SMACITE

Enhancing skills for smart city tech

SMACITE

Boosting the technical and non-technical skills and competences of smart cities technicians and engineers

WP2: Smart Cities competences map and curriculum

D2.3: Methodology for learners' training and assessment

Version 1.0

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PROJECT SUMMARY

The project aims to address the skills gap of Smart Cities technicians and engineers, by designing and testing a vocational education and training program that is based on a novel and multi-disciplinary curriculum combining digital skills on Smart Cities enabling technologies, with soft, entrepreneurship and green skills.

The expected project outputs are:

- A Smart Cities competences map and ESCO-compliant Smart Cities job profiles.
- A Smart Cities curriculum combining both technical and non-technical skills and competences and promoting personalized learning pathways.
- Learning resources for Smart Cities enabling technologies and for building the soft, entrepreneurship and green skills of Smart Cities technicians and Engineers.
- A diagnostic tool to identify personalized learning pathways.
- A MOOC for Smart Cities enabling technologies.
- Virtual Worlds for building the soft, green and entrepreneurship skills of Smart Cities technicians and engineers.

The main project beneficiaries are Smart Cities technician and engineers either from the public sector (i.e. municipalities) or enterprises providing Smart Cities solutions, as well as HEI and VET students interested in Smart Cities.

The curriculum will be tested through 4 national pilots in Greece, Bulgaria, Spain and Italy with at least 160 trainees. The certification of the skills and competences will follow a two-fold approach: (a) using micro-credentials to recognize the knowledge and skills gained through the successful completion of each online training module at the MOOC and Virtual Worlds and (b) designing the "Smart Cities Specialization Certification" that will be awarded to those passing online certifications exams with e-proctoring after the completion of the training modules.

The project will create an ecosystem for the co-design and co-development of an innovative curriculum and technology-enhanced learning tools for the upskilling/reskilling of Smart Cities technicians and engineers.

1. Introduction

This deliverable constitutes the SMACITE methodology for learners' training and assessment. It provides the methodology applied for the training and assessment of learners during the two stages of the vocational training and defines both the pedagogical framework and the technology-enhanced tools that will be utilized to deliver the vocational training and effectively engage the learners with the teaching and learning and assessment process.

D2.3 falls within the context of Task T2.3. This task targets the design of the methodology for the training (upskilling/reskilling) and assessment of Smart Cities technicians and engineers through the two different stages of the vocational training:

- Self-paced asynchronous online courses at MOOC and
- Synchronous online training at the Virtual Worlds.

Moreover, a set of educational scenarios for the Virtual Worlds training will be developed. The methodology is developed by promoting technology-enhanced learning, as well as experience-based and problem-based learning, and is linked to real-life problems that cities and their residents face today.
Moreover, T2.3 integrates social learning (online forums) and peer-assessment to promote communities of practices among learners and relevant stakeholders (e.g. HEIs, VET providers, industry).

SMACITE provides ten courses on Smart Cities enabling technologies and three courses on soft, green and entrepreneurship skills. The courses on the enabling technologies will be provided through mixed synchronous and asynchronous online means. The three courses on soft, green and entrepreneurship skills will be provided synchronously, through Virtual Worlds.

The aim of this training and assessment methodology is to provide a structured approach to the development and delivery of the vocational education and training program for Smart Cities technicians and engineers. The program is based on a novel and multi-disciplinary curriculum that combines digital skills on Smart Cities enabling technologies, with soft, entrepreneurship and green skills. The methodology will ensure that the curriculum is delivered in a consistent and effective manner, and that the learning outcomes are assessed and certified according to established standards.

The vocational education and training program will be delivered through a combination of online and offline learning activities. The online learning activities will be provided through a MOOC for Smart Cities enabling technologies and virtual worlds for building the soft, green and entrepreneurship skills of Smart Cities technicians and engineers. The offline learning activities will be provided through classroom-based training, workshops, and practical exercises.

The program will be structured around a set of learning modules, each of which will focus on a specific topic related to Smart Cities. The learning modules will be designed to promote personalized learning pathways, allowing learners to tailor their training to their individual needs and interests.

The assessment methodology will be designed to ensure that learners achieve the learning outcomes of each module and acquire the skills and competencies required for Smart Cities technicians and engineers. The assessment methodology will consist of two main components: formative assessment and summative assessment.

Formative assessment will be conducted throughout the training program, providing learners with regular feedback on their progress and identifying areas for improvement. Formative assessment will be conducted through online quizzes, practical exercises, and group discussions.

Summative assessment will be conducted at the end of each learning module and will be used to determine whether learners have achieved the learning outcomes of the module. Summative assessment will be conducted through online certification exams with e-proctoring.

Upon completion of the training program, learners will be awarded the “Smart Cities Specialization Certification” if they have successfully passed the online certification exams with e-proctoring after the completion of the training modules. This certification will demonstrate the learner's competence in Smart Cities enabling technologies, as well as soft, entrepreneurship, and green skills.

The training and assessment methodology described in this document provides a structured approach to the development and delivery of the vocational education and training program for Smart Cities technicians and engineers. The methodology ensures that the curriculum is delivered in a consistent and effective manner, and that the learning outcomes are assessed and certified according to established standards. This will enable learners to acquire the skills and competencies required for Smart Cities technicians and engineers and will contribute to addressing the skills gap in this field.

1.1 Structure of the deliverable

This deliverable is divided into 3 main Sections.

- **Section 1** introduces the deliverable. More specifically, Section 1.1 describes the structure of the deliverable, Section 1.2 describes the target audience and Section 1.3 describes the dependencies with other WPs and deliverables.
- **Section 2** describes the theoretical background underlying the curriculum. More specifically, Section 2.1 refers to the theoretical background on learning methodologies; Section 2.2 reviews assessment methodologies and Section 2.3 refers to the technological tools.
- **Section 3** describes the SMACITE training Methodology. More specifically, Section 3.1 describes the pedagogical framework; Section 3.2 describes the recommended methodology for synchronous online training and key characteristics of the curriculum, Section 3.2 describes the courses for Smart Cities enabling technologies.
- **Section 4** describes the SMACITE assessment Methodology. More specifically, Section 4.1 describes the structure of the training assessment; 4.2 describes the assessment methodology for synchronous online training; 4.3 describes the assessment methodology for asynchronous online training; 4.4 introduces the certification-related assessment.
- **Section 5** describes the SMACITE curriculum and the teaching and assessment methodology developed for the specific curriculum.
- **Section 6** describes the educational scenarios that have been discussed during the development of the deliverable.

In the Annexes of the document we present the course description template for the SMACITE curriculum (Annex I) as well as a short description of the SMACITE curriculum (Annex II).

1.2 Target Audience

The target audience of the deliverable includes the following stakeholders:

a) the SMACITE project partners who shall undertake the implementation of the project's training, and assessment

b) HEIs and VET providers that can provide the full training scheme or implement parts of the training courses,

c) trainers who can use the theoretical background and practical suggestions on how to design and deliver the SMACITE courses.

The document serves as a source of the training and assessment methodology to be undertaken by the project participants in the piloting of SMACITE training.

1.3 Dependencies with other WPs and deliverables

Deliverable D2.3 has direct connections with the following WPs and deliverables:

- **D2.1** under WP2. This deliverable defines a Smart Cities competences map and emerging job profiles, i.e. the Smart Cities Technician and Smart Cities Engineer profiles including their functions, as well as knowledge and skills (at macro level).

- **D2.2** under WP2. This deliverable provides the SMACITE curriculum for Smart cities.
- **D3.1** – **D3.4** under WP3. Those deliverables consist of the training material of the SMACITE curriculum for the upskilling and reskilling of Smart Cities Technicians and Engineers.
- **D4.2** under WP4. This deliverable will provide the MOOC for the delivery of the technical courses of SMACITE curriculum.
- **D4.3** under WP4. This deliverable will provide the Virtual Worlds for the delivery of the non-technical courses of SMACITE curriculum.
- **D5.2** under WP5. This deliverable is the Trainer/Teacher handbook that aims to support the trainers/teachers during the implementation of pilots.

2 Theoretical background

2.1 Learning methodology

2.1.1 Overview

Learning methodologies are systems of practice and procedures that educators, mentors, teachers and Learning Guides use to support and enrich the learning journeys of learners. We use different methodologies to support all types of learners. These methodologies vary in style and levels of engagement to support our vision of providing a learning opportunity for every personality. To encourage self-determined, lifelong learners, learners must be exposed to diverse learning methodologies and varied experiences. By broadening learning methodologies, educators facilitate engaging, purpose-inspired learning experiences and provide learners the required flexibility to develop their core skills and competencies. Learning methodologies widely utilised include the following:

Place-based learning expands learners' understanding of their local and global community, through the physical environment, culture, history, and people.

Experience-based learning is the process of learning through experiences and opportunities that personally engage and are significant to the learners.

Social learning suggests that people learn through interaction and observation in social settings and is one of the most powerful learning methodologies.

Project-based learning: one of the methodologies used as a strategy to impact learning and to prepare learners for the "real world".

Challenge-based learning: a framework for learning while solving real-world challenges and a way of structuring quests or projects. It builds on the foundation of experiential learning.

Nature-based learning helps provide a foundation for understanding sustainability issues and environmental challenges when people are young.

Sustainability-based learning is about reducing our ecological footprint while improving the quality of life that we value and the liveability of society.

Phenomenon-based learning tackles real-world scenarios such as media, technology, water or energy, holistically from different subject areas' perspectives.

Game-based learning relates to the use of games to enhance the learning experience.

Service based learning occurs when students achieve real objectives for the community while developing a deeper understanding and skills. Service-based learning is an educational approach that combines learning objectives with community service in order to provide a pragmatic, progressive learning experience while meeting societal needs. Service-based learning is defined as "a philosophy, pedagogy, and model for community development that is used as an instructional strategy to meet learning goals and/or content standards."

Social entrepreneurship learning aims to expose learners to the cross-disciplinary skills necessary to build effective and efficient business-based solutions to social problems.

Learning by tinkering or making relate to come together to fix things, make new things, and learn from each other.

Multilingualism, multilingual learning and culture tribes strengthen language proficiency and develops cultural awareness of societies by allowing learners to draw comparisons and learn from different languages.

Authentic learning builds learners' capacity in learning: affective, psychomotor, and cognitive, that prepares students for the 21st century.

Passion-based learning means that Learning Guides help learners explore existing passions and discover new ones, by supporting projects that are co-created by learners.

Deep learning: In an educational or business context, to conduct a form of deep learning means to perform an extensive analysis of a subject or problem.

Design thinking is a human-centred approach to innovation that can be used in many situations - such as projects & challenges, & everyone involved is a learner.

Mobile learning describes the capacity to distribute learning via online and mobile devices anywhere, anytime.

Adventure-based learning: The ability to be able to develop skills of good judgement, leadership, and interpersonal communication can all be enhanced through adventure-based learning.

Internship learning: In a changing world of employment, internship learning is an excellent way for learners to gain real world experience in their desired field.

Boot camp learning: helps people who struggle in other school settings learn more quickly or learn a specific skill in a short amount of time.

Agile learning: A modified version of agile learning is helpful as a team development goal, as well as for learners working on product development as individuals.

Research-based learning: techniques introduced to learners in many contexts to develop their interpretation, analysis, and application skills.

Open space technology learning is a methodological tool that enables self-organising groups of all sizes to deal with complex issues in a very short period of time.

2.1.2 Background on adult education principles

The theoretical background of the training methodology in the frame of SMACITE leans on the pillars of the constructivist approach, as well as the principles of adult education, soft skills training, ICT training and e-learning. The proposed training methodology is based on both theoretical and empirical approaches that have been proven successful in adult education and training in the field of ICT.

The constructivist approach

The SMACITE courses adopt the constructivist learning theory. In the constructivist paradigm, the learners are in the centre of the learning process and they are active

creators and constructors of their own knowledge. Active learning methods that give significant autonomy to trainees and control over the learning process are used. Learning outcomes follow a holistic, generalized concept of competence which is viewed from the perspective of the individuals and learners' personalities and capabilities. The main implications of constructivism adopted in SMACITE courses are the following:

1. The trainees construct their own reality based on their previous experience and mental structures and beliefs.
2. Pre-existing conceptions and knowledge of learners are very important. They are explored and addressed through training, and new knowledge is built on them.
3. The trainees reflect on their own experiences, assumptions and expectations, and develop critical thinking by analyzing and assessing ideas and schemes in safe environments. In this way, they are able to reach a new understanding of things in their profession.
4. The learners assume responsibility for their own learning, by actively participating in the training process and exploring.
5. The trainers act as facilitators, helping trainees to construct knowledge rather than to reproduce a series of facts. Under this scope, problem-based learning, investigational work, situated learning, experimental learning and action learning have a pivotal role. Discovery is facilitated by providing resources and effective use of questions.
6. Training in virtual environments emulating real world situations is very important, since trainees can deal with real tasks within communities of practice and coaching by experts.
7. Trainees develop metacognitive skills. By becoming aware of the learning process, they are able to analyse, monitor and evaluate it. They need to know how to learn by developing effective learning strategies.
8. The collaborative learning is supported by encouraging group work and collaboration in constructing knowledge. Peer learning and the utilization of peers are supported. Trainers are encouraged to provide opportunities for more as well as for less experienced participants to learn from each other, and discussion, as well as debates are promoted.
9. The trainees construct their own reality. Constructivism allows for multiple interpretations and expressions of learning. It is accepted and expected that each trainee will interpret information in different ways.
10. The assessment is performance oriented and does not claim absolute objectivity. It is mainly based on portfolios, projects, role-playing, case studies, self-evaluation etc.

Adult education principles

Adult education is largely based on the assumptions and principles of the constructivist approach. In the development of the training methodology of SMACITE the following eleven adult education principles are applied. For each principle, the way it is applied is also presented.

1. **Adults bring life experiences and knowledge to the learning environment. Experience is considered a resource of learning**

- The experience and expertise of adults should be recognized.
- Training should build on them and encourage learners to actively participate in the creation of new experiences and share their experience and knowledge.
- Learning activities should be created in a way that reinforces the use of past experience and knowledge.

2. **Adults tend to prefer self-directed, autonomous learning**

- Adult learners need control over the learning process. That gives and requires more responsibility and initiative of them. It also allows them to select, manage and evaluate their learning.
- Learners should be involved in setting goals and making decisions.

3. **The trainer should act as facilitator, coach and supporter, by finding ways to involve participants and investigating what participants want to learn.**

- Opportunities should be provided to learners to direct their own learning.
- Action-planning tools and templates should be provided to learners in order to help them develop and focus their self-directed efforts and facilitate learning

4. **Adults have preferences for the way in which they learn**

- Acceptance that not all learners respond to a given teaching method or technique.
- Providing a customized learning approach according to learners need and developing the appropriate learning strategy.
- Use of a wide variety of methods corresponding to all learners' preferences in training delivery.
- Make trainers aware of their own learning preferences.

5. **Adults learn best through collaboration and reciprocity. An environment where people learn with others while sharing what they already know**

- Low-risk environment for learning should be provided, capitalizing the different levels of knowledge and skills within the learning groups.
- The learners' self-esteem should be strengthened through team-based learning on mutual trust and respect.

6. **Adults are motivated to learn by a wide variety of factors**

- Adults are motivated by a variety of factors such as personal aspirations, expectations and internal desire or interest.
- Adults need internal motivation for learning rather than external.
- Learning should respond to their needs, interests and real-life problems, in other words, be meaningful and relevant.
- Relevance is the key factor to motivation; therefore it is important to explore the reasons why participants are interested in learning.
- The learners should be invited to identify the link between learning and satisfaction of their personal needs.
- A connection should be made between the learning content and the long-term objectives of each learner, in work and life.

7. **Adults learners are goal oriented, relevancy oriented and practical**

- Learners should be asked to identify what they would like to learn.
- Clear learning objectives should be established; furthermore, it should be explained how they relate to training activities.

- Learners should be engaged in identifying the challenges they face and the value of addressing these challenges.
- Training must show relevance to the job or other interests.
- Learning has to be applicable to adult work duties or other responsibilities and focus on practical skills, tools and methods.
- Opportunities should be given to trainees to apply knowledge in the context of practical situations and use methods to solve problems.

8. Adult learners need to be respected and learn in an appropriate learning environment

- Respect, trust and acceptance are vital for successful adult training.
- Learners need to feel safe in order to participate freely, take initiatives, experiment, and express themselves.
- Mistakes have to be viewed and used as improvement aids and not as failures.
- Creativity and an agreeable atmosphere are important, but they have to be balanced with cognitive achievements, stability, and clarity of purpose.
- The wealth of knowledge and experiences the participants bring to training should be acknowledged.
- Learners should be treated as equals.
- The participants should be allowed to voice their opinions freely.

9. Adults prefer active learning

- The more actively engaged the learner, the more effective learning is.
- Different training methodology and techniques have greater rate of retention.

10. Adults want guidance

- Adults want information that will help them to improve their situation.
- Adults do not want to be told what to do, but they want to choose options based on their needs

11. Adults have different learning styles

- Every individual has his/her own learning style depending on the preferred perception channel - visual, auditory, or kinaesthetic.
- Techniques appropriate for all types of learners should be used and combined in such a way that different perception channels are employed.
- There are also different personal learning styles referring to order, analysis level, abstraction and type of information presented and processed, that may be influenced either by the individual's personality and cognitive characteristics or by the educational system, cultural factors and professional specialization.
- The learning styles preferred by each group of trainees should be found, in order for the learning experience to be modified accordingly.

2.1.3 Training principles

In the sequel we shall refer to some of the training principles regarding soft skills, ICT training and online learning.

Soft skills

Even though there is lack of consensus on how to define soft skills, there is a common understanding that soft skills are the interpersonal human and behavioural skills needed by someone in order to apply technical skills and knowledge in the workplace. Five categories of soft skills constructs have been identified by academics such as communication skills, problem-solving and thinking skills, leadership and team working skills, ethical and moral values, and self-management. The EQAVET working group suggested another taxonomy introducing three interrelated categories of soft skills:

a) communication skills, including aspects like oral communication and conversation,

b) interpersonal skills, namely the ability to work in teams, relate to people, manage/mediate conflicts, discussions, negotiations and bargaining, and

c) problem-solving.

Given that soft skills have been positively linked to a strong level of professionalism, it is essential for the SMACITE project to follow the common principles of soft skills training given below in order for the training to be successful.

- The success of training in soft skills depends on the facilitation of experts, the contextual awareness, and the provision of support, real-world application, self-study and self-awareness.
- Soft skills are more experienced-based and need to be reinforced throughout a person's lifetime. Their development is a dynamic process that needs to be refreshed over time to reflect on career and education changes.
- Active participation of learners is a guarantee that an intervention for soft skills development is "fit for purpose".
- Not everybody learns soft skills in the same way; active learning (cooperative learning, problem-based learning), transformative learning, and making meaning of learners' experiences through reflection, are important.
- Soft skills are imparted in small groups and innovative material is needed. Training material needs to integrate a number of sources in order to achieve real and impactful results and external providers are needed to be brought.
- Since behavioural change happens over prolonged periods of time, individual soft skills development interventions or courses are not enough. Such interventions require multidisciplinary teams to create complex real-life scenarios and simulations.
- Tools should be used interactively, there must be interaction between heterogeneous groups, and learners should act autonomously.

ICT skills

The variety of areas covered in SMACITE training implies that the teaching approach should follow the principles for teaching ICT skills such as:

- Embedding and integrated: learning should be related to the purposes and needs of learners. The development and application of ICT skills should be integrated with other subjects, workplace activities and wider interests.
- Personalization: each learner should be offered an individual programme with opportunities for progression.
- Active learning: active learning methods should be used to maintain motivation by ensuring that skills are applied in real and relevant contexts.
- Collaborative learning: encouraging collaborative learning whenever possible.

On-line training

Online training such as e-learning has been developed to provide cost-effective and improved learning experiences beyond those available in classrooms. It is about the delivery of all activities of education such as instructing, teaching and learning through various electronic media. The appropriate instructional design, including the selection of appropriate theories and principles, is very important to the success of e-learning.

The theory of constructivism has been widely used in e-learning environments. Elements of constructivism such as the design of learning activities (collaboration, cooperation, multiple perspectives, real-world examples, scaffolding, self-reflection, multiple representations of ideas, and social negotiation), the learning assessment (instructor assessment, collaborative assessment, and self-assessment) and the role of the instructor (coaching, guiding, mentoring, acknowledging, providing feedback, and assessing student learning) have been included in the development of e-learning models.

The following pedagogic principles have been suggested for successful e-learning provision:

- Match to the curriculum: there must be clear objectives, relevance to content covered, appropriateness of students' activities.
- Inclusion: inclusive practices should be seen in terms of different types and range of achievement, physical disabilities, different social and ethnic groups and gender.
- Learner engagement: learners should be engaged and motivated, activities should have a worthwhile educational aim, not just to occupy the learners, but to be enjoyable, improving the learning atmosphere and avoiding adverse emotional reactions.
- Effective learning: promoting personalized learning, learner autonomy; encouraging metacognitive thinking and collaboration, providing authentic learning exhibiting multiple perspectives on a topic.
- Provision of formative and summative assessment for the purposes of improving and grading.
- Coherence, consistency and transparency: objectives, content, activities, and assessment should match to each other and have clear expectations.
- Ease of use: being open and accessible, intuitive and not requiring guidance on use, providing appropriate guidance to learners.

2.1.4 Technology-enhanced tools

In addition to the pedagogical framework, curricula also utilize a range of technology-enhanced tools to deliver the training and effectively engage the learners with the teaching and learning process. These tools include:

1. Asynchronous Online Courses: Self-paced, asynchronous online courses will be delivered through MOOCs (Massive Open Online Courses) platforms such as Coursera or edX. These platforms enable learners to access course materials at their own pace and convenience, and allow them to interact with the content in a variety of ways, such as through videos, quizzes, and online forums. MOOCs can also be designed to incorporate gamification techniques, which can make the learning process more engaging and interactive.
2. Virtual Worlds: Synchronous online training will be delivered through virtual worlds such as Second Life or OpenSim. These virtual worlds enable learners to participate in immersive and interactive simulations of real-world scenarios, such as designing a smart traffic management system or managing energy usage in a smart building. Virtual worlds can also be used to facilitate role-playing exercises, team-based problem-solving activities, and collaborative design tasks. The use of virtual worlds can help enhance the learners' sense of presence and engagement, and create a more interactive and dynamic learning environment.
3. Learning Management Systems (LMS): A learning management system is used to manage the delivery of the training, track learner progress, and provide learners with access to course materials and resources. The LMS will also enable learners to communicate with their instructors and peers, submit assignments and assessments, and receive feedback on their work. The use of an LMS can help ensure that the training is delivered efficiently and effectively, and can provide learners with a centralized platform for accessing course materials and engaging with the teaching and learning process.
4. Augmented Reality (AR): AR technologies can be used to enhance the learners' engagement with the training materials and to provide them with more interactive and immersive learning experiences. For example, AR can be used to overlay virtual objects onto real-world environments, enabling learners to interact with and manipulate these objects in a more tactile and experiential way. AR can also be used to create interactive visualizations and simulations of complex systems and processes, such as the functioning of a smart city.
5. Gamification: Gamification techniques can be used to make the training more engaging and interactive, and to promote learner motivation and participation. Gamification can involve the use of game elements such as badges, leaderboards, and point systems to incentivize learners and reward their progress. Gamification can also be used to create immersive and interactive simulations of real-world scenarios, such as designing a smart city infrastructure or managing a smart transportation system.

By incorporating a range of technology-enhanced tools and techniques, the vocational training in Smart Cities can provide learners with a dynamic, interactive, and engaging learning experience that promotes active participation and deep learning. These tools and techniques can help to create a supportive and collaborative learning environment that

enables learners to engage with real-world problems and scenarios and to develop practical skills and knowledge that can be applied in their future careers as Smart Cities technicians and engineers.

2.2 Assessment methodology

2.2.1 Definition

When discussing about assessment it is customary to consider a number of different concepts such as assessment, evaluation, test and so on. Each of these terms has different meaning and emphasises on different aspects.

Assessment is the process of objectively understanding the state or condition of a thing by observation and measurement. In the case of training, assessment means taking a measure of its effectiveness, focusing on learning, teaching and outcomes and providing information for improving learning and teaching. In other words, assessment is the use of a range of methods to determine the attainment of trainees. Evaluation is wider and refers to determining how a particular course or programme has performed. An effective evaluation of training must evaluate more levels (i.e. reaction, learning, behaviour, results) so that the training provider understands the full effects of the training programme.

A typical framework used to evaluate educational programs is the four-level Kirkpatrick model. Kirkpatrick's four levels are designed as a sequence of ways to evaluate training programs. The four levels of Kirkpatrick's evaluation model are as follows:

1. Reaction - The degree to which participants find the training favorable, engaging and relevant to their jobs
2. Learning - The degree to which participants acquire the intended knowledge, skills, attitude, confidence and commitment based on their participation in the training
3. Behavior - The degree to which participants apply what they learned during training when they are back on the job
4. Results - The degree to which targeted outcomes occur as a result of the training and the support and accountability package

Many practitioners believe that as you proceed through each of the levels, the evaluation becomes more difficult and requires more time. Today, Kirkpatrick-certified facilitators stress "starting with the end in mind," essentially beginning with Level 4 and moving backward in order to better establish the desired outcome before ever planning the training program. When done strategically, reaching these levels does not have to be any more expensive or time consuming, but will still help to ensure on-the-job performance of learned behaviours and skills.

Assessment in the context of education involves deciding, collecting, and making judgments about evidence relevant to the goals of learning. In other words, assessment is the systematic process of documenting and using empirical data on the level of knowledge, skills, attitudes, and competences, achieved by learners. Assessment may be part of an evaluating process of a course or a training project or institution, since evaluation focuses on components of training different than course content or mastery level of outcomes.

2.2.2 Assessment in constructivist approaches

In the constructivist approach, learning is an open-ended process through which outcomes are constructed in the learners' minds according to their individuality. Constructivism supports the active engagement of learners, and considers learning as determined by what goes on in peoples' minds. The focus is on how people construct meaning, while their prior knowledge is a significant determinant of their capacity to learn new things. Achievement is attained when the learner improves understanding of conceptual structures and competences in processing strategies.

Learners' assessment in constructivism should be more subjective and focus on the process. Since prior learning influences new learning, formative assessment is a crucial element from the pedagogical point of view. In constructivism, teaching and assessment are blended in order to achieve the goals of training. Assessment should be more performance-based and include portfolios or projects rather than use traditional methods. Furthermore, assessment seeks to close the gap between current and new understandings and metacognition is also considered as an important dimension of learning. So, assessment should also focus on self-evaluation of the learner.

2.2.3 Scope

The scope of assessment in constructivism is to gain deeper understanding of individual learners in their specific learning context and is seen as a social, contextually specific and interpretive activity. Assessment is not seen as an objective measurement process; rather, it is a human interaction involving the human as the primary assessment instrument. The focus is on why we do what we do in terms of assessment. Assessment tools are the vehicles for promoting self-reflection, self-evaluation and goal setting. Through assessment, an improved understanding of the needs, values, interests and abilities of learners is accomplished, thus assessment is part of the learning process and not separate from it.

2.2.4 Principles

There are many principles and values that should guide the development and implementation of training assessment, that should be:

Valid: Validity refers to the accuracy of assessment. An assessment can be considered as valid when it is appropriate for its purpose, it assesses what is wanted to be measured. It allows the interpretation and inferences which can be drawn from the assessment outcomes to be meaningful and justifiable. There are three kinds of validity. (a) Content validity refers to the extent to which the content of assessment is representative of the domain that the assessment seeks to measure. (b) Face validity refers to the extent that the assessment tool makes sense as a reasonable way to assess what it is intended to assess. (c) Construct validity concerns the extent to which an assessment actually measures what is indented to measure. All types of validity are achieved choosing the appropriate assessment methods and tools.

Authentic: Authenticity refers to ensuring that the assessed achievements belong to the learner. Achievement of desired learning outcomes is to be measured as close as possible to the intentions behind the outcomes.

Reliable: Reliability refers to the extent to which the results can be said to be of acceptable consistency and precision. It refers to the extent to which the assessment if repeated would give the same results.

Sufficient: Sufficiency relates to the requirement that enough evidence should be provided as specified in evidence requirements and assessment methodology.

Fair and equitable: This means that all learners have equivalence of opportunity to succeed even their experiences are not identical. Assessment practices should never discriminate between learners. Assessment tools should not put anyone in an unfair situation [13].

Transparent: Transparency refers to the fact that assessment needs to be in line with the desired learning outcomes and the scope of learning. Learners should have a clear understanding of assessment criteria [16].

Able to motivate learners to learn: Assessment should support the structure of learning and motivate the learners to make choices about their learning through self-assessment and monitoring activities [13].

Able to promote deep learning: Learners should not be driven to surface learning because of the ways their learning is going to be assessed [16].

Timely and incremental: An assessment that occurs at the end of learning is not much used in providing feedback; earlier opportunities should be provided for rehearsal and feedback [16]. Feedback to learners should be continuous.

Efficient and manageable: The burden of resources should not be excessive, nor should be the demands on learners when undertaking assessment tasks [16].

2.2.5 Types of assessment

There are different types of assessment that serve different purposes as described below.

Summative assessment is a more formal type of assessment and often takes place at the end of a course. Summative assessment allows learners, trainers and training providers to establish whether the desired learning outcomes have been achieved through the training course and to what extent. It provides the final profile of the learner. Summative assessment is geared towards reporting at the end of the training for purposes of certification. It is essentially passive and does not have immediate impact on learning.

Formative assessment has a monitoring function, enabling trainers and trainees to track progress, estimate the effectiveness of the training methods and make adaptations where necessary. In other words, formative assessment serves three key purposes a) where learners are in their learning, b) where they need to go, and c) how to get there. Formative assessment involves a continuing cycle of activities which includes the following key elements: a) the provision of clear goals which are shared with the learners, b) learners are in the centre of the process. c) learners take part in gathering and interpreting evidence regarding the accomplishment of goals, d) trainers (if available) and learners make decisions together related to the next steps, e) feedback is provided to learners which is used to adjust training. Formative assessment is therefore the process that leads to the enhancement of learning during learning and feed forward rather than provide feedback after learning.

Diagnostic assessment is used to evaluate the learners' status related to knowledge, skills attitudes and competences, possible learning challenges when training starts. This helps the identification of specific learning needs of the learners and adaptation of training.
Self-assessment: Adult learners are more self-directed and need to be responsible for their learning. Self-assessment is essential to learning because learners can achieve a learning goal if they understand it and can assess what they can do to reach it. The desired learning outcomes and what is required to complete the tasks successfully need to be made clear in the case of self-assessment. Self-assessment: a) promotes learning, providing judgment which benefit the learning process, b) gives a raised level of awareness of perceived levels of abilities, c) motivates goal orientation, d) the range of assessment techniques is expanded, e) learners participate in their own evaluation and f) leads to beneficial post course effects. Since ownership of learning is transferred to the learners via self-assessment, the engagement of learners is improved. Self-assessment consolidates learning, opens up new levels of understanding and drives away misconceptions.

2.2.6 Assessment based on Bloom's taxonomy

Bloom's taxonomy is a set of three hierarchical models used for classification of educational learning objectives into levels of complexity and specificity. The three lists cover the learning objectives in cognitive, affective and psychomotor domains. The cognitive domain list has been the primary focus of most traditional education and is frequently used to structure curriculum learning objectives, assessments and activities.

The models were named after Benjamin Bloom, who chaired the committee of educators that devised the taxonomy. He also edited the first volume of the standard text, *Taxonomy of Educational Objectives: The Classification of Educational Goals*.

The publication of *Taxonomy of Educational Objectives* followed a series of conferences from 1949 to 1953, which were designed to improve communication between educators on the design of curricula and examinations.

The first volume of the taxonomy, *Handbook I: Cognitive* was published in 1956, and in 1964 the second volume *Handbook II: Affective* was published. A revised version of the taxonomy for the cognitive domain was created in 2001.

Figure 1: Bloom's Taxonomy in the Cognitive domain (knowledge-based)

In the 1956 original version of the taxonomy, the cognitive domain is broken into the six levels of objectives listed in Table 1. In the 2001 revised edition of Bloom's taxonomy, the levels have slightly different names and their order was revised: Remember, Understand, Apply, Analyze, Evaluate, and Create (rather than Synthesize).

Level	Description
Knowledge (Remember)	Knowledge involves recognizing or remembering facts, terms, basic concepts, or answers without necessarily understanding what they mean. Some characteristics may include: • Knowledge of specifics—terminology, specific facts • Knowledge of ways and means of dealing with specifics—conventions, trends and sequences, classifications and categories • Knowledge of the universals and abstractions in a field—principles and generalizations, theories and structures
Comprehension (Understand)	Comprehension involves demonstrating an understanding of facts and ideas by organizing, summarizing, translating, generalizing, giving descriptions, and stating the main ideas.
Application (Apply)	Application involves using acquired knowledge to solve problems in new situations. This involves applying acquired knowledge, facts, techniques and rules. Learners should be able to use prior knowledge to solve problems, identify connections and relationships and how they apply in new situations.
Analysis (Analyze)	Analysis involves examining and breaking information into component parts, determining how the parts relate to one another, identifying motives or causes, making inferences, and finding evidence to support generalizations. Its characteristics include: • Analysis of elements • Analysis of relationships • Analysis of organization
Evaluation (Evaluate)	Evaluation involves presenting and defending opinions by making judgments about information, the validity of ideas, or quality of work based on a set of criteria. Its characteristics include: • Judgments in terms of internal evidence • Judgments in terms of external criteria
Synthesis (Create)	Synthesis involves building a structure or pattern from diverse elements; it also refers to the act of putting parts together to form a whole or bringing pieces of information together to form a new meaning. Its characteristics include: • Production of a unique communication • Production of a plan, or proposed set of operations • Derivation of a set of abstract relations

Table 1: Cognitive domain levels

Bloom taxonomy and learning outcomes

There are "verb tables" to help identify which action verbs align with each level in Bloom's Taxonomy. One may notice that some of these verbs on the table are associated with multiple Bloom's Taxonomy levels. These "multilevel-verbs" are actions that could apply to different activities. For example, one could have an outcome that states "At the end of this lesson, students will be able to **explain** the difference between H_2O and OH-." This would be an ***understanding*** level outcome. However, if one wanted the students to be able to "…**explain** the shift in the chemical structure of water throughout its various phases." This would be an ***analyzing*** level verb.

Adding to this confusion, one can locate Bloom's verb charts that will list verbs at levels different from what we list below. Just keep in mind that it is the skill, action or activity you will teach *using that verb* that determines the Bloom's Taxonomy level.

Bloom's Level	**Key Verbs (keywords)**	**Example Learning Outcome (By the end of this course, the student will be able to:)**
Create	design, formulate, build, invent, create, compose, generate, derive, modify, develop.	*…design an original homework problem dealing with the principle of conservation of energy.*
Evaluate	choose, support, relate, determine, defend, judge, grade, compare, contrast, argue, justify, support, convince, select, evaluate.	*…determine whether using conservation of energy or conservation of momentum would be more appropriate for solving a dynamics problem.*
Analyze	classify, break down, categorize, analyze, diagram, illustrate, criticize, simplify, associate.	*…differentiate between potential and kinetic energy.*
Apply	calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, perform, present.	*…calculate the kinetic energy of a projectile.*

Understand	describe, explain, paraphrase, restate, give original examples of, summarize, contrast, interpret, discuss.	*…describe Newton's three laws of motion to in her/his own words*
Remember	list, recite, outline, define, name, match, quote, recall, identify, label, recognize.	*….recite Newton's three laws of motion.*

Table 2: Bloom taxonomy

2.2.7 Exploration of assessment methods

To select the right assessment methods many factors should be considered, such as the learning activities that learners are engaged in, the learning outcomes and other factors to be assessed. The different types of cognitive demand are also important when designing an assessment. Depending on the ability that assessment seeks to measure, the levels of cognition (i.e. knowledge, manipulation, application, analysis, synthesis, evaluation based on Bloom's taxonomy of educational objectives) and the right method of assessment should be found.

There are many decisions that should be taken when developing an assessment strategy; some useful guiding questions in designing assessments are listed below:

− Who will collect the data?
− How will the data be collected and interpreted?
− How will the data be recorded and communicated?
− Is the method of assessment chosen consonant with the learning outcomes?
− Is the method relatively efficient to the learners and staff time?
− What alternatives are there, what are their advantages and disadvantages?
− Do the assessment tasks match the outcomes?
− Are the adopted schemes and criteria appropriate?

3 SMACITE Training Methodology

3.1 Pedagogical framework

The pedagogical framework for the training and assessment of learners during the two stages of vocational training in Smart Cities is designed to promote experiential and problem-based learning. This means that learners will engage in tasks and activities that simulate real-world scenarios and challenges that they may face as Smart Cities technicians and engineers.

Experiential learning is an approach to learning that emphasizes the learner's active engagement in the learning process. It enables learners to develop practical skills and knowledge that can be applied in real-life situations. In the context of Smart Cities, experiential learning could involve, for example, working with data sets to analyze energy consumption patterns in a particular area of the city, or designing and testing a prototype of a smart waste management system.

Problem-based learning is an approach to learning that emphasizes the learner's engagement with real-world problems. Learners are presented with a problem or challenge and are encouraged to work collaboratively to develop a solution. In the context of Smart Cities, problem-based learning could involve, for example, developing a plan to reduce traffic congestion in a particular area of the city, or designing a system to monitor air quality in different parts of the city.

The pedagogical framework will also incorporate personalized learning approaches, which will enable learners to customize their learning experience based on their individual needs and preferences. Personalized learning could involve, for example, allowing learners to choose the topics they want to study, or providing them with different pathways through the training program, based on their prior knowledge and experience.

In addition to experiential, problem-based, and personalized learning approaches, the pedagogical framework will also incorporate social learning and peer-to-peer learning approaches. Social learning involves learning through interaction with others, such as through online forums or discussion groups. Peer-to-peer learning involves learners working collaboratively to solve problems and provide feedback to one another. These approaches will help to create a supportive learning environment where learners can share their experiences, learn from one another, and develop a sense of community.

The pedagogical framework for the training and assessment of learners during the two stages of vocational training in Smart Cities is designed to promote a holistic and effective approach to learning. The framework incorporates a range of approaches that are tailored to the needs and preferences of individual learners, and enable learners to engage with real-world problems and scenarios. It also promotes collaboration, communication, and community-building among learners and relevant stakeholders. By providing a comprehensive and engaging learning experience, the pedagogical framework will help to ensure that learners are well-equipped to tackle the complex challenges of building and managing smart cities.

3.2 Training methodology for synchronous online training

3.2.1 Training methods and techniques

In accordance with the theoretical training methodology background presented, the training methods and techniques recommended for the SMACITE training courses are selected with respect to content and duration of the synchronous online training and the desired learning outcomes. More specific, the training methods:

1. Promote experiential, collaborative, active, transformational and self-directed learning.
2. Address all perception channels (visual, auditory and kinaesthetic) and cater for different learning styles, when used in combination.
3. Are differentiated according to the learning activity type:
   - *Exploitation activities* reveal existing representations, experience and knowledge, provide reflection and critical thinking, and lead to the realization of training or reconstruction needs.
   - *Presentation of information* provides new material for the construction of new schemes, knowledge, attitudes and skills in harmony with the desired learning outcomes.
   - *Application in practice* leads to the acquisition and consolidation of new skills, competences and experiences.

The trainer, while determining the frequency and the extent to which each teaching technique will be used, has to consider the unique characteristics of each learner group and the learning styles of the learners involved. Training techniques can be added or omitted according to the needs.

The training techniques per learning activity recommended for the modules of soft, green and entrepreneurship skills are presented in the following. Their use is not obligatory; it depends on the needs of the learners and the choice of the trainers.

Exploration

- Representation exercises
- Memory activation
- Questions
- Reflection
- Brainstorming
- Self-observation
- Group activities
- Group discussion
- Self-assessment
- theory/paper critiquing

Presentation of information

- Lecture
- Demonstration
- Use of multimedia
- Flipped learning

- Support with handbooks or other material
- Interview/lecture from expert
- Self-study
- Learning platform
- Group discussion

Application in practice

- Brainstorming
- Role-play
- Simulation
- Exercises
- Case study
- Experimenting
- Working in teams
- Teambuilding and groups activities
- Presentation by learner
- Peer learning
- Workshops
- Moral dilemma exercises
- Self-assessment
- Reflection
- Individual coaching session
- Action plan
- Concept writing

3.2.2 Training methodology for asynchronous on-line training

In accordance with the presented theoretical training methodology background, the training methods and techniques recommended for the delivery of SMACITE online training are the following:

- **Self-paced online training**. Self-paced online training has many advantages. It is highly flexible, which makes participation to the training easy. This is critical, as the main beneficiaries of SMACITE training are likely to have strict work obligations, so flexibility is key for them. Furthermore, self-paced online training can also improve learning retention, as the learners often retain content better when they have time to absorb concepts between lessons. Additional benefits exist, after the completion of the course, as it continues to be a great reference tool when questions will arise during training.
- **Asynchronous online training** to promote learner autonomy. Asynchronous events are time-independent, so each learner is able to participate in the online training according to his/her program. A self-paced course is an example of asynchronous Learning because online learning can take place at any time.
- **Learner-centred content**. Learner-centred content presents many benefits. It provides self-reflection opportunities, as the learners want to know, how information

relates to and benefits them directly, enables personalization and responds to individuals' needs. So, the online Open Educational Resources should be relevant and specific to learner's needs and responsibilities in professional life.

- **Personalization** to promote effective learning. Self-study courses should be customizable to reflect learner's interests and needs. In addition, learners should be able to build their own customized learning path, as when you allow your learners to choose what they want to learn, they feel valued.

3.2.3 Training methods and techniques for synchronous training

The phases of the implementation in the frame of SMACITE are:

a) Information and agreement between all the partners involved (training provider and trainee) regarding the detailed description of training, and preparation of the training. At this stage the training provider prepares:

- a detailed task description; a checklist of the tasks that need to be trained; administration information such as lesson plans and schedule; adjustment of all the aforementioned in collaboration with the enterprises. All this information will be enclosed into a training guide.
- a core training material based on the learning outcomes.

b) Implementation and evaluation of training. At this stage:

- supervisors involve the trainees according to the task description and break the procedure down into steps.
- trainers, based on the training guide tasks and training material, implement the training, explaining to the trainees what they are required to do and why, let them perform the required tasks autonomously, give them time to replicate tasks, observe carefully without interfering if it is not necessary, provide constructive feedback and guide them to adjust their performance. They will also adapt or provide additional training material if needed.

There are many techniques that have been proposed to be used in training such as:

- **Basic techniques**: relatively simple techniques, such as giving feedback about performance, consultation, modelling, supervision, observation, learning by doing, demonstration.
- **Meta-techniques**: making use of the basic techniques and further involving one-to-one relationships between the trainer and the learner such as mentoring, coaching, counselling, peer training.
- **Organized activities** such as job rotation, quality circles, case studies.
- **Media-based techniques,** such as computer-assisted learning, e-learning, reading.
- **Other techniques,** such as action learning, briefings, consultants, delegation, find-out-yourself, meetings, unplanned opportunities.

Furthermore, the following techniques are proposed for the training in the frame of SMACITE curriculum:

Project: This behavioural technique focuses on problem analysis and solving and requires the active involvement of trainees. Trainees are given a description of a situation and are asked to come to decision or solve a problem. This can be done in small groups or individually. Trainers need to provide the ideal solution and be open to assess and discuss solutions proposed by trainees. This technique is particularly useful if the cases reflect real world situations. Therefore, trainees can learn how to analyse and solve problems on an actual base. Moreover, the trainees learn the importance of accepting the opinions of others.

Supervision: The main objective of supervision, as used in SMACITE training courses, is to assist trainees in developing the professional skills and competences described by the learning outcomes. Trainees are guided in developing their competences, role awareness, and effective working methods, according to their developmental level. An essential element of supervision is to teach task and problem analysis. Through this process, trainees gain the necessary motivation, autonomy and self-awareness to successfully move to the next level of professional development. Supervision provided by SMACITE: a) establishes clear performance objectives and promotes quality standards, b) focuses on problem-solving and monitoring performance objectives, c) enables trainees to continuously improve their own performance, d) provides feedback and recommendations, e) motivates and empowers, f) encourages participatory decision making. Effective supervision leads to higher-quality services, enhanced productivity, as well as to trainees with a wider range of skills and increased ability to function with autonomy. In SMACITE, supervision can play a significant role in the professional development of trainees, not only in terms of technical skills but also in developing soft, green and entrepreneurial skills.

Coaching: Coaching focuses on the individual's needs and accomplishments providing encouraging feedback and suggestions to improve performance. It is a collaborative solution-focused, result-orientated and systematic process in which the trainer facilitates the enhancement of work performance, self-directed learning and personal growth of the trainee. Coaching appears to be effective during formative education, by encouraging motivation and developing skills related to reflection and critical thinking. Coaching will be used in SMACITE to assist trainees to develop soft, green and entrepreneurial skills. Trainers will work directly with the trainees in individual sessions on regular basis. In line with the desired learning outcomes and according to the trainees' individual needs the trainers will agree with the trainees on a set of tangible and well-defined goals according to the acquisition of skills.

The trainers will determine the frequency and the extent of training techniques, considering the unique characteristics of each learner or learner group, the learning styles of the learners involved. Training techniques can be added or omitted according to the needs. Trainers can also use more techniques, such as basic techniques, meta-techniques, organized activities, media-based techniques or other techniques.

There are also some additional elements that could strengthen the trainees' support:

− One-to-one feedback sessions

− Individual consultations

− Group discussions

3.2.4 Tools and platforms

To promote technology-enhanced learning, the methodology for training and assessment of Smart Cities technicians and engineers can leverage online platforms such as MOOCs and Virtual Worlds. Trainees can engage with self-paced asynchronous online courses at MOOCs, where they can learn about the theoretical and technical aspects of Smart Cities. The courses can be structured to provide experience-based and problem-based learning, where trainees can work on real-life problems that cities and their residents face today. This can help them to develop practical skills and knowledge that can be applied to their work in Smart Cities.

The methodology also includes synchronous online training at Virtual Worlds, where trainees can engage in immersive and interactive learning experiences. Virtual Worlds can provide a realistic and dynamic environment where trainees can practice their skills and knowledge in simulated real-life scenarios. Trainees can collaborate with peers, receive feedback from trainers, and engage in problem-solving exercises. This can enable them to apply what they have learned in a social and supportive setting, promoting social learning and the formation of communities of practices among learners and relevant stakeholders, such as HEIs, VET providers, and industry.

To further promote communities of practices, the methodology can integrate social learning tools such as online forums and peer-assessment. Online forums can enable trainees to engage in discussions with their peers, share their experiences and insights, and learn from each other. Peer-assessment can enable trainees to evaluate each other's work and provide feedback, promoting constructive criticism and collaborative learning. This can help to build a sense of community and foster a culture of continuous learning and improvement among Smart Cities technicians and engineers.

By integrating technology-enhanced learning, experience-based and problem-based learning, real-life problems, social learning, and peer-assessment, the methodology can provide a comprehensive and effective approach to upskilling and reskilling Smart Cities technicians and engineers. The methodology can enable them to develop practical skills and knowledge that can be applied to real-life situations, and to engage with their peers and relevant stakeholders in a collaborative and supportive learning environment. This can help to create a skilled and knowledgeable workforce that can address the complex and rapidly changing challenges of Smart Cities, and contribute to the sustainable development of urban environments.

Concluding, the design of the methodology for the training and assessment of Smart Cities technicians and engineers through the two different stages of vocational training is aimed at providing learners with the necessary knowledge and skills to perform their roles effectively. The self-paced online courses at MOOC provide trainees with flexibility and accessibility, while the synchronous online training at Virtual Worlds provides an

immersive and interactive learning experience. The assessment process is designed to evaluate learners' knowledge and skills and provide feedback on their performance.

4 SMACITE training assessment

4.1 Structure of SMACITE training assessment

In SMACITE assessment methodology we follow the argument that the emphasis should shift from summative to continual, diagnostic and formative assessment throughout the learning process, which is in line with the constructivist approach, also employed in SMACITE. Constructivism is in favor of evaluation for learning (formative and self-assessment) rather than evaluation of learning (summative assessment). Such shift considers the application of learning instead of standardizing learners and allows the individual differences to surface.

SMACITE assessment methodology also takes into consideration the argument that assessment should reflect the practice of the profession or practice being assessed, while at the same time giving learners the opportunity to demonstrate their knowledge and skills and connect them to their own previous experience. This argument is also considered an essential aspect of adult learning.

At the same time, we take into consideration the fact that constructivist assessment techniques have been surrounded by controversy. Most trainers acknowledge the significance of using formative assessment and self-assessment but at the same time they are advocating the validity and reliability of standardized testing, which are supported by summative assessment. They argue that through assessment the performance of learners (i.e. their knowledge, know-how, skills and competences) need to be measured using predefined criteria (i.e. the learning outcomes).

Thus, the assessment methodology suggested for SMACITE training courses is drawn upon a combination of constructivism assessment principles and more traditional ones. In SMACITE assessment methodology, formative and summative assessment as well as self-assessment are followed.

A combination of formative assessment and self-assessment is applicable throughout the learning procedure and to all phases of training (synchronous and asynchronous online learning) and has a cumulative use. It is guided by the principles of the constructivism approach. The methods and tools used are described in the following.

Summative assessment will be carried out in two ways. First, the results of ongoing (formative) assessment are collected in the personal files of each learner. Second, after the completion of each of the training phases the learners will be asked to demonstrate how they will be able to combine and integrate multiple aspects of training in complex situations. The methods and tools used have been already described.

The combination of cumulative assessment and final tasks compiles the final assessment of each learner. The details of the monitoring and assessment methodology applied to each phase of training are presented in the following sections.

4.2 Assessment methodology for synchronous online training

4.2.1 Description

Given the general objectives and structure of SMACITE assessment presented above, synchronous online training, formative and summative assessment as well as self-assessment will be implemented. Self-assessment is a particularly useful method for adults when assessing soft, green and entrepreneurship competences. The tools to be used for assessment are in line with the teaching methodologies presented. Monitoring will be ongoing and will be implemented throughout the duration of synchronous online training using specific tools and exploiting data provided by assessment. The assessment tools that are described in detail in the following are recommended for each type of assessment (formative, summative, self-assessment). Formative and self-assessment take place throughout the phase of synchronous online training, while summative assessment takes place at the end of the training.

4.2.2 Assessment types, structure and tools

Assessment tools have been selected on the basis of their compatibility with the principles of constructivism and adult learning and are presented briefly as follows.

Case study: Case studies are popular tools used for both formative and summative assessment as well as self-assessment. They depict real life situations in which problems need to be solved. Trainees are introduced to a real or fictional case study, either as individuals or in groups, and they are asked to identify a set of problems, and subsequently apply their knowledge of the subject to the case. Case study is a powerful learning tool for developing cognitive skills; when conducted in groups, it can enhance oral communication and team building.

Group/team work: allows for the employment of different skills, knowledge and experiences that individuals have. It can be approached both as a skill to be learned and as a means of carrying forward curriculum concerns and of enriching classroom experience.

Portfolio: A portfolio is a collection of student work that allows assessment by providing evidence of effort and accomplishments in relation to specific instructional goals. They can be used both as a record of students' development in a number of areas, as well as a means of summative assessment. Portfolios can contain evidence reflecting a wide range of skills and attitudes and can reflect development.

Presentation: It is often used to assess students' learning in individual or group projects. It is the process of showing and explaining a topic to an audience. Presentation assessment usually consists of a topic for the student to research, discuss and present. Questions and answers are usually following the presentation.

Peer evaluation: It helps to create a learning community within a classroom. Students are exposed to the thinking of their peers and their alternative feedback as peers' observation may differ from each other. With peer evaluation, students see each other as resources for understanding and checking for quality work against previously established criteria.

Role playing: it is considered as a form of experiential learning. Students learn through their exploration as they are provided with opportunities for learning situated in a real-life context through simulating the activities of their profession. Role playing significantly contributes to learning and assessment as it provides opportunities to reflect on learning, to show how tacit knowledge works etc. At a culminating academic moment (such as the end of a module) a role play can take the form of an exhibition or demonstration and can serve as a summative assessment tool.

Tests: depending on the knowledge, skills and competences that need to be assessed, mid-term tests are types of summative assessment. They can be oral or written. In the case of oral exams, the presentations skills become an essential aspect of what is evaluated. Written tests can be composed by multiple choice questions, close form questions, short answers, matching questions and structured questions.

Final test: it can be oral or written, depending on the knowledge, skills and competences that need to be assessed, and is a type of summative assessment. In the case of oral exams, the presentations skills become an essential aspect of what is evaluated. Oral exams can take the form of an one-to-one interview as a means to explore what students have learned by using a more personalized oral interaction. An important element here is that the trainer can influence how the interview proceeds in order to test certain skills. Written final tests can be composed by multiple choice questions, cloze questions, short answers, matching questions, and structured questions.

The assessment structure and tools proposed for SMACITE synchronous online training are presented in the following table. **The training providers and trainers can select the appropriate tools** according to the characteristics of the trainees and the purposes of assessment.

	Assessment Type			
Tools	**Diagnostic**	**Formative**	**Self-assessment**	**Summative**
Case study		X	X	X
Group/team work		X		
Portfolio		X	X	X
Presentation		X		X
Peer evaluation		X		
Role playing		X		X
Mid Test				X
Final test				X
Checklist	X		X	
Rating scale			X	

Table 3: Assessment types.

4.3 Assessment methodology for asynchronous learning

4.3.1 Description

Formative, summative and self-assessment will be used during the e-learning phase of SMACITE training. After the completion of each educational module, a combination of formative/self-assessment will be applied aiming to assess trainees' progress and enable

trainers to estimate the effectiveness of the e-learning phase. When the trainees complete each SMACITE course, summative assessment will be applied aiming to assess whether the desired learning outcomes of the online educational modules have been achieved and to what extent.

Monitoring will be active during the whole phase of the online training enabling trainees to monitor their progress. The assessment and monitoring tools that will be used during the e-learning phase are presented below.

4.3.2 Assessment types, structure and tools

As asynchronous online learning will be self-regulated, the assessment tools that will be used are mid quizzes during the phase of combined formative/self-assessment (end of each educational module) and final quizzes during the phase of combined summative/self-assessment (end of all educational modules). The quizzes will be completed online at each phase of assessment and will be composed by multiple choice questions and matching questions providing direct feedback to trainees about the results of the assessment.

4.3.3 Monitoring structure and tools

Integrated tools of the online courses' platform will be utilized for e-learning objective-based monitoring. Common tools provided by well-known online courses platforms are learner progress dashboards, grading charts, activity completion, course completion, course reports, etc. Data collected by such tools will be utilized for the observation and collection of objective measurements, like the e-learning attendance, completion rate of online modules, etc.

Furthermore, electronic questionnaires will be available at the end of the educational modules aiming to measure the perspectives of trainees regarding their participation in the online courses, performance and satisfaction. Data collected by these questionnaires, will be used for subjective-based monitoring. Furthermore, the outcomes of combined formative/self-assessment and summative/self-assessment will be used for monitoring purposes.

The tools to be used are questionnaires, task performance checklists, portfolios, incident analysis, and action plans.

4.4 Final Assessment for certification

After the completion of synchronous and asynchronous online training, a final assessment test will take place. This final assessment is a summative one, applied for purposes of certification**.** The final assessment test will be designed by a set of multiple-choice questions aiming to assess in a combined way the learning outcomes that the trainees got during the SMACITE training. This final assessment test will be in alliance with the requirements of the certification scheme.

The trainee will have to apply theoretical and practical knowledge acquired through all training modules in an integrative, critically reflective manner. Trainees should be able to

demonstrate through final assessment test that they are able to perform tasks in an adequate, efficient and professional way.

The training material providers will be responsible for the production of the final assessment tests, in consultation with UNICERT as the certification provider. More details on the certification procedure will be provided at Deliverable D3.4.

5. SMACITE curriculum teaching and assessment design

The SMACITE curriculum implies a shift from a narrow perspective, viewing the curriculum as a list of subjects to be taught, towards a broader perspective, characterizing it as the overall learning experience of.
The curriculum combines an adaptive blend of technical courses for Smart Cities enabling technologies and non-technical courses for building the soft, entrepreneurship and green skills and competences for Smart Cities Technicians and Engineers. Each course is divided further into learning units allowing students to build their own learning personalized learning pathways based on their needs and the outcomes of the diagnostic tool (Task 4.1), thus promoting student-centered learning. Moreover, the curriculum promotes problem-based learning, technology-enabled learning, as well as experience-based learning.

The overall methodology followed for the development of the SMACITE curriculum is described in the sequel.

5.1 Design methodology

Designing the methodology for the training and assessment of Smart Cities technicians and engineers through two different stages of vocational training (self-paced asynchronous online courses at MOOC and synchronous online training at Virtual Worlds) requires a thoughtful and well-structured approach. The analysis of the design methodology for each stage is as follows:

Stage 1: Self-paced asynchronous online courses with MOOC

The steps followed are as follows:

1. Identify the knowledge and skills required: The first step in designing the methodology for self-paced online courses is to identify the knowledge and skills that Smart City technicians and engineers require. This process involves conducting a needs analysis to determine the specific competencies needed to perform the roles and responsibilities associated with Smart City jobs. A comprehensive list of competencies may include technical knowledge in areas such as IoT, big data, AI, cloud computing, and cybersecurity, as well as non-technical competencies like urban planning, transportation systems, energy systems, and waste management.
2. Develop a comprehensive curriculum: Once the competences have been identified, a comprehensive curriculum must be developed. The curriculum should be designed to provide theoretical knowledge and practical skills, and should be structured to meet the diverse needs of the trainees. The curriculum should include learning objectives, instructional strategies, and a variety of activities that engage learners.
3. Develop appropriate training material: The curriculum should be supported by appropriate training materials that cater to different learning styles and preferences. The materials could include online lectures, e-books, videos, quizzes, and interactive

activities. The materials should be designed to complement the curriculum and provide trainees with the necessary knowledge and skills.

4. Provide trainees with access to MOOC platforms: The training should be delivered through MOOC platforms, which provide flexibility and accessibility. Trainees can take the courses at their own pace and from any location, which makes it easier for those with busy schedules to engage in training. The MOOC platforms should be user-friendly, intuitive, and accessible on multiple devices.
5. Assess trainees' knowledge and skills: The assessment process should be designed to evaluate trainees' knowledge and skills. This involves designing quizzes, assignments, and projects that are aligned with the curriculum and the learning objectives. The assessments should be formative, providing feedback on learners' performance, and summative, evaluating learners' overall achievement.

Stage 2: Synchronous online training at Virtual Worlds

1. Identify the knowledge and skills required: The first step in designing the methodology for synchronous online training is to identify the competences that Smart City technicians and engineers need to acquire. This may involve building on the competences acquired in the first stage or introducing new competences. The competences should be aligned with the learning objectives and the needs of the trainees.
2. Develop a comprehensive curriculum: Once the competences have been identified, a comprehensive curriculum should be developed. The curriculum should be designed to provide theoretical knowledge and practical skills, and should be structured to meet the diverse needs of the trainees. The curriculum should be supplemented with instructional strategies and activities that promote active learning.
3. Develop appropriate training material: The curriculum should be supported by appropriate training materials, such as presentations, videos, simulations, and virtual environments. These materials should be designed to enhance the learning experience and help trainees acquire the necessary knowledge and skills.
4. Provide trainees with access to Virtual Worlds: The training should be delivered through Virtual Worlds, which provide an immersive and interactive learning environment. Trainees can participate in real-time training sessions, interact with trainers and peers, and engage in activities that simulate real-world scenarios. The Virtual Worlds should be accessible and easy to use, with features that enhance the learning experience.
5. Assess trainees' knowledge and skills: The assessment process should be designed to evaluate trainees' knowledge and skills. This involves designing quizzes, assignments, and projects that are aligned with the curriculum and the learning objectives. The assessments should be formative, providing feedback on learners' performance, and summative, evaluating learners' overall achievement. The assessment should also be designed to evaluate the application of knowledge and skills to real-world situations.

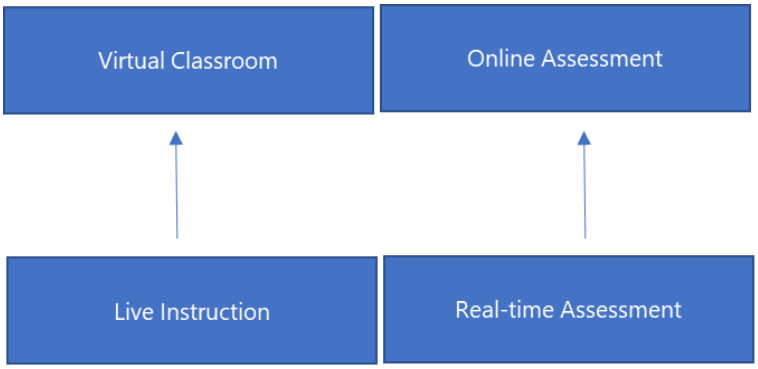

Figure 2: Stage 1 Self-paced online course

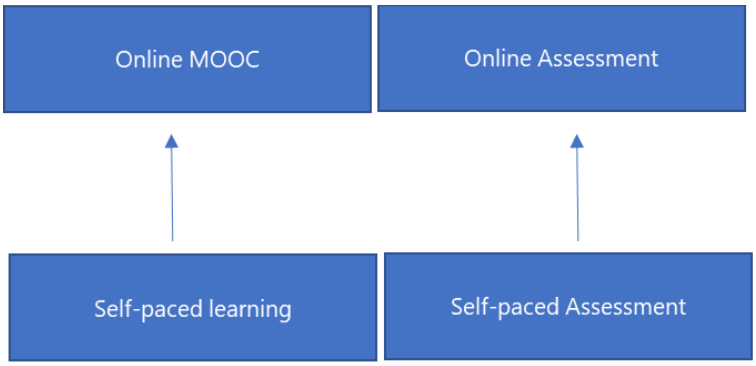

Figure 3: Stage 2 Synchronous online training

In Stage 1, learners will access self-paced online courses through a Massive Open Online Course (MOOC) platform. They will have the flexibility to learn at their own pace and complete the course modules according to their schedule. The online courses will be designed to incorporate technology-enhanced learning, experience-based learning, and problem-based learning approaches. Learners will have access to various multimedia resources, including videos, simulations, and interactive exercises. Additionally, online forums will be available to promote social learning and the formation of communities of practice among learners.

In Stage 1, learners will also have access to self-paced online assessments that will evaluate their understanding of the course material. The assessments will be designed to measure learners' knowledge and competency levels through different question formats, such as multiple-choice, fill-in-the-blank, and short answer. The assessments will be adaptive, meaning that the level of difficulty will adjust to the learner's performance to ensure that the learner is challenged appropriately.

In Stage 2, learners will participate in synchronous online training sessions through a virtual classroom platform. The sessions will be led by experienced trainers and subject matter experts who will engage learners in interactive discussions, case studies, and problem-solving exercises. The virtual classroom platform will offer various tools for communication and collaboration, such as real-time chat, breakout rooms, and whiteboards.

In Stage 2, learners will also have access to online assessments that will evaluate their understanding and application of the knowledge and skills acquired in the virtual

classroom sessions. The assessments will be designed to measure learners' ability to apply the course concepts to real-life problems that cities and their residents face today. The assessments will include peer-assessment to promote communities of practices among learners and relevant stakeholders (e.g. HEIs, VET providers, industry).

Overall, the methodology for the training and assessment of learners during the two stages of vocational training incorporates a pedagogical framework that integrates technology-enhanced learning, experience-based learning, and problem-based learning approaches. Additionally, the methodology utilizes various technology-enhanced tools to deliver the vocational training and effectively engage the learners with the teaching and learning process.

5.2 SMACITE training and assessment methodology

The methodology for the training and assessment of learners during the two stages of vocational training in Smart Cities is based on a pedagogical framework that incorporates technology-enhanced tools to deliver the training and engage learners with the teaching and learning process.

The pedagogical framework includes experiential and problem-based learning, which will enable learners to engage with real-life problems that cities and their residents face today. Learners will have the opportunity to work on practical tasks that require them to apply the skills and knowledge they have acquired during their training. The framework also includes peer-to-peer learning, social learning, and personalized learning approaches that will enable learners to collaborate with their peers, share experiences, and learn from one another.

The technology-enhanced tools that will be utilized to deliver the vocational training and engage learners with the teaching and learning process include MOOCs and Virtual Worlds. MOOCs will provide learners with access to self-paced, asynchronous online courses that they can complete at their own pace. The courses will cover theoretical and technical aspects of Smart Cities and will be designed to promote experiential and problem-based learning. They will be delivered using multimedia and interactive resources such as videos, animations, quizzes, and simulations.

Virtual Worlds will provide learners with a simulated environment where they can practice their skills and knowledge in realistic scenarios. The Virtual Worlds will be designed to enable learners to collaborate with their peers, receive feedback from trainers, and engage in problem-solving exercises. They will provide an immersive and interactive learning experience that will enhance the learners' engagement and motivation.

The methodology will also incorporate social learning and peer-assessment approaches. Online forums will be utilized to enable learners to engage in discussions with their peers, share experiences and insights, and learn from one another. Peer-assessment will enable learners to evaluate each other's work and provide constructive feedback. The social learning and peer-assessment approaches will promote collaborative learning and the formation of communities of practices among learners and relevant stakeholders, such as HEIs, VET providers, and industry.

Overall, the methodology for the training and assessment of learners during the two stages of vocational training in Smart Cities will be designed to provide a comprehensive and effective approach to upskilling and reskilling Smart Cities technicians and engineers. The methodology will enable learners to acquire practical skills and knowledge that can be applied to real-life situations, engage with their peers and relevant stakeholders in a collaborative and supportive learning environment, and promote a culture of continuous learning and improvement.

More specifically, the curriculum includes ten (10) courses that deal with technical knowledge and skills, and 3 with non-technical knowledge and skills.

For each course, the following elements are provided:

- The course category, name, code and duration.
- The course description
- The course objectives
- The learning outcomes (i.e. knowledge and skills) for each of the identified job profiles (i.e. Smart Cities Technicians and Smart Cities Engineers) and their link to the identified objectives.
- The teaching and learning methods for the course.
- The assessment methods to evaluate the performance of the students
- The recommended textbook(s)
- The outline of the course that includes the different learning units, the target Smart Cities profile, the associated learning outcomes, the week(s) for the delivery of each learning unit and the estimated effort in hours for each learning unit.

The template developed for the SMACITE curriculum is provided in Appendix I; the development of the SMACITE courses is presented in Appendix II. The full SMACITE curriculum is provided as Deliverable 2.2 of the SMACITE project.

The teaching and assessment methods adopted for the SMACITE curriculum are presented in Tables 1 and 2 respectively.

In Table1, in the second column we present the course name. In the third column the total hours of each course, and in the fourth column the number of weeks over which the course duration spans is presented. In the last two columns we present the number of hours devoted to asynchronous and synchronous teaching.

		#hours	**#weeks**	**Teaching methods (online)**	
#	**Course Name**			**Asynchronous**	**Synchronous**
1	Smart Cities	40	7	38	2
2	Internet of Things	44	8	42	2
3	Cybersecurity	50	6	48	2
4	Cloud Computing	40	7	38	2

5	Data Analytics and Visualizations	40	7	38	2
6	Machine Learning with Big Data	40	7	38	2
7	3D Printing	28	7	28	0
8	Blockchain	28	7	28	0
9	Drones	24	6	24	0
10	Autonomous Vehicles	24	6	24	0
11	Soft skills	40	8	-	40
12	Entrepreneurship skills	40	8	-	40
13	Green skills	25	7	-	25

Table 4: Synchronous vs. asynchronous teaching in SMACITE courses

In Table2, in the third column we present the number of planned quizzes for each course; in the fourth column we present the weight of the quizzes to the assessment of the course. In the last two columns we present the number of assessment tests and projects for each course, along with their weight in the assessment of the course.

		Interim assessment		**Final assessment**	
		#Quizes	**% of quizes**	**Assessment Test**	**Project**
1	Smart Cities	4	80%	1 (20%)	-
2	Internet of Things	5	75%	-	1 (25%)
3	Cybersecurity	6	75%	-	1 (25%)
4	Cloud Computing	4	80%	1 (20%)	-
5	Data Analytics and Visualizations	3	80%	-	1 (20%)
6	Machine Learning with Big Data	3	80%	-	1 (20%)
7	3D Printing	4	75%	-	1 (25%)
8	Blockchain	4	75%	-	1 (25%)
9	Drones	4	75%	-	1 (25%)
10	Autonomous Vehicles	4	75%	-	1 (25%)
11	Soft skills	4	75%	-	1 (25%)
12	Entrepreneurship skills	4	100%	-	-
13	Green skills	3	75%	-	(1) 25%

Table 5: Assessment methods (quizzes vs project-based) in SMACITE courses

6 Educational Scenarios

6.1 Introduction

An educational scenario constitutes a structured plan, which describes the educational process of a course and aims to guide teachers during this process. It basically defines the form and the content of the teaching experience i.e., learning outcomes, pedagogical

theories, orientation, etc. and provides the sequence of the learning activities and learning material during a specific learning process.
According to the learning objectives of each educational scenario, specific educational methods are used, which in turn determine the flow of activities, the appropriate tools and the role of the teacher.
Educational scenarios that could be implemented in Virtual Worlds for the training and assessment of Smart Cities technicians and engineers include:

Virtual city planning: In this scenario, trainees can learn how to design and plan Smart Cities using virtual tools and technologies. The scenario can simulate various urban environments, and trainees can explore different scenarios and evaluate the impact of different planning decisions on the environment, economy, and society. For example, trainees can design and implement transportation systems that reduce traffic congestion and improve air quality, or they can design energy-efficient buildings that reduce energy consumption and promote sustainability.

This scenario can be highly immersive and interactive, allowing trainees to experiment with various planning strategies and receive real-time feedback from trainers. The virtual environment can simulate various challenges that urban planners face, such as population growth, climate change, and resource constraints. Trainers can provide feedback on the trainees' designs, offering suggestions and improvements based on best practices and real-world experience. This feedback can help trainees to refine their planning skills and develop a better understanding of the complex issues involved in designing and managing Smart Cities.

Simulation of IoT devices: In this scenario, trainees can learn how to design and deploy IoT devices in Smart Cities. Trainees can use virtual tools and technologies to design and deploy sensors, gateways, and other IoT devices, and collect and analyze data in real-time. For example, trainees can design and implement a smart lighting system that adjusts the brightness of streetlights based on the time of day, weather conditions, and pedestrian traffic.

This scenario can be highly practical and hands-on, allowing trainees to gain real-world experience with IoT devices and data analytics. The virtual environment can simulate various challenges that IoT designers face, such as data security, network connectivity, and device compatibility. Trainers can provide feedback on the trainees' designs, helping them to optimize their devices and improve their data analysis skills. This feedback can help trainees to develop a better understanding of the technical and operational aspects of deploying IoT devices in Smart Cities.

Virtual cybersecurity training: In this scenario, trainees can learn how to identify and prevent cyber threats to Smart City infrastructure. Trainees can explore different types of cyber threats, such as phishing, malware, and denial-of-service attacks, and learn how to design and implement security protocols that protect Smart City systems from these threats. For example, trainees can design and implement a security protocol that detects and prevents unauthorized access to a Smart City transportation system.

This scenario can be highly relevant and timely, given the increasing importance of cybersecurity in Smart Cities. The virtual environment can simulate various cyber threats and scenarios, allowing trainees to gain real-world experience with cybersecurity tools and techniques. Trainers can provide feedback on the trainees' security protocols, helping them to improve their cybersecurity skills and knowledge. This feedback can help trainees to develop a better understanding of the technical and organizational aspects of cybersecurity in Smart Cities.

Virtual smart city design: In this scenario, trainees can learn how to design and plan Smart Cities using virtual reality tools. Trainees can explore different design principles and methodologies, such as human-centered design, sustainable design, and resilient design, and learn how to apply them to Smart City projects. For example, trainees can design and plan a Smart City transportation system that prioritizes pedestrian safety, reduces carbon emissions, and integrates with other modes of transportation.

This scenario can be highly immersive and creative, allowing trainees to experiment with different design concepts and technologies. The virtual environment can simulate various design scenarios and challenges, such as limited resources, competing priorities, and community input. Trainers can provide feedback on the trainees' design strategies, helping them to optimize their approaches and improve their design thinking skills. This feedback can help trainees to develop a better understanding of the technical and creative aspects of Smart City design.

In addition to the above, trainees can also learn how to apply emerging technologies such as 5G, IoT, and AI to Smart City projects, and how to evaluate the social, environmental, and economic impacts of their designs. This scenario can also enable trainees to collaborate with other trainees and experts from different backgrounds, providing opportunities for interdisciplinary learning and knowledge sharing. Overall, virtual Smart City design can be an effective and engaging way to upskill and reskill Smart Cities technicians and engineers, and prepare them for the complex and rapidly changing landscape of Smart Cities.

Virtual data analytics: In this scenario, trainees can learn how to collect, analyze, and visualize data in Smart Cities. Trainees can explore different types of data sources, such as sensor data, social media data, and public records, and learn how to design and implement data analytics strategies that generate insights and inform decision-making. For example, trainees can analyze data from a Smart City transportation system to identify patterns of traffic congestion and recommend improvements to the system.

This scenario can be highly practical and data-driven, allowing trainees to gain real-world experience with data analytics tools and techniques. The virtual environment can simulate various data scenarios and challenges, such as data quality, data privacy, and data visualization. Trainers can provide feedback on the trainees' data analytics strategies, helping them to optimize their approaches and improve their data interpretation skills. This feedback can help trainees to develop a better understanding of the technical and analytical aspects of data analytics in Smart Cities.

Virtual stakeholder engagement: In this scenario, trainees can learn how to engage and collaborate with different stakeholders in Smart Cities. Trainees can explore different types of stakeholders, such as government agencies, community groups, and private sector organizations, and learn how to design and implement engagement strategies that promote trust, transparency, and participation. For example, trainees can design and implement a public engagement campaign that solicits feedback and input from local residents on a proposed Smart City project.

This scenario can be highly relevant and interpersonal, allowing trainees to gain real-world experience with stakeholder engagement and communication strategies. The virtual environment can simulate various stakeholder scenarios and challenges, such as conflicting interests, cultural differences, and political considerations. Trainers can provide feedback on the trainees' engagement strategies, helping them to improve their communication skills and stakeholder management knowledge. This feedback can help trainees to develop a better understanding of the social and organizational aspects of Smart Cities.

These educational scenarios provide trainees with an immersive and interactive learning experience in Virtual Worlds. They allow trainees to apply the knowledge and skills they have acquired to real-world scenarios and receive feedback from trainers. The scenarios are designed to meet the specific competences needed for Smart City jobs and can be adapted to suit the diverse needs of trainees.

6.2 SMACITE Educational Scenarios design

Working on T2.3 a number of online meetings were performed between the involved partners. More precisely, the following partners participated:

Partner	Role	Participant name
UniWA	• Responsible for T2.2	Ioannis Voyiatzis Christos Troussas Evangelos Fotopoulos
OTC	• participant in T2.3 • responsible for the development the soft skills curriculum	Polina Kontodiakou
APRO	• participant in T2.3 • responsible for the development the green skills curriculum	Analisa Riso
UniCERT	• responsible for the development of the entrepreneurship curriculum	Gerogia Griva

The above partners had meetings on:

- Friday 24 February 2023, 12:00 CET
- Monday 3 April 2023, 12:00 CET

The discussion on the educational Scenarios on the Virtual Worlds was concluded during the SMACITE meeting in Sofia. During these meetings, the Scenario Template provided in Appendix II was discussed. Initially, the following scenarios were proposed and discussed.

Soft Skills (SS) curriculum-related scenario(s)

Since Soft skills are horizontal and help people to be developed personally and professionally, an unconventional training environment could stimulate the interest of the trainees and make them realize the importance and need in enhancing soft skills.

Soft Skills Scene Description
A group of people in an inconvenient environment undertake different tasks in order to find their way out to their camp

Activities to take place
- Case studies
- Practical activities that enhance collaboration and communication (projects, puzzles, riddles)
- Problem solving activities (quizzes)

Educational goals (what is the user expected to experience in the scene)?
- realize the level to which soft skills are important contributing to their professional and personal development in general
- see how important the cultivation of their interpersonal communication skills is
- realize the importance of teamwork and collaboration for achieving better results / reaching the goals set within the team
- cultivate (through problem-based activities) critical thinking skills enhancing creativity as well, by pushing them to think out of the box in order to overcome possible obstacles
- learn how to motivate others, act with empathy recognizing the significance of EQ.
- learn how to be adaptive, flexible and resilient to changes.

Green Skills GS curriculum-related scenario(s)

Green skills are involved in many aspects of people's daily life and city management, so activities take place in different environments. We prefer job or daily life settings to a school to create a most informal and stimulating training environment.

Green Skills Scene-1 Description

Protagonists arrive in the town hall where they meet the City Manager in his/her office (whiteboard with lists and charts, library, PC) that needs help. At the end of activities, the City Manager invites them to visit the Tech Park.

Activities to take place
Watch videos, quizzes, readings

Educational goals (what is the student expected to experience in the scene)

- Become familiar with concepts related to sustainability and sustainable management of human activities typical of cities.
- Identify strengths and weaknesses in smart city management

Green Skills Scene-2 Description

Tech Park – Power house: a control room with live data and a whiteboard/map where the protagonist meets the Energy Manager. Wind turbines and solar panels in the background.

Activities to take place
Watch videos, quizzes, readings, interactive activities (e.g. Play with tools that show how production/costs/choices can change energy balance and pollution

Educational goals (what is the user expected to experience in the scene)?
- Discover different options available, reflect on alternative strategies to improve the sustainability of the analysed systems.
- Evaluate and predict performance improvement in planning new strategies

Green Skills Scene-3 Description

Tech Park - Waste Plant. A water treatment plant, a waste treatment plant with a warehouse

Activities to take place
Watch videos, quizzes, readings, interactive activities

Educational goals (what is the student expected to experience in the scene)
- Discover different options available, reflect on alternative strategies to improve the sustainability of the analysed systems.
- Evaluate and predict performance improvement in planning new strategies

Entrepreneurship (EP) skills curriculum-related scenario(s)

The ability of the entrepreneur to make quick decisions is critical in the early recovery of a crisis-affected business. The decision to engage in business trading and operations necessitates decisive actions, which include the creation and adaptation of a financial solution as well as a business model.

Entrepreneurship Scene Description

A city has undergone an extreme situation. The infrastructures that will support the city's growth must be monitored and taken care of.

Activities to take place
Watch videos, quizzes, readings, interactive activities, Case studies of developing and implementing next-step strategies

Educational goals (what is the student expected to experience in the scene)

- Participants will demonstrate entrepreneurial self-efficacy and confidence in their ability to succeed and complete the task of (re)launching business.
- Participants will be "running on adrenaline" due to the unexpected loss.
- Participants will exhibit opportunity-seeking behaviors based on what appears to be effective reasoning (what they know) and will be highly motivated to launch/continue the business while adapting to the new business environment.
- The post-disaster situation will lead to evaluate the options and take immediate decisions.

After a series of fruitful discussions, the scenes that will be implemented in the context of the virtual worlds will be decided upon implementation, considering the activities and educational goals/experience mentioned.

ANNEX I: Course Description Template for SMACITE Curriculum

COURSE CATEGORY	

COURSE DESCRIPTION

OBJECTIVES	
This unit aims to:	

LEARNING OUTCOMES		
Smart Cities Engineer		Link to aims
By the end of the course, the students will (knowledge):		
Moreover, by the end of the course, the students will be able to (skills):		
Smart Cities Technician		
By the end of the course, the students will (knowledge):		

Moreover, by the end of the course, the students will be able to (skills):	

TEACHING & LEARNING METHODS	Total Hours: 40

ASSESSMENT METHODS			
Type	Submission Week	% contribution	Learning outcomes Assessed

OUTLINE	Smart Cities Profile	LOs	Week	Estimated effort in hours

Annex II: SMACITE Curriculum

	Course	Estimated effort in hours
Technical courses	Smart Cities	40
	Internet of Things	44
	Cybersecurity	50
	Cloud Computing	40
	Data Analytics and Visualizations	40
	Machine Learning with Big Dta	40
	3D Printing	28
	Blockchain	28
	Drones	24
	Autonomous Vehicles	24
Non-technical courses	Soft skills	40
	Entrepreneurship skills	40
	Green skills	25

A. Technical courses

1. Smart Cities

Outline	Hours
1 Introduction to the concept of Smart City	
1.1 Definitions of Smart City, objectives, agents and applications, supplies, security, capacity	1 hour
1.2 Enabling technologies of Smart Cities in the perception, network, data management, and application layers	2 hours
1.3 Technological challenges	2 hours
2 Cases of success	
2.1. Optimization of mobility and transport/logistics networks.	4 hours
2.2. Optimization of supply chain and waste management systems.	2 hours
2.3. Optimization of IT/communication networks	2 hours
2.4. Monitoring and automation	4 hours
2.5. Economic development and employability towards sustainable growth.	2 hours
3 Technological solutions for Smart Cities	
3.1. Data sources	3 hours
3.2. Data analysis: from raw data to information. Aggregation, visualization, dashboards, digital twins and artificial intelligence in data management.	3 hours
3.3. Decision and notification systems. Short term and long-term predictive models, metrics, simulations, and the What-If analysis.	4 hours
3.4. Formats, standards and protocols for system integration.	4 hours
4. Planning and deployment of Smart Cities solutions	
4.1. Problem detection and analysis of appropriate technical solutions	1 hour
4.2. Feasibility analysis	1 hour
4.3. Governance, communication, citizen engagement and participation.	1 hour
4.4. Deployment, monitoring (KPI) and improvement/modification implementation	2 hours
5 Revision	
5.1 Course revision	2

2. Internet of Things

Outline	Hours
1 Introduction to IoT	
1.1 What is the Internet of Things	2
1.2 Hardware and software components of IoT	3
1.3 IoT architecture	2
1.4 IoT data flow and messaging protocols	2
1.5 IoT applications for Smart Cities	2
2 IoT Devices	
2.1 Sensors and actuators	3
2.2 Microcontrollers	3
2.3 System interfaces	2
2.4 Limitations and vulnerabilities	2
2.5 Installation and configuration of common IoT devices	4
3 IoT Communications	
3.1 Radio Frequency protocols	2
3.2 Low Power Wide Area Networks	3
4 IoT for automation and control	
4.1 IoT devices for automation and control systems	3
4.2 Applications for Smart Cities utilizing IoT devices and automatic control systems	3
5 IoT Cloud	
5.1 IoT and cloud integration	3
5.2 Application development and cloud processing	3
6 Revision	
6.1 Course revision	2

3. Cybersecurity

Outline	Hours
1 Introduction to Cybersecurity in Smart Cities	
1.1 Critical services in Smart Cities	1
1.2 Industrial Control Systems (ICS) and IIOT	4
2 Cyber threats and attacks	
2.1 Malware	1
2.2 Social engineering	1
2.3 Phishing	1
2.4 Passive attacks (port scanning, sniffing...)	1
2.5 Active attacks (DOS, SQL injection...)	6
3 Cybersecurity policies and measures	
3.1 Industry standards	2
3.2 cybersecurity improving measures	4
4 Cybersecurity tools and techniques	
4.1 Segmentation (Firewalls, VLAN...)	3
4.2 Cryptography (PKI, SSL/TLS...)	3
4.3 Authentication certificates	3
4.4 Securing communications (VPN, secure protocols ...)	3
4.5 Secure code development	1
5 Monitoring a Smart City	
5.1 Monitoring software (IDS, IPS, SIEM)	2
5.2 IDS/IPS free tools (Wireshark, Snort...)	4
6 Risk management	
6.1 Risk Management Plan	1
6.2 Disaster Recovery Plan	1
7 Course revision	2

4. Cloud computing

Outline	Hours
1 Introduction to Cloud Computing	
1.1 Evolution: from individual servers to cloud-connected servers. Recentralization of computing capacity motivated by the need for greater speed and cost optimization	1
1.2. Business models in Cloud Computing.	2
2 Cloud Computing Infrastructure	
2.1. Servers (processors, memories and storage systems), racks and Points of Delivery.	2
2.2. Network equipment: Network Interfaces, switch, connection aggregation (bonding) and Internet connection.	2
3. Deployment of Cloud Computing solutions	
3.1 Virtual machines and hypervisors. IaC (Infrastructure as Code) (practical application with Promox and Ansible)	4
3.2 Containers (practical application with Docker)	4
3.3. Container orchestration (Kubernetes)	2
3.4. Container management (Portainer)	2
3.5. Monitoring and alerts (Prometheus and Grafana)	2
4. Hyperscalers: Amazon Web Services, Microsoft Azure and Google Cloud Platform	
4.1. Amazon Web Services	3
4.2. Microsoft Azure	3
4.3. Google Cloud Platform	3
5. Introduction to software development and deployment for Cloud Computing	
5.1. Native programming paradigms for Cloud Computing: MapReduce, microservices and serverless	2
5.2. DevOps. Deployment techniques: CI/CD (continuous integration and deployments), Canary, and Blue/Green	2 hours
5.3. General security principles applied to Cloud Computing. ZeroTrust. VPN. IdaaS. Redundancy	2 hours
6. New technologies applied to Cloud Computing	
6.1. AIOps. Application of AI techniques in the automation of Cloud Computing systems.	1 hour
6.2. Edge Computing. Latency reduction for IoT systems.	1 hour
5 Revision	
5.1 Course revision	2

5. Data analytics and visualizations

Outline	Hours
1 Introduction to Data Analytics and Data Visualization	
1.1 What is Data Analytics	1,5
1.2 What is Data Visualization	1,5
1.3 Advantages of Data Analytics and Visualization	1
1.4 Data Analytics and Data Visualization for Smart Cities	2
2 Data Analytics for SC	
2.1 Computing and Cloud Storage infrastructure	1
2.2 Manage cloud data and storage	1
2.3 Data variety and quality criteria	1
2.4 Advanced analytics algorithms	3
2.5 Implement Realtime analytics	2
3 Data Visualization for SC	
3.1 Visualization methods and techniques	2
3.2 Software tools for Data Visualization	2
3.3 Realtime visualizations and user interactivity	4
4 SM Use Cases	
4.1 A reference architecture for Big Data Analytics	8
4.2 Clustering techniques and visualization for SC	8
5 Revision	
5.1 Course revision	2

6. Machine Learning with Big Data

Outline	Hours
1 Introduction to Machine Learning with Big Data	
1.1 What is Machine Learning (ML) and types of techniques	1.5
1.2 ML, Information Retrieval, Data Mining and Statistics	2
1.4 ML applications in Smart Cities	1.5
2 ML for Smart Cities	
2.1 Types and sources of Smart Cities data and Big Data	2.5
2.2 Programming tools for implementing ML	3
2.3 Libraries and functions for using basic ML algorithms	4
2.4 Techniques applied per Smart Cities application domain	2
2.5 Selection of appropriate ML techniques and effective decision making	2
3 ML case studies for Smart Cities	
3.1 ML for smart mobility and transportation	3
3.2 ML for smart environment management	2.5
3.3 ML for smart government	2.5
3.4 ML for smart industry and production	2.5
4 ML combined with IoT and Cloud Computing	
4.1 IoT data streams	2
4.2 ML for IoT data streams	2
4.3 Study case of ML application on a cloud infrastructure	5
5 Revision	
5.1 Course revision	2

7. 3D printing

Outline	Hours
1. Introduction to 3-d Technologies	2
2. 3d Design	0
2.1 3d Modeling and Rendering	2
2.2 3d Design environment	2
2.3 3d Printing fields and software	2
2.4 3d Design methods	2
3. 3d printing	0
3.1 Introduction	2
3.2 History	2
3.3 3D printer operation	2
3.4 Parts of a 3d printer	2
3.5 3D printing methods	2
3.6 Printing materials- Advantages & disadvantages	2
3.7 CAD/Slicers	2
3.8 Object Libraries	2
4. Applications of 3D printing in Smart cities	2

8. Blockchain

Outline	Hours
1. Blockchain architecture	2
2. Types of Blockchain technology	2
3. Cryptography	2
4. Data structures	2
5. Smart contracts	2
6. Web development	2
7. Programming for blockchain	4
8. Blockchain applications for SCs	0
8.1 Smart energy	2
8.2 Smart mobility	2
8.3 Public administration and services	1
8.4 Reals estate and smart real estate	1
8.5 Smart healthcare	1
8.6 Smart Tourism	1
8.5 Blockchain and IoT	2
8.6 Blockchain and Cybersecurity	2

9. Drones

Outline	Hours
1. Introduction	1
2. Historical review	1
3. Types of unmanned vehicles	2
4. Drone technology	0
4.1 Drone Anatomy	2
4.2 Hardware and software stack	2
4.3 Drone programming	0
4.3.1 Mission planner	2
4.3.2 Swarms and swarm programming	2
5. Drone applications	0
5.1 Search and rescue	2
5.2 Load distribution	2
6. Drone applications in Smart cities	0
6.1 Traffic Management	0,5
6.2 Crowd Management	0,5
6.3 Disaster Control and Monitoring	0,5
6.4 Smart Transportation	0,5
6.5 City Planning	0,5
6.6 Illegal Construction Supervision	0,5
6.7 Engineering Monitoring	0,5
6.8 Municipal Waste Management	0,5
6.9 Urban Security	0,5
6.0 Case study: Drone Monitoring System Smart City	3,5

10. Autonomous Vehicles

Outline	Hours
1. Introduction to autonomous cars	1
2. Historical review	1
4. Technology of Autonomous cars	0
4.1 Levels of Autonomous Driving	1
4.2 Communication Technologies	1
4.3 Components	1
4.4 Objectives	1
4.5 Required Capabilities	1
4.6 Artificial Intelligence	1
4.7 Emerging Technologies	1
5. Requirements	0
5.1 Fault Tolerance	1
5.2 Latency	1
5.3 Architecture	1
5.4 Resource Management	1
5.5 Localization	1
5.6 Security and Privacy	2
6. Open Challenges	0
6.1 Security	2
6.2 Radar Interference Management	1
6.3 Heterogeneous Vehicular Networks	1
6.4 Artificial Intelligence for Autonomous Driving Cars	2
6.5 Edge-assisted Autonomous Driving Cars	2

B. Non-technical courses

1. Soft skills

Outline	Hours
1 Introduction to Soft Skills	
1.1 The role of Soft Skills for Professional Development / Hard vs Soft skills	1
2 Interpersonal Communication	
2.1 Introduction to interpersonal communication: Definition and key elements	1
2.2 Basic principles of effective communication and key barriers	1
2.3 Effective negotiations: key characteristics of a successful negotiator, negotiation styles and strategies	3
2.4 Description of the negotiation process	1
3 Teamwork and Collaboration	
3.1 Definition of Teamwork and collaboration and key benefits	1
3.2 Building effective teams	3
3.3 Setting common goals	2
3.4 Conflict Resolution	2
4 Critical Thinking and Problem Solving	
4.1 Critical thinking: definition and key components	1
4.2 Introduction to problem solving	1
4.3 The problem-solving process and its importance	3
4.4 Creative Problem solving	3
4.4.1 Introduction to the creative problem-solving process	1
4.4.2 Creative problem solving through design thinking	2
4.5 Barriers to encounter during decision making	1
5 Leadership and Management	
5.1 Leadership: definition and importance	1
5.2 Manager vs Leader	1
5.3 Leadership styles	2
5.4 The importance of motivation	2
5.4.1 Key factors that affect motivation	1
5.4.2 How to motivate your Employees	1
5.5 The role of Emotional Intelligence in leadership	3
5.5.1 Definition and Key Characteristics	1
5.5.2 What it takes to be an effective leader	2
6 Managing Through Change	
6.1 Introduction to change management: definition, factors of occurrence and importance	2
6.2 The change management process	2
6.3 Adaptability, Resilience, and Openness to change	1

7 Revision	
7.1 Course revision	2

2. Entrepreneurship skills

Outline	Hours
1 Introduction to Entrepreneurship	
1.1 Introduction to Entrepreneurship	1
2 Entrepreneurship	
2.1 Concept of entrepreneurship	1
2.2 Business Types	1
2.3 Entrepreneurship Types and Models	2
2.4 Entrepreneurship Approaches	1
2.5 Entrepreneurship and economy	2
3 Project management	
3.1 Project management principles	2
3.2 Project management methodology and techniques	4
4 Entrepreneurship and Innovation	
4.1 Concept and Need for Innovation	1
4.2 Development of New Products and Services	2
4.3 Financing of Business Ventures	2
4.4 Smart Home Technologies	2
4.5 Quality Standards	2
4.6 Legal regulations	2
5 Business Plan	
5.1 Structure	3
5.2 Market Research–Competitive Advantage	2
5.3 Marketing–Pricing–Communication–Sales	3
5.4 Costs - Financial Ratios - Cash Flows - Taxes	3
6 Revision	
6.1 Course revision	2

3. Green skills

Outline	Hours
1 Apply the circular economy concept	
1.1 Sustainability, Circular Economy and Green economy: definitions and principles	2
1.1.1 Circular Economy standards and assessment method	1
1.1.2 ESG - Environmental, social, and corporate governance	1
1.2 Sustainable Development Goals (SDGs) and Green New Deal	1
1.3 LCA (Life Cycle Assessment) applied to Smart Cities	2
2 Energy conservation	
2.1 Introduction to energy management and conservation	1
2.2 EMS Energy Management Systems: data and impact	2
2.2.2 The role of Energy Manager and Energy Management related certifications	1
2.3 Energy management planning in smart cities	2
2.4 Case studies on energy efficiency, consumption reduction and conservation	2
3 Waste management	
3.1 Waste classification and environmental impact of waste	2
3.1.1 Waste sampling and analysis	1
3.2 Sustainable waste management	3
3.3 Supply chain management and the 5Rs (Reduce, Reuse, Refurbish, Repair and Recycle): the value of waste	2
4 Revision	
4.1 Course revision + final test	2

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