



METACITIES Excellence Hub in South-Eastern Europe

Regional Research and Innovation Strategies

White paper

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Glossary of Terms and Abbreviations

Abbreviation / Term	Description
R&I	Research and Innovation
CY	Cyprus
GR	Greece
BG	Bulgaria
SDGs	Sustainable Development Goals

1 Executive Summary

This white paper delves into the local Research and Innovation (R&I) strategies of Cyprus (CY), Greece (GR), and Bulgaria (BG), focusing on utilizing advanced technologies such as Digital Twins and the Metaverse to enhance smart city infrastructures. These technologies are pivotal in addressing the unique urban and regional challenges faced by these countries, fostering sustainable development, and improving the overall quality of life for citizens.

By adopting Digital Twins, cities can monitor and manage infrastructure in real time, enhancing resource management and increasing resilience against crises. The Metaverse, on the other hand, opens new pathways for citizen engagement, offering immersive experiences where individuals can actively participate in shaping their urban environments. The synergy between these technologies and local R&I strategies positions the CY, GR, and BG clusters to drive inclusive economic growth, strengthen infrastructure resilience, and align with global sustainability objectives.

The clusters in CY, GR, and BG are poised to become leaders in smart city development by promoting data-driven decision-making and streamlining public services. Furthermore, these clusters are committed to integrating these initiatives with the European Green Deal and SDGs, particularly SDG 11, which calls for inclusive, safe, resilient, and sustainable cities.

2 Introduction

Cities across the European Union are facing numerous complex challenges, such as rapid urbanization, climate change, environmental sustainability, and evolving economic dynamics. As urban populations increase, the demand for smart solutions that foster efficiency, sustainability, and resilience becomes more pressing. Traditional approaches to city management are proving inadequate in meeting the rising demands for infrastructure, resource management, and quality of life improvements.

This white paper explores how the clusters in Cyprus (CY), Greece (GR), and Bulgaria (BG) can address these multifaceted urban challenges by leveraging Research and Innovation (R&I) strategies, particularly focusing on transformative technologies like Digital Twins and the Metaverse. By utilizing these technologies, cities can develop digital representations of their physical environments, enabling authorities to simulate, monitor, and manage urban systems in real-time. These capabilities allow for predictive modelling and proactive interventions, thus improving the efficiency of public services and urban infrastructure.

Moreover, the integration of the Metaverse into urban management offers a unique platform for fostering public engagement. Citizens can interact with virtual city models, enhancing participatory decision-making processes and enabling them to contribute meaningfully to urban development plans.

Through R&I strategies, the CY, GR, and BG clusters seek to harness smart technologies to address local challenges, such as reducing carbon footprints, optimizing resource use, and improving transportation systems. By aligning their local R&I strategies with broader European and global sustainability frameworks, like the European Green Deal and the United Nations' Sustainable Development Goals (SDGs), these clusters aim to create climate-resilient, smart cities that foster inclusivity and improve the quality of life for all residents. Ultimately, these strategies will empower municipalities with the necessary tools to respond to present and future challenges through innovative solutions and collaborative stakeholder engagement.

3 Local R&I Strategies of CY, BG and GR Clusters

The purpose of the current section is to articulate the local R&I strategies for each cluster within the METACITIES project. This section aims to provide guidance for each cluster in the formulation of their R&I strategies, direct investment decisions, and engage stakeholders, ultimately contributing to the successful implementation of Digital Twin and Metaverse technologies in the context of the METACITIES project and the achievement of the Sustainable Development Goals (SDGs). The development and implementation of tailored local R&I strategies will enable each cluster to leverage its strengths, address local challenges, and capitalize on the potential of Digital Twin and Metaverse technologies in its region. These local R&I strategies will serve as a foundation in shaping the [joint R&I strategy](#), reflecting the shared vision and goals of the METACITIES project, and aligning with its methodology and objectives.

It is worth mentioning that the METACITIES project aligns its objectives with the United Nations SDGs [1]¹, ensuring that the R&I strategies contribute to sustainable and inclusive growth.

Understanding the importance of communicating and articulating the local R&I strategies among the clusters is vital to ensure the success of the METACITIES project. Through these strategies, clusters can effectively mobilize resources, engage stakeholders, and drive innovation in Digital Twin and Metaverse technologies. Furthermore, well-defined R&I strategies can help clusters adapt to the changing technological landscape and make informed decisions about investments and partnerships in their regions.

In this section, we outline the background and key focus areas of each cluster, identify their local R&I strategy objectives and priorities, and propose initiatives that can be pursued to achieve their goals. Additionally, we will explore collaboration opportunities with other clusters and discuss mechanisms for coordinating and ensuring synergy among the different local R&I strategies.

3.1 Methodology

The methodology for this procedure involves a structured, multi-step approach. It started with an analysis of the current state of digital transformation with emphasis on Digital Twins (DTs) and Metaverse technologies for each of the CY, GB, and GR clusters. Facilitated by the Quadruple Helix representation in each of the digital ecosystems, each cluster gathered information on their R&I framework at the national level, and assessed the region's infrastructure, economic readiness, and social conditions. This analysis was conducted through a series of workshops and focused groups within each cluster, where all partners contributed with experts and representatives from various sectors. All major national/regional policy recommendations and documents were thoroughly discussed and the outcomes of the workshops were consolidated and conveyed to the Metacities cross-border meetings through working papers/documents. The goal was to develop a unified framework across the clusters by identifying common challenges and opportunities for collaboration within the METACITIES project.

Based on these findings, the study proposed recommendations and guidelines aimed at fostering cross-border collaboration and innovation. It then formulated research and innovation (R&I) strategies for each regional cluster, aligning their objectives towards shared goals to create a cohesive joint strategy. The shared vision for the future of smart cities and regions was defined, using a

¹ Available at: <https://sdgs.un.org/sites/default/files/2022-05/2.1.4-27-Umar-Metaverse4SDG.pdf>

Reference Model for Collaboration based on the Quadruple Helix (QH) Approach, tailored to each cluster's needs.

This methodology ensures a systematic progression from analysis and strategy development to practical implementation and evaluation. Below the consolidated summaries of the local R&I strategy efforts, that ensured that the cross border long term R&I strategy for METACITIES Excellence Hub will complete the regional/local efforts.

3.2 CY Cluster Local R&I Strategy

Cyprus, like many European nations, faces rapid urbanization and various environmental challenges, including increased demand for resources, strain on infrastructure, and issues such as pollution and urban heat islands. Combined with broader environmental changes, these challenges threaten ecosystems, biodiversity, human health, and social systems. Addressing them is crucial for promoting sustainable development and ensuring long-term societal well-being.

Investing in interdisciplinary research and innovative solutions, particularly in smart cities, offers a promising path forward. By adopting digital technologies, Cyprus can enhance resource efficiency, improve quality of life, and drive sustainable economic growth. Research and Innovation (R&I) play a key role in this transformation by fostering job creation, improving healthcare, promoting efficient energy and water use, and addressing climate change.

To guide this transition, Cyprus' R&I framework is shaped by several national strategies, including the "Innovate Cyprus 2019-2023" R&I framework, the "Cyprus Digital Strategy 2020-2025," the "Cyprus Smart Specialization Strategy 2030," and the National Smart Cities framework. These initiatives aim to improve citizens' quality of life, create better jobs, enhance healthcare access, and increase energy and water efficiency. On a regional level, under the 2021-2027 European Structural and Investment Funds (ESIF), local authorities have developed Sustainable Spatial Development Strategies (SSDS), which were reviewed and approved by the Ministries of Interior and Finance. Notable plans include those for Nicosia, South Nicosia, Larnaca, and Limassol, all contributing to sustainable development across Cyprus.

Until recently, Cyprus lacked a unified approach to smart city development, which resulted in fragmented initiatives by individual municipalities. To address this, the Deputy Ministry of Research, Innovation and Digital Policy (DMRID) assumed a coordinating role in 2020 to create a national smart city strategy. This strategy, supported by €35 million from the Recovery and Resilience Fund (RRF), focuses on enhancing citizen experience, resource efficiency, and environmental sustainability. It also seeks to unify existing initiatives, promote a digital economy, integrate smart technologies, and align with global sustainability goals, including the UN's Sustainable Development Goal 11 and the EU's mission for climate-neutral cities by 2030.

Through the Smart City project, the Deputy Ministry of Research, Innovation, and Digital Policy (DMRID) aims to develop and implement the national CY Smart City Platform, funded by €35 million from the Recovery and Resilience Fund (RRF), to provide a unified, nationwide approach to smart city technologies. This platform will integrate projects from various municipalities to optimize citizens' quality of life, resource use, and operational efficiency, offering services through a Software as a Service (SaaS) model. Initially, it will support smart parking, smart lighting, and smart waste management, with future plans for additional solutions. In alignment with this, under

the METACITIES project, the CY Cluster will focus on smart urban planning and smart parking, utilizing geospatial and real-time data to enhance urban development and parking efficiency, contributing to sustainability. Managed through a Platform as a Service (PaaS) model, the platform will allow municipalities to select which smart solutions to implement, prioritizing sustainability, security, and privacy with the use of advanced technologies and citizen-centric services.

3.3 GR Cluster Local R&I Strategy

A smart city leverages digital and telecommunications technologies to enhance the efficiency of services for residents, businesses, and administrations. In addition to improving essential services like transportation, water supply, and waste management, smart cities prioritize resource efficiency and reducing pollution. They also aim for more interactive and responsive governance and safer public spaces, addressing the needs of aging populations. Greek cities have embraced innovative technological solutions, supported by financial tools such as the NSRF 2014–2020, and have experimented with various business models, identifying both challenges and benefits. The shift toward smart cities in Greece and Europe is designed to improve service accessibility, reduce social issues like poverty and unemployment, lower environmental impacts, and facilitate data-driven policy-making. The COVID-19 pandemic showcased how smart cities can positively impact daily life by enabling teleworking, e-democracy, and citizen participation.

The Research and Innovation (R&I) Strategy focuses on aligning local and regional strategies for smart cities, particularly in Western Greece and Patras, with the broader European innovation framework. Patras' smart city transformation is guided by several national and regional strategies, including the National Recovery and Resilience Plan "Greece 2.0," the "Digital Transformation Bible 2020-2025," and the "Smart Specialization Strategy 2021-2027." These initiatives aim to enhance quality of life, promote sustainable urban mobility, improve energy management, and foster digital connectivity. On a local level, Patras has already implemented a Strategic Plan for its smart city goals, focusing on modernizing infrastructure, boosting service efficiency, and leveraging new technologies to ensure sustainable urban development.

Patras and the Greek Cluster are proactively addressing smart city challenges by aligning with national, regional, and local strategies that emphasize digital transformation. Patras is at the forefront of this effort, having already implemented both a Strategic Smart City Plan and a Sustainable Urban Mobility Plan. The R&I Strategy for Patras aligns with SDG 11, aiming to make the city inclusive, safe, resilient, and sustainable through innovative technologies. It focuses on enhancing safety, environmental sustainability, accessibility, economic sustainability, and inclusivity. The strategy also emphasizes collaboration between local government, scientific institutions, businesses, and organizations to promote innovation and effective resource utilization. The overall goal is to increase smart specialization in Patras and Western Greece, fostering cooperation among stakeholders to create a modern, efficient government using ICT for citizens' well-being.

Through the METACITIES project, the Greek Cluster focuses on two key areas: Smart Mobility and the Smart Environment. Smart Mobility initiatives include identifying high-risk traffic points, monitoring driver behavior, providing real-time data on public transport and traffic, and improving accessibility for disabled and senior citizens. Sensors and smart cameras will be deployed throughout Patras to monitor traffic, optimize emergency response routes, and reduce CO2 emissions by improving public transport efficiency. In the Smart Environment, the focus is on smart energy

management, real-time air and water quality monitoring, and waste management improvements. Energy-saving systems are already in place in schools, while smart sensors track environmental conditions such as pollution. Future plans include monitoring stormwater grates to prevent blockages, introducing semi-subterranean recycling bins with wireless monitoring, and installing a smart fire detection system with advanced technology for quick response. These efforts aim to use cutting-edge technologies to improve urban sustainability, safety, and the quality of life in Patras.

3.4 BG Cluster Local R&I Strategy

The United Nations' Sustainable Development Goal (SDG) 11, focused on creating sustainable cities and communities, emphasizes the importance of digital technology and policy support in transforming urban areas to meet growing economic, social, and environmental demands. As cities play a key role in achieving the European Green Deal's goal of climate neutrality by 2050, the Fourth Industrial Revolution is accelerating urban development through innovations like Digital Twin technology, which bridges the physical and digital worlds for improved city management. Policy reform, digital innovation, and institutional change are essential for modernizing urban planning, governance, and service models.

Bulgaria, through its smart city development initiatives, has the opportunity to tackle social, urban, and environmental challenges, potentially transforming them into drivers of economic growth and social welfare. Research and Innovation (R&I) are key to this transformation, driving sustainable development, enhancing well-being, and offering political, technological, and financial benefits. National and regional strategies for Bulgaria are focused on sustainable development and digital transformation, aligning with broader European goals. Key strategies such as the National Development Programme BULGARIA 2030, the Digital Transformation of Bulgaria 2020-2030, and the Innovation Strategy for Smart Specialisation 2021-2027 aim to foster economic growth, reduce inequalities, enhance digital infrastructure, and promote innovation in key sectors like ICT, biotechnology, and clean technologies. On a regional level, cities like Sofia and Burgas have implemented strategies to accelerate smart growth, improve climate resilience, and enhance connectivity. These efforts are modernizing Bulgaria's economy, improving public services, and leveraging new technologies to ensure sustainable urban and regional development.

However, Bulgaria currently lacks a unified approach to implementing smart city solutions, resulting in uncoordinated initiatives across different municipalities. The Bulgarian R&I approach, aligned with the Clean Technology, Circular and Low Carbon Economy theme of RIS3 2021-2027, aims to promote smart development and reduce resource consumption across all sectors. This approach supports national and European goals, including the European Green Deal and the UN Sustainable Development Goals. The strategy focuses on increasing smart specialization in Bulgarian cities by fostering collaboration among local governments, businesses, NGOs, and scientific communities, with the ultimate goal of creating innovative, green, digital, and connected cities.

Through the METACITIES project, the Bulgarian Cluster focuses on Green and Climate Adaptive Resource Management. This priority area builds on the achievements of Burgas, which has established a digital platform for managing city resources and energy consumption. The project aims to expand Burgas' success in renewable energy, particularly in photovoltaic (PV) potential and energy performance analysis, to other Bulgarian cities. Key initiatives include using a Digital Twin framework to monitor PV energy production and assess the energy performance of public buildings. Additionally,

the project supports budget planning for energy use and building renovations by providing tools for decision-making on energy efficiency investments. These efforts aim to enhance energy efficiency, reduce resource consumption, and support sustainable urban development across Bulgarian cities.

4 Shared Vision and Direction

While local R&I Frameworks, determined by a number of strategic documents and plan, have been analyzed by each participating Country (CY, GR and BG) above, this section aims to provide the initial input towards the alignment and harmonization of those individual local strategies into a comprehensive, “unified” Joint R&I strategy.

More specifically, having as input the local R&I Frameworks analyzed above, this section identifies the objectives, goals, visions, priority areas, etc, of each cluster. Then, to find a “Common ground, an “Objective Alignment” process is performed. In this process, the overlapping objectives among the different local strategies are harmonized and aligned towards forming common goals for the joint R&I strategy, ensuring they are comprehensive and mutually beneficial. The aim is to provide a clear vision and ensure that all regions are moving in the same direction, towards shared goals! Achieving this, ensures that the joint R&I strategy has clear, cohesive, and agreed-upon objectives, that will guide the collaborative efforts of all clusters towards common goals.

4.1 Identification of Overlapping/Common Objectives

In **Error! Reference source not found.** are identified all the goals and objectives that are extracted from the National Level Strategies of each cluster, presented in the sections above.

TABLE 1: COMMON GOALS AND OBJECTIVES OF THE CLUSTERS.

ALL GOALS/OBJECTIVES				
Objective/Goal	Comments	CY	GR	BG
Digital Transformation and Innovation	Enhance research and innovation capacities, and foster a culture of innovation and technological development. Focus on the development of digital infrastructure, skills, and a competitive digital economy. Modernize public administration, promote digital adoption in businesses, and enhance the digitalization of services to citizens.	X	X	X
Connectivity and Infrastructure Development for Digital Transformation	Develop and deploy secure digital infrastructure, provide access to digital skills and knowledge, and strengthen the digital connectivity. Achieve high-speed connectivity, and improve digital competitiveness, digital infrastructure and technology adoption.	X	X	X
Sustainable Economic Growth	Reduce social and territorial inequalities, and promote shared prosperity. Achieve sustained economic growth by diversifying economies and promoting competitiveness. Modernize key economic sectors, improve the efficiency of the justice system, and enhance competitiveness.	X	X	X

ALL GOALS/OBJECTIVES				
Objective/Goal	Comments	CY	GR	BG
Environmental Sustainability, Low-Carbon Economy and Green Transition	Promote clean energy, climate mitigation, and the transition to a low-carbon economy. Emphasize the importance of clean air, biodiversity, and resource efficiency, as well as, the importance of climate risks mitigation and environmental protection.	X	X	X
Transport and Digital Connectivity	Improve transport connectivity, by enhancing smart urban mobility, and improve digital connectivity, including high-speed road and digital links.	X	X	X
Enhancing Education and Skills	Share a commitment to improve education and skills development, enable the populations to adapt to technological changes and participate in the digital economy.	X	X	X
Digital Skills and Human Resources	Develop skills in high-tech areas related to Smart Specialization and Industry 4.0, promote a culture of innovation and technological transformation development. Strengthen the link between science and business, support research and innovation ecosystems, and promote public and private investment in research and development.	X	X	X
Research, Innovation, and Education	Strengthen research and innovation capacities, enhance skills development, and improve human resources in the fields of new technologies and innovation.	X	X	
Improving Social Inclusion and Healthcare	Emphasize the importance of social inclusion, healthcare, and the well-being of their populations. Address health and environmental challenges, extend the development of knowledge and technological capabilities in health and environmental technologies, and provide access to effective and inclusive social policies.	X	X	
Entrepreneurship regarding Research Innovation	Strengthen research and innovation ecosystems, promote public and private investment in R&D, and support the link between science and business	X	X	X
Becoming a Regional Hub in Research and Innovation	Position itself as a regional hub for research, scientific excellence, innovation, technological development, and entrepreneurship. Foster a sustainable system of academic and research excellence, and promote knowledge transfer, commercial exploitation, and social innovation.	X		

ALL GOALS/OBJECTIVES				
Objective/Goal	Comments	CY	GR	BG
	Enhance its extroversion in research and innovation, and foster strategic collaborations with selected countries and international organizations. Attract foreign investment in high-tech companies based in the country.			
Cultural Change and Entrepreneurship	Nurture a culture of creativity, innovation, and entrepreneurship at all levels of education, industry, society, and the state, foster a favorable environment for technological development and innovative entrepreneurship.	X	X	X
Job Creation and Labor Market Participation	Redesign and strengthen its active labor market policies, reform labor laws, and invest in education, vocational training, and skills to increase job creation and labor market participation.		X	
Strengthening Financial Sector and Capital Markets	Strengthen its financial sector and capital markets, promote research and innovation, and improve the efficiency of the justice system.		X	
Realizing Full Digital Transformation	Create a secure environment that unlocks the full potential of digital technologies, aiming to reach the average European values under the Digital Economy and Society Index (DESI) by 2030.			X

4.2 Alignment of the Objectives and Goals

Addressing the challenges of the smart development is of paramount importance for South east European countries to ensure that they can effectively adopt and benefit from Digital Twins and Metaverse technologies. By investing in the necessary infrastructure and overcoming these challenges/barriers, the region will be better positioned to capitalize on these technologies' opportunities and drive innovation in smart cities and regions.

Cross-border collaboration is crucial in addressing the challenges and improving the region's technological readiness. By working together, countries in Southeast Europe can pool resources, share expertise, and jointly invest in digital infrastructure projects to support the widespread adoption of Digital Twins and Metaverse technologies. The METACITIES project emphasizes the importance of regional cooperation and aims to facilitate such collaborative efforts.

By addressing key policy, technological, capacity building, and funding challenges, the METACITIES project can contribute to successfully developing and deploying these technologies in smart cities and regions, improving the quality of life, economic growth, and sustainability across the participating countries.

In the context of METACITIES, the concept of complementarity between clusters is crucial for fostering collaborative innovation and achieving the project's objectives. The table provided above serves as a valuable tool for discerning the individual goals and objectives of each cluster at a national level.

However, it is essential to recognise that the true power lies in identifying both the common objectives shared by these clusters and the divergent ones.

This discernment enables the development of a well-structured and unified Research and Innovation (R&I) strategy. By pinpointing the common objectives, we can foster a harmonious and efficient collaboration among all clusters, effectively working together to realize the project's overarching goals. Equally significant is the identification of non-shared goals, as this presents an opportunity for collective problem-solving and knowledge exchange. When clusters engage in tackling open issues, it not only facilitates the exchange of ideas and solutions for shared goals but also opens the door to acquiring new insights and forging collaborations that can create new local opportunities. These synergies, both within current projects and for future endeavours, are vital for maximizing the impact and success of this initiative.

5 Conclusion

This white paper outlines a strategic and comprehensive approach for Cyprus, Greece, and Bulgaria to leverage advanced technologies, such as Digital Twins and the Metaverse, to transform their urban environments into smart, resilient cities. By incorporating these technologies, the clusters are well-positioned to address the complex challenges posed by rapid urbanization, climate change, and socio-economic shifts, ensuring they remain competitive in a global context.

The tailored local Research and Innovation (R&I) strategies of each cluster reflect their unique needs while aligning with broader regional and global frameworks, including the European Green Deal and the UN's Sustainable Development Goals (SDGs). By fostering regional innovation, particularly in areas such as smart mobility, urban planning, and climate-adaptive resource management, these clusters will significantly contribute to sustainable economic growth and the development of climate-resilient cities.

A critical factor in the success of these efforts is the collaboration among local governments, private sector partners, academic institutions, and citizens. The alignment of their R&I strategies, as highlighted in the shared vision section, ensures that efforts are not duplicated and that all stakeholders are working toward common objectives. For example, Digital Twins enable real-time monitoring and proactive management of infrastructure, while the Metaverse opens new pathways for public participation in urban development.

In conclusion, the collaborative efforts of these clusters in adopting smart technologies will set a benchmark for future urban development across Southeast Europe. Their emphasis on sustainability, innovation, and active stakeholder participation highlights their dedication to building dynamic, climate-resilient cities capable of thriving amidst evolving global challenges.

References

- [1] Amjad Umar, “Metaverse for UN SDGs – An Exploratory Study,” in *Science-Policy Brief for the Multistakeholder Forum on Science, Technology and Innovation for the SDGs*, May 2022.