted that there is a strong representation of "ad hoc" courses, understood as additional training for those who have already achieved some educational background and are likely to be active in professional life – continuous education, workshop, online courses, etc. The representation of MBA courses is rather modest in both studies.

Considering the declared areas of topics within the courses examined in GLOBAL, the study's authors examined how various dimensions of smartness, such as smart mobility, were covered in terms of the correspondence between the courses and sub-dimensions of smartness, such as ICT. This distribution is depicted in Figure 13.



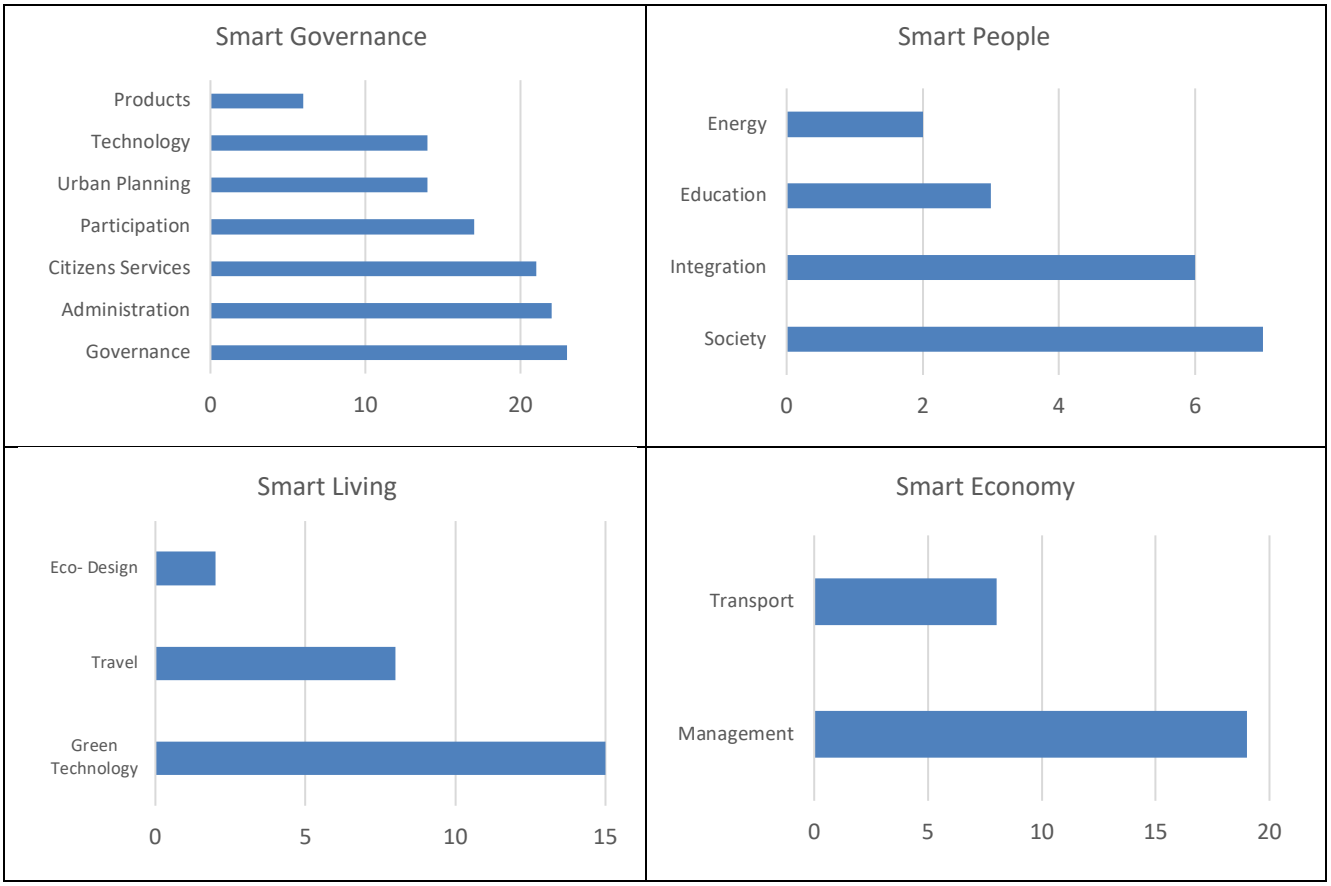


Figure 14. GLOBAL – dimensions and sub-dimensions of smartness in relation to the number of courses (based on Figure 13, Deliverable D1.2)

It can be noticed that in the case of Smart Mobility, there is significant domination of ICT. In the case of Smart Environment, there is a relatively equal distribution, with the dominating position of Material and Resources. However, the representation of a few sub-dimensions is rather vestigial. In the case of Smart Governance, Governance, Administration, and Citizen Services are the most popular sub-dimensions. The Smart People dimension is mostly covering Society and Integration topics. Smart Living is dominated by Green Technology and Smart Economy by Management. Among all dimensions, the high popularity of Governance, Administration, Citizen Services, Material, or Resources should be noted.

A more general insight into thematic areas of the courses is included in AMERICA. The programs of the courses were first grouped into so-called areas of knowledge, which are “quite extensive and somewhat generalist” as the authors admit. The distribution of assignments, possibly multiple per program, is depicted in Figure 14.

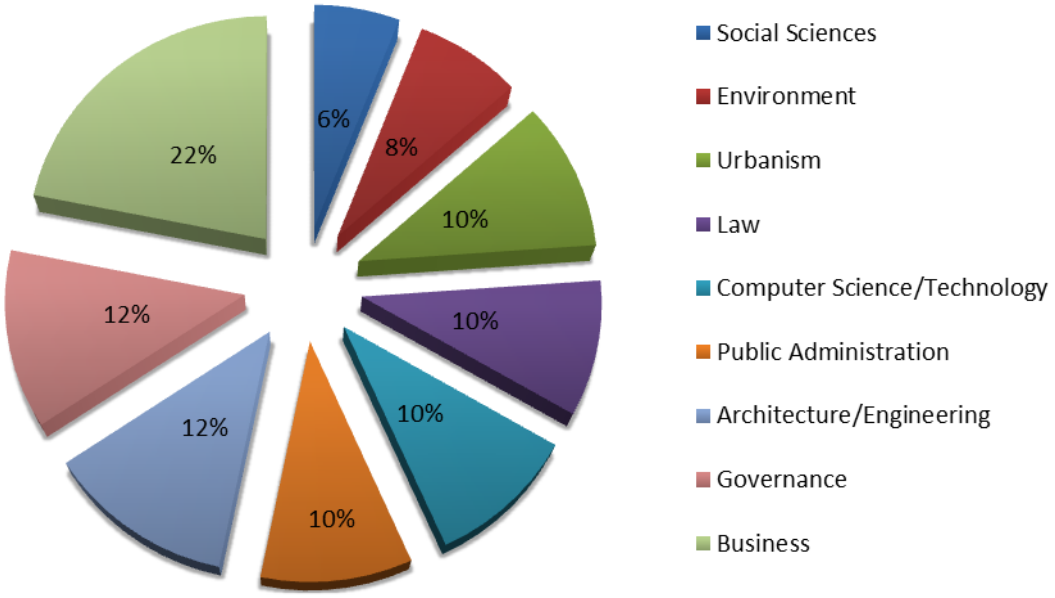


Figure 15. AMERICA – knowledge areas with the percentage of the assignments

Business is the most represented area of knowledge, with 22% of the assignments. Architecture/Engineering is the knowledge area in 12% of the assignments. It is somehow interesting compared to the earlier classification, where 50% of the courses were found belonging to the "Engineering" category.

In a more detailed analysis of the curricula of the courses, the subjects taught within them were assigned to certain "subject areas". The distribution is depicted in Figure 15.

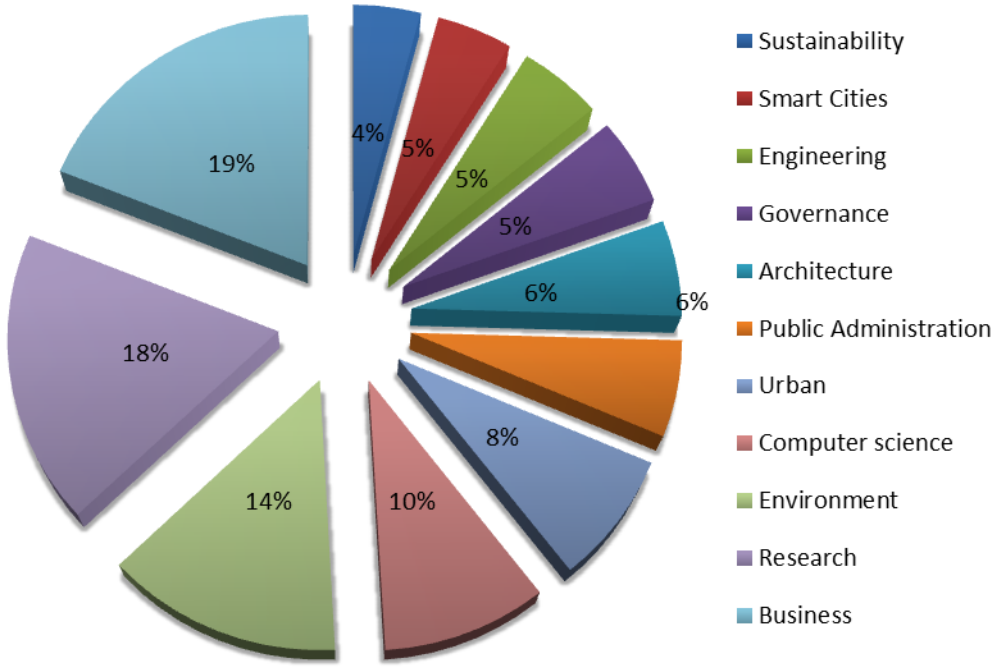


Figure 16. AMERICA – areas of knowledge with a percentage of the assignments

Business and research are the areas dominating here with 19% and 18% assignments respectively. It should be noted that subjects that can be fairly assigned to “Sustainability” and “Smart Cities” areas are at the bottom of this list with 4% and 5% respectively. Also, it is confirmed that despite the Engineering-dominated primary categorization of the courses, engineering subjects are poorly represented. One can loosely conclude that business is such demanding human activity that it requires the biggest number of subjects devoted to, regardless of a course’s profile.

The above can be confirmed by the AMERICA’s authors themselves, who admit that (Deliverable 1.3):

> *Regarding the curriculum of the programs, there is a broader scope in the business-oriented subjects (economy, administration, management and planning) and those related to the course itself, related to the scientific methodology and other actions required by the course (workshop, field visits, graduation work, among others). With the theme of global warming and territoriality, the disciplines that focus on the environment are relatively well covered by the sample. The activities that have the title or direct relationship with Smart Cities and Sustainability are proportionally smaller than those of business and the environment, leaving space to foster these areas.*

Within CAP4CITY project, we definitely intend to foster these areas.

Speaking of the actual competencies that the potential students are expected to acquire, authors of GLOBAL managed to count and list them, as is depicted in Figure x. Here it is also noticed that such a list is actually a compatible extension of the list of soft skills occurring in SSC vacancy announcements.

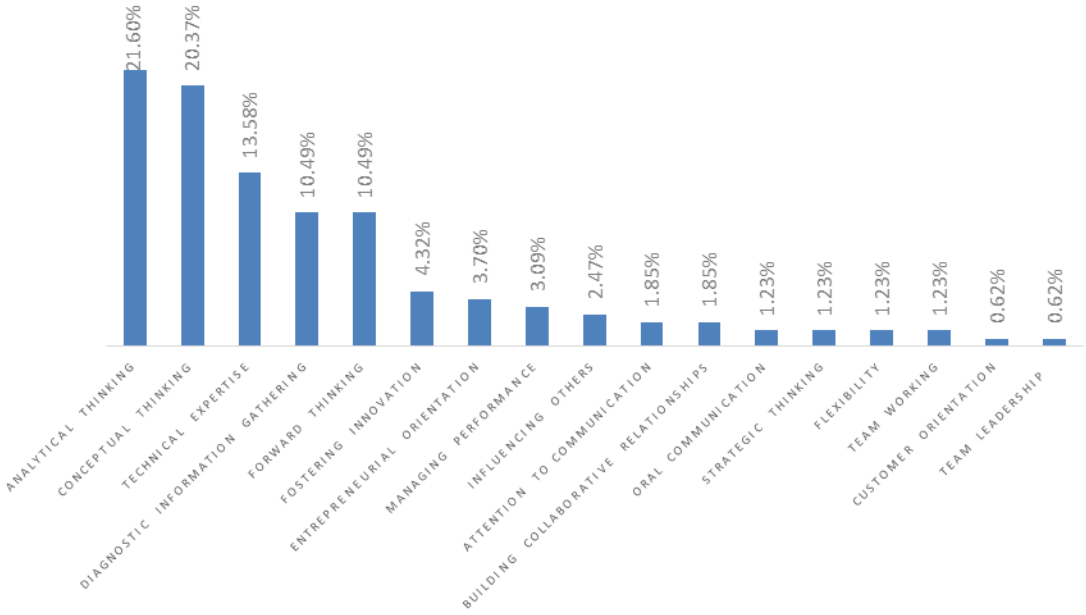


Figure 17. GLOBAL – most popular competencies achieved with the SSC courses (Figure 16, D1.2)

Analytical and conceptual thinking are the most popular competencies. Their high position can be regarded as positive since, without thinking, it is very hard to be smart. We can also see that the course alumni can achieve technical expertise and diagnostic information gathering. On the other side, it is likely that they will have to learn on their own how to be a team leader or how to be oriented at customers. As depicted in Table 13, the essential elements of skills and knowledge have been mapped to the programs representing each of the four main categories of the GLOBAL study’s courses.

Table 13. GLOBAL – Competencies built through the SSC training (Table 15, D1.2)

Knowledge and skills	Program groups

	Sustainability group	Smartness group	Specific smartness and sustainability group	Data science in smart sustainable cities group
Skills	Realizing the co-creation sociotechnical policy contexts	Entrepreneurial and executive management skills	Discovering of the collected geospatial data	Assess the quality of urban planning
	Design processes within the built environment	An open analytical and problem-solving mind	Predictive analysis and big data tools	Reduce cybersecurity challenges
	Enabling strategic feasibility design	Ability to communicate with technical and non-technical audiences	Aim at discovering new possibilities	Improve the liveability and governance of cities
	Builds the newest entrepreneurship thinking	Ability to gather new insights independently	Develop and implement the behaviour control algorithms	Learn online
	Combine theoretical and practical research	Ability to present ideas and innovative solutions	Applying the smart technology-driven framework of the internet of things	Solve the issues surrounding urban environment
	Realize the comparison of different real-life cases	Ability to analyse the urban theory	Develop the model of complex system behaviours	Be aware of smart automation products
Knowledge	Advanced understanding of key sustainability issues	Deep knowledge of operational design	Approaches focus on complex AI systems	Understand of the citizen design concept
	Understanding the key issues related to sustainable development	Deep knowledge of electrical energy	Knowledge of new the algorithms which will implement the research outcomes	Understand the internet of things
	Understanding the related key sustainability issues	Insights into ethical and social-economic problems	Analytics of health	Understand the role and importance of data
	Ability to understand the sustainable and economically balanced city	The wider understanding of the socioeconomic context	Analytics of new media	Understand various industrial stages

On the other side, the more general view is presented in AMERICA, where the so-called learning goals of the courses are aggregated into Bloom's Taxonomy Cognitive Objectives and summarized, see Figure 17.

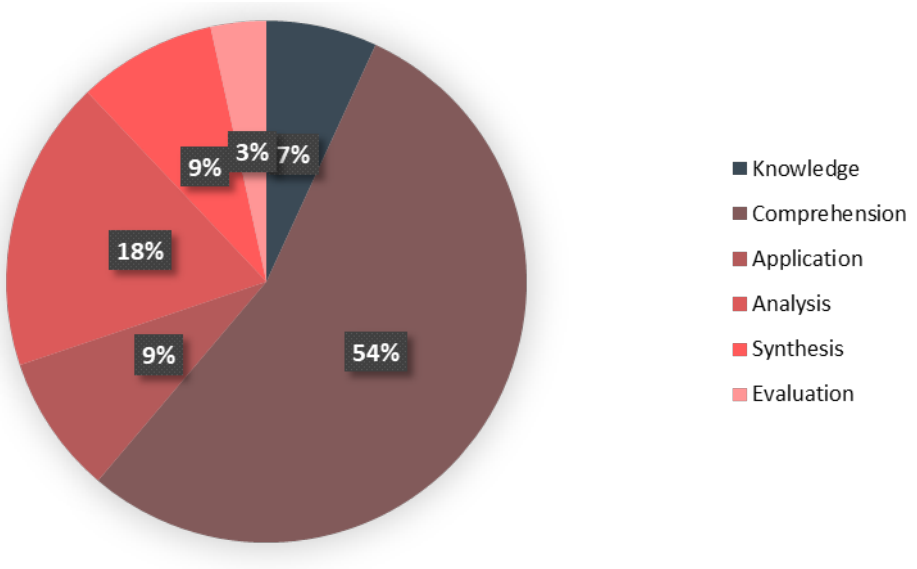


Figure 18. GLOBAL – most popular competencies to achieve with the SSC courses (Figure 16, D1.2)

Here it is clear that comprehension is the main learning goal to achieve. One can observe a clear parallel with the competency of thinking – the latter is usually mandatory for comprehension. The course participants will also learn how to analyse things, and to a much lesser extent, how to evaluate them.

The alumni of SSC courses are expected to play some roles in the SSC initiatives. Such roles can be individual, collective, intra-organizational, or inter-organizational. GLOBAL study analyses the courses considering such classification of roles. Table 14 depicts such analysis taken for dimensions of sustainability.

Table 14. Numbers of courses preparing for different roles in different dimensions of sustainability

Dimensions of sustainability	Roles			
	Individual	Collective	Intra-organizational	Inter-organizational
Environmental	34	11	18	7
Social	25	12	8	7
Economic	18	10	10	9
Institutional	10	8	5	3

It can be noted that most represented roles are the individual ones and the least represented – inter-organizational ones. In general, it is likely that a course will educate a future individual employee in the environmental or social dimension. Those who want to play inter-organizational roles within the institutional dimension of sustainability may have some problem with finding the right training offer. In Table 15, a similar analysis is performed for dimensions of smartness.

Table 15. Numbers of courses preparing for different roles in different dimensions of smartness

Dimensions of smartness	Roles			
	Individual	Collective	Intra-organizational	Inter-organizational
Smart Environment	34	12	18	7
Smart Mobility	22	7	10	3
Smart Economy	13	10	6	7

Smart Governance	11	8	7	4
Smart People	5	3	0	4
Smart Living	2	1	0	1

Here the situation is rather similar. The dominating profile is the one preparing to individual roles within Smart Environment and Smart Mobility. Once again, inter-organizational roles are poorly served by the courses' curricula. It should be noted that the "Living" dimension of smartness is almost not covered within the educational programs.

3.3.4 Smart Sustainable City Education – Summary

SSC educational programs are indeed a very broad and interesting topic. For those particularly interested in further exploration, we can recommend careful reading of the deliverables listed above. Below, some of the main conclusions, as delivered by their authors.

- All analysed educational programs in SSCs develop competencies that respond to the demand for knowledge, skills and attitudes expressed in the corresponding vacancy announcements (GLOBAL).
- Three significant gaps were identified between the demand and supply of the relevant educational programs (GLOBAL): most programs do not declare in their titles and content the presence of sustainability and smartness focus, few programs exist that allow data science specialists to build competencies clearly aimed at the smart sustainable cities domain, and while individual roles are most often developed by the education programs, intra-organizational roles are equally in demand by employers. Thus the latter require more attention when developing new and updating existing education programs.
- There is a lot of room for improvement of the content presented by the programs (AMERICA).
- There is a major deficiency in achieving and promoting the competencies and skills required for the study and training of critical and competent SSC graduates (AMERICA).
- The training programs should focus on more interdisciplinary subjects in order to reach the level of knowledge and the specific competencies of SSC (AMERICA).

3.4 Smart Sustainable City – Courses and Training Modules

Given the conclusions of the previous subsection, it is understandable that there is still a wide space for improvement in the domain of SSC-oriented education. In this section, we preview the resources prepared by the CAP4CITY project, carefully designed to satisfy the identified SSC competency building needs. The course catalogue can be found within the T2.3 module of the project.

To emphasize the interdisciplinary nature of SSC field, the competencies and areas were mapped into a variety of disciplines that would form a SSS-related curriculum. Therefore, the developed courses belong to one of the following thematic areas, which are strongly represented by the expertise among the CAP4CITY partners:

- Business and economics
- Communication
- Governance
- Information systems
- Legal and Ethical implications of SSC
- Public Administration/Management
- Social Science
- Socio-technical ICT
- Urban Studies and Sustainability

The structure above can be directly related to the SSC Roadmap, described earlier within this section. It identifies the following dimensions of SSCs: social, economic, environmental, governance and urban infrastructure. Then, course areas such as Social Science or Socio-Technical ICT can be associated with the social dimension, Business and Economics, Public Administration/Management – with economic dimension, etc. The portfolio was designed with the implementation of the Roadmap-elaborated concepts in mind. This categorization is also in line with the findings of studies on the educational program, also introduced within this section, e.g. with dimensions of sustainability, dimensions of smartness, or areas of the SSC knowledge. The following sections elaborate on the CAP4CITY course portfolio. Each course belongs to one of the defined thematic areas. The courses are prepared and supplied by one of the CAP4CITY partners.

3.4.1 Area 1 – Business and economics

Economic sustainability principles is a course developed by the University Externado de Colombia. The course teaches students how to understand the principles of Economic Sustainability, how to align such principles with the new urban agenda and sustainable development, and how to integrate them into the economic agenda of a city. As a result, they are expected to be able to formulate business models oriented towards the fourth industrial revolution and apply the principles of Economic Sustainability within the framework of SSC initiatives.

Innovation for urban transformation is a course developed by the Tallinn Technological University. Students attending this course will understand the global dimension of innovation, promote innovation thinking, learn how to develop innovation labs and incubators, plan and promote innovations, etc. Innovation will be discussed at the national, sectoral or technological levels, with social innovation regarded as a driver of urban transformation.

3.4.2 Area 2 – Communication

Communication and Social Network Interaction is a course developed by Universidad Nacional del Sur. The course delivers soft skills such as communication (including effective use of social networks in the successful promotion of SSCs), personal development, negotiation, leadership, and marketing. The students will also learn strengthened communication skills targeting right audiences and purposes, use of marketing tools to improve SSC citizens' quality of life, etc.

3.4.3 Area 3 – Governance

E-democracy and e-participation is a course developed by Universidad Católica del Norte. It is designed to equip its students with competencies such as understanding what it means to be a citizen in society, being familiar with the concepts of e-participation and e-democracy, knowledge of tools and projects oriented towards citizen engagement, etc. One of the lead topics is the problem of digital inclusion, which is essential in building a healthy SSC community.

Evidence-based and Collaborative Governance is a course developed by Pontificia Universidade Catolica of Rio Grande do Sul. The course aims for students to "understand the complex relations involved in governance-related subjects in order to establish evidence-based and multi-stakeholders decision-making governance processes" through topics such as governance, public governance, collaborative governance, decision-making processes, etc.

Smart City Governance is a course developed by Danube University Krems. It is focused on governance within SSC, thus meant to develop competences within the "Smart Governance" dimension by introducing concepts such as SSC governance frameworks and mechanisms, governance in municipal operations centres, etc. The students are expected to achieve skills in dealing with SSC stakeholders, territorial actors, establishing strategic partnerships, etc.

User-driven service design and co-creation is a course developed by the National University of La Plata. It develops the skills of service design, e.g. delivery, channels and strategies for public service delivery, and program design, e.g. human-computer interaction and design of interfaces. Students will learn how to "analyse diverse information about SSC" and "make decisions about different methodologies for designing SSC services". The emphasis is also on co-creating public value with citizens, understanding the needs of vulnerable groups, and improving the urban space and welfare of citizens.

3.4.4 Area 4 – Information systems

Information Management is a course developed by Universidad Nacional del Sur. It is designed for students to understand the concepts of data, information and knowledge and their value in organizations. Information is an essential asset in smart organizations, so the managerial and methodological issues within this domain are carefully addressed, including problems of information governance, operations, security and quality. Also, new and emerging technologies such as Data Warehousing, Big Data or Business Intelligence shall be discussed and analysed.

Information systems for decision-support is a course developed by Danube University Krems. The course builds various competences concerning the development of intelligent systems, application and assessment of tools for information systems, application of GIS, etc. As the area is extensive, the authors plan to "give a sense of the range of topics associated with Systems Theory and Information Systems and how this field has expanded over the past half-century".

3.4.5 Area 5 – Legal and Ethical Implications of SSC

Cybersecurity, privacy and ethical implications is a course developed by Escuela Colombiana de Ingeniería Julio Garavito. The students on this course will learn about ethical, privacy and cybersecurity implications in development and deployment of SSC solutions. They will be able to identify threats and vulnerabilities and propose mitigation and prevention solutions. Some of the topics covered include information ethics, design of digital services for SSC, cybersecurity environment, infrastructure and technical solutions, etc.

Legal competences for SSC is a course developed by Externado de Colombia University. The course is oriented towards legal and juridical aspects of SSC development. Its lead topic is "understanding the environmental, social and economic dynamics of the territories and cities… in regard to the UN's Sustainable Development Goals and the New Urban Agenda". Among competencies taught are juridical aspects of technology contracts in SSCs, legal and contractual mechanism for SSCs, citizens privacy protection, regulatory and contractual frameworks, etc.

3.4.6 Area 6 – Public Administration/Management

Local-level organizational structures and processes is a course developed by the Gdańsk University of Technology. The course will equip the students with competencies such as: conducting local level restructuring of smart cities, rethinking and reformulating local organization, simplification of procedures, etc. The course is centred on the topics of organizational management in SSC, organizational restructuring, legal management and business processes in SSC, etc.

Management and strategies for urban transformation is a course developed by the Gdańsk University of Technology. The course is about strategic management and problem solving essential for SSC decision-makers. It will teach students how to diagnose problems and select the right methods of their description, how to prepare a long-term vision and mission, how to choose and prioritize projects in the strategic plan, how to manage the digital change in the urban environment, etc. Essential skills include problem-solving, strategic thinking, analytical thinking, and strategic planning.

Methods and tools for city management is a course developed by Pontificia Universidade Catolica of Rio Grande do Sul. The course aims at presenting innovative methods to be applied in the management of SSCs. Students will learn how to identify problems and use tools to find innovative solutions-oriented on improving city management. The topics include dimensions and areas of SSC management, Design Thinking, Lean Thinking, Agile, technologies for city management, etc.

Monitoring and assessment of SSC solutions is a course developed by the Tallinn Technological University. The course is about monitoring and assessment in the SSC context. Students shall acquire the knowledge of methodologies, frameworks, tools, indicators and practical issues involved in the assessment of SSCs.

SSC-related project management is a course developed by Technical University Federico Santa María. The course teaches students how to formulate multidisciplinary strategies and solutions in SSCs, how to evaluate SSC performance, integrate and coordinate interdisciplinary teams, etc. It is centred on the issues of project management, project planning, and coordinating projects in public administration.

SSC-related Project Planning is a course developed by the Tallinn Technological University. Students attending this course will learn project management, planning approaches, budget planning and management, data-driven planning, etc. The teaching will consider the specificity of the local context for carrying out SSC initiatives.

3.4.7 Area 7 – Social Science

Smart City applications is a course developed by the National University of La Plata. The course will develop several competencies including the ability to analyse different smart city-related problems, e.g. transport or waste management, designing mobile services, understanding mobile applications, analysing actual solutions for SSCs, making decisions about adding intelligence to mobile applications, etc. In general, the course will raise the issues of software systems for SSCs, with emphasis on mobile devices and applications.

Smart City: Context, Policy and Government is a course developed by the Gdańsk University of Technology. The course introduces foundational issues for SSCs, analysed in the historical, legal, managerial and even psychological context. Problems such as SSC history, data, funds, trends, actors and their roles, management, as well as some fundamental decisions, e.g. whether to build an SSC at all and what role technology should play, will be covered.

Introduction to Smart Sustainable Cities is a course developed by Universidad Nacional del Sur. The course examines the contribution of SSCs to the United Nations' Sustainable Development Goals. The courses tackle opportunities and challenges for urban growth and ways to build and manage inclusive and resilient smart sustainable cities.

3.4.8 Area 8 – Socio-Technical ICT

Data-Driven Management and Analytics (DDMA) with Smart Sustainable City (SSC) context is a course developed by the Technological University of Delft. The course introduces the data-driven approach to handling SSCs. The course is centred on applying DDMA projects in the SSC context, including scoping, methodologies, metrics, assessment and tools.

Digital and Urban Infrastructure is a course developed by Escuela Colombiana de Ingeniería Julio Garavito. The course prepares students to understand the theory, the current state, and issues associated with urban infrastructure planning. These issues are discussed in the context of accelerating urbanization processes, including "how to plan in order to address the unforeseeable problems that cities will face".

Disruptive Technologies in Smart Sustainable Cities is a course developed by Danube University Krems. The course presents and discusses modern technological solutions that significantly alter the way people (and cities) operate. Thus, the program is centred on the issue of emerging technologies and their potential users. Technologies and technological phenomena such as the Internet of Things, Blockchain, Virtual Reality, Machine Learning, etc. will be examined along with reference to building and functioning of SSC initiatives.

IT Development is a course developed by the Technical University Federico Santa María. The course deals with ICT aspects of SSCs while merging technical issues with human orientation, i.e. social computing. The students attending this course will learn the basics of software development, sociotechnical ICT levels, IT development methodologies such as waterfall or agile, and IT model prototyping for SSCs.

IT Governance and Management is a course developed by Universidad Católica del Norte. The courses will familiarize its students with the issues related to the implementation of IT in government environments. SSC-connected issues covered include IT in delivering public value, adoption of technology, knowledge management, IT governance and society, etc.

Open Government within Smart Sustainable Cities (SSC) Context is a course developed by the Technological University of Delft. The courses apply the concept of Open Government in the SSC context. Various aspects of Open Government will be analysed, e.g. the key characteristics, benefits, challenges, legal factors, privacy, design principles, prototyping, etc.

3.4.9 Area 9 – Urban Studies and Sustainability

Environmental Sustainability is a course developed by Faculdade Meridional. The course will teach students how to understand and assess various issues of climate, biodiversity and energy. The authors will map these problems to the context of SSCs, e.g. explaining bioclimatic-urban territory relationships.

Social Sustainability is a course developed by Pontificia Universidade Catolica of Rio Grande do Sul. The course will present and discuss various issues related to social sustainability, e.g. corporate social responsibility, social entrepreneurship, social enterprise, etc. Among the competencies developed, considered essential to the SSC context, is "Responsibility to realize your role as a citizen".

Technical Sustainability is a course developed by Faculdade Meridional. While sustainability is the multidimensional concept, the course deals with technical sustainability. The students will "gain a comprehensive view of designing the technical sustainability in terms of its environmental and social quality, resources, emissions and other aspects as part of the lifecycle". Among the topics covered are the impact of buildings (energy, water, materials, site, biodiversity, etc.), assessment methods, sustainable building strategies, etc.

Urban Planning is a course developed by Faculdade Meridional. The course will familiarize its students with the issues of rational, sustainable and citizen-engaging urban development. Among others, issues such as key concepts of planning, indicators, impact on the quality of life, adaptation to the local context, etc. will be introduced. Also, various specialized topics, e.g. street planning, green corridors, promoting walking and cycling, will be presented as well.

3.4.10 Summary

The portfolio of CAP4CITY courses and training modules is rich and, unlike most educational programs discussed earlier, directly focused on developing competencies that are required for future SSC professionals. It seeks to cover the broad spectrum of SSC-related domains, from fundamental, such as philosophical rationales behind making the cities smarter and more sustainable, to strictly technical ones, such as adapting highly specialized pieces of knowledge, such as data-driven projects to the SSC context. While the future SSC professionals are likely to occupy positions associated with various dimensions of smartness and sustainability and will play various associated roles, from individual to intra-organizational, we believe that such a versatile grasp of topics can bring tangible benefits to students.

4. LEARNING MATERIALS – DEVELOPMENT

The aim of this section is to provide some resources and guidelines for developing new courses that can help build competencies for planning, implementing and managing Smart Sustainable Cities. In successive sections, the content covers the course development process (Section 4.1), competencies needed for planning, implementing and managing SSCs (Section 4.2), how to define learning objectives for SSC courses (Section 4.3), what is the target audience for such courses (Section 4.4), what pedagogical approaches can be used (Section 4.5), and how to design SSC course curricula including decisions on the timeline, scope and sequencing of topics (Section 4.6).

4.1 Course Development Process

This section aims to outline the process and structures used in developing a new course on Smart Sustainable Cities. In particular, the development applies the CAP4CITY project deliverables.

The overall process of a new course development consists of ten steps. Step 1 aims to develop the substantive content of the course, comprising the development of learning objectives, content, sequencing, sourcing and others. Next, the pedagogical methods for the course delivery are defined in step 2, followed by materials production in step 3. The course is then tested in step 4 and assessed in step 5, followed by the revision and implementation on the platform in step 6. The course is then delivered on this platform, including the attainment of the course objectives in step 7. After completion, the course is assessed in step 8. The assessment provides necessary inputs into required modifications to the course objectives, content, method and delivery in step 9 followed, again, by testing and reimplementation of the platform. The course is finalized with the final course assessment in step 10.

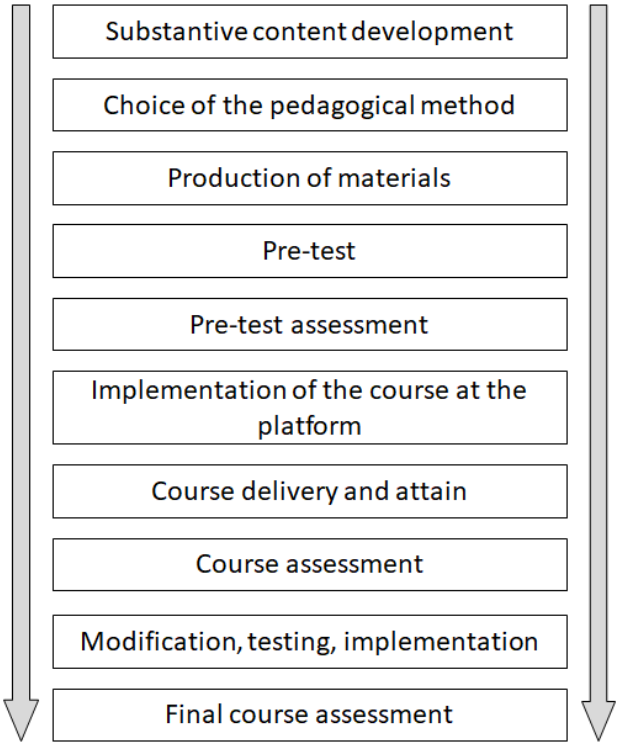


Figure 19. Development steps of the Smart Sustainable City course

The most important document to serve as output from the course development process is the course card. The card, presented in Table 16, comprises the following elements:

- the overall information about the course within the university study program,
- detailed course description to the learners,
- learning outcomes concerning knowledge, competencies, and skills developed during the course,
- consistency with an educational program in the field of study,
- overview of the student's effort measured by the working hours,
- pre-requisites – competencies requested from the learners upon entry,
- the passing and failing criteria,
- the recommended and supplementary literature,
- tools and resources,
- the costs associated with the course (software licenses, certificates, outdoor classes, etc.),
- communication methods, and
- some examples of the assignments and tasks performed during the course.

Table 16. The template of the course card

Course name			Course code			
Field of study						
Date of commencement of studies			Academic year of course realisation			
Education level			Subject group			
Mode of study			Mode of delivery			
Year of study			Language of instructions			
Semester of study			Assessment form			
Learning profile						
Unit responsible for the course	Department of ...					
Lecturer(s)	Course supervisor					
	Teachers/ Instructors					
Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	Total
Number of study hours						
Number of e-learning hours						
Learning activity	Contact hours in class		Contact hours at consultations		Self-study	Total
Number of study hours						
Course objectives	• ... • ...					
Learning outcomes	Course outcome		Learning outcome		Verification method	
	Knowledge: Competency: Skills:					
Course curriculum	Lecture_1 Lecture_2 ...					
Pre-requisites and co-requisites						
Assessment methods and criteria	Subject passing criteria		Passing threshold		Percentage of the final grade	
	Written colloquium Laboratory Project ...					
Recommended reading	Basic literature					
	Supplementary literature					
	Link to e-resources					
Example issues / example questions / tasks being completed						
Work placement						

To correctly address the objectives and learning outcomes of the courses, the teachers can use the database of the SSC-related education programs. This database is a useful benchmarking tool that can support teachers in developing course content. Every element of the course card can be revised using the database.

4.2 Competencies

The competencies are organized into three layers. The top layer is high-level goals, understood as the preferred research and educational practices by the host university. Beneath them are the learning objectives which determine specific competencies acquired during courses. Finally, learning activities represent individual course elements.

The CAP4CITY project provides a wide range of competencies identified in various project deliverables. First, the literature review and the extensive vacancy review identified multiple roles for SSC-related competencies. This review was followed

by a review of existing educational programs. The results were catalogued within two databases – the database of SSC-related education programs and the database of SSC-related education content. Next, the competencies developed by the educational programs conducted by each partner university in multiple fields of studies were identified during the workshop sessions. Example results of the workshops are present in Table 17 and Table 18.

Table 17. Example competencies developed through the workshops in Chile and Colombia (Estevez et al. 2019)

University	Field of study	Competencies Workshop #1
UNIVERSIDAD EXTERNADO DE COLUMBIA	Planning	Apply data science for public policies Plan with awareness about the local context Adjust the gap between citizen's need or problem and the perception that the State has about that same need or problem (..)
	Legal framework	Know the legal and regulatory frameworks for SSC Understand the impact of new legal instruments that support changes to promote SSC initiatives. (..)
	Innovation	Know new and different methodologies for designing SSC services. Adapt innovations to a specific context (..)
	Technology	Apply data science to guide the formulation of public policies Develop cybersecurity services to promote community trust in digital services
UNIVERSIDAD CATÓLICA DEL NORTE	Urban and Territorial Development	Understand climate change Use geographic information systems Understand sustainable urban planning
	Laws and regulations	Know the institutions and current legislation Understand e-government regulations Understand national and international funding initiatives Understand patent regulations Analyze current Chilean legislation on data use
	Entrepreneurship and innovation	Understand innovation as a globality Design and development of prototypes associated with city challenges Manage innovation Plan the innovation Design CANVAS models Know the basics of startups Apply Scrum methodologies.

Table 18. Competencies identified during the workshop in Brazil (Estevez et al. 2019)

Ability to establish strategic partnerships
Act proactively
Apply tactical urbanism
Build interdisciplinary solutions

Collect and analyze data for incremental or disruptive innovation
Define methods, objectives and guidelines
Design education strategies for citizenship and environmental and social awareness
Develop the ability to deal with people
Develop and apply instrument analysis to better understand territories
Develop convergence among different levels of government and social actors
Develop creativity skills
Develop empathy skills
Develop leadership and influence skills
Develop local talents
Develop long term planning
Develop negotiating skills
Develop planning and management skills
Develop problem-solving skills
Develop project planning and management skills
Develop representativeness and protagonism
Develop resilience and awareness behind distinct political and economic scenarios
Develop risk planning and risk management skills
Develop self-management skills
Develop social control mechanisms
Develop the ability to plan and execute digital inclusion strategies
Enhance innovation capacity for environmental and social development
Establish assertive communication among actors
Establish collaboration mechanisms
Establish governance mechanisms
Establish guidelines based on SDGs
Establish mechanisms for openness and participation
Foster, raise and manage financial resources
Identify and analyze society's demands and specificities
Improve ecosystem thinking
Improve governance actions
Improve innovation capacity for social development
Improve public resources management
Insert ICTs in management processes
Integrate technical-social-political aspects in decision-making processes
Lead and work with multidisciplinary teams
Observe contextual adequacy of solutions
Promote environmental and social awareness
Simplify communication of outcomes

Understand emerging technologies and their potential uses
Understand legal and normative aspects for public policy development
Understand the applicability of IT solutions
Understanding and better use of public spaces
Use big data to support decision making

The competencies identified within the workshops conducted in partner countries are summarized and presented in Appendix E. These competencies become the basis for the course card and the learning objectives development. The competencies and skills developed by the courses are the basic sources of their learning outcomes. The learning outcomes, defined for particular courses, should be formulated through affirmative statements and should include the outcomes in terms of knowledge, skills and attitudes (i.e. competencies).

Within the CAP4CITY project, the roadmap was developed to help identify the necessary competencies, to be delivered through the courses, for planning, implementing and managing SSCs. The identified phases and steps suggested by the SSC roadmap were mapped to the potential competencies needed to perform each step.

In sum, the SSC roadmap can help with the definition of skills, knowledge, and attitudes, needed for the administrative workforce, professionals and the general population for each step of SSC development, i.e. analysing the context, planning actions, maintaining and monitoring initiatives, etc. Table 19 below presents the competencies identified for each phase of the SSC roadmap. The full list of competencies defined within the roadmap is presented in Appendix E.

Table 19. Example competencies for different phases of the roadmap (Azambuja and Pereira 2019)

Step	Description	Competencies	Training Needs / Pedagogical Approach
Planning			
Planning Capacities	• Defining who to be involved, reviewing who is to be involved • Definition of roles and responsibilities (internal and external) • Champion (leader) definition to promote the SSC initiatives, check performance, ensure communication and motivate stakeholders	• Analytical thinking • Building collaborative relationships • Decisiveness • Developing others • Empowering others • Fostering teamwork • Frequent interaction with others • Human awareness • Influencing others • Leading others • Managing performance • Persuasive communication	• Stakeholders analysis • Canvas model • Design thinking
Managing Policies and Capacities, Engaging Citizens, Establishing Partnerships			
Engaging Citizens	• Create mechanisms to allow citizen participation and co-creation • Create a communication plan. • Make use of coordination mechanisms • Establish horizontal structures to foster collaboration	• Effective engagement • Stakeholder identification • Allow discussions	• Discussion • Workshops
Putting in Practice			
Creating SSC solutions, services and initiatives	• Initiatives for all city areas and basic community needs • Solutions for smart education, smart health, smart energy, smart water,	• Project Management Skills • Ability to solve interdisciplinary problems • Technological Knowledge	• Problem-based learning • Working in multidisciplinary

	smart waste management, smart mobility, smart buildings and constructions	• Urban Planning	and multicultural teams
Adopting the Solution and Creating Knowledge			
Planning improvements	• Feedback analysis and improvements planning	• Know the social, natural, economic, cultural and political situation of the city • Know local, regional, national problems • Analyse the territory in a holistic and systematic way • Develop planning and management skills plus the ecosystem thinking • Convergence among different government levels and social actors	• Case studies • Scenarios • Good practices, guidelines • Frameworks and standards
SSC Continuous Improvement (Monitoring)			
Ensuring stakeholder alignment with SSC goals	• Include internal and external stakeholders	• Know local, regional and national problems • Knowledge of the geography of the territory • Design new models of city participation • Develop convergence among different levels of government and social actors • Develop ecosystem thinking • Promote government-industry-academia alignment	• Prototyping • Roleplaying • Smart city cases • Field trip to communities • Problem-based learning

The full list of competencies defined within the workshops is presented in Appendix E.

As universities apply various methods of defining competencies, according to (Estevez et al. 2019), a framework for competency development should include the following elements:

- Identifying behaviours, habits, and problems linked to the local community. This could entail participation or even directly working with community actors.
- Recognizing the possibilities of different technologies for improving the quality of life of citizens and communities (not all instrumental technologies, but organizational and symbolic technologies that concern processes).
- Identifying the barriers and problems that these technologies can cause.
- Analysing case studies that describe the use of technologies and solutions in the local context.
- Planning strategies, procedures and policies that address ethical aspects of integration into everyday life.
- Apply planned solutions in different areas, for example, transportation, education, institutional transparency, environment, procedures, etc.
- Define legal and regulatory mechanisms to regulate the use of technologies.
- Define indicators or metrics that allow the evaluation of the implemented projects.

4.3 Learning Objectives

At the start of the learning objectives formulation, a teacher is recommended to answer a few fundamental questions regarding the outcomes of the courses such as:

- What is the goal of the course?

- What is the expected outcome?
- What will my students gain from this course?

By answering these questions, the teacher envisions what the outcome should be for students. This will determine what resources are needed for course development and why. The outcome approach helps the teacher meet the expected teaching outcomes and create content that is focused and shaped. The teacher can use the following questions to investigate the expected outcomes of the course:

- What are the students expected to do?
- What are the students expected to say?
- What are the students expected to perform?

The importance of learning objectives in planning, teaching and evaluating educational sessions is widely recognized. The objectives are the relevant parts of each program and course description. They can be referred to by different names, such as instructional objectives, educational objectives, performance objectives, and intended learning outcomes. Learning objectives are the expected, observed, teachable and learnable behaviour of the target audience. They are the intentional and expected results to be achieved by most of the course participants, a statement of what learners will exhibit by the end of each lesson, unit or course. The purpose of the learning objective is twofold. First, it provides the learners' perspective by explaining what the student will learn, what she should know, what should she focus on, and how does it apply to her personally? It orientates the student's concentration on important aspects, provides certainty of what they are learning and why they are learning particular content. Second, the learning objectives benefit from the teacher's effort to reassure the learners, stay focused on the learning path, and align instruction to the stated goals.

Learning objectives should be formulated on two levels: the lowest, determining the minimum level of achievement of the objectives, and the highest, indicating the full achievement of the intended results by the majority of the target audience (Ferguson 1998). The benefits of the learning objectives formulation are providing direction for planning learning opportunities, guidance for selecting appropriate teaching strategies and materials, and a reference point to the learning assessment. The definition of the learning objectives forces the educators to focus on substantive learning experiences and help establish the relevance of the information, content, and skill being taught.

The learning objective consists of specific components such as audience, behaviour, condition and degree (ABCDs) (Ferguson 1998). They describe the course participant:

- what they will learn,
- by when they will learn,
- to what degree they will learn,
- under which conditions they will learn,
- with what resources they will learn, and
- under what constraints they will learn.

Each objective must indicate the target audience and present behavioural verbs. The latter indicate learner actions and establish the objective's accomplishment. The example components of the learning objectives for an SSC course are presented in Figure 19. There are many formats of objective development. Usually, the objective development is stated after a preface "The student will…", "The student will be able to …", or provide a statement in behavioural terms.

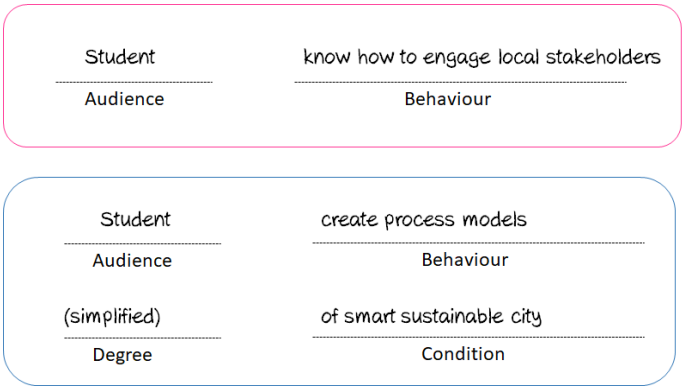


Figure 20. Components of the learning objectives of a Smart Sustainable City course

A learning objective can be broken into two parts, an observable action and a subject. Referring to the example above, "create" is an easily observable action and "student" is the subject. The subject is expected to develop the ability to create by the end of the course, the process models. Such a description explains what students will learn if they spend time and effort required by the course. The teacher should establish learning objectives for each lecture separately. See Table 22.

Table 20. Example learning objectives

By the end of the lecture, a student will be able to:
Explain the role of CIO in local level government
Identify responsibilities assigned to CIO's role in local level government
Choose the optimal place of CIO in the organization structure of local-level government

The behaviour element of the learning objective needs a verb that indicates learners' behaviour. These are understood as the observable, behavioural terms to assess learner's progress and achievements. The list of measurable verbs that indicate cognitive actions, helpful in formulating learning objectives are specified in Table 21.

Table 21. Linguistic model of the learning objectives (Ferguson 1998, Gronlund 1994)

Level	Verbs
COGNITIVE DOMAIN	
Knowledge	Define, describe, identify, label, list, name, state
Comprehension	Discuss, estimate, explain, give examples, identify, locate, paraphrase, report, restate, summarize
Application	Apply, change, compute, demonstrate, modify, operate, prepare, produce, relate, select, solve, use
Analysis	Analyse, arrange, break down, compare, differentiate, illustrate, infer, outline, relate, sort, select, categorize, criticize, detect
Synthesis	Arrange, categorize, combine, compile, compose, design, formulate, generate, modify, organize, plan, relate, reconstruct, revise, summarize
Evaluation	Appraise, assess, compare, conclude, contrast, criticize, debate, defend, evaluate, judge, justify, revise, score, summarize, support
PSYCHOMOTOR DOMAIN	
Perception	Attend to, choose, describe, detect, differentiate, identify, select, separate
Set	Copy, display, express, move, position, proceed, react, respond, show
Guided response	Apply, assemble, demonstrate, discriminate, dismantle, manipulate, operate, organize, simulate, solve
Mechanism	Apply, assemble, demonstrate, discriminate, dismantle, manipulate, operate, organize, simulate, salve, (done independently, without coaching or direction)
Complex response overt	Apply, assemble, demonstrate, discriminate, dismantle, manipulate, operate, organize, simulate, solve, examine, find, practice, reassemble, test

Adaptation	Adapt, alter, change, correct, create, design, modify, rearrange, reorganize, revise, shift, substitute, vary
Origination	Arrange, build, combine, create, design, originate, produce
AFFECTIVE DOMAIN	
Receiving	Accept, ask, attend, focus, follow, listen, observe
Responding	Agree, answer, comply, choose, comply, discuss, practice, present, select
Valuing	Ask, accept, choose, complete, defend, explain, follow, initiate, justify, select, share
Organization	Adhere, alter, arrange, choose, combine, commit, complete, defend, explain, integrate, modify, relate, resolve
Characterization	Act, adhere, commit, continue, discriminate, defend, display, endure, explain, influence, modify, perform, practice, use

According to Gronlund (1994), general learning objectives need to be followed by specific learning outcomes that clearly define performance expectations in the attained objective, for example:

- General objective:
  - Understand organizational restructuring of the SSC
- Specific objectives:
  - Know organizational processes
  - Design the organization structure of an SSC
  - Describe the ICT-driven organizational change in local government

While course descriptions look much like learning objectives, they are not the same. The difference is that the course descriptions' statement is broad. It provides a general sense of the course content but not specific skills or knowledge the student will gain. Figure 20 presents an example SSC course description.

This course, Smart City Governance, is designed for learners with little or no background smart city governance. It provides an introductory examination of strategies that benefit all community stakeholders, stakeholders management, strategic partnership establishing and maintenance. Our goal is to understand the governance mechanisms of the smart sustainable city.

Figure 21. Example description of the Smart Sustainable City course

There are many theories in educational training. This research comes from different fields of study such as educational psychology, philosophy and design. No matter which approach is used, the values of learning objectives remain consistent. Two most common reference frameworks used when discussing learning objectives are Bloom's taxonomy (Bloom and Krathwohl 1956) and Kirkpatrick's levels of evaluation (D. L. Kirkpatrick 1994; D. Kirkpatrick 1996). Bloom's taxonomy is the framework that classifies the learning objectives into levels of complexity in mastering. The framework presents six main skills which the student should be able to master by the end of the course, presented in Figure 21 and described as follows:

- Remembering – the learning outcome that entails the remembering, e.g. "The student will be able to **recite/recall** from memory the types of machine learning".
- Understanding – the learning objective that entails users understanding the subject matter, e.g. "Students will be able to **compare, organize, interpret, describe**, **etc.**"
- Applying – the learning objective that entails the student **solving** a problem or **doing** an assignment.
- Analysing – the learning objective that entails the student providing a connection among ideas in an observable way, e.g. "The student will analyse the organizational structure of the city of Gdansk and write the most appropriate changes referring to organization structure's restructuring guideline" in the form of a report or recommendations.

- Creating – the learning objective that entails the student resolving the contradictions and putting parts together to form a new whole, combining ideas and listing them, i.e. "The student will **categorize, combine, compile, compose, create, design, explain, generate, modify, organize, rearrange, etc.**".
- Evaluating – the learning objective that entails the student's ability to judge the value of the compiled material for a given purpose based on established criteria. This level is the highest in the cognitive hierarchy because it contains the elements of all other levels, e.g. "The student will **appraise, compare, conclude, contrast, criticize, discriminate, explain, justify, interpret, relate, summarize and support** …".

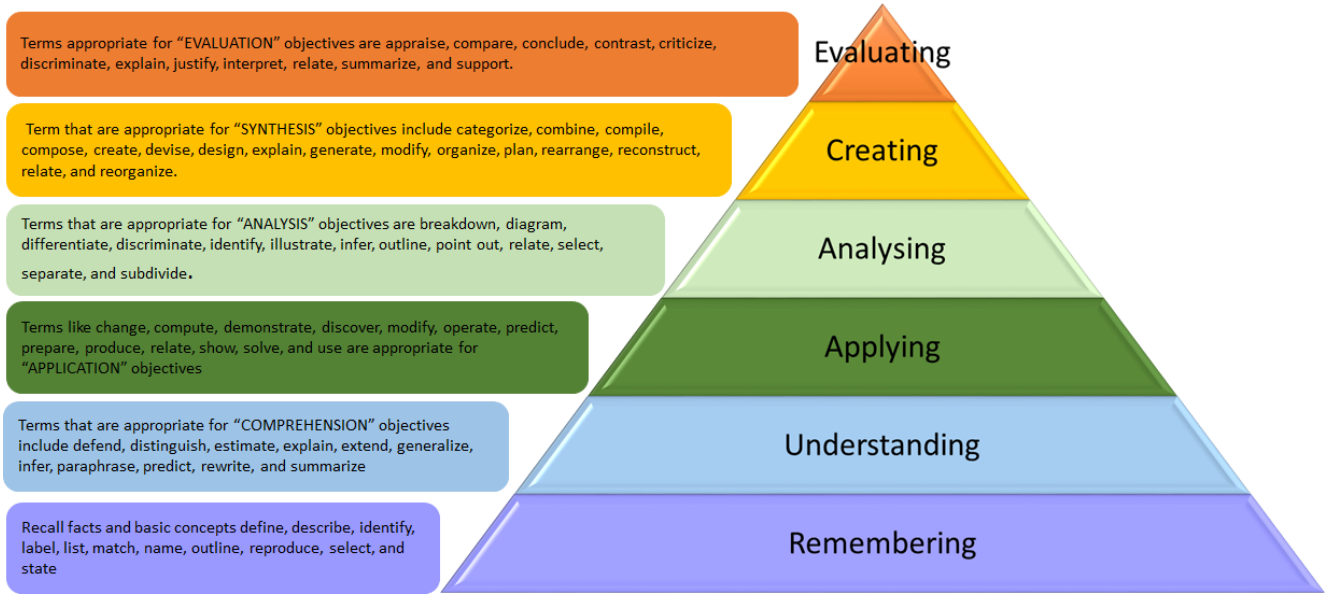


Figure 22. Bloom's taxonomy of the learning objectives (Bloom and Krathwohl 1956)

The Kirkpatrick's evaluation model was proposed for the first time by Kirkpatrick in 1960s (D. L. Kirkpatrick 1994). The model has been used for more than thirty years as the primary design for organizing and evaluating training in non-profit organizations. The popularity of this model for evaluating training programs results from the clear demonstration of the training results, hence simplifying the complex process of evaluating training programs. The Kirkpatrick model includes four levels of evaluation: reaction, learning, behaviour and results. Reaction is the act that learners demonstrate to all effective factors during a training period. Typically, this type of assessment is a one-time survey, i.e. "Please rate the course on a scale of 1 to 5, when 5 is being the best". This assessment is typically given by the end of the course, so the feedback is immediate. By Learning, the model refers to the way and the extent of changes in participants by attending training courses. This assessment shows the teacher how well the learning objectives were met. Typically, this assessment is aligned with the learning objectives. Behaviour implies whether a training course has caused a desired change in the learners' behaviours. It is not widely used as the learners' behaviours would need to be observed within days or months. Results imply whether the training course has resolved the existing problems and helped in achieving organizational goals. This assessment is understood as the evaluation of the long-term performance.

Several tools developed by the CAP4CITY project are supporting the learning objectives development: a database of SSC-related education programs (Beninca et al., 2019.), the database of SSC-related education contents (Durkiewicz 2019), and the SSC roadmap (Azambuja and Pereira 2019).

4.4 Target Audiences

Courses are delivered in many ways beyond the traditional classroom, like simulations, interactive e-learning, 3D gaming, online synchronous classrooms, and others. With all these different deployment methods, teachers must take into account

different learner audiences: university, corporate, government, independent professionals, clerks, managers, and more. The teacher needs to consider possible combinations of audiences with deployment methods. This gives him many possibilities to conduct the course and modify the objectives to specific audience requirements. However, the preposition and learning objective never changes. The changes occur in the number, granularity, style and brevity of objectives.

The target audience of the SSC courses is various SSC stakeholders. Thus, the course content could be modified regarding business participants, i.e. vendor employees that need to know the functioning of the local government, team members of the government IT departments that need to expand their knowledge on agile product development, or government decision-makers looking for methods of smart city management and governance.

For instructions to be efficient and effective, they should be tailored to meet the needs of the target audience. The way teachers approach creating instructions for specific concepts will depend greatly on the characteristics of the course's target audience. They will vary regarding the target of college students, corporate workers or government representatives. For determining the target audience, the following issues should be under consideration: age, motivations, digital literacy skills, access to resources, limitation or disabilities, background knowledge or familiarity with the content to be taught, etc.

It is recommended to know the target audience well, even survey the target audience before the course starts, rather than continue to learn more about the audience, their abilities, motivations and expectations during the course. It is challenging to create a personalized course plan for each learner but taking time to consider some of the above-mentioned issues about the group helps to tailor the instruction to the specific audience.

4.5 Pedagogical Approaches

The workshops held in Latin America (Estevez et al. 2019) determined many different options for organizing and delivering SSC training. These options are listed in Table 22.

Table 22. Different modalities for organizing Smart Sustainable City training (Estevez et al. 2019)

1.	agreements with municipalities to capture and analyse large volumes of real data
2.	analysis and discussions about existing theories
3.	the applied workshop, models, robotics, etc. to integrate practice and theory
4.	case study analysis including different type of resources, like videos, cases, etc.
5.	communities of practice
6.	contests
7.	conversational initiatives
8.	debates
9.	fellowships
10.	fieldwork – getting out of the classroom
11.	future labs for planning the city
12.	innovative exercises, as a part of fieldwork
13.	invited citizen sharing personal story-telling
14.	invited experts from different countries and disciplines
15.	laboratories - territorial labs
16.	maker space
17.	mobile app applications
18.	on-site practices
19.	piloting, virtual reality, augmented reality, robotics
20.	projects based learning with communities
21.	prototyping
22.	site visits to innovative organizations and data centres
23.	social ideas laboratory

24.	talks and expositions of authorities and experts
25.	technology-immersed experiences using social media
26.	TED talks
27.	theatre workshops
28.	urban laboratory
29.	urban studies and trips
30.	workshops to facilitate integration between theory and practice

The same workshops also determined possible pedagogical methods applied in different knowledge domains. Such methods, with knowledge domains and examples, are listed in Table 23.

Table 23. Pedagogical approaches determined from the workshop in Bahia Blanca (Estevez et al. 2019)

Knowledge domain	Pedagogical model	Examples
Energy management	problem-based learning	• identify the critical components of the energy matrix • plan and implement efficient electrical management
Data intelligence for decision making	problem-based learning	• ability to develop intelligent systems applicable in different areas • exploit information from different sources for decision making
Environmental quality	project- and problem-based learning	• identify critical aspects/issues and their interrelation • develop and implement solutions • raise awareness of the environmental issue
Security of people and data	project- and problem-based learning	• identify problems and solutions for the safety of people (crimes, accidents, natural disasters) and data (hacking, etc.) • implement technical solutions and public policies • train in the perception of risk for the citizen
Inclusive education	problem-based learning	• generate educational material for all citizens at different levels (formal/informal education) • raise awareness of the importance of education/training/ lifelong learning (through the use of different technological instruments and multidisciplinary workshops)
Negotiation and citizen participation		• design models and platforms for citizen participation • identify stakeholders • design models of behaviour identification, mediation, negotiation, build human-capacity
Communication		• design communication networks for specific audiences • evaluate the most appropriate communication channels • learn to communicate using clear and simple language • develop communication skills
Public policies		• learn methodologies for planning, implementing, executing and monitoring • critically analyze public policies based on sustainable development objectives • develop dashboards for monitoring public policies
Legislation		• know the basic legal framework for protecting rights

		• adapt public policies and citizen participation to guarantee basic rights • design reasonableness controls in the early stages of the life cycle

While developing the curriculum, it is important to have different learning styles in mind. The social-interpersonal style characterizes those that prefer to learn in groups, whereas solitary-intrapersonal style prefers to learn in isolation. There is a verbal style in which the learner usually learns the best while speaking or writing. The auditory style in which the learners learn by listening. Visual style means that learners prefer pictures, images, diagrams, and videos to understand the concepts. The logical style uses systems and mathematical reasoning, as well as kinaesthetic, understood as hands-on activities, movement and touch. Most learners characterize the combination of a few learning styles. Thus, the teacher needs to consider various learning styles when planning the curriculum to address the learners.

Activating methods are a group of methods that are meant to make teaching and learning take place unconventionally. Classes should motivate students to act, think creatively and solve problems creatively. Activating methods make the learner become a person who has an impact on what will happen during the lesson, becoming the co-creator of the didactic work (Faust and Paulson 1998). This group of the method is based on learning through action, cooperation, and experience (Barrows and Tamblyn 1980; Coles 1991). In the beginning, the teacher must take into account the characteristics of the target audience, as well as various types of pedagogical methods, to meet the requirements (Westwood 2008).

There are three levels of communication when using activating methods:

1. communication refers to the task and the goal that is to be achieved
2. communication refers to the relationship that occurs in the group when working on a problem
3. communication refers to personal impressions and feelings that the individual feels during the task

Among the activating methods, we can distinguish (Blenker et al. 2014; Mwasalwiba 2010):

- **Integrative methods** – designed to introduce a friendly atmosphere in a group to work effectively and efficiently; learners are adopting the elements of discussion, expressing their own opinions, and understanding different points of view; examples of integrative methods are brainstorming, conceptual map, jigsaws, sorting strips, and turn and talk (Bretz and Thompsett 1992; Corner 2002).
- **Creative problem-solving methods** – unconventional approaches to the problem; developing skills of discussion; the examples are the six hat method and the passwords puzzles (Parnes and Meadow 1959; Meadow, Parnes, and Reese 1959; Al Maghraoui et al. 2019; Basadur, Graen, and Green 1982; Swartz and Parks 1994; Lipman 2003).
- **Developing creative thinking** – this group of methods and techniques helps share the unconventional thinking; the examples are brainstorming, the journalistic six (who, what, when, where, why and how), historical examination, or the trigger concepts (Gube and Lajoie 2020).
- The **drama method** is to play roles (situations), initially to defend own reasons, then in discussion trying to find a way of the situations to solve the problem and to make a decision; this method involves participants intellectually and emotionally (Bolton 1985).
- This **simulation method** is used to recreating a situation or a problem that is artificial or real; this method can present a full or an incomplete view of the reality; is a reference to a probable real situation; this method activates students, referring to their future professional situations (Cant and Cooper 2010).
- **Discussion** – occurs in every collective exercise with varying degree and intensity; understood as a collective dealing with a specific problem, it is about exchanging thoughts and views during the development of the material; it serves to exchange views; the topic of discussion should be known in advance, and students should be prepared (Parker and Hess 2001; Alivernini and Manganelli 2011; Cohen 2020). Discussion techniques include:
  - dialogue – when an issue is considered by two people;

- observation (panel) – led by a few people but the whole group is listening to it; after members present their views, any participant may speak by asking a question or taking part in the discussion;
- round table – the free exchange of views for adopting a joint solution; and
- seminar-type discussion – most common in all universities, it consists of the presentation of research results and the content of scientific articles; students are prepared and take part in the discussion substantively.

The lecture is the dominant method of education in a college or university. It is the oldest and the most connected with didactic traditions at every university. The critical condition for the success of a lecture is the involvement of learners with the lecture. Thus, the lecture's structure should be arranged logically as a whole. The introduction consists of attracting attention, development and ending. The important aspects of the lecture delivery are voice modulation, speaking speed, as well as the preparation of each lecture in the form of a substantive plan or outline. The features of a good lecture are: interesting, logical, accessible, useful, simulating, related to practice, and correlated within each item.

Exercises are another basic of didactic organization in a university. The objective of the exercise is to develop skills, conscious use of scientific knowledge in various mental operations, research work, and practice. It is an introduction to self-studies and to independent student work in solving problems, getting information, confronting and analysing information, creating favourable conditions for teaching independence (Felder et al. 2000). The role of the exercise task is to:

- supplement, deepen and expand knowledge obtained during the lecture and from the textbook;
- develop skills, cognitive interests, ability to creatively solve problems, and shape scientific interests;
- control and self-control of understanding and composure of the material;
- develop skills to use appropriate research methods in a particular scientific discipline; and
- prepare for future work by assimilation of professional skills, linking theory and practice.

Exercises are classified into laboratory exercises, design exercises, clinical exercises, conservatoriums, and workshops. The workshops (Estevez et al. 2019) identified various pedagogical methods applied by such exercises, such as:

- blended learning
- case studies: select existing cases, develop and test cases, enable multipliers in teaching cases
- collaborative learning
- design thinking: a solution-based approach to solving problems in a practical way which includes field data collection and the development of prototypes
- entrepreneurship when assessing projects and proposed solutions in project-based and problem-based learning
- flipped classroom
- gamification: the application of games can help think about an ideal smart city and focus on solutions
- learn by doing
- multidisciplinary project-based learning
- oral and written communication
- peer-to-peer learning
- practical cases
- problem-based learning: focus-group approaching problem solving under a troubleshooting lab concept
- project-based learning: the development of projects can be useful to drive students to reach results after a certain time, as well as to focus on an objective situation
- research-based learning
- service learning: identify problems, make proposals for a solution, present solutions to those who can apply them
- station rotation: while working in groups with different activities, for example, dimensions of city challenges, the activities/roles rotate to involve all groups
- story-telling: a story of a city can be created, involving all actors and artefacts, past facts and city challenges, as a way to better discuss contextual elements
- teamwork
- technology-mediated interactive applications, like, e.g. apps deployed in smartphones

4.6 Creating Curricula

When teaching the material for the first time, the timing can be one of the most difficult things to plan for. It is important to determine the amount of time available to teach the curriculum as well as how much information should be conveyed (Uchiyama and Radin 2009). This is why it is necessary to consider a timeline, scope and sequence of instructions (Harden 2001; Biggs 1999). The scope refers to the depth at which one would cover information and the sequence to the order in which the material should be covered (Morehead, Pamela; LaBeau 2004).

When determining the scope, a teacher needs to consider three issues: to assure that learners understand the concepts being taught, how much time is available to cover that subject, and what level of understanding is necessary for this particular subject? One solution is to break down the content into separate units in university Moodle to make sure that it is well understood, how much time is available for each unit, and plan the sequence and order (Harden 2001; Jacobs 1997).

The sequencing depends on the teacher's situation if she is teaching a one-semester course or a one-time lecture class. Using the educational management system, the teacher can create content sequencing, starting with a broad overview and then getting into specific course contents (Biggs 1999). There are a number of ways to carry out the sequencing of the course content (Uchiyama and Radin 2009). The teacher can start moving from simple concepts towards more complex ones. It is also possible to put the content in order, so the teacher has a pre-requisite material covered. Before some courses, the learner needs to know certain concepts (Jacobs 1997). There is a possibility of sequencing in the chronological model from micro to macro, teaching big concepts first and then breaking them down into smaller components, etc. The teacher can also reverse this process, teaching the small concepts and leading the learners to the overall concept, towards the big picture (Morehead, Pamela; LaBeau 2004).

It is also possible to use an upward or backward design of the curriculum. In the upward model, instructions are created by first considering the topic that is to be taught, then determining what will be taught, planning the delivery and creating assessments at the end (H. Taba 1962). Backward design flips this model and determines the final results (learning objectives) that the teacher wants the learners to achieve first (Wiggins and McTighe 2006; R. Tyler 1949). Once the learning outcomes are decided, the teacher determines what evidence is needed to demonstrate that the results were obtained, thus creating assessments (Uchiyama and Radin 2009; Richards 2013). Finally, the teacher plans the instruction accordingly, focused on the content that is included in the assessments, which will determine the success with regards to the learning objectives. Figure 22 depicts the backward design, which is the most popular among academics.

Figure 23. Backward course design

The sequencing should fit the teacher's particular situation regarding time, scope and resources dedicated to the course. When designing the curriculum, it is important to provide some predictability for the learners on learning objectives, the assessment, feedback and guides the learners will receive from the instructor. From the learner's and the teacher's perspective, it is important to align the assignment with the learning objectives. There is a fundamental rule for assignment development: "align each item of your course assessment directly with a learning objective in your course"(Jacobs 1997). There is a need to provide the certainty that every exam question is linked to the learning objective. Thus, the teacher can measure if students learn what is expected from them, identify successes and failures for each learning objective. The alignment between the assessment and the learning objective provides a clear roadmap of necessary revisions and improvements and prevents creating assessment questions not aligned to learning objectives (Wiggins and McTighe 2006). A useful tool for curriculum design, Figure 23 provides a template for the assessment of learning outcomes.

Assessment of the Learning Outcomes

Field of study: _____
Year, semester: : _____
Course name: : _____
Form and degree of study: : _____
Lecturer: : _____

Assessment methods and criteria :

Criterion	Output	Comments
KNOWLEDGE		
activity		
case study		
exam		
essay		
test		
reading		
the presentation		
other / what? /		
SKILLS		
activity		
case study		
exam		
test		
project		
homework		
other / what? /		
COMPETENCIES		
activity		
presence		
work by rupees		
the presentation		
other / what? /		

Does the assessment cover all learning objective?

.....

Comments from the Verification of Learning Outcomes Committee

The proposed method of crediting allows to realize the learning outcomes:

outcome number (according to the course card)	fully	partly	to a small extent	no outcome

Attachments:
1 course card
2. completed and graded student's: colloquia, exams, projects, essays, sets of oral questions , etc. 10 items in total from all lecturers .

Figure 24. Template for the assessment of learning outcomes

When preparing the curriculum, the teacher should provide plenty of predictability to the learners in terms of the course policies such as grading and passing, absences and rules of excusing, keeping the deadlines of the assignments, access to

the course resources, contact hours with the teacher, as well as consultation hours provided to the learners. The less predictability, the more learners' confusion and frustration arise regarding course attendance and passing criteria, which can be a significant obstacle to learning (Biggs 1999).

When developing the curricula, a teacher should consider the logistics of the course. Important considerations regarding such logistics (Uchiyama and Radin 2009; Morehead, Pamela; LaBeau 2004; Harden 2001; Judith K. March 2008) include:

- The relevance of the instruction – how existing instruction fits the overall picture of the course? Is it mandatory or optional? Is it a pre-requisite for further learning? Is it something the learners must pass to move on?
- Time constraints – when will the training begin and when will it end?
- Format – is it a face-to-face contact with the learners, or will the instructions be done online?
- Access to the resources – when will the learners be able to access the resources? Do they need to obtain them directly from the teacher, or obtain them online? Do learners have a way to access online content?
- Communication plan – establish the way that the learners can contact the teacher with questions. Is it through the learning management system, form, email, phone, text? Can the learners contact each other, and how?

Resources are an important part of any curriculum. Here a teacher is responsible for finding the accurate and quality resources that the learners can use. These resources could be from the teacher's own organization, published by a reputable source, or created by the teacher. One of the most important steps in creating an effective curriculum is to identify the key resources that can be utilized. The instructions should be built around these resources. The teacher can use sources such as books, documents, articles, videos, podcasts, infographics, webinars, and more.

The CAP4CITY project has developed tools that support curriculum development, understood as course resources. For instance, D1.5, the database of SSC-related education content, provides a wide spectrum of information to help develop new courses. Here are some examples of educational use cases with the database D1.5:

1. **Educational use case #1**
    - Select a case study from the worksheet „Cities – case studies"
    - Examine the sets of desired competencies
    - Compare it with the contents of „SSC competencies"
    - Analyse and discuss whether the competencies were accurately formulated by the initiative
2. **Educational use case #2**
    - Go to the „Job vacancies" worksheet
    - Aggregate the data from different countries
    - Build an aggregated list of expected competencies for each of the countries
    - Compare the findings for each country
    - Analyse and discuss whether there are regularities within the offers coming from a country
    - Analyse and discuss whether such regularities vary between different countries
3. **Educational use case #3**
    - Go to the worksheet „Material – readings"
    - Select a number of publications covering a relatively wide timespan
    - Read it (given their accessibility) and note some significant conceptions and postulates
    - Analyse and discuss whether conceptions are evolving
    - If so, discuss how technological and social progress may impact them

5. LEARNING MATERIALS – DELIVERY

5.1 Social Learning Theory

In the 1960s, with the rise of the behavioural theories of learning, Albert Bandura (Bandura 1986) has bridged the behavioural and cognitive sides of learning. In the social learning theory, learning is a cognitive process: people learn in the social context and learning may occur even without performing the directly reinforced behaviours. Bandura proposed that we can learn behaviour in this way, but also can learn values and attitudes.

People learn by observing other people's behaving and the consequences of such behaviour. Such behaviours can serve as models that we can imitate. When an individual sees someone reinforce their behaviour, it makes her more likely to exhibit that behaviour. When an individual sees other people being punished for certain behaviour, it makes him less likely to pursue that behaviour. In both cases, the individual does not perform the behaviour by herself and is not personally rewarded or punished. Individuals watch someone else and learn from the consequences they observe. Although reinforcement has a role to play in learning, that is not the only thing that leads to learning. Learning may occur without any noticeable change in behaviour because learning involves extracting information from what has been observed. The change in behaviour may occur after the observation has occurred.

This is an active process: observation, cognition, and context, all influence what we learn and when we choose to exhibit a certain behaviour. Bandura identified three types of learning models:

1. Live models – with the live model, a person demonstrates the desired behaviour that we can observe directly, in order for us to imitate this behaviour. They show us what to do.
2. Direct instructions – with the direct instruction model, a person describes the desired behaviour in detail and provides instructions to learners about how to do it then they perform the described behaviour. Classrooms, life chats and community fora often require direct instructions.
3. Symbolic instruction – with the symbolic instruction, modelling occurs through media including the web, written and/or illustrated information, video and audio, in the form of instructional materials. The situations may be real or fictional. People can learn from animated characters and imaginary situations as easily as they can learn from people in real situations. A learner then performs the behaviour as instructed. Examples of symbolic instruction are instruction manuals, books, self-directed training, frequently asked questions, and help centres.

Social learning is increasingly used in mass education. It is nothing more than learning with an emphasis on human interaction with the social environment. The theory assumes that new skills are acquired through two mechanisms:

- Modelling, i.e. learning by observing someone else's actions and effects. The condition is to focus on the behaviour of the model, remember this behaviour, and try it out in practice.
- Learning through consistency.

Social networking sites such as Facebook and Twitter encourage people to share information and contact each other. Often, however, they encourage them to take action without a purpose, to learn things that do not serve development. In the theory of social learning, there is an element of moderation, activating the group to exchange knowledge and experience. The goal is to gather participants. While there is no controller, there is a mentor and leader who inspires actions, particularly teamwork, mutual communication, and experience sharing. The focal point is to stimulate discussion, particularly by finding and motivating people with predispositions to be a leader. Their activity is crucial to the exchange of information.

5.2 Connectivism Theory

Connectivism is a theory of teaching adapted to the possibilities created by the digital age (Siemens 2005). One of the most important aspects of this theory is using a network with its various nodes and connections as a central metaphor for learning. A node can be anything that connects to other broad information, data, feelings, and images. Learning is the

process of creating connections between different nodes and developing the network. However, not all connections have equal strength in learning; many of them are too loose. The theory of connectivism assumes that we make decisions based on a pool of information that changes all the time. The method of data selection and finding the right sources is important. It is associated with the efficiency and effectiveness of gaining knowledge and experience.

The principles of connectivism include (Siemens 2005):

- learning and knowledge are based on diversity of opinions,
- knowledge can exist in various devices,
- learning is related to specific information resources,
- the potential to acquire knowledge is more important than what we currently know,
- the most important is updating knowledge,
- decision making is a learning process, and
- the knowledge one needs lies at the heart of learning activities.

5.3 Student-Teacher Relationships

The social role that a teacher plays in the education process in traditional teaching is obvious. In distance learning, both the teacher and the student should be involved in the learning process and also be interested in the environment in which the process takes place. New technologies force a change in the role and extension of student and teacher responsibilities.

The teacher should have not only the knowledge in the subject of the course but also the field of information technology. She should have both psychological and social competence. Conducting a course on the Internet means adopting various roles relevant to the learning objectives and outcomes. The teacher becomes a mentor, an observer. She should understand and respect other peoples' views or value systems and adhere to ethical norms and principles common in the network. An e-learning teacher should have the following competencies:

- competencies in information technology,
- competencies in education design,
- competencies in analyses and
- business competencies.

The student also needs to develop various competencies like reading comprehension, regularity, communication and teamwork. Typical student needs and expectations are the following:

- a precise definition of the rules of work in the course,
- rules of passing, rules of communication and deadlines,
- methods of assessment,
- good course navigation,
- the right volume and variety of materials,
- constant contact with the teacher,
- teacher's involvement,
- flexible task deadlines,
- provision of feedback,
- technical support, and
- individual approach.

Recommendations for organizing e-learning:

1. Preliminary course information and syllabus should always be available, preferably in the first module.
2. The syllabus should be available no later than at the beginning of the first lesson.
3. Before starting the first lesson, learners must have information on:

- The schedule and the rules of work. This includes rules for assessment and passing the course, deadlines for test publishing, task assignments, activities, and forms of communication such as fora, reports and solutions.
- Communication media and hours of consultation with the teacher. The consultations should be held both online and traditionally at the university campus.

Providing help to students include:

- choosing learning methods and techniques to eliminate learning difficulties;
- remembering that the course material should be adjusted to the course timeframe;
- understanding that not every student has the right skills such as independence or good work organization;
- not underestimating simple technical problems so as not to discourage students;
- students learn when they have time, and when they solve problems;
- students first learn what interests them, and only later what will be useful to them;
- students cannot be left alone, communicating with the teacher and other students are key;
- students learn faster when their mistakes are corrected and when supported by advice;
- the teacher is required not only to check students but also to motivate and activate them; and
- science is primarily based on communication.

5.4 Forms of Distance Learning

Distance learning occurs when a teacher does not have direct contact with students. Interpersonal communication is replaced by traditional mail and communication technologies. The first example of distance learning is the corresponding schools. Thus, the only condition for distance learning is the provision off two-way communication. Modern forms of distance learning include e-learning and blended learning.

E-learning enables contact between teachers and students via the Internet. It is recommended:

- when a course has a deep curriculum,
- when a course is attended by many students,
- when students are geographically dispersed and have limited mobility,
- when students have access to the Internet and possess their own devices,
- when students are motivated to learn,
- when the content will be used in the future,
- when the training aims to build cognitive skills, and
- when there is a need to collect data.

Blended learning is also called mixed, complementary, or integrated learning. It combines traditional learning methods – direct contact with the teacher during traditional classes, with activities conducted remotely using a computer and the Internet (Graham and Bonk 2006). The content determines which elements are taught traditionally and which remotely.

This method of teaching has many advantages. The teacher has the opportunity to meet students during traditional classes. She can also plan the division of content delivery so that within the process of remote education, students gather knowledge and develop skills using the best method. This method of education facilitates the stimulation of students to learn in a way that directly influences the achievement of the learning outcomes (Singh 2003).

Bersin (2004) identifies two main models of blended learning: program flow model – the learning activities are organized in sequential order, and the learners have deadlines to accomplish various assignments; and core-and-spoke model – the major learning course is provided, and a set of supplemental materials is available to extend the main course.

One of the most popular blended learning methods, considered by some as ideal and often used in the corporate world, is the flipped classroom. The main assumption of the flipped classroom is learning at home from multimedia materials provided by the teacher. In traditional classes, learners receive from the teacher answers to all questions about the material and perform practical exercises. During a lesson, the teacher has time to conduct experiments based on previously learned

concepts. The flipped classroom allows individualized teaching. It requires learners to work independently at home, but the research shows (Lai and Hwang 2016)that the students' involvement in learning is increased, e.g. after implementing the flipped classroom, the number of people who obtained positive results in mathematics increased from 56% to 87%.

The process of learning information does not require the learner to be particularly active. However, the repeating and combining of the elements already learnt require an increased mental activity. This is the right place to exhibit the role of the teacher in the learning process, which is to activate students to work. Using the flipped classroom, the teacher can save time spent by students passively and independently listening to the teacher's lecture and use it to interact with other students, for example enhancing teamwork skills, solving problems by combining different departments of knowledge, and learning combinations of skills. In such a way, the student can see how their knowledge can be used. Access to educational materials allows for any number of repetitions and running of interactive exercises contained within the content to check the correct understanding of the concepts. Thus the teacher can give more opportunities to verify the learner's knowledge.

Despite such advantages, it is worth remembering the limitations of the flipped classroom. This method largely transfers responsibility for the learning outcomes to the student. A role of the teacher is limited to the mentor and guardian function. This requires a lot of activity from the learner, as well as a high degree of commitment and expanding competences to the information technology field from the teacher.

5.5 Communication in Distance Learning

Two basic forms of communication in distance learning are synchronous and asynchronous communication. In the case of synchronous communication, the communication between the learners and teachers and between the learners themselves takes place instantaneously and in real-time. Teachers need to moderate and direct conversations. Learners receive feedback immediately. Examples of synchronous communication tools are chat and instant messaging, audio and video conferences, webcasting, application sharing, whiteboards, polling, etc. In the case of asynchronous communication, the learners receive a response after some time. This allows teachers to give a more detailed and thoughtful answer. Examples of synchronous communication tools are mail correspondence, online material, multimedia, email, podcasts, videocasts, blogs, webcasting, wiki, discussion forum, etc.

According to the level of interactivity, the didactic process is divided into courses with a distance teacher, courses based on online teaching materials only, and virtual classes. In courses with a distance teacher, learners read the didactic material on their own, solve problems by themselves, and perform interactive exercises. The learners can contact their teacher through a forum, chat, or video conferencing anytime this is needed. In a course based on online teaching materials only, the teaching materials are posted on the Internet while the learners must be independent and disciplined, and solve all problems by themselves. Virtual classes are organized similarly to traditional classrooms. The lesson takes place online with a teacher in a small group or individually according to the previously defined hours. The teacher and students use appropriate tools and applications that provide free communication, execute exercises and participate in assessments.

5.6 Motivation in Distance Learning

Motivation is a key element of the course delivery and one of the most important issues facing a teacher. Keeping motivation during distance learning is a difficult task. The motivational factors to aid this task include (Keller, xxx) attention, relevance, confidence and satisfaction. A few simple rules to maintain a high level of motivation includes:

- keeping a friendly atmosphere,
- taking care of well-defined credit rules and time frames,
- providing feedback to student assessment,
- adapting the learning pace to the speed of the learners,
- adopting various delivery methods which activate participation such as, e.g. games or control questions, and
- replying to forum posts as promptly as possible so as not to lose interest in the course.

In order to increase the motivation and the level of learner activity, the teacher should encourage learners to perform, create a positive atmosphere, encourage students to share their opinions on the course and progress with assignments,

motivate students to show proactivity, and support their efforts. The teacher's role includes: building working groups, and clarifying to students what is the purpose of their work, what is the effort required, and what knowledge resources are available to solve assignments. The teacher should also provide feedback on any errors or misunderstandings.

Many factors are lowering the level of participation. First, critical assessment is lowering the readiness to ask questions and discuss the feedback received. Lack of summary at the end of classes, no diversity in methods and tools used during classes, lack of acceptance of students' views and ideas, etc. are some of the barriers to participation.

5.7 Designing Attractive Classes

The design of attractive classes for learners is difficult. Today's youth are brought up in the world of technologies. Their perception and expectations very often differ from the teachers'. Using longer text to read or a small number of graphical elements to illustrate the discussed content often results in decreasing the effectiveness of distance learning.

During distance classes, communication differs from traditional classes. Verbal contact might be difficult, and communication via messengers is not always functional for different subjects. For example, building electronic solutions to problems that require the use of technology and formal sciences takes much more time than discussing "social" topics. Moreover, the lack of direct contact with the teacher increases the difficulty of keeping participants motivated and active.

There are also barriers to the use of the latest technologies among teachers. On one side, we have students they are ready to actively participate in distance learning, having advanced know-how about IT application and tools. On another side, there is a teacher that need to build her IT skills to the comparable level. A recommended approach is that beginner distance teachers conduct a small number of hours of distances classes at the start of the course. This would give them the necessary time to build the knowledge, skills and experience in distance learning.

The distribution of content and activity must also be revised:

- the content should be dosed in small information packages that can be consulted often,
- film materials should be no longer than five minutes,
- elements that can be visualized should be visualized,
- numerous repetitions during reading classes will help learners to properly master the material,
- the teacher should regularly update information on fora, check tasks, and provide feedback on tests,
- distance course modules should be published in the right order, and
- evaluation surveys should be used to improve content quality.

Teachers must be aware that educational content published on the Internet will be available for next cohorts. If the content remains constant for several editions of a course, passing this course will require less effort from the students.

As part of making distance classes attractive, serious games are often used to test the learners' knowledge. The substantive issue of the game is a challenge to be addressed. A user unconsciously becomes a player and focuses on achieving the best results in the shortest time possible. The knowledge becomes an addition to fun. Commitment allows for achieving better results. According to the statistics, gamification becomes an effective activation method:

- the material absorption time is reduced by approximately 30%,
- users keep their focus for around 50 minutes,
- the material absorption increases from 50 to 100%,
- understanding of the topics increases to about 50-60%, and
- the learning pace increases by around 60%.

In higher education, e-learning is mostly equated with the use of platforms. A platform is an advanced tool that combines different functions and provides students with online classes supported by different tools for creating courses and participating in them. Platforms allow teachers to create presentations in the form of websites, interaction lessons, files or redirections. The platform provides communication options such as chats, forums, and video consultations. Most of the platforms provide group work tools as well as tools to verify the knowledge of the learners. The current educational platforms are considered as a learning management system. One of the most popular of them is Moodle.

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APPENDIX

A. TEACHING MATERIALS – BACKGROUND

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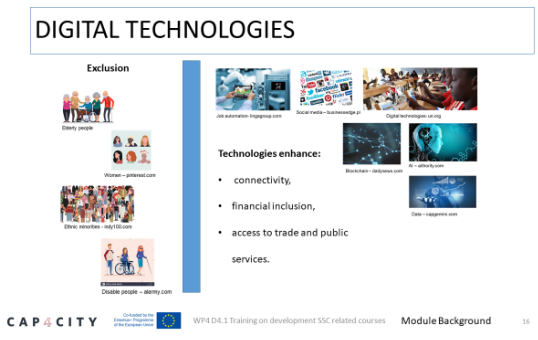
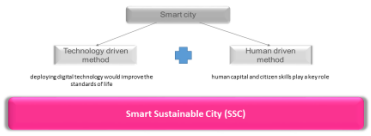


SMART CITY

SSC DEFINITION



Smart Sustainable City is a territory (urban and rural) in continuous transformation, enabled by digital technology and innovation, stakeholder engagement and collaboration, constructing human, institutional and technical capacities to solve problems and create new development opportunities, within the aim of raising and maintaining the quality of life in communities, and pursuing sustainable development.

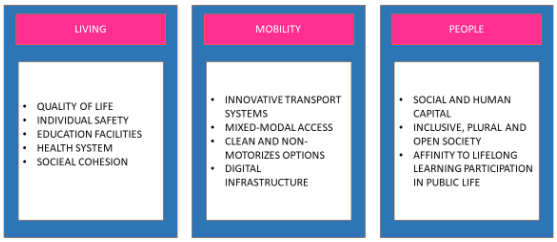
SMART SUSTAINABLE CITY

Source: Schuch de Azambuja and Pereira, 2020.

SMARTNESS

- Cities demands infrastructure systems to manage current administration challenges.
- A mixture of digital technology and digital innovation is taking place in the urban environment.
- Smart cities mean:
  - more responsive government,
  - better citizen engagement,
  - more transparency,
  - more effective collaboration.

SMART CITY DIMENSIONS



SMART CITY DIMENSIONS

SUSTAINABILITY

Sustainable development is "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (UN, 1987)

- Sustainable development is underpinned by five principles:
  - poverty alleviation,
  - environmental policy integration,
  - intra- and inter-generational equity,
  - participation in public decision-making, and
  - addressing technological and environmental limits to growth
  - the United Nation's Millennium Development Goals (UNDP 2005) already highlighted the role of local communities in reaching sustainable development.

SUSTAINABILITY

Sustainable urban development is a central part of the 2030 Agenda for Sustainable Development which aim to "*make cities inclusive, safe, resilient and sustainable*"

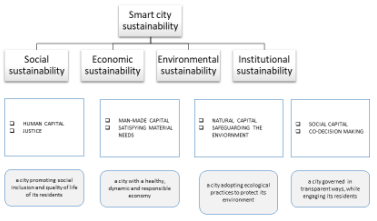
The new urban agenda entails "rethinking the way we build, manage, and live in cities through drawing together cooperation with committed partners, relevant stakeholders, and urban actors at all levels of government as well as the civil society and private sector" (United Nations 2015).

SUSTAINABILITY

- Smart sustainable cities represent latest stages in progression through digital, intelligent, smart and smart sustainable cities.
- Digital Cities integrate digital technology into the city's core infrastructure systems.
- Intelligent Cities rely on the Digital City infrastructure to build intelligent buildings, transportation systems, schools, enterprises, public spaces, and public services, and integrate these into intelligent urban systems.
- Smart Cities deploy intelligent urban systems to serve socio-economic and ecological development, and to improve quality of life and address the origins of social instability in cities.
- Smart sustainable cities focus on "a continuous transformative process, based on stakeholder engagement and collaboration, and building different types of human, institutional and technical capacities.
- Smart sustainable city "contributes to improving the quality of life of its citizens by pursuing socio-economic development and protecting natural resources among other locally-defined priorities".

(Estevez, Lopes, and Janowski, 2016)

SUSTAINABILITY DIMENSIONS



GOVERNANCE

- According to the stakeholder theory, **governance** is the interaction and collaboration of different stakeholders in decision-making processes (Albino, Berardi, and Dangelico 2015; Garcia Alonso and Lippez-De Castro 2015).
- It creates the enabling environment that requires adequate legal frameworks and efficient processes to ensure that government is responsive to the needs of citizens (UN Habitat 2009).
- **Governance** is the way cities organize internally and over the city administration boundaries (Bergh and Viaene 2015).
- Smart sustainable city projects are used by both municipal administrations and politicians to create solutions that meet sustainability goals. They may adopt infrastructure-intensive and citizen-centric approaches, all of which are complex projects that need administrative support.
- City administrations need to understand how to run such projects effectively and how they are impacted by them.

GOVERNANCE

- Adjusting to the dynamic environment of smart sustainable cities, cities are forced to introduce new governance models with strong local government support for public management (Testoni and Boeri 2015).
- A new form of relationship management occurs, reshaping the role of government, businesses, citizens, universities and other stakeholders collaborating on innovative digital urban solutions within new processes and new governance structures.
- According to Bergh & Viaene (2015) transformed city governance should: balance control with empowerment, adopt open form of teamwork and collaboration, co-construct business processes with community outside of the organization endorsement, involve experimentation and continuous improvement, influence cultural stance toward uptake and adoption of the solution, and manage motivational issues of the smart city stakeholders.

SMART GOVERNANCE

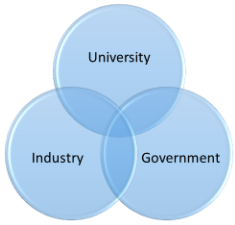
- **Smart governance** as "the ability of governments to make better decisions through the combination of ICT-based tools and collaborative governance" Pereira et al. (2018).
- Part of smart city governance, institutional factors are smart actions such as collaboration, cooperation, partnership, citizen engagement or participation, that enable interaction and communication amongst smart city stakeholders (Nam and Pardo 2011).

SMART SUSTAINABLE CITY STAKEHOLDERS

SSC PARTNERSHIP

- Municipal governments cannot bring sustainable smart solutions by themselves.
- The deployment of smart applications in cities are the result of close collaboration between public and private partners with an active engagement of citizens. Many smart cities innovations are the result of public-private partnerships.
- Challenges:
  - diversity in participating organizations' aims,
  - barriers in communication,
  - difficulties in developing joint operation modes,
  - managing perceived power imbalances,
  - building trust, and
  - managing the logistics of working with geographically-dispersed partners.
- As partnerships involve organizations with different cultures that participate on a voluntary basis, leadership in such initiatives cannot rely on formal control over members but on specific set of capabilities such as:
- **system thinking** – ability to understand and communicate ideas with regards to technical, institutional and organizational relationships;
- **value based thinking** – ability to create and communicate compelling visions that motivate participation and commitment among partners;
- **collateral leadership and power sharing** – ensuring that a diverse array of role-players develop a commitment and capacity for taking decisions and contributing resources to lead to the success of the initiatives; and
- **process-based leadership** which entails cultural change, involvement, urban living labs and urban transition labs

TRIPLE HELIX MODEL



PARTNERSHIP WITH CITIZENS

- **Citizen engagement** is a predominant factor that influence the outcomes of smart sustainable city.
- The literature also suggests a mix of smart city solution between top-down, government-led approaches and bottom-up, citizen-driven approaches.
- Among disadvantages of both approaches, the top-down approach is detached from citizen needs and preferences while the bottom-up approach lacks sufficient coordination.
- A hybrid approach adopts elements of the top-down planning and coordination, and bottom-up citizen engagement and feedback.

PARTNERSHIP WITH INDUSTRY

- Smart city service or infrastructure development can be set up by different processes:
  - sometimes by central government authority,
  - sometimes in partnership between city authorities and private technology providers, and
  - sometimes in the forms of public-private governance arrangements .
- The most effective realization of this concept is through collaboration with businesses.
- A well-designed **public-private partnership** is a vital enabler to successful smart sustainable city initiatives.
- Many smart sustainable city projects are the result of private companies' investments in revenue-based solutions.

PARTNERSHIP WITH ACADEMIA

- Universities may be regarded as structurally aligned pools of human resources necessary for steering smart sustainable city policies ("knowledge cities"), with the key role for informatics and telecommunication engineers (Grimaldi and Fernandez 2017) and big data experts, who directly contribute to creating infrastructural solutions to critical problems (Mayer-Schonberger and Cukier 2013).
- Universities have been among the first actors interested in studying and experimenting with smart city pilots, thereafter being joined by many other stakeholders (Dameri, Negre, and Rosenthal-Sabroux 2016).
- The involvement of universities, industries and government in smart sustainable city planning, development and management responds to the triple helix model (Etzkowitz and Leydesdorff 1995).

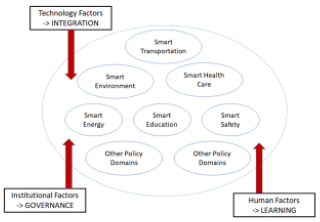
SOCIETAL AND ORGANIZATIONAL LEARNING

- An important outcome of successful partnership is individual and organizational learning, which is emphasized regarding the role of intermediary organizations in urban sustainability transitions (Hodson and Marvin 2010).
- **Organizational learning** is the process of change in thinking and action affecting individuals, groups and the entire organization, both embedded in and affecting the organization (Crossan et al.1999).
- The basic challenge of organizational learning is the tension between assimilating new learning (exploration) and applying what has been learned (Crossan, Lane, and White 1999).
- Managing the tension between novelty and continuity is critical (March 2008), positioning organizational learning as a fundamental strategic process and the principal means of achieving strategic renewal (Vera and Crossan 2004).
- Combining the stakeholder knowledge with knowledge introduced by communities, experts, researchers and governmental representatives helps identify collective problems and ideas to solve them. This, in turn, influences social learning and the sharing of the information learned with decision-makers (Dyer and Dyer 2017; Neuvonen and Ache 2017; De Oliveira Musse et al. 2018).

INNOVATION ECOSYSTEM

- New technologies, limited budgets, turbulent and disruptive environment, etc. all put pressure on cities. Facing such pressures, city governments must be prepared to undergo internal change.
- As smart sustainable initiatives are by nature innovative, in order to execute and benefit from such initiatives cities must be also ready to innovate. However, innovation requires a different management approach than traditional city operations (Bergh and Viaene 2015).
- Innovation forces city governments to look beyond front-end improvements and digitalization, towards end-to-end improvement that including back office processes, and digital innovation.
- A smart sustainable city therefore emerges as a member in a larger **innovation ecosystem**, exploiting social and economic development thanks to the integration of universities, industry and government to generate a creative renewal in knowledge economy and society (Dameri, Negre, and Rosenthal-Sabroux 2016).
- Schaffers et al. (2011) conceptualize the 'urban value creation system' consisting of a smart city ecosystem in which different stakeholders build sustainable partnership in the context of an emerging green ecology.

THREE DIMENSIONAL SMART CITY MODEL



Source: Nam, Pardo, 2011

SSC ROLES

The urban development that leads from digital, to intelligent, to smart and smart sustainable cities requires a growing number of roles to work together in order to plan, design, implement and manage the ongoing city transformation, enabled by digital technology and digital innovation.

The concept of "**role**" is associated with a position in an organization, charged with specific responsibilities to discharge which an employee assigned this role needs certain "competencies".

- Political leaders
- Government leaders
- Project managers
- Public managers
- Technical staff
- Service staff
- Business managers
- Citizens

CIO ROLE

- A particular government leader role for smart sustainable city transformation is the city's **Chief Information Officer** (CIO).
- This role is responsible for smooth operation of the city's digital platforms and services, and for building and managing city-business-people partnerships to address city's needs using its digital platforms and innovations.
- CIOs play an important role in:
- urban transitions;
- authentic deliberation between disparate stakeholders and interests;
- particularly in highly polarized societies;
- maintaining distinction and linkage between deliberation and implementation;
- applying creative approaches to managing ambiguity and conflict (Hamann and April 2013).

ROLES FOR SSCs

COMPUTER SCIENCE

Product manager/Operations manager, Junior Hardware/Embedded Developer, Junior / Senior Backend (Fullstack) Developer, Software Developer, Digital Marketing Specialist, Software Engineer, Cloud Data Architect, Test Engineer, Senior Software Engineer- Central Systems, Senior Data Analyst / UI Designer, Android Tech Lead, Data Scientist, Software Developer for the Smart Community Unit, Programme Analyst, Software Engineer, Intern for front end development, C++ Developer, Development Manager, Smart City IoT Project Manager, IoT Solution Manager, Smart City and Smart Building, Machine Learning and Deep Learning Researcher, Computer Vision Researcher, Natural Language Processing Researcher, Machine Learning and Deep Learning Algorithm Engineer, Intelligent Platform Senior Architect, Intelligent Platform and Application Software Engineer, Intelligent Platform and Application Software Project Product Manager, IT Project Manager, smart grid specialist, Senior Cyber Security Analyst - SOC, Senior Java Engineer for Lohika Smart City Project, Test & Support Developer, Hardware Technician, Hardware Production Technician, Support Technician, Project Technician

ENVIRONMENT

Acoustic Measurement Engineer - Propulsion, Mechanical Engineer Energy Systems Aircraft Integration, Maintenance Planner, Principal Optical Sol Architect-Webscale, Earthquake Data Scientist, Flood Data Scientist, Coastal Storm Surge, Flood Data Scientist: Urban Flooding, Field Service Engineer, Sustainability Manage, Sustainability Program Coordinator, Environmental Specialist, Wind Turbine Inspector, FleetEngineer - Wind Turbine Blades, Wind Technician III, Wind Commissioning Technician, Energy Auditor, Energy Management Analyst, Senior Director, Sustainability Consulting

INDUSTRY

Product Engineering Intern, Senior Product Designer, Product Manager, Visual Designer, Content Marketer, Technical Designer Emerging Technologies, Product Stream Autonomous Drive, Senior Mechanic, Design Engineer, Engineer- Product Dewelopship, Electrical Design Engineer, Field Tech, Deployment Engineer, Loads Engineer, Electrical Motor Engineer, Engineer for Autonomous Flight Systems

ROLES FOR SSCs

MANAGEMENT

Director of Business Development, Sales Engineer, Deployment Project Manager, Sales & Marketing Intern, Safety & Reliability Engineer, Customer Support & Community Manager - Liquid, Head of Sales, Sales Agent, Partnerships & Business Development Manager, Customer Support Lead - Manager Service Client, Customer Success Manager, Customer Support Specialist, Account Manager, Contract Data Management Specialist, Senior Key Account Manager, Commercial Markets Lead, Business Analyst, Smartcities Media Sales-OOH/DOOH/Experiential, Manager of Engineering, Policy/Public Affairs Programme Manager, Strategy and Business Development Manager, Associate Director, Vertical sales engineer (VSE - Smart City), International Chief Technical Advisor on Sustainable Cities, Business Development and Sales professional, Smart City Sales Manager, Senior Director of Smart City Solutions, Management Consultant, CRM Specialist, Director Operations Sales, Works Manager, Director, Solar Energy, Commissioning Manager, Volunteer Admin & HR Team Leader, Wind Commissioning Technician, Wind Technician III, Wind Turbine Inspector, Works Manager, Development Manager

URBAN PLANNING

Urban Planner, Structural Design Specialist - CAD & BIM, developing a Strategic Plan for a Smart, Connected City, Project Assistant, LEED Project Manager, LEED Reviewer

SSC ROLES IN RELATION TO SUSTAINABILITY AND SMARTNESS

Sustainability				Roles	Smartness					
Environmental	Economic	Institutional	Social		Smart economy	Smart environment	Smart living	Smart mobility	Smart people	Smart governance
x				Contract Data Management Specialist, Sr. Key Account Manager, Treasury Manager	x					
x				Software Engineer, Account Manager, Business Development Manager, Chief Representative, Client Solutions Manager, Commissioning Manager, Content Marketer, Customer Success Manager, Customer Support Lead - Manager Service Client, Data Scientist, Director of Business Development, Director of R&D, Director - Solar Energy, Energy Management Analyst, Environmental Specialist, Field Service Engineer, Fleet Engineer - Wind Turbine Blades, IT Project Manager, LEED Project Manager, LEED Reviewer I, Product Engineering Intern, Product Manager, Product manager/Operations manager, Project Assistant, Sales & Marketing Intern, Senior Director, Sustainability Consulting, Senior Software Engineer- Central Systems, Smart City Sales Manager, Software Developer, Sustainability Program Coordinator, Sustainability Project Coordinator, Test Engineer, Vendor Relations Analyst, Visual Designer, Volunteer Admin & HR Team Leader, Wind Commissioning Technician, Wind Technician III, Wind Turbine Inspector, Works Manager, Development Manager		x				
x				Works Manager, Development Manager, Accounting Officer, Design Engineer, Developing a Strategic Plan for a Smart, Connected City, Electrical Design Engineer, Energy Auditor, Sales Executive			x			
x				Acoustic Measurement Engineer - Propulsion, C++ Developer, Deployment Engineer, Deployment Project Manager, Electrical Motor Engineer, Engineer for Autonomous Flight Systems, Field Tech, Intern for front end development, Loads Engineer, Maintenance Planner, Mechanical Engineer, Energy Systems Aircraft Integration, Safety & Reliability Engineer, Sales Engineer, Senior Frontend, Developer, Senior Mechanic, Software Engineer, Strategy and Business Development Manager				x	x	
x				Development Manager						

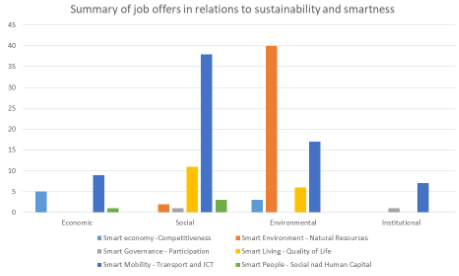
SSC ROLES IN RELATION TO SUSTAINABILITY AND SMARTNESS

Sustainability				Roles	Smartness					
Environmental	Economic	Institutional	Social		Smart economy	Smart environment	Smart living	Smart mobility	Smart people	Smart governance
			x	Business Development and Sales professional, Account Manager IoT Smart Cities, Account Manager of Smart City products, Business Development, Chief of Staff, City Operations, CRM Specialist, Director of Operations, Director Operations Sales, Electrical Motor Engineer, Engineer for Autonomous Flight Systems, Enterprise Account Executive, Front End Engineer, Hardware Production Technician, Hardware Technician, Head of R & D Projects, Manager of Engineering, Operations & Fulfillment Specialist, Operations Associate, Policy/Public Affairs Programme Manager, Product Designer (UX/UI), Product Manager, Project Technician, Safety & Reliability Engineer, Senior Cyber Security Analyst - SOC, Senior Procurement Officer, Senior Product Manager, Service Manager, Site Reliability Engineering, Smart Grid Specialist, Smart City IoT Project Manager, Software Developer, Software Developer for the Smart, Community Unit, Software Engineer, Support Technician, Technical Designer Emerging Technologies, , Product Stream Autonomous Drive, Test & Support Developer, User Support				x		
			x	Associate Director, Engineer frontend, R&D Engineer					x	

SSC ROLES IN RELATION TO SUSTAINABILITY AND SMARTNESS

Sustainability				Roles	Smartness					
Environmental	Economic	Institutional	Social		Smart economy	Smart environment	Smart living	Smart mobility	Smart people	Smart governance
x				Principal Optical Sol Architect-Webscale, Senior Data Analyst, Senior Product Designer, Talent Acquisition Specialist Europe, Talent Acquisition Trainee	x					
x				International Chief Technical Advisor on Sustainable Cities	x	x			x	
x				Android Tech Lead, Customer Support & Community Manager - Liquid, Head of Sales, IoT Solution Manager Smart City and Smart Building, Partnerships & Business Development Manager, Sales Agent, Senior Director of Smart City Solutions, UX / UI Designer, Vertical sales engineer (VSE - Smart City)						
x				Sustainability Manager						x
	x			Programme Analyst						x
		x		Business Development and Sales professional, Computer Vision Researcher, Intelligent Platform and Application Software Engineer, Intelligent Platform and Application Software Project Product Manager, Intelligent Platform Senior Architect, Machine Learning and Deep Learning Algorithm Engineer, Machine Learning and Deep Learning Researcher, Natural Language Processing Researcher				x		
x				Senior Director, Sustainability Consulting, Works Manager		x				
x				Management Consultant, Programme Analyst, Urban Planner, International Chief Technical Advisor on Sustainable Cities						x
x				Works Manager, Digital Marketing Specialist, Junior / Senior Backend (Fullstack) Developer, Junior Hardware/Embedded Developer, Business Analyst, Commercial Markets Lead, Developing a Strategic Plan for a Smart, Connected City, Digital Anthropologist/IoT Data Operations Specialist, Earthquake Data Scientist, Flood Data Scientist: Coastal Storm Surge, Flood Data, Scientist: Urban Flooding, Engineer- Product Stewardship, Smartcities Media Sales-OOH/DOOH/Experiential, Software Developer				x		

Summary of job offers in relations to sustainability and smartness



RESPONSIBILITIES

SSC Dimension	Responsibilities
Smart economy	• working closely with account teams and business users to develop and execute technical account strategies; • creating candidate profiles and supporting talent Acquisition Partners with accurately tracking candidate profiles through the relevant application steps; • developing and implementing robust quality assurance processes to include assurance for contract data completeness and accuracy. • customer signatures for contracts, • addendums, • pricing letters, and contract management controls; • managing daily cash positions across all bank accounts and preparing monthly cash management reports; • monitoring performance of existing technology and building business cases for technology enhancements; • develop company and departmental policies and procedures that will lead to enhanced cash management

RESPONSIBILITIES

SSC Dimension	Responsibilities
Smart living	• creating commercial go-to-market strategies; • working closely with the product team to understand and influence product roadmap while moving into the commercial vertical markets; • interacting with stakeholders in government, academia, and the private sector to negotiate data acquisition agreements; • collaborating with data science and engineering teams to ensure data sufficiency and quality control; • building models to improve damage prediction of structures due to earthquakes; • designing new software components and systems and re-designing existing software components and systems; • coordinating junior developers; developing designs in BIM, Revit, and AutoCAD under the guidance of the engineering team and project manager; • end-to-end design of IoT devices, board designs and production and testing procedures; • coordinating with network and hardware specialists to solve challenging problems cutting across various domains of technology and exposing efficient and robust APIs; • making intuitive, beautiful and performant mobile apps to expose exciting and challenging new use cases; • participating in all stages of product planning, right from envisioning to execution to delivery; • designing and executing inbound and outbound marketing campaign strategies for brand visibility and lead generation; • setting project governance, managing risks and variations in project scopes, managing internal and external stakeholders, overseeing project financials; • maintaining regular customer contact and following up in order to anticipate project, support or training needs, while keeping customer satisfaction; • developing specialized knowledge surrounding water management systems including sewers, storm drains, flood control, and more

RESPONSIBILITIES

SSC Dimension	Responsibilities
Smart environment	• IoT connectivity management; • writing good quality test specifications in the test management tools; • designing and implementing RESTful API servers and consumers to integrate platforms with other data providers/consumers; • assessing the privacy impact and shape what can and cannot be done taking into account the ethics policy and relevant legislation; • identifying suitable partners that will contribute to realizing the potential of application domains; • contributing to the development of new strategic areas that complement the Urban Data Project vision; • delivering software to agreed time and quality targets whilst working in Agile/SCRUM; • designing and producing communication assets for banners, • social media ads and other visual or motion products; developing leading edge strategies to expand the reach, impact, and quality of customer engagement including responding to and resolving customer queries through chat, email and social media; • building and executing a territory plan to sell technology in Europe; • providing LEED documentation management and support to project teams on green building projects; • installing, commissioning and testing AMCS hardware and software products including all wiring and mechanical work on refuse collection vehicles; • and recording and reporting all service and repair visits using ERP system to meet and/or exceed the expectations of customers

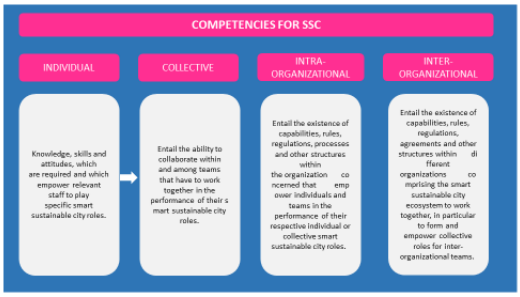
RESPONSIBILITIES

SSC Dimension	Responsibilities
Smart people	• organizing the fund. • researching new opportunities, • managing projects; • developing, implementing, maintaining and monitoring a range of KPIs for each centre in respect of energy use, waste volumes, recycling targets, carbon reduction; • ensuring the development of effective internal relationships with procurement, development, design and construction, • facilities management, shopping centre retailers, waste teams, cleaning teams, centre teams, to enable their effective participation in environmental and sustainable requirements; • creating the kite energy and sustainability program; • creating a cost-benefit analysis for financial investments; • designing and developing 3D rendering components and virtual humanoid animations.
Smart governance	• providing client-centric, value-added management consulting services to a variety of strategic and operational opportunities and practice areas; • supporting respective City Program and Service Leads in the development and implementation of smart city initiatives from an I&T and smart city framework perspective; • and consulting with relevant municipal, provincial, federal and international subject matter experts to conduct required research and sharing relevant research materials.

SSC COMPETENCIES

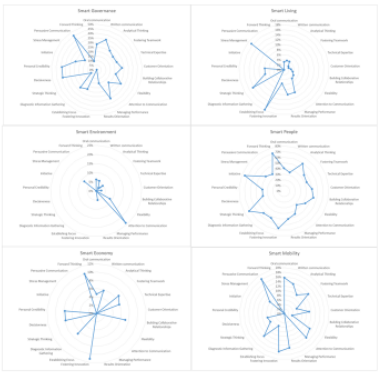
- Smart sustainable cities require strong competencies for public governance in the digital world.
- The concept of **competency** (Blanchard and Thacker 2004) comprises knowledge, skills and attitudes that allow employees to discharge the responsibilities associated with their assigned roles.
- **Knowledge** is the cognizance of facts, truths and principles gained from formal training and/or experience; the application and sharing of knowledge is critical to individual and organizational success.
- A **skill** is a developed proficiency or dexterity in mental operations or physical processes acquired through specialized training; the execution of skills results in successful performance.
- An **attitude** is a kind of soft skill to perform in physical or mental activities affiliated with a given profession.

TYPOLOGY OF COMPETENCIES FOR SSC

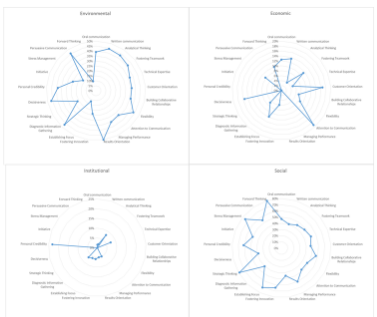


SKILLS AND ATTITUDES FOR SSC

SOFT SKILLS IN RELATION TO SMARTNESS



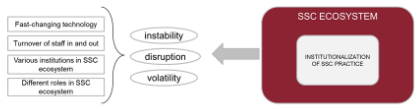
SOFT SKILLS AND ATTITUDES IN RELATION TO SUSTAINABILITY



DEMAND FOR EDUCATIONAL DEGREES FOR SSC

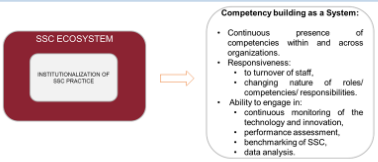
Dimensions of smartness	Degree	Field
Smart Economy	Bachelor, Bachelor of science, Master, Master of science, MBA	computer networking, accounting, finance, economics
Smart Environment	Bachelor, Bachelor of science, Master of science, MBA	computer science, ICT, electrical engineering, electronics engineering, software engineering, marketing, journalism, business administration, sales, environmental science, management, economics, policy, architecture, engineering, public health, environmental management, aerospace engineering, mechanical engineering, business, physics, math's science, ecology, media, education, sociology, international relations, science, material science, sustainability
Smart Living	Bachelor, Bachelor of science, Master, Master of science, PhD, MBA	structural engineering, geophysics, civil engineering, engineering, architecture, planning, environmental science, natural resource management, material science, technology, chemical engineering
Smart People	Master	architecture, engineering, sustainability, mathematics, informatics, meta-programming
Smart Mobility	Bachelor, Bachelor of science, Master, Master of science, PhD, MBA	mechanics, aerospace engineering, administration, electrical engineering, robotics, mechatronics, electronics, it, computer science, information systems, computer engineering, telecommunications electrical engineering, statistics, mathematics, marketing, business, management, public administration, economics
Smart Governance	Master, post-secondary education, MBA	energy, transport, waste management, urban economics, environmental sciences, urbanization, public, business administration, business technology, managing information systems

SSC COMPETENCY BUILDING



- **Institutionalization of SSC practice** means a systematic development of competencies among various individuals and teams working within and across government, business, civil society and other organizations taking part in the smart sustainable city ecosystem, specific to the roles they are supposed to play within such ecosystem.
- Complementing the nature of smart sustainable cities, competency development must be sustained, i.e. take into account:
  - the turnover of staff in and out of different organizations,
  - roles and teams operating within the smart sustainable city ecosystem,
  - the evolving landscape of technological and smart sustainable city innovation that affects the expectations and responsibilities associated with various roles,
  - and the nature and content of the competencies required for such roles.

SSC COMPETENCY BUILDING

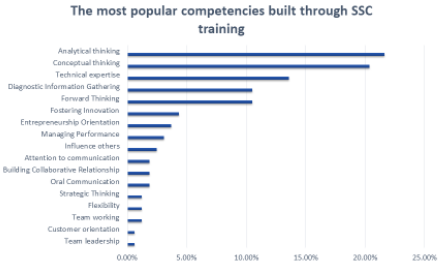


- The central role in SSC ecosystem should be played by academic institutions.
- Competency building requires the development of relevant education and training programs, maintaining the relevance of such programs, and building the capacity of university faculty to deliver such programs to relevant audiences within the smart sustainable city ecosystem.
- Decision support requires the performance of analytical and research tasks in response to the needs and in close collaboration with city administrations and other partners in order to ensure the provision of relevant local data and experience, and validate research findings.

ACADEMIA ROLE IN CMPETENCY BUILDING

- Education, training, research and analysis are all core businesses of academic institutions.
- Challenges:
  - Lack of specific know-how on how to apply their core business to the domain of smart sustainable cities.
  - Lack of the tradition of multi-disciplinarity, i.e. experts in informatics, management, economics, urbanization and other disciplines working together on the problems of smart sustainable cities.
  - Lack of the capacity for sustained collaboration in education, training, research and analysis with city administrations, businesses, civil society and other actors in the smart sustainable city ecosystem.
- Symmetrically, city administrations and other actors in the ecosystem may be lacking the collaboration capacity with academic institutions. In turn, such collaboration requires building inter-organizational capacity for smart sustainable cities.

COMPETENCIES DEVELOPED BY EDUCATION PROGRAMS FOR SSC



SKILLS BUILT BY EDUCATION PROGRAMS

Knowledge and skills	Program groups			
	Sustainability group	**Smartness group**	**Specific smartness and sustainability group**	**Data science in smart sustainable cities group**
Skills	Realizing the cocreation sociotechnical policy contexts	Entrepreneurial and executive management skills	Discovering of the collected geospatial data	Assess the quality of urban planning
	Design processes within built environment	Open analytical and problem-solving mind	Predictive analysis and big data tools	Reduce cybersecurity challenges
	Enabling strategically influence feasibility design	Ability to communicate with technical and nontechnical audiences	Aim at discovering new possibilities	Improve liveability and governance of cities
	Builds the newest entrepreneurship thinking	Ability to gather new insights independently	Develop and implement the behaviours control algorithms	Learn online
	Combine theoretical and practical research	Ability to present ideas and innovative solutions	Applying smart technology-driven on the framework of internet of things	Solve the issues surrounding urban environment
	Realize the comparison of different real-life cases	Ability to analyse urban theory	Develop the model of complex system behaviours	Be aware in smart automations products

KNOWLEDGE BUILT THROUGH EDUCATION PROGRAMS

Knowledge and skills	Program groups			
	Sustainability group	**Smartness group**	**Specific smartness and sustainability group**	**Data science in smart sustainable cities group**
Knowledge	Advanced understanding of key sustainability issues	Deep knowledge on operational design	Approaches focus on complex AI systems	Understand of citizen design concept
	Understanding the key issues related to sustainable development	Deep knowledge on electrical energy	Knowledge of new the algorithms which will implement the research outcomes	Understand the internet of things
	Understanding the related key sustainability issues	Insights into ethical and social economic problems	Analytics of health	Understand the role and importance of data
	Ability to understand the sustainable and economically balanced city	Wider understanding of socioeconomic context	Analytics of new media	Understand various industrial stages

CAP4CITY

Strengthening Governance Capacity for Smart Sustainable Cities

THANK YOU FOR ATTENTION.

B. TEACHING MATERIALS – RESOURCES

https://livettu.sharepoint.com/:p:/s/SUSTAINProject/EdzAgv20UrxFihhUPfRexvUBYvLOf8QQ0olvmECooEnvNQ?e=CK3YdN

C. TEACHING MATERIALS – DEVELOPMENT

CAP4CITY

Strengthening Governance Capacity for Smart Sustainable Cities

MODULE: SSC COURSE DEVELOPMENT

Developed by: Magdalena Ciesielska, Tomasz Janowski, Gdansk University of Technology

POLITECHNIKA GDAŃSKA

CAP4CITY WP4 D4.1 Training on development SSC related courses

Agenda

1. SSC Course Development
2. Competencies
3. Learning Objectives
4. Target Audiences
5. Pedagogical Approaches
6. Creating Curricula

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Development 65

SSC Course Development

- The overall process of a new course development consists of a few steps.

- Substantive content development
- Choice of the pedagogical method
- Production of materials
- Pre-test
- Pre-test assessment
- Implementation of the course at the platform
- Course delivery and attain
- Course assessment
- Modification, testing, implementation
- Final course assessment

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Development 66

SSC Course Card

The course card is the main document of the course and provides:

- overall information about the course within the university study program,
- detailed course description to the learners,
- learning outcomes concerning knowledge, competencies, and skills developed during the course realization,
- consistency with an educational program in the field of study,
- overview of student's effort measured by the working hours,
- pre-requisite competencies requested from the learners,
- the passing and failing criteria,
- the recommended and supplementary literature,
- tools and resources,
- the costs associated with the course (software licenses, certificates, outdoor classes, etc.),
- communication methods,
- some examples of the assignments, tasks delivered during the course.

Course name			Course code			
Field of study						
Date of commencement of studies			Academic year of course realisation			
Education level			Subject group			
Mode of study			Mode of delivery			
Year of study			Language of instructions			
Semester of study			Assessment form			
Learning profile						
Unit responsible for the course	Department of ...					
Lecturer(s)	Course supervisor					
	Teachers/ instructors					
Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	Total
Number of study hours						
Number of e-learning hours						
Learning activity	Contact hours in class		Contact hours at consultations		Self-study	Total
Number of study hours						
Course objectives	• ... • ...					
Learning outcomes	Course outcome		Learning outcome		Verification method	
	Knowledge: Competency: Skills:					
Course curriculum	Lecture_1 Lecture_2 ...					
Pre-requisites and co-requisites						
Assessment methods and criteria	Subject passing criteria		Passing threshold		Percentage of the final grade	
	Written colloquium Laboratory Project					
Recommended reading	Basic literature					
	Supplementary literature					
	Link to e-resources					
Example issues / example questions / tasks being completed						
Work placement						

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Development 67

Competencies

The CAP4CITY project provides a wide range of competencies identified by the various project's deliverables:

- extensive vacancy review identified multiple roles for SSCs and assigned competencies;
- database of SSC-related education programs;
- database for SSC-related education content;
- competencies related to the educational programs and field of study.

- High-level competencies
- The learning objectives
- Individual course elements

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Development 68

Competencies developed by the workshops sessions

Competence
1. Design education strategies for citizenship exercise and environmental and social awareness
2. Develop the ability to plan and execute digital inclusion strategies
3. Establish governance mechanisms
4. Develop representativeness and protagonism
5. Establish assertive communication among actors
6. Collect and analyze data for incremental or disruptive innovation
7. Establish mechanisms for openness and participation
8. Promote environmental and social awareness
9. Develop long term planning
10. Develop planning and management skills
11. Improve innovation capacity for social development
12. Establish collaboration mechanisms
13. Understand emerging technologies and their potential uses
14. Lead and work with multidisciplinary teams
15. Develop convergence among different levels of government and social actors
16. Identify and analyze society's demands and specificities
17. Develop empathy skills
18. Define methods, objectives and guidelines
19. Use big data to support decision making
20. Improve public resources management
21. Insert ICTs in management processes

Source: Extract of the competencies developed through the workshop sessions

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Development 69

Competencies developed by the workshops sessions

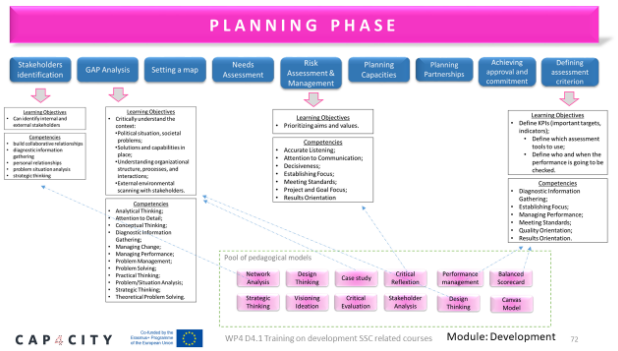
University	Field of study	Competencies Workshop #1
UNIVERSIDAD EXTERNADO DE COLUMBIA	Planning	Apply data science for public policies Plan with awareness about the local context Adjust the gap between citizen's need or problem and the perception that the State has about that same need or problem (...)
	Legal framework	Know the legal and regulatory frameworks for SSC Understand the impact of new legal instruments that support changes to promote SSC initiatives. (...)
	Innovation	Know new and different methodologies for designing SSC services. Adapt innovations to a specific context (...)
	Technology	Apply data science to guide the formulation of public policies Develop cybersecurity services to promote community trust in digital services

Source: Extract of the competencies developed through the workshop sessions

Competencies defined by SSC Roadmap

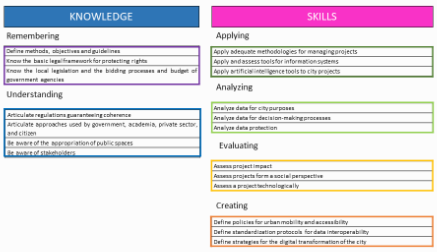
To access the full catalogue of SSC Roadmap phase and associated competencies go to: https://livettu.sharepoint.com/:x:/r/sites/SUSTAINProject/_layouts/15/Doc.aspx?sourcedoc=%7B7B676420-2AC0-4752-B78B-518FFD75983009%7D&file=CAP4CITY-D2.1-Roadmap-steps-Mapping-Training-%20WORKSHOP%20RESULTS.xlsx&action=default&mobileredirect=true

Step	Description	Competencies	Training Needs / Pedagogical Approach
Planning Phase			
Planning Capacities	Defining **who** is going to be involved / reviewing who is involved *Definition of Roles and Responsibilities (internal and external); *Champion (leader) definition to promote the SSC initiatives, check performance, ensure communication and motivate stakeholders.	• Analytical Thinking; • Building Collaborative Relationships; • Decisiveness; Developing Others; • Empowering Others; • Fostering Teamwork; • Frequent Interaction with others; • Human-awareness; • Influencing Others; • Leading Others; • Managing Performance; • Persuasive Communication.	Stakeholders Analysis; Canvas Model; Design Thinking.
Managing Policies and Capacities: Engaging Citizens and Establishing Partnerships			
Engaging Citizens	*Create mechanisms to allow citizen participation and co-creation; *Create a communication plan. * Make use of coordination mechanisms; * Establish horizontal structures (to foster collaboration).	• Effective engagement; • Stakeholder identification; • Allow discussions.	• Discussion; • Workshops.
Putting in Practice			
Creating SSC solutions / services / initiatives	*Initiatives for all city areas and basic community needs; *Solutions for Smart Education, Smart Health, Smart Energy, Smart Water, Smart Waste management, Smart mobility, Smart Buildings and constructions	1) Project Management Skills; 2) Ability to solve interdisciplinary problems; 3) Technological Knowledge; 4) Urban Planning.	• Problem based learning (for 1); • Working in teams (multidisciplinary and multicultural) (for 2).



Competencies' Analysis

- The full list of competencies defined within the workshops is presented in Appendix E.



Framework for Competency Development

- Identifying behaviours, habits, and problems linked to the local community. This could entail participation or even directly working with community actors.
- Recognizing the possibilities of different technologies for improving the quality of life of citizens and communities (not all instrumental technologies, but organizational and symbolic technologies that concern processes).
- Identifying the barriers and problems that these technologies can cause.
- Analysing case studies that describe the use of technologies and solutions in the local context.
- Planning strategies, procedures and policies that address ethical aspects of integration into everyday life.
- Apply planned solutions in different areas, for example, transportation, education, institutional transparency, environment, procedures, etc.
- Define legal and regulatory mechanisms to regulate the use of technologies.
- Define indicators or metrics that allow the evaluation of the implemented projects.

Learning objectives

- The importance of objectives in planning, teaching and evaluating educational sessions is widely recognized.
- Learning objectives can be referred to many different names, including instructional objectives, educational objectives, performance objectives and intended learning outcomes.
- Learning objectives are expected, observed, teachable and learnable behavior of the target audience.
- Objectives are intentional and expected results to be achieved by most of the course participants.
- The learning objectives are a statement of what learners will exhibit by the end of the lesson, unit or course.

Learning Objectives

- The purpose of the learning objective is to provide the learners' perspective, explaining what the student will learn, what he/she should know, what should he focus on, and how does it apply to him personally? It orientates the student's concentration on important aspects, provides certainty of what they are learning and why they are learning particular content.
- Secondly, the learning objectives benefit the teacher's effort to reassure the learners, stay focused on the learning path, align instruction to the stated goals.

Learning objectives

- At the begging of the learning objectives formulation, the teacher is recommended to take set back and to answer a few fundamental questions regarding the course's outcomes such as:
  - *What is the course goal?*
  - *What is the expected outcome?*
  - *What will my students gain from this experience?*

Learning objectives

The teacher can use the following questions to investigate the course's outcomes:

- *What are the students expected to do?*
- *What re the students expected to say?*
- *What are the students expected to perform?*

The components of the learning objective

- what they will learn,
- by when they will learn,
- to what degree they will learn,
- under which conditions they will learn,
- with what resources they will learn, and
- under what constraints they will learn.

A learning objective can be broken into two parts, an observable action and a subject.

Learning objective- example

Student	know how to engage local stakeholders
Audience	Behaviour

Student	create process models
Audience	Behaviour
(simplified)	of smart sustainable city
Degree	Condition

By the end of the lecture, a student will be able to:
Explain the role of CIO in local level government
Identify responsibilities assigned to CIO's role in local level government
Choose the optimal place of CIO in the organization structure of local-level government

ABCDs: Audience, Behavior, Condition, Degree

Behavior element

- The behaviour element of the learning objective needs a verb that indicates learners' behaviour.
- These are understood as the observable, behavioural terms to assess learner's progress and achievements.

Level	Verbs
COGNITIVE DOMAIN	
Knowledge	Define, describe, identify, label, list, name, state
Comprehension	Discuss, estimate, explain, give examples, identify, locate, paraphrase, report, restate, summarize
Application	Apply, change, compute, demonstrate, modify, operate, prepare, produce, relate, select, solve, use
Analysis	Analyse, arrange, break down, compare, differentiate, illustrate, infer, outline, relate, sort, select, categorize, criticize, detect
Synthesis	Arrange, categorize, combine, compile, compose, design, formulate, generate, modify, organize, plan, relate, reconstruct, revise, summarize
Evaluation	Appraise, assess, compare, conclude, contrast, criticize, debate, defend, evaluate, judge, justify, revise, score, summarize, support

Learning objectives: general and specific

- General objective:

  Understand organizational restructuring of the SSC

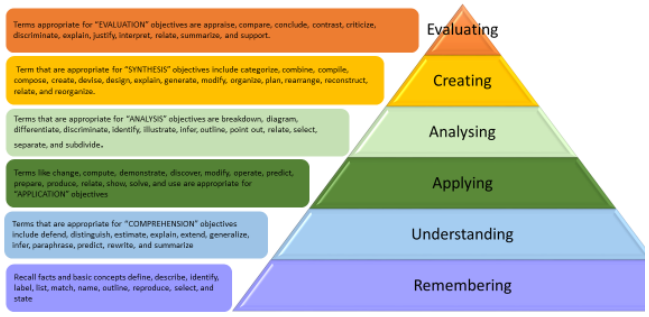
- Specific objectives:
  - Know organizational processes
  - Design the organization structure of an SSC
  - Describe the ICT-driven organizational change in local government

Course description

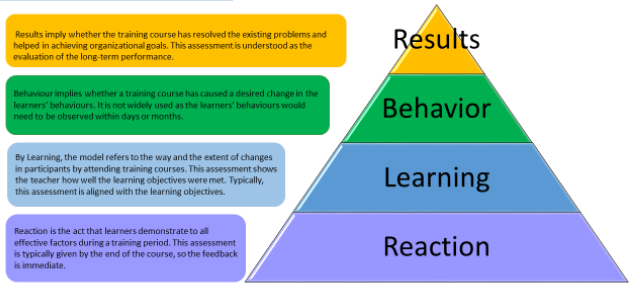
This course, Smart City Governance, is designed for learners with little or no background smart city governance. It provides an introductory examination of strategies that benefit all community stakeholders, stakeholders management, strategic partnership establishing and maintenance. Our goal is to understand the governance mechanisms of the smart sustainable city.

- While course descriptions look much like learning objectives, they are not the same.
- The difference is that the course descriptions' statement is broad. It provides a general sense of the course content but not specific skills or knowledge the student will gain.

Bloom's Taxonomy

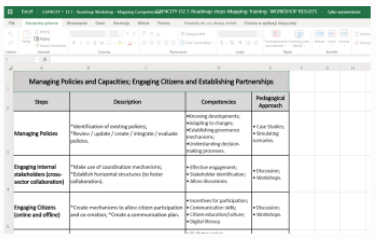


Kirkpatrick model



Cap4City tools for setting the learning objectives

Tool: Roadmap for SSC



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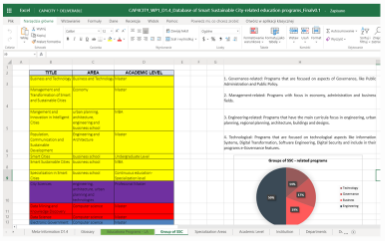
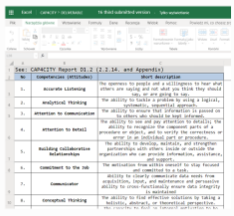
Cap4City tools for setting the learning objectives



D1.4 The database of SSC-related education programs



D1.5 The database of SSC-related education contents

Target audiences

- Courses are delivered in many ways beyond the traditional classroom.
- With all these different deployment methods, teachers must take into account different learner audiences:
  - university,
  - corporate,
  - government,
  - independent professionals,
  - clerks,
  - managers, and more.
- The teacher needs to consider possible combinations of audiences with deployment methods.
- This gives him many possibilities to conduct the course and modify the objectives to specific audience requirements.
- The adjustment occurs in the number, granularity, style and brevity of objectives, not in the learning objectives!

Target audiences

- The target audience of the SSC courses is various SSC stakeholders.
- Thus, the course content could be modified regarding business participants:
  - vendor employees that need to know the functioning of the local government,
  - team members of the government IT departments that need to expand their knowledge on agile product development,
  - government decision-makers looking for methods of smart city management and governance.
- It is recommended to know the target audience well, even survey the target audience before the course starts, rather than continue to learn more about the audience, their abilities, motivations and expectations during the course.
- It is challenging to create a personalized course plan for each learner but taking time to consider some of the above-mentioned issues about the group helps to tailor the instruction to the specific audience.

Pedagogical approaches for SSC course

- The workshops held in Latin America (Estevez et al. 2019) determined many different options for organizing and delivering SSC training.

1.	agreements with municipalities to capture and analyse large volumes of real data
2.	analysis and discussions about existing theories
3.	the applied workshop, models, robotics, etc. to integrate practice and theory
4.	case study analysis including different type of resources, like videos, cases, etc.
5.	communities of practice
6.	contests
7.	conversational initiatives
8.	debates
9.	fellowships
10.	fieldwork – getting out of the classroom
11.	future labs for planning the city
12.	innovative exercises, as a part of fieldwork
13.	invited citizen sharing personal story-telling
14.	invited experts from different countries and disciplines

Pedagogical approaches

- The same workshops also determined possible pedagogical methods applied in different knowledge domains. Such methods, with knowledge domains and examples

Knowledge domain	Pedagogical model	Examples
Energy management	problem-based learning	• identify the critical components of the energy matrix • plan and implement efficient electrical management
Data intelligence for decision making	problem-based learning	• ability to develop intelligent systems applicable in different areas • exploit information from different sources for decision making
Environmental quality	project- and problem-based learning	• identify critical aspects/issues and their interrelation • develop and implement solutions • raise awareness of the environmental issue
Security of people and data	project- and problem-based learning	• identify problems and solutions for the safety of people (crimes, accidents, natural disasters) and data (hacking, etc.) • implement technical solutions and public policies • train in the perception of risk for the citizen

Learning styles

- Social-interpersonal style - characterizes those that prefer to learn in groups,
- Solitary-intrapersonal style - prefers to learn in isolation.
- Verbal style - in which the learner usually learns the best while speaking or writing.
- Auditory style - in which the learners learn by listening.
- Visual style - means that learners prefer pictures, images, diagrams, and videos to understand the concepts.
- Logical style - uses systems and mathematical reasoning, as well as kinaesthetic, understood as hands-on activities, movement and touch.

Most learners characterize the combination of a few learning styles.

Activating methods

- Activating methods are a group of methods that are meant to make teaching and learning take place unconventionally.
- Classes should motivate students to act, think creatively and solve problems creatively.
- Activating methods make the learner become a person who has an impact on what will happen during the lesson, becoming the co-creator of the didactic work.
- This group of the method is based on learning through action, cooperation, and experience.

- There are three levels of communication when using activating methods:
  - communication refers to the task and the goal that is to be achieved
  - communication refers to the relationship that occurs in the group when working on a problem
  - communication refers to personal impressions and feelings that the individual feels during the task

Activating methods

- Integrative methods
- Creative problem-solving methods
- Developing creative thinking
- The drama method
- Simulation method
- Discussion

Excercises

- The objective of the exercise is to develop skills, conscious use of scientific knowledge in various mental operations, research work, and practice.
- It is an introduction to self-studies and to independent student work in solving problems, getting information, confronting and analysing information, creating favourable conditions for teaching independence.
- The role of the exercise task is to:
  - supplement, deepen and expand knowledge obtained during the lecture and from the textbook;
  - develop skills, cognitive interests, ability to creatively solve problems, and shape scientific interests;
  - control and self-control of understanding and composure of the material;
  - develop skills to use appropriate research methods in a particular scientific discipline; and
  - prepare for future work by assimilation of professional skills, linking theory and practice.

Excercises for SSC courses

- blended learning
- case studies: select existing cases, develop and test cases, enable multipliers in teaching cases
- collaborative learning
- design thinking: a solution-based approach to solving problems in a practical way which includes field data collection and the development of prototypes
- entrepreneurship when assessing projects and proposed solutions in project-based and problem-based learning
- flipped classroom
- gamification: the application of games can help think about an ideal smart city and focus on solutions
- learn by doing
- multidisciplinary project-based learning
- oral and written communication
- peer-to-peer learning
- practical cases
- problem-based learning: focus-group approaching problem solving under a troubleshooting lab concept
- project-based learning: the development of projects can be useful to drive students to reach results after a certain time, as well as to focus on an objective situation
- research-based learning
- service learning: identify problems, make proposals for a solution, present solutions to those who can apply them
- station rotation: while working in groups with different activities, for example, dimensions of city challenges, the activities/roles rotate to involve all groups
- story-telling: a story of a city can be created, involving all actors and artefacts, past facts and city challenges, as a way to better discuss contextual elements
- teamwork
- technology-mediated interactive applications, like, e.g. apps deployed in smartphones

Creating curricula for SSC course

- Timing can be one of the most difficult things to plan when creating SSC course.
- Recommendations:
  - consider a timeline,
  - consider scope - depth at which one would cover information
    - to assure that learners understand the concepts being taught,
    - how much time is available to cover that subject, and
    - what level of understanding is necessary for this particular subject
  - consider the sequence of instructions
    - broad → specific
    - simple concept → complex concept
    - micro → macro

SSC course design

- Upward model - instructions are created by first considering the topic that is to be taught, then determining what will be taught, planning the delivery and creating assessments at the end.
- Backward design flips this model and determines the final results (learning objectives) that the teacher wants the learners to achieve first.

SSC course logistics

- When developing the curricula, a teacher should consider the logistics of the course.
  - The relevance of the instruction – how existing instruction fits the overall picture of the course? Is it mandatory or optional? Is it a pre-requisite for further learning? Is it something the learners must pass to move on?
  - Time constraints – when will the training begin and when will it end?
  - Format – is it a face-to-face contact with the learners, or will the instructions be done online?
  - Access to the resources – when will the learners be able to access the resources? Do they need to obtain them directly from the teacher, or obtain them online? Do learners have a way to access online content?
  - Communication plan – establish the way that the learners can contact the teacher with questions. Is it through the learning management system, form, email, phone, text? Can the learners contact each other, and how?

Educational case study #1

- Select a case study from the worksheet „Cities – case studies”
- Examine the sets of desired competencies
- Compare it with the contents of „SSC competencies”
- Analyse and discuss whether the competencies were accurately formulated by the initiative

Educational case study #2

- Go to the „Job vacancies” worksheet
- Aggregate the data from different countries
- Build an aggregated list of expected competencies for each of the countries
- Compare the findings for each country
- Analyse and discuss whether there are regularities within the offers coming from a country
- Analyse and discuss whether such regularities vary between different countries

Educational case study #3

- Go to the worksheet „Material – readings”
- Select a number of publications covering a relatively wide timespan
- Read it (given their accessibility) and note some significant conceptions and postulates
- Analyse and discuss whether conceptions are evolving
- If so, discuss how technological and social progress may impact them

CAP4CITY

Strengthening Governance Capacity for Smart Sustainable Cities

Thank you for attention!

D. TEACHING MATERIALS – DELIVERY

CAP4CITY
Strengthening Governance Capacity for Smart Sustainable Cities

MODULE 5: SSC COURSE DELIVERY

Developed by: Magdalena Ciesielska, Tomasz Janowski, Gdansk University of Technology

POLITECHNIKA GDAŃSKA

CAP4CITY WP4 D4.1 Training on development SSC related courses 104

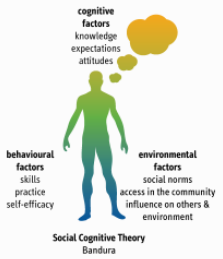
Agenda

- Social Learning Theory
- Connectivism Theory
- Student-Teacher Relationship
- Forms of Distance Learning
- Communication in Distance Learning
- Motivation in Distance Learning
- Designing Attractive Classes

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Delivery 105

Social Learning Theory

- Learning is a cognitive process: people learn in the social context and learning may occur even without performing the directly reinforced behaviours.
- People learn by observing other people's behaving and the consequences of such behaviour.
- Such behaviours can serve as models that we can imitate.



CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Delivery 106

Types od learning models

- Live models – with the live model, a person demonstrates the desired behaviour that we can observe directly, in order for us to imitate this behaviour. They show us what to do.

CAP4CITY WP4 D4.1 Training on development SSC related courses Module: Delivery 107

Types od learning models

- Direct instructions – with the direct instruction model, a person describes the desired behaviour in detail and provides instructions to learners about how to do it then they perform the described behaviour.
- Classrooms, life chats and community fora often require direct instructions.

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Types od learning models

- Symbolic instruction – with the symbolic instruction, modelling occurs through media including the web, written and/or illustrated information, video and audio, in the form of instructional materials.
- The situations may be real or fictional. People can learn from animated characters and imaginary situations as easily as they can learn from people in real situations. A learner then performs the behaviour as instructed.
- Examples of symbolic instruction are instruction manuals, books, self-directed training, frequently asked questions, and help centres.

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Social Learning Theory

- Social learning is increasingly used in mass education. It is nothing more than learning with an emphasis on human interaction with the social environment. The theory assumes that new skills are acquired through two mechanisms:
  - Modelling, i.e. learning by observing someone else's actions and effects. The condition is to focus on the behaviour of the model, remember this behaviour, and try it out in practice.
  - Learning through consistency.

Connectivism Theory

- Connectivism is a theory of teaching adapted to the possibilities created by the digital age.
- One of the most important aspects of this theory is using a network with its various nodes and connections as a central metaphor for learning.
- A node can be anything that connects to other broad information, data, feelings, and images.
- Learning is the process of creating connections between different nodes and developing the network.

Connectivism Theory

- The principles of connectivism include:
  - learning and knowledge are based on diversity of opinions,
  - knowledge can exist in various devices,
  - learning is related to specific information resources,
  - the potential to acquire knowledge is more important than what we currently know,
  - the most important is updating knowledge,
  - decision making is a learning process, and
  - the knowledge one needs lies at the heart of learning activities.

Student – Teacher Relationship

- An e-learning teacher should have the following competencies:
  - competencies in information technology,
  - competencies in education design,
  - competencies in analyses and
  - business competencies.

Student – Teacher Relationship

- The student also needs to develop various competencies like reading comprehension, regularity, communication and teamwork. Typical student needs and expectations are the following:
  - a precise definition of the rules of work in the course,
  - rules of passing, rules of communication and deadlines,
  - methods of assessment,
  - good course navigation,
  - the right volume and variety of materials,
  - constant contact with the teacher,
  - teacher's involvement,
  - flexible task deadlines,
  - provision of feedback,
  - technical support, and
  - individual approach.

Recommendations for organizing e-learning

- Preliminary course information and syllabus should always be available, preferably in the first module.
- The syllabus should be available no later than at the beginning of the first lesson.
- Before starting the first lesson, learners must have information on:
  - The schedule and the rules of work. This includes rules for assessment and passing the course, deadlines for test publishing, task assignments, activities, and forms of communication such as fora, reports and solutions.
  - Communication media and hours of consultation with the teacher. The consultations should be held both online and traditionally at the university campus.

Help to students includes:

- choosing learning methods and techniques to eliminate learning difficulties;
- remembering that the course material should be adjusted to the course timeframe;
- understanding that not every student has the right skills such as independence or good work organization;
- not underestimating simple technical problems so as not to discourage students;
- students learn when they have time, and when they solve problems;
- students first learn what interests them, and only later what will be useful to them;
- students cannot be left alone, communicating with the teacher and other students are key;
- students learn faster when their mistakes are corrected and when supported by advice;
- the teacher is required not only to check students but also to motivate and activate them; and
- science is primarily based on communication.

Forms of Distance Learning

- Distance learning occurs when a teacher does not have direct contact with students. Interpersonal communication is replaced by traditional mail and communication technologies.
- E-learning enables contact between teachers and students via the Internet. It is recommended:
  - when a course has a deep curriculum,
  - when a course is attended by many students,
  - when students are geographically dispersed and have limited mobility,
  - when students have access to the Internet and possess their own devices,
  - when students are motivated to learn,
  - when the content will be used in the future,
  - when the training aims to build cognitive skills, and
  - when there is a need to collect data.

Forms of Distance Learning

- Blended learning is also called mixed, complementary, or integrated learning. It combines traditional learning methods – direct contact with the teacher during traditional classes, with activities conducted remotely using a computer and the Internet. The content determines which elements are taught traditionally and which remotely.
- Advantages of blended learning:
  - opportunity to meet students during traditional classes;
  - within the process of remote education, students gather knowledge and develop skills using the best method.
- Models of blended learning:
  - program flow model – the learning activities are organized in sequential order, and the learners have deadlines to accomplish various assignments; and
  - core-and-spoke model – the major learning course is provided, and a set of supplemental materials is available to extend the main course.
- Flipped classroom is learning at home from multimedia materials provided by the teacher. The flipped classroom allows individualized teaching.

Communication in Distance Learning

- Synchronous communication, the communication between the learners and teachers and between the learners themselves takes place instantaneously and in real-time.
- Examples of synchronous communication tools are chat and instant messaging, audio and video conferences, webcasting, application sharing, whiteboards, polling, etc.
- In the case of asynchronous communication, the learners receive a response after some time.
- Examples of synchronous communication tools are mail correspondence, online material, multimedia, email, podcasts, videocasts, blogs, webcasting, wiki, discussion forum, etc.

Motivation in Distance Learning

- A few simple rules to maintain a high level of motivation includes:
  - keeping a friendly atmosphere,
  - taking care of well-defined credit rules and time frames,
  - providing feedback to student assessment,
  - adapting the learning pace to the speed of the learners,
  - adopting various delivery methods which activate participation such as, e.g. games or control questions, and
  - replying to forum posts as promptly as possible so as not to lose interest in the course.

Designing Attractive Classes

- Do not use longer text.
- Use large numer of graphical elements to illustrate discussed content.
- Conduct a small number of hours of distances classes at the start of the course.
- The content should be dosed in small information packages that can be consulted often.
- Film materials should be no longer than five minutes.
- Elements that can be visualized should be visualized.
- Numerous repetitions during reading classes will help learners to properly master the material.
- The teacher should regularly update information on fora, check tasks, and provide feedback on tests.
- Distance course modules should be published in the right order.
- Evaluation surveys should be used to improve content quality.

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Strengthening Governance Capacity for Smart Sustainable Cities

Thank you for attention!

E. AUXILIARY MATERIALS – COMPETENCIES

The following tables provide SSC competencies associated with the taxonomy by Bloom and Krathwohl (1956).

Table 24. Competencies for Smart Sustainable Cities – Remembering

Define methods, objectives and guidelines
Know the basic legal framework for protecting rights
Know the local legislation and the bidding processes and budget of government agencies
Know about available tools and their scope
Know about citizens and their needs
Know about emotional intelligence
Know about financial supports
Know about financial programmes
Know about information security and how to assess tools
Know about international, national and local standards and policies for city development
Know about local history and prospects
Know about local sociology
Know about public policies and the state
Know about sustainable development goals
Know about telecommunications
Know about the purpose and value of technology
Know about biotechnology
Know about citizen participation and open data
Know about new technologies, e.g. artificial intelligence, internet of things, block-chain
Know about web applications
Know actors and their relationships with sustainable collaborative economy
Know and recognize the roles and actors linked to the design of smart cities
Know approaches for adapting and formulating new regulations and norms for the SSC
Know basic technologies for software development
Know concepts about anthropology
Know how research based on state of the art can restrict the validity of the exercise
Know how to conduct critical benchmarking
Know how to focus on cross-cutting social inclusion issues
Know how to govern the local stakeholders
Know how to interpret and modify existing norms to adapt them to the 4th industrial revolution
Know methodologies for quantitatively assessing benefits of SCC
Know methodologies for social studies for conducting effective fieldwork
Know new and different methodologies for designing SSC services.
Know the economic relationships of the city, the economy-forced migrations (from rich neighbourhoods to suburbs, and from suburbs to the farms), and new economic models (collaborative markets)

Know the epistemological view of the citizenry
Know the legal and regulatory frameworks for SSC
Know the new collaborative economic models
Know the norms for different projects
Know the urban history and plan with a prospective view
Know the various city sectors – transport (networks, systems and flows), energy, governance
Know about data scouting
Know about international norms
Know about local legal-institutional structures
Know how to keep up-to-date with technology
Know methodologies applied in successful case studies
Know methods for civic education
Know models for territorial innovation
Know technologies for data management
Know the state of the art of the legal framework
Know about responsible citizenship
Know about urban mobility
Know how to do strategic planning
Know how to make actor maps
Know how to search and discriminate data and information
Know how to structure data
Know International trade law
Know legislation for environmental pollution
Know national energy policies
Know national policies for environmental issues
Know the alternatives to finance projects of cities and territories
Know the basics of startups
Know the institutions and current legislation
Know the privacy protection regulations
Know the UN sustainable development goals
Know the urban laws

Table 25. Competencies for Smart Sustainable Cities – Understanding

Articulate regulations guaranteeing coherence
Articulate approaches used by government, academia, private sector, and citizen
Be aware of the appropriation of public spaces
Be aware of stakeholders
Be aware of environmental issues
Be flexible for applying models
Contextualize the solutions

Define and assess business models and alternative funding sources
Define indicators or metrics that allow the evaluation of the implemented projects.
Define legal and regulatory mechanisms to regulate the use of technologies
Demonstrate having a holistic vision of technology
Demonstrate intelligent behaviour in relationships with others
Flexibility, adapt to changes
Holistic view
Identify and analyze society's demands and specificities
Identify and present a case study and to play different roles to propose different solutions
Identify the barriers and problems that these technologies can cause
Identify behaviours, habits and problems linked to a community. It has to do with being able to even participate or work with community actors.
Identify critical aspects/issues and their interrelation
Identify local and / or territorial needs
Identify needs and opportunities of sustainable businesses
Identify new users in the city
Identify problems and solutions for the safety of people (crimes, accidents, natural disasters) and data (hacking, etc.)
Identify projects that contribute to smart city models
Identify the real needs of different social levels in the city
Identify social actors
Identify stakeholders
Identify the critical components of the energy matrix
Identify risks for data vulnerability
Innovate thinking in the implementation process
Interpret and produce visual representations for oral and written communication
Learn about geographical information systems
Learn dynamic approaches for territorial planning
Learn the geography of the territory
Learn good practices for territorial management
Learn how to be creative
Learn how to learn
Learn how to write projects
Learn techniques for overcoming resistance to change
Learn to be a visionary
Learn to be proactivity
Observe contextual adequacy of solutions
Recognize the possibilities of different technologies in the quality of life of citizens and the community (not all instrumental technologies, but organizational and symbolic technologies that concern the process)
Recognize the needs required to implement the different aspects of smart sustainable cities

Reflect on how innovation can reach citizens
Rethink and reformulate the local organization
Self-empowerment and active digital participation
Think about future scenarios
Think about the ultimate aim
Think in a disruptive way
Think the smart city in terms of smart citizens following a psychological approach
Understand a given context or a problem holistically, considering the various dimensions
Understand a process through the use of simplified simulations
Understand and develop innovative processes
Understand civic education
Understand climate change
Understand climate change
Understand Cybersecurity
Understand the dependencies between education and technologies
Understand e-government regulations
Understand emerging technologies and their potential uses
Understand the features and needs of the territory
Understand global contexts
Understand how companies work
Understand how projects work
Understand how the SSC concept used currently is placed in a historical line
Understand Information security
Understand innovation as a globality
Understand Insurance in international trade
Understand Intellectual Property Law
Understand local specificities
Understand national and international funding initiatives
Understand the National Investment System
Understand open data policies
Understand patent regulations
Understand sustainable urban planning
Understand technology as a means
Understand territorial geographical, social, economic and eco-systemic features
Understand the bases of ecology
Understand the bioclimatic-urban territory relationships
Understand the city and its context-specific issues – models, visions, components, like culture, economy, etc.
Understand the effects of climate change on the environment
Understand the evolution of the smart city to the smart territory concept
Understand the impact of new legal instruments that support changes to promote SSC initiatives.

Understand the impact of the 4th industrial revolution based on data science
Understand the legal and normative aspects for public policy development
Understand the legislation for technology monitoring
Understand the public spaces for better use of them
Understand the role of Immigration in the city
Understand the underlying philosophy of SSC
Understand the use of budgets for city projects
Understand IT solutions applicability

Table 26. Competencies for Smart Sustainable Cities – Applying

Ability to establish strategic partnerships
Act proactively
Adapt innovations to a specific context
Adapt programs and projects to the specific characteristics of the regional context.
Adapt project design methodologies to territorial projects
adapt public policies and citizen participation to guarantee basic rights
Adapt regulations guaranteeing the preservation of the environment and natural resources
Adapt the regulations to the specific characteristics of the territory
Adapt to change
Adapt to change
Adapt to contextual conditions
Adjust the gap between citizen’s need or problem and the perception that the State has about that same need or problem
Apply a dynamic approach for planning
Apply a holistic spatial vision
Apply a professional ethics
Apply active learning methodologies
Apply adequate methodologies for managing projects
Apply and assess tools for information systems
Apply artificial intelligence tools to city projects
Apply automation tools for city problems
Apply clean, renewable technologies
Apply communication tools
Apply data science for public policies
Apply data science to guide the formulation of public policies
Apply data science
Apply data sciences in city projects
Apply data visualization and analysis in city solutions
Apply deep learning to city problems
Apply digital manufacturing tools

Apply economically sustainable principles in city environments
Apply geographic information systems
Apply Institutional ethics
Apply IoT to city problems
Apply planned solutions in different areas, for example, transportation, education, institutional transparency, environment, procedures, etc.
Apply Scrum methodologies.
Apply study results to urban planning
Apply systemic thinking
Apply tactical urbanism
Apply technology to favour inclusion and ensure citizen participation
Apply technology with empathy with the natural environment
Apply the Territorial Planning Instruments
Apply TICs for social transformation
Apply tools for ensuring transparency and for creating public value
Apply empathy in interaction with stakeholders in the city
Apply and assess green technologies
Apply cybersecurity norms
Apply methodologies that promote innovation and creativity for planning
Apply systemic management
Apply tools for prototyping
Apply virtual reality techniques
Be creative to innovate
Be proactive
Be sensitive and take care of the environment
Build human-capacity
Collaborate to ensure harmonic teamwork and build consensus
Collaborative leadership
Commitment
Communicate assertively with government officials
Communicate in an assertive way
Conduct strategic planning
Contextualize the use of APPs in a specific project
Critical thinking
Develop the ability to deal with people
Develop and apply instrument analysis to better understand the territory
develop communication skills
Develop convergence among different levels of government and social actors
Develop creativity skills
Develop empathy skills

Develop leadership and influence skills
Develop local talents
Develop long term planning
Develop negotiating skills
Develop planning and management skills
Develop problem-solving skills
Develop project planning and management skills
Develop representativeness and protagonism
Develop resilience and awareness behind distinct political and economic scenarios
Develop risk planning and risk management skills
Develop self-management skills
Develop social control mechanisms
Develop the ability to plan and execute digital inclusion strategies
Empathy
Enhance innovation capacity for environmental and social development
Ensure convergence of legal and regulatory frameworks
Entrepreneurship
Establish assertive communication among actors
Establish collaboration mechanisms
Establish governance mechanisms
Establish guidelines based on SDG
Establish mechanisms for openness and participation
Experience sharing
Focus on stakeholders´ needs
Follow a multidisciplinary approach for managing projects, considering social, technological, legal and other issues
Foster, raise and manage financial resources
Generate dialogue and articulate actions with territorial actors
Generate projects and to encourages students to think about complete cases and strategic solutions
Implement green technologies
Implement technical solutions and public policies
Innovate through new approaches for problem-solving
Innovate through practical workshops
Innovate with environmentally-friendly infrastructure
Innovate with a systemic vision
Insert ICTs in management processes
Integrate open data through different government levels
Integrate Technical-social-political aspects in decision-making processes
Interdisciplinary work
Know how to do
Lead and work with multidisciplinary teams

Lead innovative processes
Lead engaging stakeholders
Lead with agile thinking
Leadership
Learn how to exploit the legal framework practically, for example, learn about legal hacking
Learn methodologies for planning, implementing, executing and monitoring
Learn to communicate using clear and simple language
Make smart contracts (BlockChain)
Manage abstraction for applying technology without foundational knowledge
Manage innovation
Manage natural environmental risks
Manage projects related to SSC
Manage projects
Manage resources
Manage resources in a sustainable way
Manage the territory following a systemic approach
Manage tools for executing, monitoring and communicating initiatives
Manage stakeholders
Managing generational, climatic and technological changes
Negotiate with stakeholders
Oral and written communication
Participate
Participatory work
Plan and implement efficient electrical management
Plan following a convergent approach
Proactivity
Promote/conduct participatory processes for decision making
Promote capacity building activities in other countries as mandatory requirements (institutional capacity)
Promote an educational system based on research and knowledge generation
Promote Innovation thinking
Promote environmental and social awareness
Raise awareness about the usage of technology for achieving a specific purpose
Responsibility
Set priorities
Simplify communication of outcomes
Strategic planning and management control
Teamwork
Think strategically
Use 3D PRIVAR Advanced manufacturing tools

Use a global strategic thinking
Use a social vision
Use big data to support decision making
Use data mining tools
Use environmental social assessment
Use geographic information systems
Use interface platform design
Use negotiation skills for the execution of projects that integrate several actors
Use of big data methodologies for city projects
Use of data in the decision-making process
Use of economic assessment methodologies
Use of E-worm tools for improving the city image
Use of Marketing and Advertising
Use of marketing for sustainable development
Use of statistics and econometrics of big data for city analysis
Use of territorial branding
Use open-source resources to solve city problems
Use social networks to promote the activities and projects in the city
Use technologies to develop applications in health, transportation, and education
Use the skills developed to improve the quality of life of the most vulnerable sectors
Use Virtual Reality / Augmented Reality tools to city projects
Use alternative sources of energy
Work in multidisciplinary teams
Work in multidisciplinary teams

Table 27. Competencies for Smart Sustainable Cities – Analyzing

Collect and analyze data for incremental or disruptive innovation
Align local and neighbourhood regulations to international standards
Analysis of social networks
Analytical thinking
Analyze case studies describing the use of technologies and solutions in the local context
Analyze current Chilean legislation on data use
Analyze current Chilean legislation on data use
Analyze data for city purposes
Analyze data for decision-making processes
Analyze data protection
Analyze the impact of new terms or new application of terms like intelligent, green, sustainable
Analyze the technical feasibility of technological solutions
Assume risks
Assume the roles of main actors and not of speculators

Conduct new risk analysis – state security, citizen security, business security
Conduct prospective studies for the territory
Conduct research
Connect data to the territory
Critically analyze public policies based on sustainable development objectives
Critically analyze the use of resources in daily activities (water, energy, etc.)
Diagnose actual and potential problems relevant to a city to intervene
Exploit information from different sources for decision making
Explore the ways in which open data is published, governed and used
Integrate data for city solutions
Integrate renewable energy policies in city projects
Monitor sustainability indicators
Obtain data for making decisions
Research about the relationships between economy and ecology
Rethink and reformulate processes
Select relevant sources of information for entrepreneurship

Table 28. Competencies for Smart Sustainable Cities – Evaluating

Assess a project in a city context
Assess electronic government policies
Assess project impact and benefits achieved by the programs – how to do it and what to measure
Assess project impact
Assess projects form a social perspective
Assess a project technologically
Assess the regional development plan critically
Assess potential benefits and risks of technologies
Compare Chilean regulations in Smart cities with regulations from other countries
Evaluate the impact of actions in terms of the preservation of the environment and biodiversity
Evaluate the most appropriate communication channels
Improve ecosystem thinking
Improve innovation capacity for social development
Improve public resources management
Improve governance actions
Specify how to ensure reliable technologies

Table 29. Competencies for Smart Sustainable Cities – Creating

Ability to develop intelligent systems applicable in different areas
Build APP´S prototypes for business interaction
Build interdisciplinary solutions
Conduct two-way interactions with stakeholders

Create solutions based on analysis of facts and circumstances
Create data models and manage data
Define legal frameworks for technological and entrepreneurial initiatives understanding what can and cannot be done
Define metrics and key performance indicators
Define policies for social integration
Define policies for urban mobility and accessibility
Define standardization protocols for data interoperability
Define strategies for the digital transformation of the city
Design a model to promote citizen participation
Design administrative structures and legal frameworks knowing what is possible
Design alternative urban models
Design and development of prototypes associated with city challenges
Design and implement cybersecurity norms
Design and integrate technologies
Design bounded public policies
Design campaigns to promote the city
Design CANVAS models
Design cities for applying models promoting green, collaborative and orange economies
Design communication networks for specific audiences
Design e-commerce initiatives for the city
Design education strategies for citizenship exercise and environmental and social awareness
Design efficient processes in terms of the consumption of natural resources and the care of biodiversity
Design financial and economic plans
Design impact studies
Design instrument for ensuring transparency in the local governance
Design legal frameworks adaptable to changes in technology, entrepreneurship, innovation
Design logistics
Design marketing proposals to improve the quality of life of citizens
Design models and platforms for citizen participation
Design models of behaviour identification, mediation, negotiation
Design open data and transparency policies
Design open government policies
Design policies for energy efficiency
Design policies for environmental sustainability
Design programs for co-creation of value with citizens
Design programs that balance the welfare of citizens and care for the environment and consumption
Design programs that harmonize the urban space and the natural environment
Design prototypes of urban solutions
Design public policies in terms of territories not exclusively of cities

Design reasonableness controls in the early stages of the life cycle
Design road transport technology
Design secure software architectures
Design services for the city
Design solutions according to the context and locally available alternatives
Design strategies or products
Design strategies that benefit all community stakeholders
Design the territorial organization
Design Urban labs for citizen participation
Design waste management policies
Design legal instruments for collaboration
Design self-regulatory frameworks, i.e. soft-law models
Designing citizen-centred solutions, considering the context of the problem, the use of the solution and its profile
Designing communication and education campaigns and training on sustainable smart cities
Designing sustainable smart cities with a long-term vision, with a capacity to evolve, reusable, sustainable and open
Develop a critical thinking
Develop alternative government models
Develop and implement solutions
Develop capacities for understanding the territory
Develop continuous learning
Develop cybersecurity services to promote community trust in digital services
Develop dashboards for monitoring public policies
Develop E-Commerce strategies for the city
Develop entrepreneurship skills
Develop general negotiation skills
Develop incubators
Develop innovation labs
Develop an instance of inclusion for citizens
Develop leadership skills
Develop negotiation skills
Develop programs that include citizens participation
Develop prototypes, APP, for the efficient use of water and energy
Develop sectoral policies, models and systems, like in education and health
Develop systemic thinking
Develop technological projects for the city
Develop public policies for innovation
Developing negotiation skills to integrate different parties (government, private sector and citizens)
Development of data transfer protocols
Elaborate public policies

Establish urban labs
Formulate a project in a city context
Formulate public policies based on local and regional institutional models
Formulate appropriate procedures for procuring and hiring innovations for technological change
Formulate public policies for the long term
Formulate public policies for the long term
Generate educational material for all citizens at different levels (formal/informal education)
Plan actions for responsibly assessing territorial biodiversity
Plan cutting-edge projects
The plan having a vision for the city
Plan in the long term
Plan including a retrospective assessment
Plan strategies, procedures, policies that address ethical aspects, integrate these cases into everyday life.
Plan the innovation
Plan with awareness about the local context
Produce effective oral and written communication
Raise awareness/raise awareness of the environmental issue (through workshops open to the community)
Raise awareness of the importance of education/training / lifelong learning (through the use of different technological instruments and multidisciplinary workshops)
Train in the perception of risk for the citizen (through workshops open to the community)
Update public policies for protecting the environment

F. AUXILIARY MATERIALS – OTHER

Table 30. Knowledge areas for Smart Sustainable City courses

Administrative reorganization
Applications
Architecture
Availability of information
Big Data
Blockchain
Budget management
Business model
Cities and infrastructure
Citizen ethics
City management
City planning
Collaborative design and development
Communication with community
Consumption optimization
Coordination
Culture
Data infrastructure
Data intelligence for decision making
Data management
Data security and privacy
Design with long term vision and evolution
Digital governance
Digital infrastructure
Digital marketing and communication
Digital technology
Economical sustainability
Economy
Education
Energy management
Engineering
Environmental quality
Environmental Sciences
Environmental sustainability
Ethics
Experience design

Governance
Government bidding processes
Health management
Implementation models
Inclusion
Informatics
Information management
Information resources
Infrastructure in general
Innovation
Integration
Internet of things (IoT)
Interoperability
Knowledge in technology
Laws and regulations
Learning based on problems
Learning based on projects
Legal framework
Legal Sciences
Machine learning
Management
Management of territorial projects
Mobility management
Monitoring of indicators
Multi-Trans and Interdisciplinary
Networks (transportation, information, mobility, energy, waste, communication)
Institutionality
Community organization
Open data
Open Platform Design
Opportunity management
Organizational management
Organizational processes
Participation
People management and communication
People safety
Pilot Prototype
Planning tools
Planning

Platforms crowdsourcing
Political Sciences
Privacy of information
Probity
Product design
Project control
Project dissemination
Project financial evaluation
Project management
Psychology
Public policies
Quality management
Quality of life
Responsible citizen participation
Reuse
Risks (mobility, water)
Road Infrastructure
Security
Services
Simplification of procedures
Smart classrooms
Social change management
Social Management
Social Sciences
Social sustainability
Sociology
Standardization
Storyteller
Strategic planning
Sustainability
Sustainable architecture
Technical sustainability
Technological infrastructure
Technological Interoperability
Technological Management
Technology innovation
Technology
Territorial logistic
Territorial management

Territorial resources
Territorial Sciences
Transport situation
Transportation / Transit
Universal access to resources
Unresolved claims
Urban and territorial planning
Urban growth
Urban planning
Urban situation
Use of technology
Waste management

Table 31. Curricular formats for Smart Sustainable City courses

5G laboratory use
Agreements with municipalities to capture and analyze large volumes of real data
Analysis and discussions about existing theories
Applied workshop, models + robotics + 3D to integrate practice and theory
Apply technology as a support for the didactic strategy, for example, audiovisual material.
APPS application (Google, ADS, Facebook, Social Networks)
Brainstorm
Case-based learning: Involve students in the study of success and failure cases related to SSC
Case studies on ethics at different levels (tax, data use, legal, etc.)
Case study analysis, including a) different types of resources, like videos, b) local, regional and international cases, and c) success and failure cases
Communities of practice
Contests
Conversational initiatives
Co-work
Debates
Design curricula based on citizen, urban, natural, technological and market dimensions.
Design thinking
Design thinking / IDEO
E-learning workshop
Encourage interaction between students from different regions to learn about different training alternatives in SSC
Equipment + infrastructure facilities
Fellowships
Field trips to communities, cities and territories
Fieldwork – get out of the classroom
Fieldwork in SSC

Flipped learning involves students in the teaching process about SSC
Implement ongoing evaluation processes about SSC capacities, consistent with pedagogical strategies
Innovative exercises, part of fieldwork
Integrate theory and practice
Internships and supervised professional practices to SSC
Invited citizen sharing personal story-telling
Invited experts, like major and government officials, from the same and other countries and from different disciplines
Involve students in the analysis and resolution of social problems
Involve students in the design of activities that promote transparency and citizen participation
Laboratories - territorial labs, future labs – for planning the city
Learning based on experimentation and prototyping
Learning based on social service involves students in the understanding and resolution of social problems
Maker space
On-site practices
Organize workshops about problems and solutions related to SSC
Piloting + virtual reality + augmented reality + robotics
PITCH
Problem-based learning: Involve students in solving real problems based on ideas, opportunities or needs of the citizens of the region
Projects based learning with communities (neighbours)
Prototyping
Research-based learning: Involve students in research projects linked to SSC
Roleplaying
Site visits to innovative organizations and data centres
Smart city cases
Social ideas laboratory
Steam (technology + science + math + engineering)
Studies in reality and Learn by doing
Talks and expositions of authorities, and experts
Technology-immersed experiences - use of social media
TED talks
Theatre workshops
Urban Laboratory
Urban studies and trips
Video-conferences
Workshops to facilitate the integration between theory and practice by applying theoretical concepts to solve practical problems

Table 32. Knowledge areas for Smart Sustainable City course development

Value oral and written communication

Collaborative learning
Multidisciplinary project-based learning, applying concepts to a practical case
Peer-to-peer learning
Learn by doing
Technology-mediated interactive applications, like apps deployed in smartphones
Flipped classroom
Service-learning
Research-based learning
Problem-based learning
Blended learning

Table 33. Roadmap competencies for Smart Sustainable City courses

https://livettu.sharepoint.com/:x:/r/sites/SUSTAINProject/_layouts/15/Doc.aspx?sourcedoc=%7B7867642D-2AC0-4752-878B-518FF0759E00%7D&file=CAP4CITY-D2.1-Roadmap-steps-Mapping-Training-%20WORKSHOP%20RESULTS.xlsx&action=default&mobileredirect=true