METACITIES Excellence Hub in South-Eastern Europe

D2.1 METACITIES cross-border R&I strategy

Document Summary Information

Grant Agreement No	101087257	**Acronym**	METACITIES
Full Title	METACITIES Excellence Hub in South-Eastern Europe		
Start Date	01.01.2023	**Duration**	48 months
Project URL	https://metacities-hub.com/		
Deliverable	D2.1		
Work Package	2		
Contractual due date	29.02.2024	**Actual submission date**	29.02.2024
Nature	Document, report	**Dissemination Level**	PU-Public
Lead Beneficiary	TUS		
Responsible Author	Vladimir Poulkov		
Contributions from	[HAEC: D. Prevedourou; P. Kalozoumis; L. Tzonis], [p-NET: M. Nicolaou, R. Ioannou], [CYENS: C. Christophorou; I. Ioannou; N. Temene; C. Ioannou], [ISBUR: D. Aleksieva; Kr. Chilikova; D. Raykov], [BUR: B. Popunkyov, A. Sirekov], [DGHB: S. Sotirov; I. Agafonova], [TUS: Vladimir Poulkov; Agata Manolova; Pavlina Koleva; Yana Tsankova], [Yodiwo: A. Matikas; S. Katsoudas; N. Kostis], [UPAT: T.Politi, S.Denazis, A. Panagiotidis, I. Tsampras] [BPM: M.Votta, C.Christidou, M.Koumarianou,G.Kotronis], [RWG:Aggeliki Kostopoulou, Dimitris Karagiannis], [UCM: Eleftherios Loizou, Angelos Thrasyvoulou], [DMRI: Elena Pouli]		

Funded by the European Union

Funded by the European Union under the Grant Agreement No. 101087257. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Revision history (including peer reviewing & quality control)

Version	Issue Date	% Complete	Changes	Contributor(s)
V0.1	01.09.2023	10	Table of Contents	Vladimir Poulkov (TUS), C. Christophorou (CYENS), I. Ioannou (CYENS), D. Prevedourou (HAEC)
V0.1	07.09.2023	10	Quality Check	Ioanna Ioannou (eBOS)
V1.0	15.10.2023	50	Chapters 1-3	[HAEC: D. Prevedourou; P. Kalozoumis; L. Tzonis], [p-NET: M. Nicolaou, R. Ioannou], [CYENS: C. Christophorou; I. Ioannou; N. Temene; C. Ioannou], [ISBUR: D. Aleksieva; Kr. Chilikova; D. Raykov], [BUR: B. Popunkyov, A. Sirekov], [DGHB: S. Sotirov; I. Agafonova], [eBOS: Ioanna Ioannou] [TUS: Vladimir Poulkov; Agata Manolova; Pavlina Koleva; Yana Tsankova], [Yodiwo: A. Matikas; S. Katsoudas; N. Kostis], [UPAT: T.Politi, S.Denazis, A. Panagiotidis, I. Tsampras], [BPM: M.Votta, C.Christidou, M.Koumarianou,G.Kotronis], [RWG:Aggeliki Kostopoulou, Dimitris Karagiannis], [UCM: Eleftherios Loizou, Angelos Thrasyvoulou], [DMRI: Elena Pouli]
V2.0	02.01.2024	80	Chapters 4-6	[HAEC: D. Prevedourou; P. Kalozoumis; L. Tzonis], [p-NET: M. Nicolaou, R. Ioannou], [CYENS: C. Christophorou; I. Ioannou; N. Temene; C. Ioannou], [ISBUR: D. Aleksieva; Kr. Chilikova; D. Raykov], [BUR: B. Popunkyov, A. Sirekov], [DGHB: S. Sotirov; I. Agafonova], [TUS: Vladimir Poulkov; Agata Manolova; Pavlina Koleva; Yana Tsankova], [Yodiwo: A. Matikas; S. Katsoudas; N. Kostis], [UPAT: T.Politi, S.Denazis, A. Panagiotidis, I. Tsampras], [BPM: M.Votta, C.Christidou, M.Koumarianou,G.Kotronis], [RWG:Aggeliki Kostopoulou, Dimitris Karagiannis], [UCM: Eleftherios Loizou, Angelos Thrasyvoulou], [DMRI: Elena Pouli]
V3.0	15.02.2024	90	Chapters 7 – 8 & Content update (Chapters 1-6)	Vladimir Poulkov (TUS), C. Christophorou (CYENS), I. Ioannou (CYENS), D. Prevedourou (HAEC)
V4.0	22.02.2024	95	Quality Check	Ioanna Ioannou (eBOS)
V5.0	29.02.2024	100	Revisions and Finalisation	Ioanna Ioannou (eBOS) Vladimir Poulkov (TUS)

©METACITIES, 2023

Disclaimer

The content of the publication herein is the sole responsibility of the publishers, and it does not necessarily represent the views expressed by the European Commission or its services.

While the information in the documents is believed to be accurate, the authors(s) or any other participant in the METACITIES consortium make no warranty of any kind regarding this material including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

Neither the METACITIES Consortium nor any of its members, their officers, employees or agents shall be responsible nor liable in negligence nor otherwise, howsoever in respect of any inaccuracy or omission herein.

Without derogating from the generality of the foregoing, neither the METACITIES Consortium nor any of its members, their officers, employees or agents shall be liable for any direct or indirect or consequential loss or damage caused by nor arising from any information advice or inaccuracy or omission herein.

Copyright message

©METACITIES Consortium, 2023-2026. This Deliverable contains original, unpublished work except where indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both. Reproduction is authorized, provided the source is acknowledged.

Table of Contents

1 Executive Summary 11
2 Introduction 13
2.1 Mapping METACITIES outputs 13
2.2 Deliverable Overview and Report Structure 16
3 Current State of DTs and Metaverse in Southeast Europe 18
3.1 Technological Landscape 18
3.1.1 Digital Twins and Metaverse Development in Southeast Europe 18
3.1.2 Infrastructure and Technological Readiness in Southeast Europe 19
3.2 Economic and Social Aspects 20
3.2.1 Economic Aspects 20
3.2.2 Social Aspects 21
3.3 Key Challenges and Opportunities 22
3.3.1 Challenges and Considerations in Digital Twins and Metaverse Implementation 22
3.3.2 Opportunities for Cross-border Collaboration 26
3.4 Recommendations and Implementation Guidelines 30
3.4.1 Policy Recommendations 31
3.4.2 Technological and Infrastructural Recommendations 31
3.4.3 Capacity Building and Human Resources Development 31
3.4.4 Funding and Investment Opportunities 32
3.5 Overall Remarks 32
4 Local R&I Strategies of CY, BG and GR Clusters 33
4.1 EU Missions for Sustainable Urban Development in Europe 33
4.2 CY Cluster Local R&I Strategy 35
4.2.1 Introduction 35
4.2.2 National Level Strategies and Plans 35
4.2.3 Municipal or Inter-municipal Sustainable Spatial Development Strategies 45
4.2.4 Summary of the National Level and Regional Level Strategies and Plans 48
4.2.5 Funding and Resources 55
4.2.6 Guidelines of Local R&I Strategies Vision and Goals 57
4.2.7 CY Cluster Priority Areas in the Scope of METACITITIES project 60
4.3 GR Cluster Local R&I Strategy 61

4.3.1 Introduction 61
4.3.2 National and Regional Level Strategies and Plans 62
4.3.3 Municipal Sustainable Spatial Development Strategies 71
4.3.4 Summary of the National/Regional/Local Level Strategies and Plans 75
4.3.5 Funding and Resources 80
4.3.6 Guidelines of Local R&I Strategies Vision and Goals 81
4.3.7 GR Cluster Priority Areas in the Scope of METACITITIES project 83
4.4 BG Cluster Local R&I Strategy 85
4.4.1 Introduction 85
4.4.2 National Level Strategies and Plans 85
4.4.3 Local Strategic Documents 88
4.4.4 Digital Twin Initiatives 89
4.4.5 Summary of the National Level and Regional Level Strategies and Plans 90
4.4.6 Funding and Resources 94
4.4.7 Guidelines of Local R&I Strategies Vision and Goals 96
4.4.8 BG Cluster Priority Areas in the Scope of METACITITIES project 100
4.5 Shared Vision and Direction 101
4.5.1 Identification of Overlapping/Common Objectives 101
4.5.2 Alignment of the Objectives and Goals 103
5 Joint R&I Strategy for the METACITIES Project 105
5.1 Shared Vision, Objectives, Priorities and Goals 105
5.2 SWOT Analysis for the METACITIES Excellence Hub 106
6 Quadruple Helix Collaboration 111
6.1 Stakeholder Types and Involvement 111
6.2 QH Collaboration Approach within regional innovation ecosystems 113
6.2.1 CY Cluster Priority Areas in the Scope of METACITITIES project 116
6.2.2 GR Cluster Priority Areas in the Scope of METACITIES project 126
6.2.3 BG Cluster Priority Areas in the Scope of METACITITIES project 141
6.3 QH Collaboration Approach across regional innovation ecosystems 147
7 Methodology and Implementation Plan 150
7.1 Introduction 150
7.2 Common Methodology 150

7.3 Implementation Plan 159
7.3.1 Formulation of Proposed Activities 159
7.3.2 Implementation Plan Guidelines 169
7.4 METACITIES Implementation Plan 177
7.4.1 Indicative action plan implementation 177
8 KPIs and Milestones for R&I Strategy Implementation 180
8.1 Key Performance Indicators 180
8.1.1 Introduction 180
8.1.2 General Principles for KPI Definition 180
8.2 Project objectives, outcomes, and KPI selection 181
8.3 KPIs description 186
9 Conclusion 192
References 193

List of Figures

Figure 1: R&I strategic framework under the title “Innovate Cyprus” 37
Figure 2: The Digital Strategy for Cyprus 2020-2025 38
Figure 3: Smart City as a collaborative ecosystem 114
Figure 4: Cross border qh collaboration 148
Figure 5: Methodology for the METACITIES Joint Strategy 150
Figure 6: Implementation Plan’s Timetable - General Template 177

List of Tables

Table 1: Adherence to METACITIES GA Deliverable & Tasks Descriptions 13
Table 2: Key challenges for Digital Twin and Metaverse deployment 22
Table 3: Cross-border collaboration opportunities 26
Table 4: National Level Strategies and Plans – Cyprus Cluster 49
Table 5: Regional Level Strategies and Plans – Cyprus Cluster 52
Table 6: CY Cluster vision, mission and goals 59
Table 7: Vision and strategic objectives of Patras development plans 75
Table 8: Regional programs vision and objectives 78
Table 9: Greek cluster vision, mission, and goals 82

Table 10: National Level Strategies and Plans – Bulgarian Cluster 90
Table 11: Regional Level Strategies and Plans – Bulgarian Cluster 92
Table 12: Financing by NRRP component and pillar, '000 BGN 94
Table 13: Funding opportunities from EU and national funds 95
Table 14: Bulgarian cluster vision, mission, and goals 98
Table 15: Common goals and objectives of the clusters 101
Table 16: Relation of priority areas to the goals of METACITIES excellence hub 108
Table 17: Stakeholder Types 111
Table 18: Public Sector - Values Offered to QH Groups and Values Received from QH Groups 115
Table 19: Public Sector - Values Offered and Values Received to/from the rest of the QH Groups .. 119
Table 20: Businesses - Values Offered and Values Received to/from the rest of the QH Groups 120
Table 21: Academia - Values Offered and Values Received to/from the rest of the QH Groups 120
Table 22: Citizens - Values Offered and Values Received to/from the rest of the QH Groups 121
Table 23: Public Sector - Values Offered to QH Groups and Values Received from QH Groups 124
Table 24: Business - Values Offered to QH Groups and Values Received from QH Groups 125
Table 25: Academia - Values Offered to QH Groups and Values Received from QH Groups 125
Table 26: Citizens - Values Offered to QH Groups and Values Received from QH Groups 126
Table 27: Public Sector - Values Offered to QH Groups and Values Received from QH Groups 131
Table 28: Business - Values Offered to QH Groups and Values Received from QH Groups 133
Table 29: Academia - Values Offered to QH Groups and Values Received from QH Groups 133
Table 30: Citizens - Values Offered to QH Groups and Values Received from QH Groups 134
Table 31: Public Sector - Values Offered to QH Groups and Values Received from QH Groups 138
Table 32: Business - Values Offered to QH Groups and Values Received from QH Groups 139
Table 33: Academia - Values Offered to QH Groups and Values Received from QH Groups 140
Table 34: Citizens - Values Offered to QH Groups and Values Received from QH Groups 141
Table 35: Public Sector - Values Offered and Values Received to/from the rest of the QH Groups .. 145
Table 36: Businesses - Values Offered and Values Received to/from the rest of the QH Groups 145
Table 37: Academia - Values Offered and Values Received to/from the rest of the QH Groups 146
Table 38: Citizens - Values Offered and Values Received to/from the rest of the QH Groups 146
Table 39: Action Plan – General Template 176
Table 40: Detailed Description of the Action (Template) 176
Table 41: PRIORITY AREA A) SMART AND SAFE MOBILITY - Indicative ACTION PLAN 178

Table 42: PRIORITY AREA B) SMART ENVIRONMENT - Indicative ACTION PLAN 178
Table 43: PRIORITY AREA C) SMART URBAN PLANNING - Indicative ACTION PLAN 178
Table 44: PRIORITY AREA D) GREEN AND CLIMATE ADAPTIVE RESOURCE MANAGEMENT - Indicative ACTION PLAN 178
Table 45: Expected outcomes of the project 182
Table 46: Relation between the objectives and expected outcomes of the project 183
Table 47: KPI and their relation to the project objectives 184
Table 48: KPIs and their relation to the objectives from the Joint R&I Strategy 185
Table 49: List of KPIs to track progress and impact 186
Table 50: KPI and evaluation milestones 191

Glossary of Terms and Abbreviations

Abbreviation / Term	Description
AI	Artificial Intelligence
ALMPs	Active Labour Market Policies
APIs	Application Programming Interfaces
BG	Bulgaria
BMs	Business Models
CCA	Cyprus Consumers Association
CO2	carbon dioxide
CPR	Common Provisions Regulation
CSR	Corporate Social Responsibility
CY	Cyprus
CYRI	Cyprus' National board for Research and Innovation
DESI	Digital Economy and Society Index
DIHs	Digital Innovation Hubs
DMRID	Deputy Ministry of Research, Innovation and Digital Policy
DRS	Disaster Recovery Site
ESG	Environmental, Social and Governance
ESIF	European Structural and Investment Funds

Abbreviation / Term	Description
EU	European Union
GIS	Geospatial Information Systems
GR	Greece
HPC	High-Performance Computing
IBPF	Integrated Business Process Framework
ICT	Information and Communication Technology
ICTs	Information Communication Technologies
IoT	Internet of Things
IP	Intellectual Property
IS3	Intelligent Specialization Strategy
IT	Information Technology
J&P	Joannou & Paraskevaides
KPIs	Key Performance Indicators
NFN	Nicosia Fiber Network
NO2	Nitrogen dioxide
NRRP	National Recovery and Resilience Plan
NWN	Nicosia Wireless Network
O3	Ozone
ODTF	Open Digital Twin Framework
OECD	Organization for Economic Co-operation and Development
OP	Operational Program
PA1; PA1.6	Priority Axis 1; Priority Axis 1.6
PA2; PA2.2	Priority Axis 2; Priority Axis 2.2
PaaS	Platform as a Service
PO	Policy Objectives
PoCs	Proof of Concepts
PPPs	Public-Private Partnerships
PV	Renewable

Abbreviation / Term	Description
QH	Quadruple Helix
R&D	Research and Development
R&I	Research and Innovation
RE	Regulation
RRF	Recovery and Resilience Facility
RRF	Recovery and Resilience Fund
S^3CY	Smart Specialization Strategy for Cyprus
SaaS	Software as a Service
SAR	Synthetic Aperture Radar
SDGs	Sustainable Development Goals
SEE	Southeast Europe, South-east Europe
SEs	strategic enablers
SMEs	Small and Medium Enterprises
SO	Specific Objectives
SpO	Specific Objectives
SO2	Sulphur dioxide
SP	strategic pillar
SPs	strategic pillars
SSDS	Sustainable Spatial Development Strategy
SSSS	Sofia`s Smart Specialisation Strategy
SUMP	Sustainable Urban Mobility Plan
SUMPs	Sustainable Urban Mobility Plans
TS	Thematic Sectors
UCM	Union of Cyprus Municipalities
UN	United Nations
UX	User eXperience
VMS	Variable Message Sign

1 Executive Summary

This deliverable (D2.1) presents the results of Task 2.1, Task 2.2, Task 2.3, and Task 2.4. The work presented in this deliverable was carried out in eight major steps.

First, an analysis is conducted related to the current state of Digital Twins (DTs) and Metaverse in South East Europe (SEE), focusing on the key areas of development and the overall technological readiness of countries to embrace DTs and Metaverse technologies. The basic information for Digital Twins and Metaverse as well as an extensive literature review on existing solutions that have already been developed in Southeast Europe countries and worldwide in general, was provided in Deliverable D3.1. Here the regions' infrastructure and technological readiness, the economic, and the social aspects of the implementation of DTs and Metaverse technologies, are presented.

As a next step, are identified the common challenges that Southeast European countries, including Cyprus, Bulgaria, and Greece, may face in implementing and adopting Digital Twins and Metaverse technologies. The opportunities for collaboration among the Cyprus (CY), Bulgarian (BG), and Greek (GR) clusters within the context of the METACITIES project are outlined, for the goal of the creation of a joint framework for the successful adoption and implementation of Digital Twins and Metaverse technologies in SEE. Building on these findings, a set of recommendations and implementation guidelines that should be considered during the development of the joint vision/strategy, aimed at fostering cross-border collaboration, innovation, and development in Digital Twins and Metaverse are proposed.

By analyzing the challenges, opportunities, and the recommendation and implementation guidelines from the first two steps, valuable insights are gained into the potential of Digital Twins and Metaverse technologies for smart cities and smart regions in SEE. Based on this knowledge, guidance is provided for each cluster in the formulation of their Research and Innovation (R&I) strategies, direct investments and stakeholders engagement, ultimately contributing to the successful implementation of Digital Twin and Metaverse technologies in the context of the project.

Following, the objectives, goals, visions, and priority areas of each cluster are identified. The overlapping objectives among the different local strategies are harmonized and aligned towards the formation of 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, ensuring that the joint R&I strategy has clear, cohesive, and agreed-upon objectives, to guide the collaborative efforts of all clusters towards the common goals.

Based on the identification of the common goals and objectives among the clusters' R&I strategies, as a next step is defined the shared vision for the future of smart cities and smart regions. This is done in relation to the objectives of the project and the relation of the priority areas to the goals of the METACITIES excellence hub.

The sixth step is the definition of a Reference Model for Collaboration, based on the Quadruple Helix (QH) Approach, applied in the context of Smart Cities. This model will be followed and properly adapted to the smart city cases to be addressed by each of the three regional innovation ecosystems. For each such priority area, comprehensive agendas for research and innovation are developed and are outlined the key research topics, methodologies, and activities that will be undertaken to achieve relevant identified goals and objectives.

The next step concerns the definition of the methodology and the implementation plan the METACITIES project's partners should follow to reach the objectives of the Joint Strategy. The strategic

approach and practical steps to be taken are given, which will serve as a roadmap for guiding the partners through the various stages of the Joint Strategy, from conceptualization to execution.

Finally, a set of indicators and important milestones to track progress and measure the impact towards the implementation of the R&I strategy are defined. The KPIs are related to the implementation of the major goals of the joint strategy, and reflect its outcomes.

Summarizing all the steps above, the basic outcomes and contributions from the work in this deliverable are related to: the state of the art of DTs and Metaverse in South-east Europe; the analysis of local R&I Strategies of the 3 innovation Ecosystems (GR, BG and GR clusters); the identification of the common objectives and alignment of respective goals; the definition of the approach for a Quadruple Helix Collaboration; the development of the Joint R&I Strategy for the METACITIES Project; the definition of methodology and implementation plan guidelines of the joint R&I Strategy; the selection of KPIs to be used to measure the successful implementation of the strategy.

2 Introduction

2.1 Mapping METACITIES outputs

This section presents the METACITIES Grand Agreement (GA) commitments, as extracted from the formal deliverable and task description, in respect to their outputs and work to be performed. The purpose is to aid the reviewer in finding the specific sections of the document where the respective tasks' requirements are addressed but also to guide the author through and serve as a check list to address everything that is needed to be addressed.

Table 1: Adherence to METACITIES GA Deliverable & Tasks Descriptions

METACITIES GA Component Title	METACITIES GA Component Outline	Respective Document Chapter(s)	Justification
Tasks			
Task 2.1 Long-term R&I Vision and Strategy.	This task jointly defines the long-term R&I strategies, recommendations and implementation guidelines on Digital Twins and Metaverse for smart cities and smart regions in Southeast Europe. The definition of the long-term strategies of the clusters is necessary for the development of the joint strategy and vision of METACITIES. As this is a joint effort involving actors from a large geographical area of SEE, the output of this task contributes towards convergence of the localised strategic plans thus facilitating cross-border cooperation, knowledge exchanges, and joint implementation undertakings. In addition, the joint long-term vision and strategy will serve regional and national authorities to specify their own long-term R&I strategies, direct investments, and guide their implementation.	Chapter 3 Chapter 4 Chapter 5	Chapter 3 provides insights into the potential of Digital Twins and Metaverse technologies for smart cities and smart regions in Southeast Europe (SEE), that the three clusters (CY, GR, BG) should consider in the formulation of the "unified" Joint R&I strategy. The purpose of Chapter 4 is to articulate the local Research and Innovation (R&I) strategies for each cluster within the METACITIES project. The development and implementation of tailored local R&I strategies will enable each cluster to leverage their strengths, address local challenges, and capitalize on the potential of Digital Twin and Metaverse technologies in their region. These local R&I strategies will serve as a foundation in shaping the joint R&I strategy (Chapter 7), reflecting the shared vision and goals of the METACITIES project, and aligning with its methodology and objectives. Chapter 5 provides a comprehensive overview of the

METACITIES GA Component Title	METACITIES GA Component Outline	Respective Document Chapter(s)	Justification
Tasks			
			joint R&I strategy for the METACITIES project, outlining key components, establishing a framework for cooperation and coordination, and identifying potential areas for cross-border collaboration and knowledge exchange.
Task 2.2 Conceptual Model of the QH Approach.	The task develops a QH collaboration model in which the roles and interactions of the four actors are defined and tuned to the METACITIES context, and in particular the cross-border aspect. The QH Model of innovation recognizes four major actors in the innovation system: science, policy, industry, and civil society. The participatory nature of innovation implies that the public and private sector must align their priorities for regional development. Recent case studies and surveys have indicated that civil society participation continues to be low, and the regions are experiencing difficulties in getting civil society groups involved. To overcome them, mechanisms need to be developed, through which engagement and synergies of all actors can be supported and participation of civil society can be facilitated.	Chapter 6	The Reference Model for Collaboration, based on the Quadruple Helix (QH) Approach, applied in the context of Smart Cities is developed in Chapter 6. The goal is this model to be followed and properly adapted to the smart city cases and to be addressed by each of the three regional innovation ecosystems in the context of the METACITIES project. The smart city cases to be pursued require the realization of specific interventions in the priority areas defined as part of the work related to T2.1 and documented in chapters 4 and 5. For each such priority area, comprehensive agendas for collaborative R&I agendas are developed and the key research topics, methodologies, and activities that will be undertaken to achieve relevant identified goals and objectives are outlined.
Task 2.3 Methodology and Action Plan.	This task proposes a methodological approach to translate the strategic goals of the R&I cross-border collaboration strategy into a portfolio of complementary actions involving all actors of the QH. The translation of the strategic goals of the joint strategy into actions is a	Chapter 7	The definition of the methodology and the implementation plan the METACITIES project's partners should follow to reach the objectives of the Joint Strategy is presented in Chapter 7. There the strategic approach and practical

METACITIES GA Component Title	METACITIES GA Component Outline	Respective Document Chapter(s)	Justification
Tasks			
	prerequisite for its successful implementation. the Such actions include: a). alignment of R&D&I with regional priorities and specificities; b). convergence of localized strategic plans thus facilitating cross-border cooperation, knowledge exchanges, and joint implementation undertakings; c). adoption of an open framework to facilitate co-development of an agile and efficient nexus of collaborative links; d). joint experimentation and piloting; e.) joint sustainability and investment plans; f.) definition of collaboration support actions such as staff exchange, knowledge and technology transfer.		steps to be taken in order to achieve the Joint Strategy's objectives are outlined. The chapter serves as a roadmap for guiding the partners through the various stages of the Joint Strategy, from conceptualization to execution. The developed methodology can also serve as a roadmap for the design and implementation of future Joint Strategies of other research and innovation ecosystems, as a part of the Toolbox to be created by METACITIES project.
Task 2.4 Milestones & Key Indicators to track progress and impact.	This task defines a set of indicators and important milestones to track progress and measure the impact towards the implementation of the R&I strategy. The definition of KPIs is required to track the progress and performance of the strategy in the context of achieving its goals and objectives. The strategy, methodology and action plan are a cross-border collaborative effort that aims to increase the R&I capacities of all actors in the regional ecosystems and improve their outreach to international scale. In this context, the KPIs should be related to the implementation of the major goals of the joint strategy, and reflect outcomes such as increased attractiveness for talents, increased investment funds, increased R&I outcomes, stronger linkages among the actors of the QH, and stronger	Chapter 8	In this chapter a set of indicators and important milestones to track progress and measure the impact towards the implementation of the R&I strategy are defined. The selection of the KPIs is done in such a way to allow an easy estimation of the progress and performance of the strategy in the context of achieving its goals and objectives. The strategy, methodology and action plan are a cross-border collaborative effort that aims to increase the R&I capacities of all actors in the regional ecosystems and improve their outreach to international scale. In this context, the selection of the KPIs should be done is such a way that they are related to the implementation of the major goals of the joint strategy, and reflect its outcomes.

METACITIES GA Component Title	METACITIES GA Component Outline	Respective Document Chapter(s)	Justification
Tasks			
	involvement of regional actors in R&I processes.		
Deliverable D2.1 – METACITIES cross-border R&I strategy			
This deliverable reports on the key elements of the METACITIES R&I strategy and the cross-border R&I collaboration toolbox, including the common R&I Strategy, the model of QH collaboration and support mechanisms, the joint methodology, action plan and performance and impact indicators.			

2.2 Deliverable Overview and Report Structure

The present deliverable addresses the first objective of the METACITIES project which relates to the definition of joint long-term R&I strategies and implementation guidelines on Digital Twins and Metaverse technologies for smart cities and smart regions in SEE applicable to regional innovation strategies for smart specialization. It documents the work and outcomes of WP2, which are organized as follows:

Chapter 1 is an executive summary where the general structure of the document is provided.

Chapter 2 is an introductory chapter presenting the goal and commitments of this deliverable in respect to their outputs and work to be performed as per the Grant Agreement, for the purpose to guide the reader and serve as a check list addressing the performance of the tasks related to this deliverable.

Chapter 3 provides an overview of the landscape of Digital Twins and Metaverse technologies in Southeast Europe, focusing on their technological, economic, and social aspects. It explores potential barriers faced in the three countries involved in the METACITIES project and suggests collaboration opportunities for fostering cross-border innovation and growth.

Chapter 4 articulates regional Research and Innovation (R&I) strategies for each place-based innovation ecosystem. The regional R&I strategies harness local strengths, tackle local challenges, and aim to maximize the Digital Twin and Metaverse technologies' potential. These strategies inform the joint R&I strategy.

Chapter 5 provides a comprehensive overview of the joint R&I strategy which embodies the project's shared vision and objectives while adhering to its methodology. It outlines its key components, while establishing a framework for cross-border collaboration, coordination, and knowledge exchange.

Chapter 6 focuses on defining a Reference Model for Collaboration, using the Quadruple Helix (QH) Approach, specifically for Smart Cities. This model is adjusted for each regional innovation ecosystem and the relevant smart city interventions and priority areas. QH-based Models of Collaboration for

Smart Cities are defined for both intra and inter regional innovation ecosystems' collaboration of all four stakeholder types.

Chapter 7 provides a methodological approach to translate the strategic goals of the cross-border, joint R&I strategy into a portfolio of complementary actions involving all actors of the QH, driving the process from conceptualization to implementation. The defined Actions are mapped to work packages and will form the basis of the Action Plan of the Excellence Hub to be defined within the scope of WP5.

Chapter 8 Defines and describes key performance indicators to mark significant milestones and track progress toward achieving the joint R&I strategy's objectives and project outcomes. These KPIs are selected to promptly signal changes occurring during project implementation. They will be used as the means to measure and assess quantitatively and qualitatively the win-win effects of the partnership.

Chapter 9 concludes the deliverable.

3 Current State of DTs and Metaverse in Southeast Europe

The aim of this chapter is to provide valuable insights into the potential of Digital Twins and Metaverse technologies for smart cities and smart regions [1]**,** [2]**,** [3] **in Southeast Europe (SEE), that the participating clusters (CY, GR, BG) should consider in the formulation of the "unified" Joint R&I strategy.**

More specifically, this chapter: i) Provides an overview of the current state of Digital Twins and Metaverse technologies in Southeast Europe, focusing on their technological, economic, and social aspects; ii) Explores the potential barriers/challenges that Southeast European countries, like Cyprus, Bulgaria, and Greece, may face in implementing Digital Twins and Metaverse technologies; iii) Proposes some opportunities for collaboration among the CY, BG, and GR clusters, within the context of the METACITIES project; and iv) Presents a set of recommendations and implementation guidelines that should be considered during the development of the joint vision/strategy, aimed at fostering cross-border collaboration, innovation, and development in Digital Twins and Metaverse in Southeast Europe (SEE).

3.1 Technological Landscape

The technological landscape of Digital Twins [4] and Metaverse [5] in Southeast Europe exhibits a mix of varying levels of maturity and adoption across different countries. The basic information for Digital Twins and Metaverse as well as an extensive literature review on existing solutions that have already been developed in Southeast Europe countries and worldwide in general, is provided in Deliverable 'D3.1 A: Requirements and Specification of the ODTF'.

Below we provide a brief overview of the current state of these technologies in the region, focusing on the key areas of development and the overall technological readiness of countries to embrace Digital Twins and Metaverse technologies.

In summary, the technological landscape of Digital Twins [6], [7] and Metaverse [8] in Southeast Europe is diverse and rapidly evolving [9]. While there are notable advancements and early adopters in the region, more work is needed to ensure that all countries can benefit from the potential of these technologies. Addressing infrastructure and technological readiness challenges will be crucial to unlocking the full potential of Digital Twins and Metaverse technologies in Southeast Europe.

3.1.1 Digital Twins and Metaverse Development in Southeast Europe

In Southeast Europe, the implementation of Digital Twins plays a transformative role, especially in the areas of urban planning, smart mobility, and green cities.

- **In urban planning**, Digital Twins are utilized to create virtual representations of cities, enabling stakeholders to visualize, analyze, and optimize urban infrastructure. In Southeast Europe, some countries have started experimenting with Digital Twins [10], [11] to improve their urban planning processes, while others are still in the early stages of exploration. Key application areas include transportation and traffic management, utility management, and public safety.
- **Smart mobility** is another area where Digital Twins are gaining traction in Southeast Europe. Digital Twins are being employed to optimize public transportation networks, predict traffic patterns, and manage fleets of autonomous vehicles. Some countries in the region have

started implementing Digital Twins to support their smart mobility initiatives, while others are still exploring the potential benefits.

- **Green cities** prioritize sustainability and environmental friendliness and leverage Digital Twins for various applications. These applications include monitoring air quality, optimizing waste management, analyzing the environmental impact of new infrastructure projects, and dealing with energy efficiency and climate adaptation. While there is growing interest in green city initiatives across Southeast Europe, the adoption of Digital Twins in this area is still limited.

The Metaverse concept[1], on the other hand, is an emerging concept globally [5], [12]. Though still in its infancy in the region of SEE, a few pioneering initiatives [13] led by innovative start-ups, research institutions, and technology companies exploring the Metaverse's possibilities in various sectors, such as gaming, education, and cultural heritage, indicate a growing momentum towards developing and adopting the Metaverse.

One of the significant drivers of Metaverse development in Southeast Europe is the increasing need for remote collaboration tools due to the COVID-19 pandemic and the ongoing trend towards remote work [14]. The Metaverse offers a unique opportunity for companies to create shared virtual spaces where employees can interact, collaborate, and conduct meetings more immersive and engaging than traditional video conferencing solutions. Furthermore, virtual events such as conferences, trade shows, and concerts are becoming more popular, offering new opportunities for Metaverse development in the region.

Despite the growing interest in Digital Twins and Metaverse in Southeast Europe, there are several challenges that the region must overcome to embrace this emerging technology fully. These challenges include, among others, limited access to high-speed internet, the need for significant investments in digital infrastructure, and the development of local talent and skills in VR and AR/XR technologies.

However, these challenges also present opportunities for regional cooperation, knowledge exchange, and joint investments to advance the development and adoption of the Metaverse in Southeast Europe. Overcoming the region's challenges and fostering collaboration will be essential in unlocking the full potential of the Metaverse and driving innovation in Southeast Europe.

3.1.2 Infrastructure and Technological Readiness in Southeast Europe

The successful adoption of Digital Twins and Metaverse technologies in Southeast Europe relies heavily on the region's overall technological readiness [15]. Several factors contribute to this readiness, including the availability of advanced sensors and IoT devices, the integration of artificial intelligence and machine learning, the deployment of 5G and 6G technologies, and the establishment of open data platforms. Nevertheless, there is a noticeable disparity in adopting these technologies across the region, with some countries leading the way and others lagging.

Overall, there are still several challenges that hinder the region's technological landscape, affecting the widespread adoption of Digital Twins and Metaverse technologies.

The main challenges include:

[1] A collective virtual shared space that merges the physical and digital worlds, that heavily relies on VR and AR technologies

- **Inadequate broadband connectivity:** Many areas within Southeast Europe still suffer from insufficient broadband connectivity, limiting the feasibility and effectiveness of implementing Digital Twins and Metaverse technologies. High-speed, reliable internet access is essential for these technologies to function smoothly and reach their full potential.
- **Lack of standardization:** The absence of standardization in Digital Twin and Metaverse technologies may impede interoperability and create friction in cross-border collaboration. Developing and adopting common standards can facilitate seamless integration and cooperation between various stakeholders, encouraging the proliferation of these technologies across the region.
- **Investment in digital infrastructure:** Sufficient investment in digital infrastructure is crucial for the widespread adoption of Digital Twins and Metaverse technologies. This includes upgrading network infrastructure, enhancing data storage capabilities, and investing in state-of-the-art computing resources. Without adequate investment, it will be challenging for the region to keep pace with the rapid advancements in these fields.

Addressing these challenges is of paramount importance for Southeast 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 to 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.

3.2 Economic and Social Aspects

The advantages of employing Digital Twins and Metaverse technologies [16] go far beyond their direct applications. Beyond just providing technological advancements, these technologies can provide substantial social and economic benefits to Southeast Europe, as they also have the potential to improve the overall quality of life, transform industries, create new business opportunities, and drive sustainable growth throughout the region.

3.2.1 Economic Aspects

Digital Twins and Metaverse technologies can contribute to the region's economy through several channels, including increased efficiency, cost savings, and the generation of new business opportunities [17], [9].

Some of the key economic benefits are:

- **Job creation:** The development and implementation of these technologies can lead to the creation of numerous job opportunities in diverse fields, such as software development, data analysis, virtual and augmented reality design, infrastructure management, content creation, and marketing. As demand for these skills grows, educational institutions can also expand their curricula, further driving regional job growth.
- **Investment attraction:** The growing interest in Digital Twins and Metaverse technologies can attract both domestic and foreign investment in the region. This investment can spur further

innovation and economic growth and create a supportive ecosystem for startups and established businesses in these fields.

- **Cost savings:** Digital Twins can reduce costs by optimizing resources and improving operational efficiency. For example, Digital Twin simulations can be used to test different scenarios and identify potential issues before they occur, reducing the need for physical testing and associated costs.
- **Innovation and entrepreneurship**: These technologies can foster innovation by providing new tools and platforms for entrepreneurs to develop unique solutions and create new business models. This, in turn, can lead to the growth of new industries and contribute to the diversification of the region's economy.
- **Enhanced competitiveness:** By adopting Digital Twins and Metaverse technologies, companies in the region can become more competitive globally. Leveraging these advanced tools can optimize operations, offer novel products and services, and enhance customer experiences.
- **Economic resilience:** Implementing Digital Twins and Metaverse technologies can contribute to economic stability by enabling businesses to adapt quickly to changing market conditions, improve supply chain management, and create more agile operations. This adaptability is essential for navigating economic uncertainties, ensuring sustained economic growth and stability in the region.

3.2.2 Social Aspects

From a social perspective [1], [5], Digital Twins and Metaverse technologies can potentially improve the quality of life in urban areas, promote greater social cohesion, and address various societal challenges.

Key social benefits include:

- **Resource management[2]:** These technologies can contribute to better resource management by enabling more efficient allocation of resources, reducing waste, and promoting sustainable practices. This can lead to improved environmental outcomes, such as reduced pollution and more responsible use of natural resources.
- **Citizen engagement**: Digital Twins and Metaverse platforms can facilitate enhanced citizen engagement by providing interactive, immersive environments for collaboration, consultation, and decision-making. These platforms can make governance more transparent and allow citizens to participate more actively in decision-making.
- **Accessibility**: Virtual and augmented reality experiences can make cultural, educational, and recreational activities more accessible to a wider audience, regardless of physical location or mobility constraints. This can help promote equal opportunities and bridge the gap between urban and rural areas.
- **Social inclusion:** These technologies can promote social inclusion by connecting people from different backgrounds and fostering community through shared virtual spaces. By breaking down barriers and encouraging interaction, Digital Twins and Metaverse platforms can help create a more inclusive society.

[2] In the context of Digital Twins and Metaverse technologies, it refers to the optimal allocation and utilization of various types of resources, such as physical assets, energy, and human resources, to ensure efficiency and sustainability.

- **Healthcare:** Digital Twins and Metaverse technologies can improve healthcare outcomes by allowing for remote consultations, training, and therapy sessions. They can also facilitate better management of healthcare facilities and resources, improving patient care.

3.3 Key Challenges and Opportunities

This section aims to identify the common challenges that Southeast European countries, including Cyprus, Bulgaria, and Greece, may face in implementing and adopting Digital Twins and Metaverse technologies and propose some opportunities for collaboration among the CY, BG, and GR clusters within the context of the METACITIES project.

By identifying these challenges and cross-border collaboration opportunities, the involved clusters/stakeholders can work towards addressing them and creating a joint framework for the successful adoption and implementation of Digital Twins and Metaverse technologies in Southeast Europe.

3.3.1 Challenges and Considerations in Digital Twins and Metaverse Implementation

Several challenges [18], [19][3], [20] in the performance of Digital Twins and Metaverse technologies can hinder the progress of the METACITIES project. Addressing these challenges is essential for the participating countries (Cyprus, Bulgaria, and Greece) to ensure a smooth adoption and implementation of Digital Twins and Metaverse technologies in Southeast Europe, ultimately contributing to sustainable growth, social inclusion, and improved quality of life in the region.

Below is an indicative list of key challenges/considerations encountered in the deployment of Digital Twins and Metaverse technologies (Table 2). Each item on the list is accompanied by an explanation of how the METACITIES project can play a pivotal role in providing possible solutions and mitigation actions.

Table 2: Key challenges for Digital Twin and Metaverse deployment

Key challenge/Consideration	METACITIES Project Role
Disparities in technological readiness: The disparities in technological readiness, digital infrastructure, and access to high-speed internet connectivity among Southeast European countries present a significant challenge to the widespread adoption of Digital Twins and Metaverse technologies. Addressing these issues is crucial for successful implementation and will require collective efforts and investments.	The METACITIES project can help facilitate the development of digital infrastructure and promote technological readiness within the region by supporting collaborative infrastructure projects, sharing best practices in infrastructure development, and identifying gaps in regional connectivity.
Lack of standardization: The lack of standardization in Digital Twin and Metaverse technologies is a significant obstacle	Within the context of the METACITIES project, the three clusters (CY, BG, and GR) can collaborate to develop and promote standardized approaches to Digital Twins and

[3] Available at: https://www.researchgate.net/profile/Jianguo_Ding/publication/356375388_A_Survey_on_Metaverse_the_State-of-the-art_Technologies_Applications_and_Challenges/links/62189097d548144b00b9816d/A-Survey-on-Metaverse-the-State-of-the-art-Technologies-Applications-and-Challenges.pdf

Key challenge/Consideration	METACITIES Project Role
to interoperability and cross-border collaboration. Establishing common standards and frameworks can facilitate seamless integration, fostering regional innovation and cooperation.	Metaverse technologies. By working together on shared standards and frameworks, they can enhance interoperability and collaboration across the participating countries and beyond, ultimately driving innovation in the region.
Lack of regional talent/expertise development: Nurturing local talent and expertise in VR, AR, and other related technologies is crucial for the growth of Southeast Europe's Metaverse and Digital Twins. Collaborative efforts in education, training, and knowledge sharing can help bridge skill gaps and foster a skilled workforce capable of driving technological advancements.	The METACITIES project can create joint capacity-building initiatives and facilitate knowledge exchange among the three clusters to promote regional talent development. The project can empower individuals and organizations to excel in Digital Twin and Metaverse technologies by offering workshops, training programs, and research opportunities.
Need for cross-sectoral collaboration: Opportunities for collaboration exist across various sectors, such as urban planning, smart mobility, green cities, cultural heritage, remote work, virtual events, and education. By exploring synergies and fostering cross-sectoral partnerships, countries can accelerate the adoption of Digital Twins and Metaverse technologies, ultimately driving innovation and economic growth.	The METACITIES project can provide a framework for identifying and promoting cross-sectoral collaboration opportunities among the three clusters. By aligning goals, sharing resources, and leveraging each other's strengths, they can create innovative solutions that address shared challenges and maximize the potential of Digital Twin and Metaverse technologies.
Need for new business models: These business models will capture the preferred operation mode of the smart-, meta- city/region, namely, how to implement, manage, and operate the smart/meta city business by public and non-public stakeholders. They will dictate the model of investments and developments (e.g., public vs. private vs. PPP) necessary to realize the strategy and guide the economic and social expectations of the various stakeholders.	The METACITIES project can study and analyze in what way Digital Twins and Metaverse worlds impact and transform the business processes and business models of smart cities/regions. This entails reconfiguration of business models to reconcile the multiple key requirements of current and emerging technology deployment areas, such as Digital Twins and Metaverse, and create new market opportunities.
Harnessing economic and social benefits: Digital Twins and Metaverse technologies have the potential to transform industries, create new job opportunities, and improve the overall quality of life in the region. Harnessing these benefits requires concerted efforts to overcome challenges and capitalize on collaboration opportunities. Southeast European countries can promote sustainable development, social	The METACITIES project can play a pivotal role in realizing these economic and social benefits by facilitating the exchange of best practices, promoting the adoption of innovative technologies, and enabling collaboration among the CY, BG, and GR clusters, ultimately driving positive change throughout the region.

Key challenge/Consideration	METACITIES Project Role
inclusion, and enhanced citizen engagement by doing so.	
Economic resilience and adaptability: Adopting Digital Twins and Metaverse technologies can contribute to economic resilience and adaptability in the face of changing market conditions and global challenges. Countries need to invest in these technologies to maintain competitiveness, optimize resource management, and improve supply chain operations.	The METACITIES project can support the development of resilient and adaptable strategies by encouraging collaboration among the three clusters and fostering the successful adoption and integration of Digital Twin and Metaverse technologies in the region. By jointly addressing challenges, sharing resources, and leveraging their unique strengths, the CY, BG, and GR clusters can create a more resilient and adaptable future for their citizens and industries.
Data privacy and security: As Digital Twins and Metaverse technologies become more prevalent, ensuring data privacy and security is critical. These technologies often rely on massive amounts of data collected from various sources, raising concerns about data breaches, unauthorized access, and misuse of personal information. Establishing robust data protection policies, secure platforms, and transparent practices can help mitigate potential risks and foster trust among stakeholders.	The METACITIES project can facilitate the development of secure and privacy-preserving technologies and practices by promoting collaboration among the three clusters. Through joint initiatives, they can share expertise, develop best practices for data protection, and design systems that prioritize data privacy and security.
Limited access to funding and investment: Limited access to funding and investment opportunities can hinder the growth and adoption of Digital Twins and Metaverse technologies. Encouraging public and private investments, as well as fostering the development of local startup ecosystems, can accelerate innovation in the region.	The METACITIES project can help facilitate investment and funding opportunities by connecting stakeholders, showcasing successful projects, and promoting the economic potential of the region Digital Twin and Metaverse technologies.
Lack of public awareness and engagement: The lack of awareness and understanding of Digital Twin and Metaverse technologies among the general public and key stakeholders can impede their adoption. Increasing public engagement and promoting the benefits of these technologies is crucial for their widespread acceptance and use.	The METACITIES project can support public awareness campaigns and educational programs and showcase events to foster a greater understanding of Digital Twin and Metaverse technologies and their potential impact on society and the economy.
Need for supportive regulatory environment: A flexible and encouraging regulatory environment is crucial for the growth of Digital Twin and Metaverse technologies. Outdated or	The METACITIES project can aid the exchange of best practices in policy and regulation among the CY, BG, and GR clusters and collaborate with policymakers to develop progressive regulations

Key challenge/Consideration	METACITIES Project Role
limiting regulations may pose entry barriers, suppressing innovation and adoption.	that facilitate the expansion of Digital Twin and Metaverse technologies in the region.
Need for harmonizing regulatory and policy frameworks: Southeast European countries may have varying regulatory and policy frameworks governing Digital Twins and Metaverse technologies. These disparities can create obstacles to cross-border collaboration and impede the smooth execution of the METACITIES project.	To tackle these challenges, the participating countries in the METACITIES project should cooperate to synchronize regulations, establish a shared policy framework, and foster a supportive environment for adopting and deploying Digital Twins and Metaverse technologies.
Ensure intellectual property and legal frameworks: Ensuring the protection of intellectual property rights and the development of appropriate legal frameworks for Digital Twin and Metaverse technologies is crucial. This can help create a supportive environment for innovation while safeguarding the rights of creators and developers.	The METACITIES project can facilitate developing and harmonizing intellectual property and legal frameworks among the CY, BG, and GR clusters by promoting knowledge sharing and collaboration on relevant laws and regulations.
Ensure digital inclusion and accessibility: Ensuring that Digital Twin and Metaverse technologies are accessible to all citizens, regardless of their socioeconomic background or technical abilities, is crucial for achieving social equity and maximizing the benefits of these technologies. Developing user-friendly interfaces and promoting digital literacy are essential steps towards digital inclusion.	The METACITIES project can support digital inclusion initiatives by fostering the development of accessible technologies and promoting digital literacy programs among the CY, BG, and GR clusters.
Considerations for environmental impact and Sustainability: As Digital Twin and Metaverse technologies continue to grow, it is important to consider their environmental impact and strive for sustainable development. This includes minimizing the energy consumption and carbon footprint of data centers, promoting the use of renewable energy, and encouraging responsible resource management.	The METACITIES project can emphasize sustainability by sharing best practices in environmentally-friendly technologies, encouraging the adoption of green solutions, and fostering a culture of sustainability among the participating clusters.
Ethical considerations: Addressing ethical concerns surrounding Digital Twin and Metaverse technologies is essential for building trust and ensuring responsible	The METACITIES project can facilitate discussions and collaborations around ethical issues by promoting the exchange of best practices in ethical technology development among the CY, BG, and GR clusters and encouraging the

Key challenge/Consideration	METACITIES Project Role
development. This includes respecting user privacy, avoiding the exacerbation of social inequalities, and preventing the misuse of technology for malicious purposes.	development of ethical guidelines and frameworks for Digital Twin and Metaverse technologies.
Limited awareness: Raising awareness of the benefits and applications of Digital Twin and Metaverse technologies is important for driving adoption and fostering a culture of innovation. By showcasing successful use cases and promoting the value of these technologies, stakeholders can encourage wider acceptance and use.	The METACITIES project can support promotional efforts and raise awareness of Digital Twin and Metaverse technologies by organizing events, developing marketing materials, and sharing success stories among the CY, BG, and GR clusters.
Limited resources and expertise: Countries in the region might have varying levels of resources and expertise in Digital Twin and Metaverse technologies. Some countries may lack the necessary infrastructure, skilled workforce, or funding to support the development and deployment of these technologies.	To address this challenge, the METACITIES project should focus on building partnerships, sharing knowledge and resources, and providing training and capacity-building programs to enhance the skills and capabilities of local professionals in the participating countries.
Integration of legacy systems and interoperability issues: Many countries in the region may have existing legacy systems that need to be integrated with Digital Twin and Metaverse technologies. Integrating these systems can be challenging, given the differences in technology standards, protocols, and data formats.	The METACITIES project should facilitate the development and adoption of open standards, enabling interoperability among different systems and ensuring seamless integration of Digital Twin and Metaverse technologies.

3.3.2 Opportunities for Cross-border Collaboration

Cross-border collaboration presents numerous opportunities for participating countries (Cyprus, Bulgaria, and Greece) to address shared challenges and capitalize on the potential of Digital Twin and Metaverse technologies.

The METACITIES project can serve as a catalyst for these collaborations, providing a platform for countries to work together and achieve their goals. In Table 3 are outlined some opportunities for cross-border collaboration, the pivotal role of the METACITIES project in facilitating these collaborations, and the corresponding impacts anticipated to unfold.

Table 3: Cross-border collaboration opportunities

Collaboration Opportunity & Impact	METACITIES Project Role
Sharing expertise, resources, and best practices among countries *Impact: capacity building, enhanced technical skills, and more efficient use of resources across the region.*	The METACITIES project can facilitate the exchange of expertise, resources, and best practices by creating a knowledge-sharing platform. This platform can foster an environment where countries share their experiences and learn from one another, leading to better and more efficient implementations of Digital Twin and Metaverse technologies.
Jointly developing projects and initiatives to benefit from economies of scale *Impact: attracting investment and funding, promoting the development and deployment of these technologies, and fostering regional economic growth.*	The METACITIES project can support the joint development of projects and initiatives by providing a framework for cooperation and coordination. Participating countries can pool resources, reduce costs, and streamline the implementation process, ultimately leading to more effective and impactful Digital Twin and Metaverse projects.
Establishing a common regulatory framework and harmonizing policies to facilitate collaboration and implementation *Impact: A more unified regional approach to Digital Twin and Metaverse technology implementation and increased cross-border cooperation.*	The METACITIES project can contribute to developing a common regulatory framework and harmonizing policies across participating countries. By providing a platform for discussion and coordination, the project can help create a supportive environment for innovation, ensure data security and privacy, and address potential legal and ethical concerns.
Expanding regional digital infrastructure to support Digital Twin and Metaverse technologies *Impact: Increased connectivity, reduced digital divide, and more equitable access to digital services*	The METACITIES project can facilitate the expansion of digital infrastructure in the region by identifying infrastructure gaps, sharing best practices, and promoting collaboration on infrastructure projects. By improving regional digital infrastructure, countries can ensure that Digital Twin and Metaverse technologies are accessible and effective for all citizens.
Collaborating on cybersecurity measures to protect Digital Twin and Metaverse implementations *Impact: a more secure digital environment, increased public confidence, and a stronger regional approach to cybersecurity.*	The METACITIES project can support collaboration on cybersecurity measures by providing a platform for countries to share expertise, coordinate strategies, and establish best practices. Ensuring the security and integrity of Digital Twin and Metaverse implementations is essential to protecting sensitive data and maintaining public trust.
Developing cross-border public services using Digital Twin and Metaverse technologies	The METACITIES project can facilitate the development of cross-border public services [4] by promoting the exchange of expertise, the sharing of resources, and the

[4] Digital Twin and Metaverse technologies can be used to create virtual models of transportation systems, enabling better coordination and management of cross-border transportation networks, such as trains, buses, and highways. This could lead to more efficient travel and improved transportation services for citizens traveling between participating countries.

Collaboration Opportunity & Impact	METACITIES Project Role
Impact: more efficient and effective public services, improved citizen satisfaction, and a more connected region.	coordination of service delivery. By working together, participating countries can develop innovative public services that leverage Digital Twin and Metaverse technologies to address shared challenges and improve the quality of life for citizens.
Fostering innovation ecosystems and regional tech hubs *Impact: increased innovation, job creation, and the establishment of a regional tech community.*	The METACITIES project can promote the development of innovation ecosystems and regional tech hubs, connecting startups, academic institutions, and established businesses. By fostering a collaborative environment, these hubs can accelerate the development and adoption of Digital Twin and Metaverse technologies across the region.
Collaborating on education and workforce development programs *Impact: a more skilled workforce, reduced skill gaps, and better alignment between educational programs and industry needs.*	The METACITIES project can support collaboration on education and workforce development programs, ensuring that participating countries have the necessary skills and talent to effectively leverage Digital Twin and Metaverse technologies. Countries can create joint training programs and educational initiatives by sharing resources, expertise, and best practices.
Promoting cross-border entrepreneurship and business opportunities *Impact: job creation, increased investment, and the growth of a regional startup ecosystem.*	The METACITIES project can facilitate the growth of cross-border entrepreneurship and business opportunities by creating a supportive environment for startups and small businesses focused on Digital Twin and Metaverse technologies. The project can help entrepreneurs scale their businesses across borders by fostering regional networks and providing access to resources.
Collaborating on research and development (R&D) initiatives *Impact: increased innovation, the development of cutting-edge solutions, and the advancement of regional scientific knowledge.*	The METACITIES project can support cross-border collaboration on R&D initiatives, enabling countries to pool resources and expertise to tackle shared challenges and explore new opportunities in Digital Twin and Metaverse technologies. By jointly conducting research and development, participating countries can foster innovation and accelerate advancements in these fields.
Coordinating disaster response and emergency management *Impact: improved crisis management, reduced economic and social impacts, and increased regional resilience.*	The METACITIES project can facilitate coordination in disaster response and emergency management through the use of Digital Twin and Metaverse technologies. By sharing real-time data, expertise, and resources, countries can enhance their preparedness and response to natural disasters, public health emergencies, and other crises.

Collaboration Opportunity & Impact	METACITIES Project Role
Promoting sustainable development and environmental initiatives *Impact: reduced carbon emissions, improved resource efficiency, and the advancement of regional sustainability goals.*	The METACITIES project can support collaboration on sustainable development and environmental initiatives, leveraging Digital Twin and Metaverse technologies to optimize resource management, monitor environmental impacts, and develop innovative solutions for addressing climate change and other environmental challenges.
Facilitating cultural exchange and promoting regional identity *Impact: enhanced cultural diplomacy, increased tourism, and the strengthening of regional ties.*	The METACITIES project can leverage Digital Twin and Metaverse technologies to foster cultural exchange and promote regional identity among participating countries. By creating virtual spaces that showcase the diverse cultures and histories of the region, countries can encourage cross-border understanding and appreciation.
Collaborating on smart city initiatives and urban planning *Impact: improved urban living conditions, reduced environmental impacts, and more sustainable urban development.*	The METACITIES project can support collaboration on smart city initiatives and urban planning, using Digital Twin and Metaverse technologies to optimize e.g., infrastructure, transportation, and public services across the region. By sharing expertise, best practices, and innovative solutions, countries can work together to create more sustainable, efficient, and livable urban environments.
Developing a regional data-sharing platform *Impact: more informed policy-making, enhanced regional decision-making capabilities, and the promotion of data-driven innovation.*	The METACITIES project can contribute to the development of a regional data-sharing platform, enabling participating countries to exchange valuable data, insights, and analytics related to Digital Twin and Metaverse technologies. By pooling data resources and promoting data-driven decision-making, countries can work together to optimize the implementation of these technologies.
Strengthening regional cooperation on intellectual property (IP) rights and patent protection *Impact: increased investment in R&D, the promotion of technology transfer, and the protection of regional innovators' rights.*	The METACITIES project can strengthen regional cooperation on IP rights and patent protection related to Digital Twin and Metaverse technologies. By harmonizing IP regulations, streamlining the patent application process, and promoting a common understanding of IP rights, countries can create a more conducive environment for innovation and technology transfer.
Encouraging public-private partnerships (PPPs) to accelerate technology adoption *Impact: increased investment, faster technology adoption, and stronger public-private sector relationships.*	The METACITIES project can promote public-private partnerships, bringing together governments, businesses, and other stakeholders to accelerate the adoption of Digital Twin and Metaverse technologies. By facilitating collaboration between the public and

Collaboration Opportunity & Impact	METACITIES Project Role
	private sectors, countries can leverage resources, expertise, and innovation to drive the development and implementation of these technologies.
Addressing environmental challenges through collaborative Digital Twin and Metaverse initiatives *Impact: reduced environmental impacts, increased resource efficiency, and a more sustainable regional ecosystem.*	The METACITIES project can enable participating countries to work together to address environmental challenges through the use of Digital Twin and Metaverse technologies. By collaborating on projects aimed at reducing carbon emissions, improving resource management, and promoting sustainable practices, countries can leverage these technologies to mitigate the impacts of climate change and promote environmental sustainability.
Fostering regional collaboration on emerging technologies *Impact: increased innovation, strengthened regional technological capabilities, and enhanced regional competitiveness.*	The METACITIES project can help participating countries to collaborate on other emerging technologies related t the Digital Twin and Metaverse, such as artificial intelligence (AI), the Internet of Things (IoT), and blockchain. By working together to explore and develop these technologies, countries can stay at the forefront of technological advancements and maintain a competitive edge.
Encouraging inclusive and accessible Digital Twin and Metaverse technologies *Impact: improved digital access, reduced social inequalities, and enhanced quality of life for all citizens.*	The METACITIES project can promote the development and implementation of Digital Twin and Metaverse technologies that are inclusive and accessible to all, regardless of age, gender, or socioeconomic background. Countries can make sure that all of their citizens benefit from these technologies by working together on initiatives to promote digital inclusivity.

3.4 Recommendations and Implementation Guidelines

In the sections above, we have discussed the technological landscape, the economic and social aspects, the key challenges/considerations in implementing Digital Twins and Metaverse technologies, and outlined some opportunities for collaboration among the CY, BG, and GR clusters within the context of the METACITIES project.

Building on these findings, we present a set of recommendations and implementation guidelines that should be considered during the development of the joint vision/strategy, aimed at fostering cross-border collaboration, innovation, and development in Digital Twins and Metaverse. These recommendations are organized into four main categories: i) policy; ii) technological and infrastructural; iii) capacity building and human resources development; and iv) funding and investment opportunities.

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, ultimately improving the quality of life, economic growth, and sustainability across the participating countries.

3.4.1 Policy Recommendations

To create a conducive environment for innovation and collaboration in Digital Twin and Metaverse technologies, it is essential to develop supportive policies and regulations. Some key policy recommendations include:

- **Develop national and regional policies that encourage the use of Digital Twin and Metaverse technologies**, ensuring alignment with the joint vision and priorities set forth in the METACITIES project. This may include creating legal frameworks, tax incentives, and other mechanisms to promote the development and adoption of these technologies.
- **Foster public-private partnerships (PPPs) and novel business models to support the development and deployment of Digital Twins and Metaverse in smart cities and smart regions**. These partnerships can leverage resources, expertise, and innovation from both the public and private sectors to accelerate technology adoption and drive economic growth.
- **Establish a common regulatory framework and harmonize policies across participating countries to facilitate collaboration and the implementation of Digital Twin and Metaverse technologies.** This includes addressing potential legal and ethical concerns, ensuring data security and privacy, and promoting a supportive environment for innovation.

3.4.2 Technological and Infrastructural Recommendations

A robust technological and infrastructural foundation is crucial for the successful implementation of Digital Twin and Metaverse technologies. The following recommendations focus on enhancing the region's technological and infrastructural capabilities:

- **Invest in the development of shared data infrastructures and open data platforms to facilitate data exchange and interoperability among countries.** This will enable countries to pool resources, optimize the implementation of Digital Twin and Metaverse technologies, and promote data-driven decision-making.
- **Promote the adoption of common standards and protocols for Digital Twins and Metaverse technologies to ensure seamless integration, interoperability, and scalability.** This includes supporting international standardization efforts and encouraging the use of open-source solutions where possible.
- **Support the development and deployment of secure and privacy-preserving solutions for Digital Twin and Metaverse implementations.** This involves investing in cybersecurity measures, developing best practices for data protection, and promoting trust among stakeholders and the public.

3.4.3 Capacity Building and Human Resources Development

Developing the necessary skills and expertise in Digital Twin and Metaverse technologies is critical for smart city and region initiatives' success. To address this need, the following capacity building and human resources development recommendations are proposed:

- **Establish joint training and education programs among participating countries to develop the required skills and expertise in Digital Twin and Metaverse technologies.** This may include creating specialized courses, workshops, and certifications in collaboration with academic institutions and industry partners.

- **Promote the exchange of researchers, students, and professionals among countries to foster cross-border knowledge sharing and collaboration.** This can be achieved through international conferences, exchange programs, and collaborative research projects.
- **Encourage interdisciplinary research and collaboration to address smart cities' and regions' complex challenges.** This involves promoting cooperation between experts in fields such as urban planning, engineering, computer science, and social sciences to develop holistic and innovative solutions.

3.4.4 Funding and Investment Opportunities

Securing adequate funding and investment is essential for successfully developing and deploying Digital Twin and Metaverse technologies. The following recommendations aim to facilitate funding and investment opportunities for cross-border R&I initiatives:

- **Develop joint funding schemes and investment mechanisms to support cross-border R&I initiatives in Digital Twin and Metaverse technologies.** This may include creating regional grants, venture capital funds, and other financial instruments tailored to the needs of the Digital Twin and Metaverse sector.
- **Attract international funding and investment to the region by showcasing successful case studies and innovative projects.** This can be achieved by organizing events, conferences, and exhibitions that highlight the region's strengths, expertise, and potential in Digital Twin and Metaverse technologies.
- **Encourage public-private partnerships to mobilize resources for developing and deploying Digital Twins and Metaverse technologies in smart cities and regions.** This includes exploring innovative financing models, such as blended finance or public-private co-investment schemes, to reduce the risk for private investors and leverage public funding more effectively.
- **Establish a regional innovation ecosystem that connects startups, established companies, research institutions, and investors.** This can help create synergies and facilitate the flow of knowledge, expertise, and capital among stakeholders in the Digital Twin and Metaverse sectors.

3.5 Overall Remarks

In this chapter, we have analyzed the Digital Twin and Metaverse technologies landscape, identified key challenges/considerations that Southeast European countries, like Cyprus, Bulgaria, and Greece, may face in implementing Digital Twins and Metaverse technologies, and proposed some opportunities for cross-border collaboration within the context of the METACITIES project. Also, a set of recommendations and implementation guidelines that should be considered during the development of the joint vision/strategy aimed at fostering cross-border collaboration, innovation, development and deployment of Digital Twins and Metaverse in smart cities and smart regions is presented.

The participating clusters (CY, GR, BG) must pay close attention to the findings of this chapter when formulating the "unified" joint R&I strategy. By doing so, the different Clusters will be better equipped to address the challenges, seize the cross-border collaboration opportunities, and ultimately contribute to the development of more sustainable, efficient, and resilient urban systems in the region.

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

By analyzing the challenges, opportunities, and recommendation and implementation guidelines presented in Chapter 3, CY, GR and BG Clusters can gain valuable insights into the potential of Digital Twins and Metaverse technologies for smart cities and smart regions. This knowledge aims to provide guidance for each cluster in the formulation of their R&I strategies, direct investments 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).

It is worth mentioning that the METACITIES project aligns its objectives with the United Nations SDGs [21][5], ensuring that the R&I strategies contribute to sustainable and inclusive growth.

The purpose of this Chapter is to articulate the local Research and Innovation (R&I) strategies for each cluster within the METACITIES project. The development and implementation of tailored local R&I strategies will enable each cluster to leverage their strengths, address local challenges, and capitalize on the potential of Digital Twin and Metaverse technologies in their region. These local R&I strategies will serve as a foundation in shaping the joint R&I strategy (Chapter 7), reflecting the shared vision and goals of the METACITIES project, and aligning with its methodology and objectives.

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 chapter, 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.

4.1 EU Missions for Sustainable Urban Development in Europe

The United Nations (UN) Agenda 2030 for Sustainable Development is a global policy framework that aims to end poverty, reduce inequality, and address climate change in a socially inclusive manner. The agenda acknowledges that these challenges are interrelated and require a coordinated effort from governments, businesses, civil society, and individuals. In support of its sustainability goals, the EU has announced five 'EU Missions', each with specific budgets and time lines, to address significant societal challenges. These missions play a crucial role in achieving the EU's priorities, including the European Green Deal and Europe's Beating Cancer Action Plan. The five missions are:

- **Adaptation to Climate Change:** This mission aims to support at least 150 European regions and communities to become climate-resilient by 2030.
- **Cancer: Working with Europe's Beating Cancer Plan:** This mission aims to improve the lives of more than three million people by 2030 through prevention, cure, and solutions to live longer and better.

[5] Available at: https://sdgs.un.org/sites/default/files/2022-05/2.1.4-27-Umar-Metaverse4SDG.pdf

- **Restore Our Ocean and Waters by 2030:** This mission aims to protect and restore the health of European seas and waters and ensure their sustainable use by 2030.
- **100 Climate-Neutral and Smart Cities by 2030:** This mission aims to support the development of 100 climate-neutral and smart cities by 2030, with the goal of reducing overall GHG emissions and improving quality of life for citizens.
- **A Soil Deal for Europe:** This mission aims to lead the transition towards healthy soils by creating 100 living labs and lighthouses by 2030.

To accelerate progress towards a sustainable future, the agenda identifies 17 Sustainable Development Goals (SDGs) that focus on selected areas that require urgent attention. The need for sustainable transformation is further emphasized by the 2030 Agenda for Sustainable Development, the New Urban Agenda, the Paris Agreement, and the European Commission's Green Development Agreement (Green Deal). Smart cities can represent a mechanism that guarantees the transformative power of cities for the common good, where traditional networks and services are made more efficient, using digital and telecommunication technologies, for the benefit of people and businesses.

A smart city is a city that uses emerging technologies such as the Internet of Things, Artificial Intelligence, Machine learning and Big Data, in order to make itself more viable and functional. The term "Smart City" highlights a new urban dynamic and suggests an expansion of the role of the city, requiring a holistic approach to urban management, increasing challenges and demands. It is evident that cities play a pivotal role in development worldwide and the use of technology is the means to realize the potential for development offered by 'smart cities'. They are a priority for the EU ,and, for this reason, all available financial instruments (such as the Recovery and Resilience Facility [22] and the Cohesion Policy Funds [23]) have included relevant projects, which represent a golden opportunity but require considerable central planning to ensure success and exploit economies of scale.

In fact, Europe is already running initiatives to implement the above frameworks and methods at national, regional and local level. The EU has developed a European Interoperability Framework for Smart Cities/Communities [24], which acts as an approach to support the development of interoperable services in a city/community, aiming at the sustainable development and well-being of residents, businesses, visitors and administration of cities/communities. Becoming a 'smart' city is a key objective for many local councils and municipalities as it is the cornerstone to addressing key challenges in serving citizens' needs in a tight fiscal environment. To achieve this, it is crucial to consider the fundamentals and building blocks required for this transformation.

The METACITIES project aims to leverage Digital Twin and Metaverse technologies to foster innovation, promote economic growth, and improve the quality of life for citizens across the region. To achieve these goals, the project aligns its objectives with the United Nations Sustainable Development Goals (SDGs) and the EU missions, focusing on SDG 11 and "100 Climate-Neutral and Smart Cities by 2030", ensuring that the R&I strategies contribute to sustainable and inclusive growth.

SDG 11 is one of the UN Agenda 2030's 17 Sustainable Development Goals, aiming to create inclusive, safe, resilient, and sustainable cities. This goal recognizes the critical role that cities play in achieving the European Green Deal's objective of climate neutrality by 2050. Despite occupying only 4% of the European Union's land area, cities are home to 75% of its citizens, consume over 65% of the world's energy, and are responsible for more than 70% of global CO2 emissions. Overall, cities are a significant source of global CO2 emissions, with urban transport being one of the main contributors.

Towards this end, European cities play a critical role in achieving the European Green Deal's climate neutrality objective. Since climate mitigation efforts rely heavily on urban action, it is essential to support cities in accelerating their green and digital transformation. To address this issue and make cities more energy-efficient, reduce emissions, and improve air quality, SDG 11 promotes sustainable urban transport systems, smart solutions, renewable energy sources and international collaboration. By achieving SDG 11, European cities can make a significant contribution to the Green Deal target of reducing emissions by 55% by 2030, building a more sustainable future and mitigating the impacts of climate change. In more practical terms this could offer cleaner air, safer transport and less congestion and noise to their citizens, leading to a better quality of life for all.

4.2 CY Cluster Local R&I Strategy

4.2.1 Introduction

Cyprus, like many other European countries, is experiencing rapid urbanisation and environmental challenges. With urbanisation comes increased demand for resources and services such as energy, water, transportation, and waste management, leading to environmental degradation and strain on the existing infrastructure. On the other hand, environmental changes can have far-reaching and diverse impacts on ecosystems and human societies, affecting biodiversity, natural disasters, human health, food security, and social and economic systems. These impacts can be particularly severe in urban areas, where environmental challenges such as air and water pollution, heat islands, and waste management can affect the health and well-being of citizens.

Addressing urbanization challenges and environmental protection is crucial for promoting sustainable development and ensuring the long-term well-being of ecosystems and human societies. To address these, it is crucial to invest in interdisciplinary research and innovative solutions that can transform cities and communities into more efficient and resilient environments. Specifically, by focusing on the development of smart cities, Cyprus has the chance to implement digital solutions to these urban and environmental challenges, potentially transforming these into opportunities for social welfare and sustainable economic development.

Research and Innovation (R&I) play a key role in this process. R&I drive sustainable economic development and social prosperity, enhance social well-being and can provide significant political, technological, social and financial benefits. Such benefits include, among others, the creation of new and better jobs, access to high-quality healthcare services and healthy ageing, improvements in energy and water resource efficiency and mitigation of climate change.

4.2.2 National Level Strategies and Plans

On national level, the R&I framework is determined by a number of strategic documents and plans. Key among those are listed below and further elaborated in the following subsections:

- Cyprus R&I Strategic framework: "Innovate Cyprus 2019-2023",
- Cyprus Digital Strategy 2020-2025,
- Cyprus Smart Specialization Strategy 2030, and
- National framework strategy of the "Smart Cities" sector

All these converge towards making Cyprus a hub for research, innovation, digital transformation, and sustainable development. The implementation of these strategies will have far-reaching benefits for Cypriot society. They will **enhance the quality of life for citizens**, **provide new and better jobs**,

improve access to high-quality healthcare services, and **increase energy and water resource efficiency**. A significant component of this comprehensive plan is the National Framework Strategy of the "Smart Cities" sector.

This specific strategy underscores the nation's commitment to developing smart cities that will meaningfully address urban challenges, offering solutions for improved mobility, security, e-government services, and environmental protection. Beyond addressing practical urban concerns, the evolution of smart cities will also foster a culture of creativity, innovation, and entrepreneurship, thereby driving social prosperity, and sustainable economic development in Cyprus.

4.2.2.1 Cyprus R&I strategic framework: "Innovate Cyprus 2019-2023":

Cyprus' National board for Research and Innovation (CYRI) published a new strategic framework in May 2019 called '2019-2023 INNOVATE CYPRUS' [25]. The current strategic framework adopts the following vision:

"Cyprus to become a dynamic and competitive economy, driven by research, scientific excellence, innovation, technological development and entrepreneurship, and a regional hub in these fundamental areas".

Addressing this vision, the R&I strategic framework under the title "Innovate Cyprus" revolves around three strategic pillars (SP) and six strategic enablers (SE) (Figure 1):

- **SE1 - Governance:** Adopt an integrated, coherent and operational governance system that will facilitate effective and timely implementation of R&I strategy.
- **SE2 - National R&I Strategy:** Adopt and implement a national strategy for technological, social and economic development of Cyprus, based on research and innovative entrepreneurship
- **SP3 - Research excellence:** Develop a sustainable system of academic and research excellence, based on leading international institution standards
- **SP4 - Knowledge transfer and commercial exploitation:** Enhance knowledge transfer among the science community, the public sector, the business sector and the society. Facilitate commercial exploitation of new knowledge and technology, aiming at developing competitive and added-value products, services and processes and support social innovation
- **SP5 - Innovative entrepreneurship:** Develop a favourable environment for technological development and innovative entrepreneurship
- **SE6 - Cultural change:** Nurture a culture of creativity, innovation and entrepreneurship across all levels of education, industry, society and the state
- **SE7 - International dimension:** Enhance extroversion of the national R&I system and develop targeted strategic collaborations with selected countries and international organizations in fields including science, technology and innovation. Promote Cyprus as a R&I hub, as a means to attract foreign investment in high-tech companies based in Cyprus
- **SE8 - Communication:** Increase stakeholder awareness at national and international level on the benefits and impact of R&I. Communicate the reform of the R&I governance system, R&I strategy, as well as defined policies, actions, measures and results
- **SE9 - Digital transformation:** Ensure that necessary strategies, technologies, infrastructures and skills for digital transformation of the economy are interlocked with R&I ecosystem, as facilitating and enabling factors for knowledge sharing and innovation

The "Innovate Cyprus" Strategic Framework embraces an ambitious vision, as a basis to develop an integrated R&I Strategy. The vision provides a long-term perspective to the Strategy Framework, aiming to ensure a focused effort and commitment for implementation, over time, on behalf of the State and the stakeholders involved in the national Research & Innovation system.

The aim of this framework is to set Cyprus on a new roadmap towards growth by implementing strategies that are going to increase the research and development (R&D) spending in Cyprus.

However, achieving the objectives of a new national development Strategy would require a significant increase in national investment for R&D, which is a significant indicator for the maturity and effectiveness of national R&I ecosystems.

FIGURE 1: R&I STRATEGIC FRAMEWORK UNDER THE TITLE "INNOVATE CYPRUS"

4.2.2.2 Cyprus Digital Strategy 2020-2025

The Digital Strategy for Cyprus 2020-2025 [26] (adopted in June 2020; see Figure 2) is the key policy document to accelerate Cyprus digital transformation. The implementation of the Digital Strategy is coordinated by the Deputy Ministry of Research, Innovation and Digital Policy (DMRID) and it is grounded in a clear vision for change.

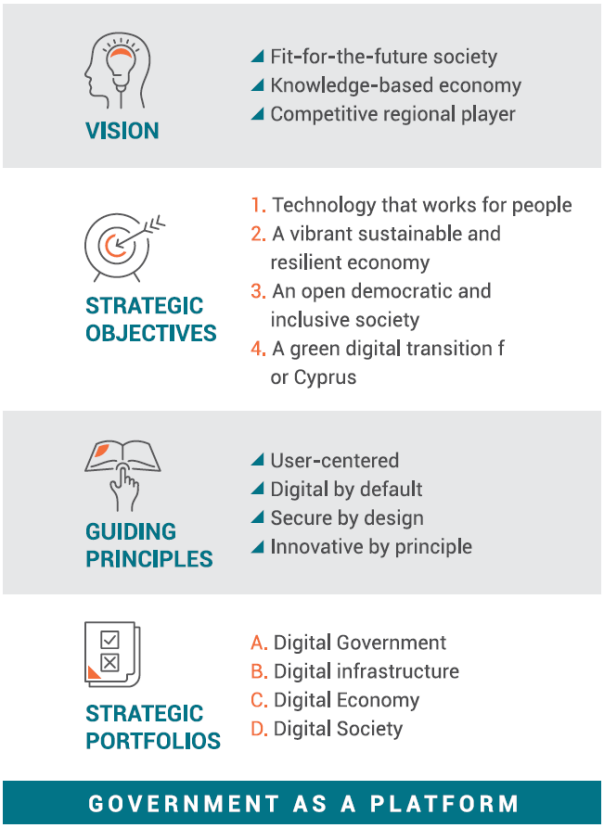

FIGURE 2: THE DIGITAL STRATEGY FOR CYPRUS 2020-2025

The vision statement foresees that Cyprus will become a fit-for-the-future society and knowledge-based economy enabled by digital and emerging technologies that will drive sustainable economic growth, social prosperity and international competitiveness.

Implementing this vision relies on achieving four strategic objectives that call for:

- **Technology that works for people:** Making technology that works for people i.e., designing technology with people in mind (user-centered) rather than expecting people to adapt to it. This is about ensuring technology makes a real difference to people's daily lives, delivering end-to-end quality services to citizens and businesses and optimising systems, structures and processes.
- **A vibrant, sustainable and resilient digital economy:** Creating a vibrant, sustainable, and resilient digital economy where companies of all sizes and in any sector can compete on equal terms, while boosting business productivity and competitiveness; and contributing to a more sustainable and resource-efficient economy. This partly involves the development, marketing, and use of digital technologies, products, and services. Additionally, it includes the creation of an economy where consumers can be confident that their rights are being respected.
- **An open, democratic and inclusive digital society:** Developing a trustworthy society in which citizens and residents are empowered in how they act, interact, and provide data both online and offline. This also includes building confidence that Cyprus' Digital Transformation journey is deeply rooted in democratic values and respects the fundamental rights of all.

- **A green, digital transition for Cyprus:** Enabling a green, digital transition for Cyprus, i.e. enabling Cyprus to transform through digital, into a modem, resource-efficient competitive economy by investing in environmentally-friendly technologies that will accelerate our transition towards clean energy and sustainable mobility, support the circular and bio-economy and enable us to achieve climate neutrality.

Crucially, it also relies on embracing a principles-based approach to guide the government's thinking in the digital era - ensuring our digital transition is, among other things, user-centered, digital by default, secure by design and innovative by principle.

The strategy describes targeted and concerted action across each one of the dimensions of the national digital transformation: government - society - economy enabled and orchestrated via "Government as a Platform". Four strategic portfolios have thus been compiled to organise all the strategic initiatives that make up the country's digitalisation action plan.

The Digital Government Portfolio includes initiatives relevant to the transformation of the government itself. This portfolio encompasses initiatives aimed at upskilling and reskilling initiatives to increase the public sector's digitalisation competency. Whilst the Digital Infrastructure, Economy and Society Portfolios include initiatives relevant to the transformation of the national infrastructure, economy and society more widely.

4.2.2.3 Cyprus Smart Specialization Strategy 2030

The Smart Specialization Strategy (S^3CY) for Cyprus for the period 2023-2030 [27] was approved by the Council of Ministers, in its session on March 30, 2023, following a proposal by the Deputy Minister of Research, Innovation and Digital Policy.

The S^3CY identifies and analyzes the priority sectors where Cyprus has a competitive advantage and can be the basis for economic development and improve the quality of life of citizens, through investments in Research and Innovation (R&D).

The SEE is an ex-ante conditionality for the utilization of resources from the European Structural and Investment Funds (ESIF) in the R&D sector. The objectives of the S^3CY are divided into three main categories as follow:

- **General Objective 1**: diversify the economy to be more sustainable and resilient, rely less on natural resources and take advantage of green and digital technologies.
    - **Specific Objective 1**: diversify to new technological fields of high knowledge complexity by relying on related technological and business capabilities. **Operational Objective**: develop competencies in Earth Observation and other space technologies, enter HPX and quantum technologies, enter new superfoods, cosmeceuticals and nutraceuticals, medical equipment.
    - **Specific Objective 2:** diversify existing competencies to enter into new niches of relatively low complexity. **Operational Objective:** diversify the application of existing competencies in digital, energy, environmental technologies and advanced materials to enter new niches in agrifood, maritime, tourism, construction.
- **General Objective 2:** citizens enjoy happy, healthy and safe life with good rewarding jobs.
    - **Specific Objective**: address health and environmental challenges. **Operational Objective**: extend the development of existing knowledge and technological capabilities in health and environmental technologies.

The priority sectors with added value to the economy and society that have been highlighted through the S^{3}CY for the period 2023-2030 are divided into 4 Modules, as follows:

Module A – Technological priority areas: include Digital Technologies and Innovative Materials

- **Digital Technologies:** The following research and innovation areas should be supported:
    - High-Performance Computing (HPC): Explore the possibilities offered by the existing HPC environment in Cyprus to develop applications on societal challenges and in areas such as energy, environment, climate, and health, prediction and simulation of natural disasters, disaster prevention and crisis management, urban development etc.
    - Quantum Technologies: Validation and demonstration projects of next generation quantum sensing technologies and devices, next generation quantum sensors from medical diagnostics and imaging to high-precision navigation and monitoring
    - Cybersecurity: Support of improvement of approaches and applications on specific environments such as energy production systems, natural resources and critical environmental infrastructures and industrial environments
    - Digital Tourism: Use augmented, virtual reality or extended reality, IoT, AI technologies and big data: (a) To develop applications and services for the promotion of tourism and the improvement the tourist experience at all stages, and (b) To develop advanced decision support systems for management of tourism businesses and policy makers.
    - Education, culture and creative industries: Develop innovative solutions to facilitate the integration of emerging technologies such as the Internet of Things, Virtual/Augmented Reality, smart objects, wearables, data analytics, artificial intelligence: (a) in next generation media, (b) in the promotion of cultural content, (c) in gaming for the creation of new experience, and (d) in education activities
    - Smart cities applications: Development of innovative solutions based on software, IoT, big data analytics, AI and blockchain technologies to addresses social and economic needs in an urban environment in areas such as mobility, energy saving, safety, community, the 15-minutes city, citizens participation etc.
    - Advanced manufacturing and processing:
        - Develop innovative approaches and methods for smart manufacturing and processing by incorporating approaches of real time big data processing, IoT and AI, decision support and expert systems, neural networks etc.
        - Scaling down advanced manufacturing technologies to meet the needs and size of SME, e.g. in the food sector
    - Acceleration of testing and demonstration: Support testbed infrastructures and specific test cases that could include big data sandboxes, data analysis and AI testbeds, IoT testbeds, immersive and virtual technologies testbed, Integration testbeds for applications on smart cities, cyber-physical security or agritech.

- **Innovative Materials:**

- Research priorities include research for improving methods of processing and recycling innovative materials as well as research for developing applications for various sectors with an emphasis on the green aspects of the applications:
  - Novel, safe, environmentally friendly, and commercially viable methods of recycling a wide range of composite materials and reuse of secondary raw materials
  - Methods of processing of nano and composite materials
  - Innovative materials with improved characteristics for industrial, construction, energy and health applications,
  - Use of nanomaterials for articles and components for earth observation and the aviation and space industry
  - Innovative materials for environmentally friendly buildings and buildings with better performance under stress (earthquakes, extreme environmental conditions).

Module B – Ecosystems: include the sectors of Agri-Food, Shipping and Renewable Energy Sources.

- **Agrifood:**
  - Diversify and improve the competitiveness of the agrifood ecosystem by supporting the development of new products and services for the farming sector, increase the quality and nutritious value of local produce and food products and diversify the local production by developing new products based on indigenous super foods
  - Support activities following the principles of agroecology aiming at increasing the resilience and sustainability of the farming system and reducing its environmental footprint
  - Mitigate the climate change impact on the agrifood ecosystem
- **Maritime and Shipping Ecosystem**
  - Digital technologies and Earth Observation for monitoring and decision making
    - Development of maritime informatics applications for ship optimization such as digital applications for diagnosis and control of systems, IoT applications for data collection, big data analytics for optimization of ships operation, energy saving and reduction of emissions, earth observation and satellite communications for monitoring ships and optimizing decisions, and fully autonomous operations in open sea
    - Cybersecurity applications for ships and fleet management
  - Decarbonization of ships
    - Development of decarbonization of ships services such as optimization of energy sources
  - Equipment and tools for applications in shipping
    - Design and development of prototypes of small zero-emission vessels, unmanned vessels, drone and robots for ships inspections and repairs
    - Advanced materials that improve the performance of vessels

- **Renewable Energy**

- Renewable energy production technologies
  - Green hydrogen, including, among other energy storage applications, use of renewable energy sources for hydrogen production, demonstration projects and testbeds with international participation
  - Small-scale wind energy systems for specific applications
  - Development of innovative solar heating and cooling technologies for the production of electricity, improvement of the performance of solar heating and cooling systems, use of thermal and cooling systems for energy storage
  - Integration of PVs in the structures of buildings, greenhouses, vehicles, or other structures for improving the design and performance
- Digital management and monitoring systems for the production and distribution of energy
  - Smart energy systems and smart grids, including innovative ways of optimizing energy supply and demand based on sensors, software, and AI algorithms.
  - Energy monitoring, intelligent control and optimization of small PV systems, monitoring of PV systems for failure, maintenance and production forecasting
- Energy efficiency in urban environments
  - Smart technologies for buildings, including energy management and optimization of energy use, optimization energy production from deferent RES including and storage.
  - Innovations for energy efficiency in existing urban structures and exploitation of synergies with the DUT partnership.

Module C – Emerging priorities/ecosystems (Emerging ecosystems): Currently only include the Space sector.

- **Space Ecosystem**
  - Exploitation and use of data generated from space-based infrastructures for downstream applications
    - Use earth observation and remote sensing technologies for monitoring and protection of agriculture production and intergrade earth observation in smart applications in agriculture (see also the Agrifood area of support).
    - Use earth observation and remote sensing technologies in the shipping sector for ship monitoring and management services and application (see also the Maritime and Shipping area of support)
    - Develop applications and services for monitoring soil subsidence and instability with applications to the conditions of buildings and cultural monuments
    - Monitoring of climate change and environmental conditions to prevent environmental disasters and reduce risk with application in various areas.
    - Use satellite earth observation and advanced remote sensing technologies for mapping and monitoring archaeological monuments and cultural heritage to identify the effects of climate change, physical events, and human pressures to address major risks

- Advanced materials for structures and equipment used in earth observation facilities and spacecrafts
- Exploitation of participation in ESA programmes for bringing results closer to the market

Module D – Catalyst sectors (Enablers): Include the Health and Environment sectors

- **Health**
  - Clinical and Genetic Investigation and Treatment of Diseases
    - Molecular and Medical Genetics (Medical Translational Research).
    - Diagnosis- Prevention/ Risk Factors/ Treatment Areas
    - Personalized medicine using genetic or other biomarker information to provide personalized treatment to patients
  - Digital health
    - Use AI and big data, IoT, innovative diagnostic imaging approaches, VR/AR, HPC and blockchain technologies to develop products and services for health management, telemedicine, tele-examination, simulations and digitally assisted independent living.
    - Use big data analytics, AI, IoT and blockchain technologies for collecting, managing, versioning and processing medical data for priority diseases
    - Development of machine learning algorithms and advanced decision support systems for the management of health services and decision making
  - Innovative products
    - Molecular diagnosis and development of specialized pharmaceuticals
    - Development of innovative materials, cosmeceutical και nutraceuticals
    - Development of medical equipment and devices
  - Promoting public health and quality of life
    - Health economics, health management, public health and policy
    - Disease prevention, infectious diseases control, environmental health
    - Healthy and active ageing, nutrition and climate change- biomonitoring and Risk Assessment.
- **Environment**
  - Adjustment to climate change
    - Monitoring of climate change and environmental conditions for prevention of environmental disasters and reduction of risk with application in various areas, e.g. agrifood, cultural heritage, tourism or construction.
    - Effects of climate change on economic activities and the society
  - Monitoring and protection of the environment from economic and human activities
    - Impact of economic activities on the environment with priority on the sectors of agriculture, livestock, aquaculture, food industry (see also in the priority area of agrifood), tourism and construction.
    - Environmental risk and methods to mitigate the impact on the environment of the extraction of hydrocarbons

        - Indoor environmental monitoring, monitoring, and improvement of air quality in the urban environment and especially in buildings
    - Greening of industry and economic activities
        - Innovative approaches to adopt circular economy practices by companies
        - development of green production methods and products that reduce consumption of energy, raw material and natural resources and waste.
    - Management of natural resources and protection of biodiversity
        - Monitoring and management of water and waste e.g., in critical infrastructures. Use of digital tools and development of digital applications
        - Monitoring and management of water and waste e.g., in critical infrastructures. Use of digital tools and development of digital applications

Focus areas were identified within each priority area. The S^3CY for the period 2023-2030 is part of the national R&D Strategy of the Deputy Ministry of Research, Innovation and Digital Policy (DMRID): Pillar D "Sectoral Priorities", and is the main action of reform 1 of section 3.2 ("Enhanced Research and Innovation") of the Recovery and Resilience Plan of Cyprus.

4.2.2.4 National framework strategy of the “Smart Cities” sector

In the framework of the “Smart Cities” sector, the development of a national framework strategy and the promotion of Smart Cities was approved by the Council of Ministers during its session on 13.11.2020, following a proposal by the DMRID.

This initiative is part of the Government's broader planning with vision to achieve the digital and green transition as well as to promote innovation, as tools for social welfare and sustainable economic development in today's constantly changing and highly competitive international environment.

The project will be under the coordination of DMRID, in collaboration with all partners (competent Ministries, local government, etc.), and will provide for the definition and adoption of the necessary reforms, policies and infrastructures that allow the effective creation of smart cities throughout Cyprus, in a uniform manner, taking into consideration economies of scale in the implementation of the various actions.

Through the utilization of smart networks and digital applications, solutions will be offered to modern urban challenges, which include, among others, issues of mobility (traffic management, availability of parking spaces), provision of e-government services, security (emergency management), and environmental protection (saving resources, reducing pollution), etc.

This initiative is currently in progress and fully aligned with the development strategy of the European Union (EU) which aims at a modern, digital, resource-efficient and competitive economy, and a climate-neutral European territory. It is expected to be a driving force for upgrading the service and improving the quality of life of citizens, and it can be financed by various financial instruments, such as the European Structural and Investment Funds, the Horizon Europe program, and the Digital Europe program which is the first purely digital financial EU program and which is part of the long-term budget 2021-2027.

4.2.3 Municipal or Inter-municipal Sustainable Spatial Development Strategies

In the absence of a specified and guiding national background, multiple non-coordinated actions and initiatives for smart cities, have been guided separately/individually by several municipalities, each operating at different speeds and different models. The most obvious example to demonstrate this disjointed approach adopted in the absence of a consistent national guideline for smart city initiatives is the **"Municipal or Inter-Municipal Sustainable Spatial Development Strategies**" that the local authorities were requested to prepare in order to claim funds for specific projects, especially through the Structural Funds of the Republic of Cyprus for the Programming Period 2021-2027.

More specifically, in the framework of the new Programming Period 2021-2027 for the exploitation of the funds available through the European Structural and Investment Funds (ESIF), in July 2020, the Ministry of Interior, in cooperation with the Directorate General for Growth of the Ministry of Finance, published a Call targeting the local authorities of Cyprus. Through this Call, the Ministries invited the local authorities (municipalities and community councils) to proceed in forming partnerships for preparing and submitting their Strategic Plans for the Sustainable Spatial Development of the area of intervention they represented. These Strategic documents were elaborated by the municipal partnerships according to specific criteria and guidelines provided through the Ministries' Call. Based on this Call, the municipalities in Cyprus proceeded in formatting several consortia and prepared their Sustainable Spatial Development Strategies. The Strategies were submitted to the two Ministries and the latter proceeded in their evaluation and approval.

These Strategies include a description of the main characteristics of the area in concern, a SWOT analysis, and based on the needs identified, specific objectives and priorities were defined, always in line with the Thematic Priorities of the EU for the period 2021-2027. The last chapter of these Strategies includes proposals for different projects to be implemented for the sustainable development of the geographical area in concern, based on the identified needs and in the framework of the priority axes formed. These projects were accompanied by a short description, an estimated budget and a time-plan.

In every such Municipal Sustainable Spatial Development Strategy (SSDS), a chapter is dedicated to the sector of 'smart cities' including specific proposed projects to this direction, however, as noted above, the proposals differ from Strategy to Strategy, according to the Municipalities' experience and identified needs in this sector. **In the next few paragraphs, the relevant parts of these Strategies are presented framing the Priority Areas defined on local and inter-municipal level, in other words on implementation level[6].**

4.2.3.1 SSDS of the Nicosia Urban Area

Priority Axis 1 (PA1) Smart Development – Innovative Transformation, **aims at exploiting the benefits of digitization for citizens, businesses, and local governments through smart city infrastructure, systems, applications, and integrated e-government systems.**

It includes proposals for actions as follows: **Smart city infrastructure, systems & applications, integrated e-government systems, and demonstration of smart city technologies in the sectors of**

[6] A limited number of Municipal Sustainable Spatial Development Strategies were not accessed for the purpose of this document, however most of the Strategies were shared by the owning local authorities and are therefore presented here.

energy, sustainable mobility, environment, circular economy, communication infrastructure, e-government, health, education, and security. More specifically:

- **1st Batch of Projects - 'Smart City Infrastructures'** proposes the expansion of the Nicosia Fiber Network (NFN), the expansion of the Nicosia Wireless Network (NWN) and the expansion of the Nicosia IoT Network. Smart City Systems proposals include the expansion of smart parking infrastructure and management of special purpose parking spaces, real time monitoring of the traffic on the city's roads, gathering the city's data in a single central point to analyze, and combine for justified decision making about the future of transportation in the city, installation of environmental sensors to know the air quality in real time and to monitor the water supply and drainage networks in order to develop actions to save and protect water resources. In addition, the Strategy proposes the establishment of a smart garbage bin system (integrated bin filling monitoring system and dynamic routing of garbage trucks), the expansion of the Smart City electronic management platform and of the Center for management and control and a system for detecting malicious actions and protecting citizens.
- **2nd Batch of Projects - 'Electronic Governance'** proposes the development of a digital interface platform for the municipality's traders in order to carry out all their transactions remotely, the development of a single interoperability framework for all digital services that will be developed in the municipalities covered by the Strategy, the positioning of every available open data on a geospatial background that would be available online, the digitization and documentation of physical records/archives and the design, creation and operation of an enterprise data warehouse.
- **3rd Batch of Projects - 'Energy Saving & Climate Change'** proposes the placement of smart meters in all municipal buildings and infrastructure, the development of a toolbox of energy interventions in neighborhoods or areas of municipalities, practical encouragement of citizens and businesses and motivation to use energy-saving and smart energy-autonomous technologies in their immediate home or work environment.
- **4th Batch of Projects - 'Transition from smart city to smart society'** proposes tackling digital illiteracy by preparing comprehensive education and training programs, the creation of a workshop to showcase and demonstrate smart city technologies and systems and an IT workshop for the transformation of local administrations into smart district administrations.
- **5th Batch of Projects - 'Smart prevention and social health systems'**, includes proposals for developing a web application for mobile devices for updating information and self-control with the aim of preventing and promoting public health, the establishment of equipment for carrying out systematic preventive health examinations at home for patients with chronic diseases or movement difficulties, equipment for monitoring for patients with chronic diseases, e-training of private and public health care providers as well as the e-training of non-specialized caregivers, and the establishment of an integrated e-health care system - a tool of sophisticated virtual and augmented reality technology, which combines mental exercises with physical activity through an interactive environment.

4.2.3.2 SSDS of the South Nicosia

Priority Axis 1.6 (PA1.6) 'Transition to smart rural solutions (smart villages)' aims at improving the quality of life through smart city systems on issues that facilitate and improve the quality of life.

In addition, *Priority Axis 2.2 (PA2.2) 'Digital infrastructure upgrade'* aims at the attraction of tourists through digitalization of significant cultural and environmental assets of the area, as well as enhancing digital connectivity.

Proposals for actions include the establishment of a Citizen Service or Support Center and/or Center for training in the use of e-government technologies, digital interconnection of cultural sites to form a touristic/worth-to-visit product and the installation of smart communities' (smart villages) systems and infrastructure.

The latter is specifically proposing the transformation of the area of intervention into a smart area with smart sensors for online measurement of (a) pollution, (b) smart library, (c) parking (d) traffic and security measurements as well as the establishment of systems for smart waste management, water networks' management and monitoring and other community social services' support.

4.2.3.3 SSDS of the Latsia and Yeri Municipalities

Priority Axis 2 (PA2) 'Improving Accessibility of the area and promoting sustainable urban mobility', sub-objective 2.2 entitled 'ICT actions / Electronic applications for the development of e-governance and e-administration' foresees the intention to adopt innovative solutions regarding the provision of e-services to citizens, with the aim of efficient provision of services to citizens, improving productivity, reducing the cost of providing services, and contributing to the protection of the environment.

In this framework, the following activities are proposed: smart parking infrastructure and systems, smart lighting infrastructure and systems, e-data management infrastructure and systems, establishment of e-info-points and establishment of citizens' electronic administration services.

4.2.3.4 SSDS for the city and the wider area of Larnaca

Specific Objective 1.3 'Investment in Culture' includes the Proposed Action 1.3.1 'Open cultural parks and routes' that concerns the installation and operation of "Smart City" infrastructure and systems and the development / installation of relevant applications for smart devices and interaction with visitors to support cultural and touristic infrastructures.

Specific Objective 2.1 'Urban Resilience' includes the Proposed Action 2.1.2 'Development of the infrastructure and equipment of the circular economy, more efficient management of resources and waste'. This set of Actions foresees the installation of equipment, infrastructure, and applications of "smart" systems for efficient water management.

Specific Objective 2.3 'Supporting Sustainable Mobility' includes the Proposed Action 2.3.2 'Transition to a sustainable urban transport system' that foresees improving road safety and traffic conditions, through the use of "smart" infrastructure, traffic management and monitoring equipment.

In addition, Specific Objective 3.3 'Modern and efficient administration' includes the Proposed Action 3.3.1 'Improving the service of Citizens and Visitors' that specifically refers to the transformation of Larnaca into a smart city. Indicative proposed actions include:

- Development of information systems for smart devices.
- Installation of smart lighting and smart energy management systems in municipal buildings.
- Establishment of smart bus stops/shelters.
- Creation of smart parking and smart parking management systems.
- Deployment of intelligent irrigation and maintenance systems for urban greenery.
- Implementation of a "house-to-house collection" system for bulky waste.
- Installation of sensors to measure, record, and inform citizens about environmental and climate parameters.
- Creation of a fiber-optic network in regeneration areas.

- Upgrade of the Municipality of Larnaca's Data Center and investment in a Disaster Recovery Site (DRS).
- Digitization of processes and registers, and development of new applications and management tools.
- Development of a flexible, wireless network of free internet access in the Shopping Center.
- Capacity Building for the operation, management and development of electronic services.

4.2.3.5 SSDS of Limassol

Priority 3 'Area upgrade, e-governance, smart-city applications and upgrading administrative capacity' aims to create a sustainable, efficient, and technologically advanced urban environment that improves the quality of life for its residents. This includes a set of Actions that foresee:

- Implementation of an integrated system of organization and operation of Municipal services' Police/Traffic obstruction (traffic enforcement). Report online and immediate response.
- Creation/Development of infrastructure, hardware and software for updating/entering data into information systems.
- Digitization of files and archives to improve record-keeping, accessibility, and efficiency.
- Upgrading of websites and improvement of public service through the website chat functionality, thereby enhancing communication and interaction with citizens.
- Enhancement of the geospatial management information systems' data of Municipalities (GIS) to better manage and analyze geospatial data, improving decision-making related to urban planning and services.

4.2.4 Summary of the National Level and Regional Level Strategies and Plans

On National level, the R&I framework is determined by a number of strategic documents and plans. Among those are the following four which are further summarised in Table 4:

- Cyprus R&I Strategic framework: "Innovate Cyprus 2019-2023"
- Cyprus Digital Strategy 2020-2025
- Cyprus Smart Specialization Strategy 2030
- National framework strategy of the "Smart Cities" sector

All these converge towards making Cyprus a hub for research, innovation, digital transformation, and sustainable development. The implementation of these strategies will have far-reaching benefits for Cypriot society.

- Enhance the quality of life for citizens
- Provide new and better jobs
- Improve access to high-quality healthcare services
- Increase energy and water resource efficiency.

On Regional level (municipal and inter-municipal), in the framework of the new Programming Period 2021-2027 for the exploitation of the funds available through the European Structural and Investment Funds (ESIF), the Ministry of Interior, in cooperation with the Directorate General for Growth of the Ministry of Finance, invited the local authorities (municipalities and community councils) to proceed in forming partnerships for preparing and submitting their Strategic Plans for the Sustainable Spatial Development Strategy (SSDS) of the area of intervention they represented.

In this context, the municipalities in Cyprus proceeded in formatting several consortia and prepared their Sustainable Spatial Development Strategies. The Strategies were submitted to the two Ministries and the latter proceeded in their evaluation and approval.

For the purpose of this document, some of these strategies were shared by the owning local authorities and presented in Table 5. Among those are:

- SSDS of the Nicosia Urban Area
- SSDS of the South Nicosia
- SSDS of the Latsia and Yeri Municipalities
- SSDS for the city and the wider area of Larnaca
- SSDS of Limassol

Table 4: National Level Strategies and Plans – Cyprus Cluster

Cyprus R&I Strategic framework: "Innovate Cyprus 2019-2023"
Vision: Cyprus to become a dynamic and competitive economy, driven by research, scientific excellence, innovation, technological development and entrepreneurship, and a regional hub in these fundamental areas. To realize this vision it develops an integrated R&I Strategy with three strategic pillars (SPs) and Six strategic enablers (SEs): • **SE1 - Governance:** Adopt an integrated, coherent and operational governance system that will facilitate effective and timely implementation of R&I strategy. • **SE2 - National R&I Strategy:** Adopt and implement a national strategy for technological, social and economic development of Cyprus, based on research and innovative entrepreneurship • **SP3 - Research excellence:** Develop a sustainable system of academic and research excellence, based on leading international institution standards • **SP4 - Knowledge transfer and commercial exploitation:** Enhance knowledge transfer among the science community, the public sector, the business sector and the society. Facilitate commercial exploitation of new knowledge and technology, aiming at developing competitive and added-value products, services and processes and support social innovation • **SP5 - Innovative entrepreneurship:** Develop a favourable environment for technological development and innovative entrepreneurship • **SE6 - Cultural change:** Nurture a culture of creativity, innovation and entrepreneurship across all levels of education, industry, society and the state • **SE7 - International dimension:** Enhance extroversion of the national R&I system and develop targeted strategic collaborations with selected countries and international organizations in fields including science, technology and innovation. Promote Cyprus as a R&I hub, as a means to attract foreign investment in high-tech companies based in Cyprus • **SE8 - Communication:** Increase stakeholder awareness at national and international level on the benefits and impact of R&I. Communicate the reform of the R&I governance system, R&I strategy, as well as defined policies, actions, measures and results • **SE9 - Digital transformation:** Ensure that necessary strategies, technologies, infrastructures and skills for digital transformation of the economy are interlocked with R&I ecosystem, as facilitating and enabling factors for knowledge sharing and innovation

The aim of this framework is to set Cyprus on a new roadmap towards growth by implementing strategies that are going to increase the research and development (R&D) spending in Cyprus.

Cyprus Digital Strategy 2020-2025

Vision: Cyprus will become a fit-for-the-future society and knowledge-based economy enabled by digital and emerging technologies that will drive sustainable economic growth, social prosperity and international competitiveness.

This vision is realized by four strategic objectives that call for:

- **Technology that works for people:**
    - Designing technology with people in mind (user-centered) rather than expecting people to adapt to it.
- **A vibrant, sustainable and resilient digital economy:**
    - Where companies of all sizes and in any sector can compete on equal terms, while boosting business productivity and competitiveness; and contributing to a more sustainable and resource-efficient economy.
    - Which includes the creation of an economy where consumers can be confident that their rights are being respected.
- **An open, democratic and inclusive digital society:**
    - In which citizens and residents are empowered in how they act, interact, and provide data both online and offline.
    - Which includes building confidence that Cyprus' Digital Transformation journey is deeply rooted in democratic values and respects the fundamental rights of all.
- **A green, digital transition for Cyprus:**
    - Enabling Cyprus to transform through digital, into a modem, resource-efficient competitive economy by investing in environmentally-friendly technologies that will accelerate our transition towards clean energy and sustainable mobility, support the circular and bio-economy and enable us to achieve climate neutrality.

Relies on embracing a principles-based approach to guide the government's thinking in the digital era – *ensuring our digital transition is among other things user-centered, digital by default, secure by design and innovative by principle.*

Cyprus Smart Specialization Strategy 2030 (S3CY)

Objective: Identify and analyze the priority sectors where Cyprus has a competitive advantage.

The objectives of the S³CY are divided into three main categories as follow:

- **General Objective 1**: diversify the economy to be more sustainable and resilient, rely less on natural resources and take advatange of green and digital technologies.
    - **Specific Objective 1**: diversify to new technological fields of high knowledge complexity by relying on related technological and business capabilities.
        - **Operational Objective**: develop competencies in Earth Observation and other space technologies, enter HPX and quantum technologies, enter new superfoods, cosmeceuticals and nutraceuticals, medical equipment.

- **Specific Objective 2:** diversify existing competencies to enter into new niches of relatively low complexity.
  - **Operational Objective:** diversify the application of existing competencies in digital, energy, environmental technologies and advanced materials to enter new niches in agrifood, maritime, tourism, construction.
- **General Objective 2:** citizens enjoy happy, healthy and safe life with good rewarding jobs.
  - **Specific Objective**: address health and environmental challenges
    - **Operational Objective**: extend the development of existing knowledge and technological capabilities in health and environmental technologies.

The priority sectors are divided into 4 Modules:

- **Module A – Technological priority areas:** include Digital Technologies and Innovative Materials
  - Use existing capabilities in digital technologies for developing innovations in several economic activities, such as agriculture, space technologies, or environmental monitoring.
  - Address the needs of several industries by differentiate the portfolio used in companies that produce innovative materials.
- **Module B – Ecosystems:** include the sectors of Agri-Food, Shipping and Renewable Energy Sources.
  - Diversify the existing competencies and allow companies to enter into niches of various levels of knowledge complexity.
- **Module C – Emerging priorities/ecosystems (Emerging ecosystems):** Currently only include the Space sector.
  - Develop new technological capabilities relying on existing competencies in digital technologies.
- **Module D – Catalyst sectors (Enablers):** Include the Health and Environment sectors
  - Linked with economic activities, which include tourism, construction, energy, agriculture, transport, etc., which are directly linked to the environment and natural resources.
  - Both areas include niches that provide opportunities for innovations and development of economic activities.
  - The larger part of the funding will go to research activities related to their role as enables.

The aim of this strategy is to identify and prioritize sectors where Cyprus has a competitive advantage and can be the basis for economic development and improve the quality of life of citizens, through investments in Research and Innovation (R&D)

National framework strategy of the "Smart Cities" sector

Vision: Achieve the digital and green transition as well as to promote innovation, as tools for social welfare and sustainable economic development in today's constantly changing and highly competitive international environment.

The project will provide for the definition and adoption of the necessary reforms, policies and infrastructures that allow the effective creation of smart cities throughout Cyprus, in a uniform manner.

Through the utilization of smart networks and digital applications, **solutions will be offered to modern urban challenges,** which include, among others: • Issues of mobility (traffic management, availability of parking spaces), • Provision of e-government services, security (emergency management), • Environmental protection (saving resources, reducing pollution). This initiative is currently in progress and fully aligned with the development strategy of the European Union (EU) which aims at a: • modern, digital, resource-efficient and competitive economy, • climate-neutral European territory. It is expected to be a driving force for **upgrading the service and improving the quality of life of citizens**.

Table 5: Regional Level Strategies and Plans – Cyprus Cluster

SSDS of the Nicosia Urban Area
Objective: Exploit the benefits of digitization for citizens, businesses, and local governments through smart city infrastructure, systems, applications, and integrated e-government systems. Includes proposal for actions such as: **1st Batch of Projects - 'Smart City Infrastructures**' proposing: • Expansion of the Nicosia Fiber Network (NFN), the Nicosia Wireless Network (NWN), and the Nicosia IoT Network. • Expansion of smart parking infrastructure and management of special purpose parking spaces • Real time monitoring of the traffic on the city's roads justified decision making about the future of transportation in the city • Installation of environmental sensors for real-time air quality monitoring and water supply and drainage networks monitoring, in order to develop actions to save and protect water resources • Development of a smart garbage bin system with integrated bin filling monitoring and dynamic routing of garbage trucks. • Development of a system for detecting malicious actions and protecting citizens **2nd Batch of Projects - 'Electronic Governance'** proposing: • Development of a digital interface platform for the municipality's traders to perform all transactions remotely. • Creation of a single interoperability framework for all digital services that will be developed in the municipalities covered by the Strategy. • Positioning of every available open data on a geospatial background that would be available online. • Digitization and documentation of physical records/archives. • Design, creation and operation of an enterprise data warehouse. **3rd Batch of Projects - 'Energy Saving & Climate Change'** proposing:

- Placement of smart meters in all municipal buildings and infrastructure.
- Development of a toolbox of energy interventions in neighborhoods or areas of municipalities.
- Practical encouragement of citizens and businesses to use energy-saving and smart energy-autonomous technologies in their immediate home or work environment.

4th Batch of Projects - 'Transition from smart city to smart society' proposing:

- Tackling digital illiteracy by preparing comprehensive education and training programs.
- Creation of a workshop to showcase and demonstrate smart city technologies and systems.
- Establishment of an IT workshop for the transformation of local administrations into smart district administrations.

5th Batch of Projects - 'Smart prevention and social health systems' proposing:

- Development of a web application for mobile devices for updating information and self-control with the aim of preventing and promoting public health.
- Establishment of equipment for carrying out systematic preventive health examinations at home for patients with chronic diseases or movement difficulties.
- Provision of equipment for monitoring for patients with chronic diseases.
- E-training of private and public health care providers and e-training of non-specialized caregivers.
- Establishment of an integrated e-health care system that combines mental exercises with physical activity through an interactive environment using sophisticated virtual and augmented reality technology.

SSDS of the South Nicosia

Objective: **'Transition to smart rural solutions (smart villages)**', improving the quality of life through the implementation of smart city systems and **'Digital infrastructure upgrade**', **to attract tourists through the digitalization of significant cultural and environmental assets and enhancing digital connectivity.**

In this framework, the following activities are proposed:

- Establishment of a Citizen Service or Support Center and/or Center for training in the use of e-government technologies
- Digital interconnection of cultural sites to form a touristic/worth-to-visit product
- Installation of smart communities' (smart villages) systems and infrastructure transforming the area of intervention into a smart area with smart sensors for online measurement of (a) pollution, (b) smart library, (c) parking (d) traffic and security measurements
- Establishment of systems for smart waste management, water networks' management and monitoring

SSDS of the Latsia and Yeri Municipalities

Objective: **'Improving Accessibility of the area and promoting sustainable urban mobility'**, foreseeing the intention to adopt innovative solutions regarding the provision of e-services to citizens, with the aim of efficient provision of services to citizens, improving productivity, reducing the cost of providing services, and contributing to the protection of the environment.

In this framework, the following activities are proposed:

- Smart parking infrastructure and systems,
- Smart lighting infrastructure and systems,
- e-data management infrastructure and systems,
- establishment of e-info-points and
- establishment of citizens' electronic administration services.

SSDS for the city and the wider area of Larnaca

Objectives:

- **'Investment in Culture'** aims to enhance cultural and touristic infrastructures by leveraging smart city systems and smart device applications.
- **'Urban Resilience'** aims to improve the efficiency of resource and waste management through the deployment of smart systems for water management.
- **'Supporting Sustainable Mobility**' aims to enhance road safety and traffic conditions using smart infrastructure and traffic management systems.
- **'Modern and Efficient Administration'** aims to transform Larnaca into a smart city, improving service to citizens and visitors.

In this framework, the following activities are proposed:

- Installation and operation of "Smart City" infrastructure and systems.
- Development of smart device applications for interaction with visitors to support cultural and touristic infrastructures.
- Installation of smart equipment, infrastructure, and applications for efficient water management.
- Use of smart infrastructure, traffic management, and monitoring equipment to improve road safety and traffic conditions.
- Development of information systems for smart devices.
- Installation of smart lighting and energy management systems in municipal buildings.
- Establishment of smart bus stops/shelters.
- Creation of smart parking and smart parking management systems.
- Deployment of intelligent irrigation and maintenance systems for urban greenery.
- Implementation of a "house-to-house collection" system for bulky waste.
- Installation of sensors to measure, record, and inform citizens about environmental and climate parameters.
- Creation of a fiber-optic network in regeneration areas.
- Upgrade of the Municipality of Larnaca's Data Center and investment in a Disaster Recovery Site (DRS).
- Digitization of processes and registers, and development of new applications and management tools.
- Development of a flexible, wireless network for free internet access in the Shopping Center.
- Capacity building for the operation, management, and development of electronic services.

SSDS of Limassol

Objective: **'Area upgrade, e-governance, smart-city applications and upgrading administrative** capacity', aims to create a sustainable, efficient, and technologically advanced urban environment that improves the quality of life for its residents

In this framework, the following activities are proposed:

- Implementation of an integrated system for organization and operation of Municipal services' Police/Traffic obstruction (traffic enforcement) with capabilities for online reporting and immediate response.
- Development and creation of infrastructure, including both hardware and software, for updating and entering data into information systems.
- Digitization of files and archives to improve record-keeping, accessibility, and efficiency.
- Upgradation of websites and improvement of public service through the website chat functionality, thereby enhancing communication and interaction with citizens.
- Enhancement of the geospatial management information systems' data of Municipalities (GIS) to better manage and analyze geospatial data, improving decision-making related to urban planning and services.

4.2.5 Funding and Resources

Funding and Resources available for the implementation of 'smart-cities' activities are available on local, national and European level. On local level, municipal own-resources and utilization of local sponsors may finance such actions. On European level, there are several different financial schemes / programs dedicated to providing support to projects promoting such solutions (e.g., Horizon Europe, Interreg Programs etc.). In this section, the main financing mechanisms on national level are presented.

4.2.5.1 "THALIA 2021-2027"

Programme "THALIA 2021-2027" constitutes a multi-annual, multi-fund development Programme that was drawn up in accordance to the Article 22 of the Regulation (EU) 2021/1060 (Common Provisions Regulation – CPR), outlining the development strategy for the utilization of the resources allocated to Cyprus through the Cohesion Policy Funds, for the period 2021-2027. The total budget of the Programme amounts to €1.81 billion, of which €968 million comes from the EU Cohesion Policy Funds, while the remaining €842 million is the national contribution.

The Programme aims to create a robust and competitive economy through smart, digital and green investments, under conditions of full employment and social cohesion. It also aligns the development priorities of Cyprus with the new priorities and the five EU Policy Objectives for the period 2021-2027. The Programme is structured through sixteen (16) Priorities, which have been established through the selection of Specific Objectives, including Priorities referred to Technical Assistance. Each Specific Objective is broken down by the type of supported actions, the indicative beneficiaries and the final recipients of the actions.

Priority 1 'Competitive, Smart and Digital Economy' includes the Specific Objective 'Digital Transformation' under which the following actions are foreseen:

- Development of information systems and applications.
- Promoting the interoperability of public electronic services.
- Development of information systems/applications/infrastructure within the Public Sector.
- Development of information systems/applications/infrastructure to further enhance electronic health and education.
- Development of information systems/infrastructure applications in Local Government Authorities.
- Providing incentives to boost digital entrepreneurship and technology.

In addition, under Priority 4 'Spatial Development', Specific Objective 'Integrated, sustainable development of urban areas' some of the relevant 'smart cities' actions promoted through the Municipal Sustainable Spatial Development Strategies will be financed.

4.2.5.2 Recovery and Resilience Plan 'Cyprus Tomorrow'

The total budget of the CY RRP amounts to €1,206 bln, which will be financed through grants of €1,006 bln (at current prices) and additional funding of about €0,20 bln in the form of loan, following the submission of relevant request to the EC. The Plan is structured around five (5) Policy Axes and thirteen (13) Components, with an implementation period up to 2026, all aligned with the Plan's strategic goal and objectives. The key strategic goal of the RRP Cyprus is about «Strengthening the economy's resilience and the country's potential for economically, socially and environmentally sustainable long-term growth and welfare».

Through the implementation of the RRP measures, the aim is to promote Cyprus as:

- A country with high levels of resilience, productivity and competitiveness through a sustainable model of long-term growth
- A country where the education system and workforce development are aligned with the skills needed for the future
- A country with high performance in Green and Digital transition
- A country with a resilient health system that follows best practices from top health systems around the world
- A welfare state with a strong protection network for those in need of state assistance
- A state of law, transparency and accountability, with strong anti-corruption mechanisms

Priority Axis 4 'Towards a digital era' with a €89,4 mln available budget, aims to ensure the digital transformation of Cyprus, through inclusive and adequate access to communication infrastructure for all citizens. This will be achieved by providing 5G mobile and fiber optic network coverage for 100% of the population, including the development of 5G mobile telephony along major terrestrial corridors and affordable Gigabit connectivity across all urban and rural areas. The axis is a fundamental part of the overall policy for the digital transformation of Cyprus, promoting a new economic model on the basis of a vision for a strong and competitive economy, based on knowledge, digital and emerging technologies.

In complementarity with a series of measures in other Policy Axes, which also contribute to the economy's digital transformation, the Plan allocation more than €280 mln in digital transition, that is around 23% of the total Plan budget.

In addition, Priority Axis 2 'Towards a green economy', Pillar 2 'Accelerated transition to a green economy' (with €447,6 mln available) includes objective 2.2 'Sustainable transport' (with €91,3 mln) that foresees actions towards the establishment of an Intelligent Transportation System using Digital Twin technologies. It also includes Objective 2.3 'Smart and sustainable water management (€87,3 mln)' that foresees Smart Water and Sewerage Networks Management measures.

Priority Axis 3 'Towards a competitive and effective economy', Pillar 3 'Strengthening the resilience and competitiveness of the economy (budgeted €422,3 mln) incudes Objective 3.4 'Modernising public and local authorities, making justice more efficient and fighting corruption' (€96 mln), in which Investment 3.4.2 'Local Administration and Spatial reform' promotes "the Formulation of «Smart

cities» national strategy - integrated plan and initiatives to improve the citizens' live conditions, optimize the use of urban resources and services and reduce the impact on the environment".

4.2.6 Guidelines of Local R&I Strategies Vision and Goals

Until recently, there was no unified approach for the implementation of solutions for 'smart cities' in Cyprus, which led to multiple and non-coordinated actions and initiatives for smart cities, guided separately/individually from a few municipalities, at different speeds and models and with possible overlays.

In a country as small as Cyprus, given the small size of the population and the country, and the island's common characteristics in terms of the natural and structured environment, it makes sense to create one 'Smart Cyprus', in which efforts are coordinated and synergies are exploited, so that the user's/citizen's experience is the same everywhere.

The Deputy Ministry of Research, Innovation and Digital Policy (DMRID), took the opportunity to perform a "well-coordinated, orchestrated and unified approach" for smart cities and by decision of the Council of Ministers, in November 2020, DMRID took on a coordinating role in developing a national strategy for smart cities and the orchestration of all existing initiatives, with the aim of the user/citizen's experience to be the same everywhere. The aim is that the smart cities strategy be designed at national level by a competent central government authority, adopting common guidelines and specifications, examining all the above challenges with respect to how they serve citizens and finally achieving a unified and homogeneous approach to serving citizens, regardless of city or region.

The Deputy Ministry's key objective, through the implementation of the nationwide strategy, is to orchestrate the existing ongoing initiatives and include them in a nationwide plan, enhanced and complemented with additional initiatives, implementation plan, governance and steering mechanism that can lead to the following goals:

I. Transform the quality of life and citizen experience
II. Optimise the city's use of resources and services
III. Maximise operational efficiencies and revenue
IV. Improve the quality of life for the citizens
V. Target the green policy and convert the city to an environmentally friendly city

Targeting the aforesaid goals, the Deputy Ministry has undertaken the responsibility of centrally leading and implementing the 'Smart City' project, which will be funded throughout (€ 35m) by the Recovery and Resilience Fund (RRF).

In the above-mentioned framework, the Cypriot cluster of the METACITIES project, initiated the current report, namely the preparation of the Cypriot R&I Strategy, a Strategy that will serve as a roadmap for the implementation of the very first, but basic steps towards this direction. The overall goal of this Research and Innovation strategy is to provide a comprehensive approach to developing smart and sustainable cities and communities in Cyprus.

Overall, the Strategy aims to result in the following:

- Creating a vibrant, sustainable and resilient digital economy, by developing, marketing and using digital technologies
- Enabling a green, digital transition for Cyprus through sustainable mobility, circular and bio-economy and climate neutrality

- Establishing a common system for consolidating data and providing information to citizens, combining data from multiple systems.
- Using the field of artificial intelligence for developing "smart systems", installing IoT and Data
- Creating a unique shared information system
- Serving all Cypriot municipalities
- Integrating existing smart city solutions that have already been developed in the Municipalities of Cyprus
- Communicating with other existing platforms
- Further growing its list of additional vertical smart city solutions.
- Promoting innovation through the possibility of cooperating with providers and investors to create services and revenue from the data marketplace.

By implementing this strategy, Cyprus can work towards achieving the United Nations' Sustainable Development Goal 11 and EU Mission for 100 Climate-Neutral and Smart Cities by 2030, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable.

In this context, the CY Cluster vision is to: "Enable Smart, Sustainable and Responsible Development in Cyprus by leveraging the latest technologies and scientific knowledge, to create innovative urban planning solutions for Smart Cities that can benefit the society by improving the quality of life and experience of citizens, optimising the use of resources and services, and maximising operational efficiencies and revenue."

The relation of the CY cluster vision to the goals and priority areas is summarized in Table 6.

Table 6: CY Cluster vision, mission and goals

VISION	MISSION	GOALS	PRIORITY AREAS	USES CASES
"Enable Smart, Sustainable and Responsible Development in Cyprus by leveraging the latest technologies and scientific knowledge, to create innovative urban planning solutions for Smart Cities that can benefit the society by improving the quality of life and experience of citizens, optimising the use of resources and services, and maximising operational efficiencies and revenue."	Create a collaborative ecosystem (public, academia business, citizen) that will leverage latest technologies, to promote urban planning innovation, drive economic growth, ensure sustainability and enhance the quality of life for all citizens across al the region of Cyprus.	•To create a vibrant, sustainable and resilient digital economy, by developing, marketing and using digital technologies •To enable a green, digital transition for Cyprus through sustainable mobility, circular and bio-economy and climate neutrality •To establish a common system for consolidating data and providing information to citizens, combining data from multiple systems. •To use the field of artificial intelligence for developing "smart systems", installing IoT and Data. •To create a unique shared information system. •To service all Cypriot municipalities. •To integrate existing smart city solutions that have already been developed in the Municipalities of Cyprus. •To communicate with other existing platforms. •Further growing its list of additional vertical smart city solutions. •To promote innovation through the possibility of cooperating with providers and investors to create services and revenue from the data marketplace.	Smart Urban Planning	Smart Urban Planning Smart Parking

4.2.7 CY Cluster Priority Areas in the Scope of METACITITIES project

Targeting the vision and goals described in section above, the Deputy Ministry has undertaken the responsibility of centrally leading and implementing the 'Smart City' project, which will be funded throughout (€ 35m) by the Recovery and Resilience Fund (RRF). The 'Smart City' project aims to develop and implement a National Platform 'CY Smart City Platform', which will provide a holistic approach for the whole country, supporting all the "Smart City" technologies and infrastructures, incorporating the various projects that have been implemented or are in the process of being implemented by some municipalities and thus achieving economies of scale, the optimization of the quality of life and experience of citizens, the optimization of the use of resources and services, the operational effectiveness and efficiency and revenue maximization. The platform is expected to operate with a central Operator, from which the Municipalities will purchase services ('Software as a service' - SaaS model).

In the context of this "Smart City" project which is expected to be implemented by 2026, the National Platform 'CY Smart City Platform' will support the three priorities (vertical solutions) provided below that the main municipalities of Cyprus have indicated and the relevant landmark and goals included in the Recovery and Resilience Fund (RRF), while at a later stage, additional vertical solutions can be added to it.

I. Vertical solution for smart parking spaces,
II. Vertical solution for smart lighting, and
III. Vertical solution for smart waste management.

DMRID has assigned to external consultants the implementation of a study on the formation of the National Smart City Strategy and the determination of operational and technical specifications for the 'CY Smart City Platform' for all three vertical solutions for smart parking spaces, Lighting, and smart waste management. The study has considered all existing initiatives that have been or are ongoing by some municipalities

Partly aligned with this "Smart City" project, in the scope of the METACITIES project, the CY Cluster will take a leading role in exploring two significant Priority Areas: 'Smart Urban Planning' and 'Smart Parking'.

- For the 'Smart Urban Planning' case, our objective is to develop an integrated platform for analysing and predicting large-scale geospatial information (GIS), local demographic data, and other geo-critical datasets from multiple sources, and extracting meaningful insights that encompass a broad array of aspects and dimensions related to urban development and growth. The overall goal is to facilitate accurate environmental impact predictions on urban areas, thereby providing valuable data that can be utilized for informed urban development planning and decision-making.
- For the 'Smart Parking' case, our objective is to develop a platform that will provide real-time information on parking availability, busy hours, and other related metrics to parking lot owners and individuals seeking parking aiming to enhance the accuracy of predictions related to parking availability. The overarching goal is to reduce time spent on searching for parking, thus creating a less stressful and more environmentally friendly urban atmosphere, contributing to the development of sustainable cities.

The insights derived from the METACITIES project will play a critical role in informing and shaping the implementation strategies for these priority areas, ensuring that the transformation towards smart urban solutions in Cyprus is as effective, efficient, and beneficial as possible.

CY Smart City Platform:

The CY Smart City Platform will be provided to the municipalities based on the PaaS (Platform as a Service) model, managed by a Contractor. The Municipalities will be able to choose which smart city solutions they will offer to their residents/ visitors.

It is also noted that the Contractor can utilize the CY Smart City Platform to develop additional Vertical IoT Solutions, further to the below three, which are specified in the DMRID's Smart Cities project, and offer any of the Solutions to the Municipalities.

The Cyprus Smart City Platform will be citizen and visitor-centric, adopt sustainable, reliable, and resilient solutions, focus on security and privacy, enable the development of open, innovative, and collaborative cities and adopt state-of-the-art technologies.

4.3 GR Cluster Local R&I Strategy

4.3.1 Introduction

A smart city is a place where traditional services are made more efficient, using digital and telecommunications technologies, for the benefit of residents, visitors and businesses, as well as the administration and its functions for the citizens.

A smart city seeks, beyond the use of Information and Communication Technologies (ICT), the more efficient management of resources and the reduction of pollutant emissions. It also seeks better services in many areas of urban functioning, such as: transportation, water supply, lighting, waste. Additionally, a smart city aims for a more interactive and responsive city administration, as well as for safer public spaces, meeting the needs of an ageing population.

Greek cities have proven to be quite bold in adopting innovative technological solutions aimed at facilitating and improving the lives of their residents. Particularly with the contribution of the financial tools (NSRF 2014 – 2020 and onwards), they benefited and adopted solutions, either in the form of pilot projects, or by applying PPP-type business models.

Many cities are experienced and mature enough, after having tested various solutions and business models. The weaknesses of the solutions and the gaps in their implementation were highlighted, as well as the possibilities to produce substantial added value, both from an economic and operational point of view. The possibilities that Greek Municipalities have, depending on the size and their characteristics, to support such solutions, were also highlighted.

Promoting the implementation of smart cities in Greece, as in the whole of Europe, must mean for the citizens: a) an increase in the efficiency and accessibility of services, b) a reduction in poverty, unemployment and social exclusion, c) a reduction in pollution and environmental impacts and d) data collection for the purpose of making available and re-using them for effective policy formulation.

Additionally, as demonstrated by the recent COVID-19 pandemic, the transformation of cities into "smart cities" has positively affected the daily lives of individuals, workers, and businesses through a series of changes related to, for example, teleworking, e-democracy and enhancing transparency, while enabling citizens to participate more actively in the decision-making process.

The purpose of this Research and Innovation Strategy is to articulate the local & regional R&I strategy, recommendations, and implementation guidelines of the Greek Cluster regarding smart cities and smart regions and to define the necessary steps for fusing it into one joint strategy of the 3 Clusters participating in the Project and forming the Innovation Hub.

Thus, the **scope** of this R&I strategy is the Western Greece Region and more specifically the Municipality of Patras.

4.3.2 National and Regional Level Strategies and Plans

The R&I strategy will be aligned to all the relevant strategic positioning documents, from the United Nations sustainable development goals (SDGs) to the Strategic Plan of the Smart City and the Sustainable Urban Mobility Plan of the Municipality of Patras. So, in this Chapter follows a brief presentation of the following strategy positioning papers and programs:

- UN SDGs - Voluntary National Review 2022
- National Recovery and Resilience Plan "Greece 2.0"
- Digital Transformation Bible 2020-2025
- Digital Transformation Program 2021-2027
- Smart Specialization Strategy (RIS3) 2021-2027
- Regional Operational Program of Western Greece for 2021-2027
- Sustainable Urban Mobility Plan (SUMP) of the Municipality of Patras
- Strategic Plan of the Smart City of the Municipality of Patras

4.3.2.1 UN SDGs - Voluntary National Review 2022

The **United Nations** has proposed 17 sustainable development goals (SDGs) to be achieved by 2030.

The SDG applying to the scope of this project is **SDG 11 "Sustainable Cities and Communities" with the aim to *Make cities and human settlements inclusive, safe, resilient, and sustainable.***

According to the ***Voluntary National Review 2022*** *on the implementation of the 2030 Agenda on Sustainable Development*, many **actions** have been planned towards the **achievement of SDG 11**, such as: modernization of the Spatial and Urban Planning legislation, elaboration and implementation of an integrated National Spatial Strategy, compulsory Urban Accessibility Plans and **Sustainable Urban Mobility Plans (SUMPs)** that will guarantee the promotion of sustainable urban mobility at local and regional level, new provisions in the Road Traffic Code aimed at covering the proper use of micro mobility vehicles, called Personal Light Electric Vehicles (active human-powered mobility).

4.3.2.2 National Recovery and Resilience Plan "Greece 2.0"

The National Recovery and Resilience Plan (NRRP) "Greece 2.0" aspires to lead the country's economy, institutions, and society into a new era; to spark a paradigm shift towards a more extroverted, competitive, and green economic model, matched with a more efficient, less bureaucratic, digitalised state, a more growth-friendly tax system, a dramatically reduced informal economy, and a strong, resilient and inclusive social safety net.

The Program introduces fundamental economic and social reforms, which will affect --apart from the economic activity--, technologies, attitudes, and institutions, thus paving the way for a transformation

which will combine economic efficiency with innovation and digital transition with protection of the environment, social cohesion, and justice.

The NRRP fully complies with the EU goals for an accelerated green transition and digital transformation of the Greek economy.

The NRRP is structured on four pillars: (a) **Green**, (b) **Digital**, (c) **Employment, skills, and social cohesion,** (d) **Private investment and transformation of the economy**.

Greece's Recovery and Resilience Plan contains a comprehensive and coherent set of reforms and investments, structured into four (4) pillars, encompassing a total of eighteen (18) components:

1. **Green Transition:**
    a. Power Up: Transition to a new, low carbon energy model.
    b. Renovate: Climate mitigation and adaptation actions for the built environment in Greece.
    c. Recharge and refuel: Transitioning to green and sustainable transport.
    d. Sustainable use of resources, climate resilience and environmental protection: alignment with the principles of a circular economy, natural environment protection and climate change.
2. **Digital Transformation:**
    a. Connect: The purpose of this component is to cover ground in very-high-speed connectivity, achieve Greece's gigabit society targets and improve its digital competitiveness.
    b. Modernise: aims to modernise the public administration by improving its operational model and achieving provision of high-quality services to citizens and businesses.
    c. Digitalisation of businesses: aims to boost the adoption of digital technologies by businesses, especially small and medium enterprises (SMEs), and close the digital gap between Greece and the EU average in this respect.
3. **Employment, skills, and social cohesion**
    a. Increasing job creation and participation in the labour market: redesign and strengthening of Greece's active labour market policies (ALMPs) and reform of labour law.
    b. Education, vocational education, training, and skills.
    c. Improve resilience, accessibility and sustainability of healthcare.
    d. Increase access to effective and inclusive social policies.
4. **Private investment and transformation of the economy**
    a. Making taxes more growth friendly and improving tax administration and tax collection.
    b. Modernise the public administration, including through speeding up the implementation of public investments, improving the public procurement framework, capacity building measures and fighting corruption.
    c. Improve the efficiency of the justice system
    d. Strengthen the financial sector and capital markets
    e. Promote research and innovation: strengthen the link between science and business; promote public and private investment in R&D.
    f. Modernise and improve resilience of key economic sectors (tourism, culture, manufacturing, agriculture & aquaculture)
    g. Improve competitiveness and promote private investment and exports

The 18 components included in the Recovery and Resilience Plan make effective contributions to all six pillars that define the scope of the Recovery and Resilience Facility (RRF) as per Regulation (EU) 2021/241).

Pillar 2 "Digital Transformation" is the most relevant to the project.

The Greek recovery and resilience plan Greece 2.0 includes an initiative with investment for "Smart Cities", which brings forward a national, European, but also global challenge related to the digital, as well as the green transition. As population concentration in major urban centers continues to increase, the demand for improved services and access to basic resources and goods will continue to increase.

This dimension puts pressure on the system of availability of basic goods such as energy, water, waste management, mobility and any other service necessary for the well-being and sustainability of populations in urban centers. In this context, digital technologies contribute to addressing these challenges, acting as a catalyst for the gradual transformation of cities into "smart cities".

Smart city solutions enable cities to use technology, information and open data to improve urban infrastructure and e-services, but also to stimulate community-driven economic development.

4.3.2.3 Digital Transformation Bible 2020-2025

The Digital Transformation Bible reflects the guiding principles, the architectural design of the systems, the strategic axes of intervention, the model of governance and implementation and all the horizontal and vertical interventions that will implement the digital transformation of the Greek society.

The Ministry of Digital Governance has developed and is implementing a national strategy for the digital transformation of the entire Greek society and economy with specific goals:

- To enable every Greek citizen to work with speed, reliability, and security on the internet.
- To serve the needs of the citizens directly and efficiently through a digital state.
- To promote the development of digital skills for all Greeks.
- To help every Greek business to become a digital business.
- To support and enhance digital innovation.
- To realize and utilize the productive value of public data.
- To integrate modern technologies in all sectors of the economy.

The key interventions of Digital Transformation incorporate a series of actions and projects organized in six distinct strategic axes. This distinction was deemed appropriate based on the nature and subject matter of the interventions, in order to clearly reflect the way in which the Digital Transformation Action Plan will be implemented. Also, special emphasis is given to the utilization of emerging technologies for the development of advanced solutions that will support the implementation of its goals. The strategic axes are presented below and analysed in 7 sections. Each Section has its goals as follows:

- Connectivity:
    - Ensure Gigabit connectivity to drivers of socio-economic development, such as educational institutions and government agencies.
    - Provide uninterrupted 5G coverage in all urban areas and all major overland transport routes.

    - Provide internet access for all European households with a minimum speed of 100 Mbps, with the ability to upgrade to 1 Gbps.
- Digital Skills:
    - Digital Investment in the Human Resources of the Country
    - Citizens' Digital Academy
    - National Alliance for Digital Skills and Employment
- Digital Public Services
    - Single Digital Portal gov.gr
    - Digital and business transformation of KEP into KEP-plus
- Digital Business
    - Digitization of all public services to businesses
    - Strengthening systems and digital services in relation to the export oriented companies
    - Dissemination of best practices for strengthening the online presence of Greek companies
- Creating new ecosystems and accelerating the digital transformation of the economy
- Utilization of data for the development of new products, business models and markets
- Digital training of private sector human resources
- Strengthening start-up entrepreneurship through the KEP - Plus program
- Development of a system for assessing the digital maturity of enterprises and documentation of the planning of state aid for their digital transformation (Digitometer)
- Advanced and integrated production systems, automation and robotics
- Development of digital services / systems to support start-ups or established businesses (scale-up)
- Utilization of IT tools for decision making (evidence-based policy) in the public sector
- Digital Innovation
    - One of the most critical pillars for the digital economy is the creation of Digital Innovation Hubs (DIHs), which are "one-stop shops" to support businesses in the digital transformation of their production processes and promote their innovation, using digital technologies.
- Advanced Technologies
    - Upgrading Research and Education Infrastructure (EDYTE) (Cloud Computing Services, Data Storage Services, etc.)
    - High Performance Computing Systems
    - Artificial Intelligence
    - Blockchain Technologies
    - Quantum-resistant cryptography applications - EuroQCI
- Integration of Technology in every sector of the economy

There is also detailed action planning and projects scheduled, running in every section.

There are also horizontal interventions:

- Horizontal digital transformation projects for public administration,
- Open and Participatory Governance,

- Enhancing Accessibility,
- Privacy and Data Protection,
- Cybersecurity.

4.3.2.4 Digital Transformation Program 2021-2027

All the Actions of the Program have been designed along the 6 Strategic Intervention Axes of the "Digital Transformation Bible 2020-2025". The program has a supervisory role regarding the implementation of all Technology, Information Technology and Communications (ICT) actions, regardless of funding source, in order to achieve the proper planning of the actions, to avoid potential overlaps and to function with synergy and complementarity. All the actions will be implemented through other national sectoral or regional programs and financial instruments. The Program Priorities and planned Actions are the following:

- **Priority: 1**. Digital Transformation of the Public Sector
  - Digital Transformation of Economy and Society
  - Applications and actions to support entrepreneurship
  - Development of ICT applications in Public Administration Sectors
  - Availability of applications and tools to strengthen Digital Skills
  - Digital Transformation of Health and Support of Special Population Groups
  - Provision of Electronic Health Services
  - Enhancing independent living
  - Digitization and Productive Utilization of Data using innovative IT technologies
  - Digital transformation of local authorities
  - Digitization Actions (Public, Cultural, Social, etc. Agencies)
  - Strengthening large-scale ICT infrastructure
  - Development of Cloud infrastructures for the hosting of Public Administration bodies, the provision of IaaS-PaaS-SaaS services and the implementation of secondary node solutions (disaster site)
  - WiFi4GR - Development of public wireless broadband internet access points - Phase B (phasing)
  - Public Sector Network (SYZEUXIS II) - Phase II (phasing)
  - Development of other types of ICT infrastructure (large-scale IT equipment, data centers, sensors and other wireless equipment)
- **Priority: 2.** Enhancing connectivity with high-speed broadband access
  - Development of very high-capacity Broadband Networks
  - UFBB Ultra High Broadband Infrastructure Development - Phase II
  - UFBB II – in areas that will not have VHCN type coverage
  - Actions to support the design, development, management and monitoring of very high-capacity broadband networks
- **Priority: 3.** Development of Digital Skills
  - Implementation of retraining programs - upgrading digital skills
  - Implementation of reskilling-upskilling programs for the employees of the General Government
  - Implementation of programs to upgrade the level of digital skills (upskilling) in matters of utilization and management of innovative digital technologies

- Implementation of systemic actions
- Development of the interministerial branch of the Digital Policy Analyst
- Support the staff capacity of the Ministry of Digital Governance to monitor Digital Skills
- Supporting the National Alliance for Digital Skills and Employment
- Support of the National Academy of Digital Skills
- Development of basic digital skills in the general population
- Priorities of technical assistance

4.3.2.5 Smart Specialization Strategy 2021-2027

The Smart Specialization Strategy is designed around 8 priority areas:

- Agro-food value chain
- Biosciences, Health and Pharmaceuticals
- Digital Technologies
- Sustainable Energy
- Environment and Circular Economy
- Transport and Logistics
- Materials, Constructions, and Industry
- Tourism, Culture and Creative Industries

The Greek Cluster R&I Strategy will be aligned with the following thematic areas of the Smart Specialization Strategy 2021-2027 of Greece:

Sector 3 - Digital Technologies, indicatively:

3.1. Data and information management technologies

3.1.1 Open and/or large-volume data (open data, big data), high-performance data analysis, graph data management

3.1.6 Common data spaces and online collaboration platforms

3.5. Smart, digitized industry and manufacturing

3.5.7 Utilization of artificial intelligence and other modern technologies (e.g., **Digital Twins**, robots, collaborative industrial robots-cobots, industrial IoT, AR/VR) for the benefit of the agri-food sector, industry/manufacturing and construction

Sector 6 – Smart Transport & Logistics, indicatively:

6.3 Green Transport - Sustainability and sustainability in transport

6.3.4 Development of simulation models and study of the structure and operation of urban networks for the implementation of smart mobility systems and infrastructures.

6.3.9 Big data analytics for mobility, transport & logistics.

6.4 Strengthening intermodality and autonomy in the transport of passengers and goods:

6.4.2 Strengthening the sharing of vehicles, especially electric ones (vehicle sharing systems).

6.4.3 Applications of interconnection and interoperability of means of transport (Public and Private).

6.7 Urban Transportation of Passengers and Goods

Each Regional Programme specializes further and focuses its Regional Innovation Strategy, along the 8 priority areas of the national Smart Specialization Strategy.

The Regional Operational Program of Western Greece has not yet specialized its RIS3 emphasis and fields of action but the following sectors are quite indicative:

A. Sector: Materials - Construction and Industry

- Possible specialization in: Materials, processes, devices & production systems for the circular economy & industrial symbiosis. E.g.:
- Systems, techniques, materials and provisions for better management, collection, recycling and reuse of water
- Technologies and recycling of composite or multilayer organic materials
- Holistic design of products with the aim of minimizing negative effects on the environment throughout their life cycle, systems and processes for tracking/monitoring/measuring the environmental footprint

B. Sector: DIGITAL TECHNOLOGIES

- Possible specialization in Smart networks & Services, e.g.:
- Collective awareness platforms for sustainability and social innovation

C. Sector: SUSTAINABLE ENERGY

- Possible specialization in Energy efficiency and energy saving, e.g.:
- Technologies, systems, processes for energy efficiency and energy saving in buildings
- Smart communities/cities with low energy consumption and almost zero emissions
- Technologies, systems and methods of interconnection and interaction of end customers for the joint production of energy from RES (RES communities) or for the joint production of electricity (citizen energy communities), its intelligent management, storage, self-consumption and sale and/or in electric vehicle charging services
- Technologies and systems for saving energy and resources as well as reducing emissions at community and/or city level
- Energy and Transport (Using sustainable energy in the transport sector):
- Energy and Roads, Rail and Aviation
- Energy and Shipping

4.3.2.6 Regional Operational Program of Western Greece for 2021-2027

Main Challenges and Opportunities in the Region

The Region of Western Greece has to manage a series of important challenges moving forward and designing its future plans. While it is the sixth wealth-producing region of Greece, it is only eleventh (out of thirteen) in terms of per capita income. Furthermore, although it is characterized by a high research potential, high per capita research and development costs and at the same time it is the first region in number of students in the country, the knowledge produced is unable to be diffused into the production and the market, depriving the regional economy of smart jobs. Although it is geographically located in one of the regions with the highest alternative energy potential (wind and solar), as well as rich natural reserves, Western Greece underutilizes this potential, being fourth in solar and wind energy production and third in hydroelectric energy production.

The Region stands out for the dynamics of the primary production sector (agriculture and livestock production), since it represents the third largest income in terms of animal production, as well as the fourth largest in terms of crop production. On the other hand, the primary production sector is characterized by small lots, non-interconnected holdings and a low level of technological integration.

The Region of Western Greece has a rich and heterogeneous cultural and natural heritage. It hosts on its territory world heritage monuments and places of special value. Nevertheless, it has developed a character of "passage" to other destinations, rather than a typical popular travel destination. In Western Greece, the tourism, transport, and catering-leisure sectors represent more than 25% of the regional economic activity and, being the sectors that have been globally most affected by the Covid-19 pandemic, are expected to directly affect the social and economic development of the region.

The above-mentioned challenges of the Region are at the center of its strategic and operational plan. The development in the Region will only come through the adoption of a realistic vision and strategies for the region, within a framework of rules and sufficient conditions. The development of infrastructure, the improvement of accessibility, the highlighting of the competitive advantages of the region at an economic level, the integration and implementation of policies for sustainability in production and the environment, the emphasis on the removal of social exclusions, the investment in knowledge and innovation, the promotion and enrichment of the tourism product of Western Greece and the focus on open, truly regional governance are areas that must be taken into account during the decision-making processes related to active regional strategic and operational planning.

Vision

The **vision** of the Regional Program of Western Greece for 2021-2027 is the following:

Transformation into a fair, smart and efficient European Region, which will be a supra-local hub of technology innovation, research and creativity, a model of social cohesion, a place where Olympism, volunteerism and culture are highlighted.

Main objectives

The Programme aims to boost economic development and create job opportunities in Western Greece. It contributes to achieving the Europe 2020 targets for smart, sustainable, and inclusive growth, also in line with the smart specialisation strategy. It should create jobs and help SMEs to become more competitive and innovation driven. EU funding will also contribute to meeting the requirements of the Union's acquis, in particular as regards waste water treatment and the increase of solid waste recycling and increase energy efficiency.

Funding priorities

The Operational Program (OP) will contribute to promoting the following strategic priorities for Western Greece, which are aligned with the relevant policy objectives (PO). Each Priority is further deployed to Specific Objectives (SO):

PO1 Smarter Europe:

Priority 1: "Reinforcement of competitiveness in production, and empowerment of entrepreneurship in terms of innovation, extroversion and increased participation in RTDI.

- SO1.i Development and strengthening of research and innovation capacities and utilization of advanced technologies
- SO1.ii Exploitation of the benefits of digitization for citizens, companies, research organizations and public authorities
- SO1.iii Enhancing the sustainable growth and competitiveness of SMEs and creating jobs in SMEs, including through productive investments

PO2: Greener Europe

Priority 2: "Environmental protection, adaptation to climate change, strengthening energy self-sufficiency and the circular economy.

- SO2.i Promotion of energy efficiency measures and reduction of greenhouse gas emissions
- SO2.ii Promotion of renewable energy sources in line with the Renewable Energy Directive
- SO2.iv Promote climate change adaptation and disaster risk prevention, resilience, taking into account ecosystem-based approaches
- SO2.v Promotion of access to water supply and sustainable water management
- SO2.vii Strengthen the protection and conservation of nature, biodiversity and green infrastructure, including in urban areas, and reduce all forms of pollution

PO3: Connected Europe

Priority 3: "Enhancing regional mobility".

- SO3.i Development of climate resilient, smart, secure, sustainable and intermodal TEN-T
- SO3.ii Develop and strengthen sustainable, climate-resilient, smart and intermodal national, regional and local mobility, with better access to TEN-T and cross-border mobility

PO4: Social Europe

Priority 4a: "Development of infrastructures in the framework of Social Cohesion"

- SO4.ii Improving equal access to quality education, training and lifelong learning services
- SO4.iii Promoting the socio-economic inclusion of marginalized communities, low-income households and disadvantaged groups
- SO4.iv Ensure equitable access to health care and strengthen the resilience of health systems, including primary health care, and promote the transition from institutional to family- and community-based care
- SO4.v: Strengthening the role of culture and sustainable tourism in economic development, social inclusion and social innovation

Priority 4b: "Development of social cohesion and human resources"

- SO4.i Improving access to employment and activation measures for all job seekers
- SO4.vi Promoting equal access to and completion of quality and inclusive education and training,
- SO4.viii Promotion of active inclusion to promote equal opportunities, non-discrimination and active participation, as well as improving employability, especially of disadvantaged groups
- SO4.ix Promotion of the socio-economic integration of third country nationals, including immigrants
- SO4.x Promoting the socio-economic inclusion of marginalized communities, such as the Roma
- SO4.xi Strengthening equal and timely access to quality, sustainable and affordable services
- SO4.xii Promoting the social inclusion of people at risk of poverty or social exclusion, including the disadvantaged and children

PO5: Europe near the citizens

Priority 5: "Improvement of sustainable local development through integrated interventions"

- SO5.i Enhancing integrated and inclusive social, economic and environmental development, culture, natural heritage, sustainable tourism and security in urban areas

- SO5.ii Strengthening integrated and inclusive social, economic and environmental local development, culture, natural heritage, sustainable tourism and security in non-urban areas

4.3.3 Municipal Sustainable Spatial Development Strategies

4.3.3.1 Sustainable Urban Mobility Plan (SUMP) of the Municipality of Patras

The **United Nations** has proposed 17 sustainable development goals (SDGs) to be achieved by 2030. The SDG applying to the scope of this project is SDG 11 "Sustainable Cities and Communities" with the aim to *Make cities and human settlements inclusive, safe, resilient, and sustainable.*

According to the ***Voluntary National Review 2022*** *on the implementation of the 2030 Agenda on Sustainable Development*, many actions have been planned towards the achievement of SDG 11, such as: modernization of the Spatial and Urban Planning legislation, elaboration and implementation of an integrated National Spatial Strategy, compulsory Urban Accessibility Plans and Sustainable Urban Mobility Plans (SUMPs) that will guarantee the promotion of sustainable urban mobility at local and regional level, new provisions in the Road Traffic Code aimed at covering the proper use of micro mobility vehicles, called Personal Light Electric Vehicles (active human-powered mobility).

It took into consideration the following strategies and programmes:

- White Paper 2011 on Mobility and Transport
- European Strategy on low emission mobility
- National Strategic Plan for Mobility and Transport in Greece
- Operational Program Transport 2021-2027
- Operational Program Environment-Energy-Climate Change 2021-2027
- Regional Spatial Planning & Sustainable Development Framework for Industry

The **aim** of the SUMP is to create a framework of strategic goals and measures, at the level of macroscopic planning, which will lay the foundations for upgrading the infrastructure and services related to the movement of people and goods within the Municipality. The preparation of the SUMP of the Municipality of Patras takes as its starting point both the fulfilment of the national and international guidelines for achieving sustainable transportation systems, as well as the findings and directions of the Municipality's existing planning.

The **vision** of the SUMP of the Municipality of Patras is the following:

"The Municipality of Patras to develop a fairer system of urban mobility, which provides conditions of comfort and safety in movement with all different available means of transport, while ensuring equality in movement for all in the coming years."

Considering the stated vision, as well as the general and specific objectives of other SUMPs and relevant Strategic Documents, the SUMP of the Municipality of Patras has concluded to the following SMART **Strategic and Specific Objectives (SpO)**:

Strategic Objective A: Development of safe and comfortable infrastructure for pedestrians and cyclists

- SpO-A1) Improving accessibility – Ensuring safe and attractive pedestrian routes.
- SpO-A2) Creation of a competitive and safe bicycle system & E.P.H.O.
- SpO-A3) Adaptation of the infrastructure to better serve the disabled groups of commuters.

Strategic Objective B: Creation of a multimodal, modern and efficient public transport system

- SpO-B1) Upgrading the level of service offered by Public Transport in the Municipality.

- SpO-B2) Improving the safety and accessibility of public transport stops and stations.
- SpO-B3) B.3) Ensuring intermodality of means of transport.

Strategic Objective C: Completion of infrastructure and management of urban motorized traffic

- SpO-C1) Improvement and maintenance of road infrastructure and upgrading of road safety.
- SpO-C2) Parking Management.
- SpO-C3) Optimization of urban freight transport and management of intercity flows.
- SpO- C4) Measures to limit the use of private vehicles.

Strategic Objective D: Renewal of the urban space and promotion of a sustainable lifestyle & movement.

- SpO-D1) Completion of urban planning (Planning and Implementation) in critical areas of Patras.
- SpO-D2) Sensitization and awareness of citizens towards sustainable urban mobility.
- SpO-D3) Introduction of new technologies to monitor traffic, parking and public transport, to improve the environment and to dynamically inform citizens.

4.3.3.2 Strategic Plan of the Smart City of the Municipality of Patras

The "Smart City Strategic Plan of the Municipality of Patras" was designed based on the specifications set out in the "Guide for submitting proposals for smart city actions by Municipalities to Information Society SA, according to the National Recovery and Resilience Plan Greece 2.0", and aligned with all the National Plans of Digital Policy, and more specifically with the:

- National Recovery and Resilience Plan “Greece 2.0”, and especially with Pillar 1-Green Transition, Pillar 2-Digital Transformation, Pillar 4-Private investments and financial transformation
- Digital Transformation Program 2021-2027, and especially Priority 1-Digital Transformation of Public Sector.
- Digital Transformation Bible 2020-2025, and especially Sector 9.9 – Digital Transformation of Cities and Communities

For the construction of the Plan, city bodies (local government, academic bodies, research institutes, professional collective bodies, etc.) collaborated through thematic Working Groups. This initiative was started by the University of Patras and then the Municipality of Patras coordinated the cooperation of the Working Groups for the construction of the Strategic Plan.

The following nine (9) thematic Working Groups were created:

- Working Group 1: Natural and Built Environment, Public Safety and Civil Protection
- Working Group 2: Energy Saving and Management
- Working Group 3: ICT & E-Governance
- Working Group 4: Mobility & Transport
- Working Group 5: Water & Waste Management
- Working Group 6: Health & Welfare
- Working Group 7: Education & Sports
- Working Group 8: Entrepreneurship
- Working Group 9: Tourism – Culture

As a result of this effort, the **following priorities emerged** for Patras as a "smart city":

1. Environment – Energy

2. Electronic Government
3. IT & Communications Technology Infrastructures
4. Mobility & Transportation
5. Health & Education
6. Culture
7. Citizen networking

As part of Patras' participation in the DCC initiative, the project team produced - among others - two (2) important projects:

- Assessment report for the city of Patras (January 2019)
- Digital Transformation Strategy for the city of Patras (April 2019)

The vision of the Strategic Plan of the Smart City of the Municipality of Patras is to become a smart digital city with the aim of improving the services provided to its citizens, professionals and visitors, through the active participation of its human resources and through innovative interventions, taking advantage of the possibilities offered by the development of modern technologies in infrastructure and services.

By using innovative interventions, let us make use of new technologies by achieving their use by citizens with a view to improving their daily lives.

The **Strategic Objectives** of the Strategic Smart City Plan of the Municipality of Patras relate to all thematic areas of activity and are as follows:

- SO1: Enhancing sustainable urban development in Patras through the application of large-scale cutting-edge technologies
- SO2: Use of new ICTs to improve the quality of services and content to citizens quickly, easily and everywhere
- SO3: Promoting the sustainable operation, management and safety of infrastructure, natural resources and the environment
- SO4: Promoting sustainable urban mobility
- SO5: Harnessing new ICTs for smart energy management of buildings and networks
- SO6: Developing connectivity through modern network infrastructures
- SO7: Promoting and exploiting interoperability and open data

The **Thematic Sectors** (TS) of the Smart City Strategic Plan of the Municipality of Patras, according to the Guide for the submission of proposals for smart city actions by the Municipalities to the Information Society S.A., as well as the **Specific Objectives (SpO)** per Thematic Sector, are as follows:

TS1: Mobility

- SpO1: Providing real-time information on urban mobility issues through electronic communication channels
- SpO2: Facilitating accessibility for special population groups and people with disabilities
- SpO3: Improving traffic, parking and road safety conditions
- SpO4: Use of urban mobility data for decision-making and policy-making on traffic and environmental issues

TS2: Safety

- SpO5: Use of new technologies for disaster prevention and protection of infrastructure and the environment in emergency situations

- SpO6: Improving infrastructure and the level of services provided to strengthen public safety

TS3: Energy

- SpO7: Promoting digital technology for energy metering, control and management in buildings and street and public lighting
- SpO8: Implementation of energy efficiency and energy reduction policies
- SpO9: Use of energy consumption data for decision making and policy making on energy saving issues

TS4: Civil Protection – Environment

- SpO10: Use of new technologies to capture environmental variables of air quality
- SpO11: Use of new technologies for the assessment of environmental parameters of swimming water quality

TS5: Water resources

- SpO12: Use of new technologies for disaster prevention during severe weather events
- SpO13: Use of new technologies for the rational and sustainable use of drinking water

TS6: Waste management

- SpO14: Implementation of smart waste collection systems and optimisation of waste collection

TS7: Economic development and construction

- SpO15: Use of new technologies to make digital applications available to citizens and visitors
- SpO16: Strengthening the cultural heritage of the Municipality through digital actions of cultural interest

TS8: Accessibility

- SpO17: Developing modern networks to support and efficiently manage smart infrastructure and save financial resources

TS9: Horizontal actions

- SpO18: Executive management of smart infrastructure subsystems to exploit information, generate new data and draw conclusions to support decision making
- SpO19: Harnessing open data of smart infrastructure subsystems to provide information to citizens, businesses, academics and researchers
- SpO20: Development of new e-services for citizens

This programme is further analysed in Smart City Actions as well as specific funding needs.

The Strategic Plan was structured based on the vision of Patras to become a smart digital city and set specific strategic goals and specific goals per thematic area. It has a direct relevance to the National Digital Policy Plans.

According to the analysis of the Plan and its proposed actions, it is documented that Patras has implemented several smart city actions in various thematic areas, always with the aim of improving the living conditions of citizens through the utilization of the possibilities offered by new technologies both in terms of infrastructure and services. New actions are proposed in the Strategic Plan, which concern both the expansion of existing smart actions on a larger scale and the implementation of new actions for the maximum possible coverage of the thematic areas of a smart city. It is characteristic that many new actions utilize the infrastructures that were created or are expected to be created in the near future by existing smart actions. The city's priorities for the utilization of ICT with the aim of serving the real needs of the native people, avoiding showcase projects and impressive big-budget projects, are the main criteria for the new actions to be included for financing from the Recovery and Resilience Fund.

For the successful outcome of this Strategic Plan, not only the implementation of investments in infrastructure and modern technology applications is sufficient, but the active and substantial involvement of local human resources. This Plan constitutes the necessary planning basis on which the implementation of the goal to make Patras a "smart city" will be based.

4.3.4 Summary of the National/Regional/Local Level Strategies and Plans

In Table 7 is presented a summary of the vision and the strategic objectives of the regional and the local Strategic Plans for the city of Patras, to be used as guidelines for the development of the vision and the goals of the local R&I Strategy.

Table 7: Vision and strategic objectives of Patras development plans

UN SDGs - Voluntary National Review 2022
The SDG applying to the scope of this project is **SDG 11 "Sustainable Cities and Communities" with the aim to *Make cities and human settlements inclusive, safe, resilient, and sustainable.***   According to the ***Voluntary National Review 2022*** *on the implementation of the 2030 Agenda on Sustainable Development*, many **actions** have been planned towards the **achievement of SDG 11**, such as: modernization of the Spatial and Urban Planning legislation, elaboration and implementation of an integrated National Spatial Strategy, compulsory Urban Accessibility Plans and **Sustainable Urban Mobility Plans (SUMPs)** that will guarantee the promotion of sustainable urban mobility at local and regional level, new provisions in the Road Traffic Code aimed at covering the proper use of micro mobility vehicles, called Personal Light Electric Vehicles (active human-powered mobility).
National Recovery and Resilience Plan "Greece 2.0"
The National Recovery and Resilience Plan (NRRP) "Greece 2.0" aspires to lead the country's economy, institutions, and society into a new era; to spark a paradigm shift towards a more extroverted, competitive, and green economic model, matched with a more efficient, less bureaucratic, digitalised state, a more growth-friendly tax system, a dramatically reduced informal economy, and a strong, resilient and inclusive social safety net.   Greece's Recovery and Resilience Plan contains a comprehensive and coherent set of reforms and investments, structured into four (4) pillars, encompassing a total of eighteen (18) components: 1. **Green Transition:**   • Power Up: Transition to a new, low carbon energy model.   • Renovate: Climate mitigation and adaptation actions for the built environment in Greece.   • Recharge and refuel: Transitioning to green and sustainable transport.   • Sustainable use of resources, climate resilience and environmental protection: alignment with the principles of a circular economy, natural environment protection and climate change.   2. **Digital Transformation:**   • Connect: The purpose of this component is to cover ground in very-high-speed connectivity, achieve Greece's gigabit society targets and improve its digital competitiveness.

- Modernise: aims to modernise the public administration by improving its operational model and achieving provision of high-quality services to citizens and businesses.
- Digitalisation of businesses: aims to boost the adoption of digital technologies by businesses, especially small and medium enterprises (SMEs), and close the digital gap between Greece and the EU average in this respect.

3. **Employment, skills, and social cohesion**
   - Increasing job creation and participation in the labour market: redesign, strengthening and overall revamping of Greece's active labour market policies (ALMPs) and reform of the labour law.
   - Education, vocational education, training, and skills.
   - Improve resilience, accessibility and sustainability of healthcare.
   - Increase access to effective and inclusive social policies.
4. **Private investment and transformation of the economy**
   - Making taxes more growth friendly and improving tax administration and tax collection.
   - Modernise the public administration, including through speeding up the implementation of public investments, improving the public procurement framework, capacity building measures and fighting corruption.
   - Improve the efficiency of the justice system
   - Strengthen the financial sector and capital markets
   - Promote research and innovation: strengthen the link between science and business; promote public and private investment in R&D.
   - Modernise and improve resilience of key economic sectors (tourism, culture, manufacturing, agriculture & aquaculture)
   - Improve competitiveness and promote private investment and exports

Digital Transformation Bible 2020-2025

The Ministry of Digital Governance has developed and is implementing a national strategy for the digital transformation of the entire Greek society and economy with specific goals:

- To enable every Greek citizen to work with speed, reliability, and security on the internet.
- To serve the needs of the citizens directly and efficiently through a digital state.
- To promote the development of digital skills for all Greeks.
- To help every Greek business to become a digital business.
- To support and enhance digital innovation.
- To realize and utilize the productive value of public data.
- To integrate modern technologies in all sectors of the economy.

There are actions concerning the Digital Transformation of Cities and Communities including solutions for smart urban mobility and parking management. With respect to the self-governing nature of the administration of cities and regions of Greece, the digital transformation strategy aims in delivering digital horizontal tools to all local organizations local government (OTA), but leaving room for each region, city or community to choose the specific digital strategy it serves best the local needs.

Digital Transformation Program 2021-2027

All the Actions of the Program have been designed along the 6 Strategic Intervention Axes of the "Digital Transformation Bible 2020-2025". The program has a supervisory role regarding the implementation of all Technology, Information Technology and Communications (ICT) actions, regardless of funding source, in order to achieve the proper planning of the actions, to avoid potential overlaps and to function with synergy and complementarity.

The Program Priorities and planned Actions are the following:

- **Priority: 1**. Digital Transformation of the Public Sector
  - Digital Transformation of Economy and Society
    - Applications and actions to support entrepreneurship
    - Development of ICT applications in Public Administration Sectors
    - Availability of applications and tools to strengthen Digital Skills
  - Digital Transformation of Health and Support of Special Population Groups
    - Provision of Electronic Health Services
    - Enhancing independent living
  - Digitization and Productive Utilization of Data using innovative IT technologies
    - Digital transformation of local authorities
    - Digitization Actions (Public, Cultural, Social, etc. Agencies)
  - Strengthening large-scale ICT infrastructure
    - Development of Cloud infrastructures for the hosting of Public Administration bodies, the provision of IaaS-PaaS-SaaS services and the implementation of secondary node solutions (disaster site)
    - WiFi4GR - Development of public wireless broadband internet access points - Phase B (phasing)
    - Public Sector Network (SYZEUXIS II) - Phase II (phasing)
    - Development of other types of ICT infrastructure (large-scale IT equipment, data centers, sensors and other wireless equipment)
- **Priority: 2.** Enhancing connectivity with high-speed broadband access
  - Development of very high capacity Broadband Networks
    - UFBB Ultra High Broadband Infrastructure Development - Phase II
    - UFBB II – in areas that will not have VHCN type coverage
    - Actions to support the design, development, management and monitoring of very high capacity broadband networks
- **Priority: 3.** Development of Digital Skills
  - Implementation of retraining programs - upgrading digital skills
    - Implementation of reskilling-upskilling programs for the employees of the General Government
    - Implementation of programs to upgrade the level of digital skills (upskilling) in matters of utilization and management of innovative digital technologies
  - Implementation of systemic actions
    - Development of the interministerial branch of the Digital Policy Analyst
    - Support the staff capacity of the Ministry of Digital Governance to monitor Digital Skills
    - Supporting the National Alliance for Digital Skills and Employment

– Support of the National Academy of Digital Skills – Development of basic digital skills in the general population o Priorities of technical assistance
Smart Specialization Strategy (RIS3) 2021-2027
The Smart Specialization Strategy is design around 8 priority areas: • Agro-food value chain • Biosciences, Health and Pharmaceuticals • Digital Technologies • Sustainable Energy • Environment and Circular Economy • Transport and Logistics • Materials, Constructions, and Industry • Tourism, Culture and Creative Industries The Greek Cluster R&I Strategy will be aligned with the following thematic areas of the Smart Specialization Strategy 2021-2027 of Greece: **Sector 3 - Digital Technologies**, indicatively: 3.1. Data and information management technologies 3.1.1 Open and/or large-volume data (open data, big data), high-performance data analysis, graph data management 3.1.6 Common data spaces and online collaboration platforms 3.5. Smart, digitized industry and manufacturing 3.5.7 Utilization of artificial intelligence and other modern technologies (e.g. **Digital Twins**, robots, collaborative industrial robots-cobots, industrial IoT, AR/VR) for the benefit of the agri-food sector, industry/manufacturing and construction **Sector 6 – Smart Transport & Logistics**, indicatively: 6.3 Green Transport - Sustainability and sustainability in transport 6.3.4 Development of simulation models and study of the structure and operation of urban networks for the implementation of smart mobility systems and infrastructures. 6.3.9 Big data analytics for mobility, transport & logistics. 6.4 Strengthening intermodality and autonomy in the transport of passengers and goods: 6.4.2 Strengthening the sharing of vehicles, especially electric ones (vehicle sharing systems). 6.4.3 Applications of interconnection and interoperability of means of transport (Public and Private). 6.7 Urban Transportation of Passengers and Goods

Each Regional Programme specializes further and focuses its Regional Innovation Strategy, along the 8 priority areas of the national Smart Specialization Strategy (Table 8).

Table 8: Regional programs vision and objectives

PROGRAM	VISION	STRATEGIC OBJECTIVES / PRIORITIES

Regional Operational Program of Western Greece for 2021-2027	Transformation into a fair, smart and efficient European Region, which will be a supra-local hub of technology innovation, research and creativity, a model of social cohesion, a place where Olympism, volunteerism and culture are highlighted.	• **Priority 1:** "Reinforcement of competitiveness in production, and empowerment of entrepreneurship in terms of innovation, extroversion and increased participation in RTDI. • **Priority 2:** "Environmental protection, adaptation to climate change, strengthening energy self-sufficiency and the circular economy. • **Priority 3:** "Enhancing regional mobility". • **Priority 4a:** "Development of infrastructures in the framework of Social Cohesion" • **Priority 4b:** "Development of social cohesion and human resources" • **Priority 5:** "Improvement of sustainable local development through integrated interventions"
Strategic Plan of the Smart City of the Municipality of Patras	The vision of Patras is to become a smart digital city with the aim of improving the services provided to its citizens, professionals, and visitors, through the active participation of its human resources and through innovative interventions, taking advantage of the possibilities offered by the development of modern technologies in infrastructure and services. By using innovative interventions, let us make use of new technologies by achieving their use by citizens with a view to improving their daily lives.	• **SO1:** Enhancing sustainable urban development in Patras through the application of large-scale cutting-edge technologies. • **SO2:** Use of new ICTs to improve the quality of services and content to citizens quickly, easily and everywhere. • **SO3:** Promoting the sustainable operation, management and safety of infrastructure, natural resources and the environment. • **SO4:** Promoting sustainable urban mobility. • **SO5:** Harnessing new ICTs for smart energy management of buildings and networks • **SO6:** Developing connectivity through modern network infrastructures. • **SO7:** Promoting and exploiting interoperability and open data
Sustainable Urban Mobility Plan (SUMP) of the Municipality of Patras	The Municipality of Patras to develop a fairer system of urban mobility, which provides conditions of comfort and safety in movement with all different available means of transport, while ensuring equality in movement for all in the coming years.	• **Strategic Objective A:** Development of safe and comfortable infrastructure for pedestrians and cyclists • **Strategic Objective B:** Creation of a multimodal, modern and efficient public transport system • **Strategic Objective C:** Completion of infrastructure and management of urban motorized traffic • **Strategic Objective D:** Renewal of the urban space and promotion of a sustainable lifestyle & movement.

According to the previous analysis, it is documented that Patras has implemented several smart city actions in several thematic areas, always with the aim of improving the living conditions of citizens through the utilization of the possibilities offered by new technologies both in terms of infrastructure and services. Additionally, many other actions are programmed to be implemented, which concern both the expansion of existing smart actions on a larger scale and the implementation of new actions for the maximum possible coverage of the thematic areas of a smart city. Many new actions utilize the infrastructures that were created or are expected to be created.

On the other hand:

- there are funding programs and resources that can be exploited, and
- the implementation of investments in infrastructure and modern technology applications is sufficient.

But for the successful outcome of the above-mentioned actions and the current project, there are some prerequisites:

- the awareness of the interested parties has to be more intense and effective,
- the active and substantial involvement of local human resources is required,
- the innovation development and the productive resources of the area must cooperate more closely.

4.3.5 Funding and Resources

The main national, regional and local strategic documents presented above conclude in specific actions and funding schemes.

As already analysed, there are resources covering all the sectors of interest addressed by the Project (Smart Mobility, Energy, etc.). Indicative funding resources and actions per program, in the area of Smart Mobility, are presented below:

Program **National Recovery and Resilience Plan "Greece 2.0":** Component 1.3. of Green Transition concerns Urban Mobility and Transport and there is provision for Electromobility.

Program **Digital Transformation Bible 2020-2025:** there are actions concerning the Digital Transformation of Cities and Communities including solutions for smart urban mobility and parking management. With respect to the self-governing nature of the administration of cities and regions of Greece, the digital transformation strategy aims in delivering digital horizontal tools to all local organizations local government (OTA), but leaving room for each region, city or community to choose the specific digital strategy it serves best the local needs.

Regional Operational Program of Western Greece for 2021-2027

Priority 3: “Enhancing regional mobility” has the following Specific Objectives, and indicative action categories under each SO:

- SO3.i: Development of climate resilient, smart, secure, sustainable and intermodal TEN-T
- Promotion of Mobility: Road Transport,
- Promotion of Mobility: Railway Transport,
- Promotion of Mobility: Maritime Transport
- SO3.ii: Develop and strengthen sustainable, climate-resilient, smart and intermodal national, regional and local mobility, with better access to TEN-T and cross-border mobility
- Upgrading the road network of the Region of Western Greece
- Road safety actions
- Projects and interventions for the upgrading of port infrastructures in the Region of Western Greece
- Development of Water Races in the Region of Western Greece

4.3.6 Guidelines of Local R&I Strategies Vision and Goals

As far as the Greek Cluster is concerned and the mobilization of the city of Patras and the Municipality of Patras towards the new challenges, the following conclusions can be deduced:

- Considering all the above-mentioned Programs and Strategies, it could be said that the National, Regional and Local Strategies and Operational Programs have taken into account the concept of Smart Cities and the need for digital transformation, and they provide the support for the development of all the systems, models and applications needed towards this direction.
- The Municipality of Patras is in the forefront of the evolutions since it already applies a "Strategic Plan of the Smart City of the Municipality of Patras" and a "Sustainable Urban Mobility Plan (SUMP) of the Municipality of Patras".
- The Greek Cluster R&I Vision and Strategy has been built upon the already successful Plans and development of the Municipality of Patras, taking into account the focus of the Regional Operation Plan. Taking into consideration the regional programs form Table 8, and especially their vision and objectives for the region and the city of Patras, as well as
- the objectives and actions relating to the aspirations of the project,

the vision, mission, and goals of the local R&I Strategy for further development of Patras as a Smart City are stated (Table 9).

The R&I strategy to be followed is aligned with the SDG 11 "Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable".

The **Vision** of the R&I Strategy is:
"Make Patras inclusive, safe, resilient, and sustainable through innovative technologies."

The **Mission** deploying this vision is the following:
Use innovative interventions and cutting-edge technologies to provide a safe, simple, user-friendly and sustainable urban environment that will improve the daily lives of all stakeholders of the city of Patras.

The **Goals** of the R&I Strategy, to fulfil its vision and mission, cover the following areas:

- Safety: The city of Patras to be a safer place for the citizens, visitors, and businesses.
- Green: The city of Patras to be a greener and healthier place to live and work.
- Accessibility: The city of Patras and its services to be more accessible to all.
- Economic Sustainability: The city of Patras to exploit more effectively all its productive and cultural resources.
- Inclusivity: The city of Patras to be inclusive for all citizens, visitors, and businesses.

These goals will be made more specific in the next chapter, where the Priority Areas and Actions will be analysed.

The implementation of the Greek R&I strategic measures contributes to the quality of life in the region. More specifically:

- It focuses on the collaboration of regional and local government, science, IT companies and organizations.
- It has built on the strengths, competitive advantages, achievements, and potential for further development of the city of Patras.
- It involves stakeholders of different specialization, promotes innovations and use of modern technologies in city management.

- It is based on evidence and includes reliable systems for monitoring and indicators for evaluation of results.
- It is designed to attract investments concerning its productive resources and their effective utilisation.

The Greek Cluster R&I Strategy aims to increase the level of smart specialization of the city of Patras and the Region of Western Greece and create an environment for better collaboration of all the contributors of the QH, i.e., local government, science, business, education, and NGO's in order to establish an example of modern local and regional government focused on the efficient usage of ICT for the well-being of citizen and society.

Table 9: Greek cluster vision, mission, and goals

VISION	MISSION	GOALS	PRIORITY AREAS	USES CASES
"Make Patras inclusive, safe, resilient, and sustainable through innovative technologies."	Use innovative interventions and cutting-edge technologies to provide a safe, simple, user-friendly and sustainable urban environment that will improve the daily lives of all stakeholders of the city of Patras.	• Safety: The city of Patras to be a safer place for the citizens, visitors, and businesses. • Green: The city of Patras to be a greener and healthier place to live and work. • Accessibility: The city of Patras and its services to be more accessible to all. • Economic Sustainability: all citizens should be able to live and prosper in the City of Patras, have access to benefits and welfare • Inclusivity: The city of Patras to be inclusive for all citizens, visitors, and businesses.	Smart Mobility	• Smart Parking • Smart Emergency Management in Smart Mobility
			Smart Environment	• Smart Mobility and Smart Environment (waste, water, air) and smart urban planning (roads, parks)

4.3.7 GR Cluster Priority Areas in the Scope of METACITITIES project

4.3.7.1 Priority Area 1: Smart Mobility

Smart Mobility is one of the main goals of the Greek Cluster, and all priority areas mentioned need intervention. Priority areas of immediate interest are specified below and will be further pursued through the METACITITES project. These areas are:

- Identify high-risk points in the city
- Driver's behaviour monitoring
- Fast proactive-reactive measures for first responders
- Reduce CO2 Emissions
- Smart Parking data
- Remove traffic/parking blockage
- Real-time tracking info for public transport
- Real-time info for traffic and congestion
- Reduce commuting time
- Information/data for parking lots for offloading
- City accessibility information for disabled/senior citizens
- Dedicated parking for disabled/senior people

These high-priority areas will be further pursued since they can be affiliated and enriched with existing infrastructures in the Municipality of Patras.

A network of sensors, smart cameras, and Bluetooth devices installed in specific city entry and exit points will provide real-time data about high-risk points, driving behaviour, traffic and congestion, traffic blockades, and fast routes for emergency responders. There are already 100 sensors installed that could provide this information and will expand. Installation of pedestrian presence and movement sensors will increase awareness, reduce accidents, and allow safe accessibility to disabled/senior citizens. Roadside controlled parking spaces, including parking spaces for disabled/senior people and offloading, will gather data and provide real-time information about the city centre and mall areas. In addition, entry-exit sensors in outdoor municipal parking lots, along with VMS (Variable Message Sign) information signs, will be a key channel for informing passing vehicles and citizens about traffic conditions in the city. Priority will also be given to expanding smart signs at Patras Urban bus stops, giving information about public transport. In combination with the interventions above, commute time will be reduced, increase the use of public transport, and therefore contribute to CO2 emission reduction.

All the above will provide real-time solutions, but proactive solutions will be given by the **Digital Twin** that will use the gathered information to analyse and optimise traffic for further improvement in all areas of smart mobility.

4.3.7.2 Priority Area 2: Smart Environment (waste, water, air) and smart urban planning (roads, parks)

Smart environment is also vital for the Greek Cluster, and all priority areas mentioned below need intervention. These priority areas are of immediate interest and will be further pursued through the METACITITES project. These areas are:

1. Smart energy metering, consumption and saving systems for public buildings
2. Real-time info for air pollution and weather conditions
3. Digitisation of citizen service

4. Accessible swimming info
5. Safety alert and monitoring of metal gratings of the rainwater network
6. Smart Recycling
7. Reduce fires

Greek cluster will further pursue these high-priority areas since they can be affiliated and enriched with existing infrastructures in the Municipality of Patras.

Installation of the necessary hardware and software in school complexes will allow the measurement of electricity consumption, energy for heating and the energy produced by any installed photovoltaic system. These systems have already been implemented in 7 school complexes, and in each complex, local computer systems measure the consumption and calculate energy savings in real-time. With a centralised lighting management system and a gateway for wired and wireless communication, the technical service of the Municipality has the possibility of direct supervision, remote management and control of the lighting network. These systems provide flexibility and straightforward lighting adaptation to the city's actual needs, additional energy savings and reduction of carbon dioxide (CO2) emissions through the possibility of brightness adjustment scenarios. Another important aspect is creating a distributed network of smart sensors to measure environmental parameters for more effective environmental management. The environmental data measurement nodes have already been installed in five locations in the city. These nodes measure Ozone (O3), Nitrogen dioxide (NO2), Sulphur dioxide (SO2), Brightness, Noise pollution, Particulate matter, Temperature and Humidity, Wind and Rainfall Measurement. Mobile apps will also be provided to citizens to monitor in real-time the analysis of the collected data on the quality of the urban environment. Use of new technologies for assessing environmental parameters of swimming water quality and digital applications available to citizens and visitors provide this information. This goal can be achieved with a sensor grid for real-time monitoring of water quality at the Municipality of Patras swimming beaches, as well as environmental conditions and warning mechanisms for various events (weather phenomena, sea pollution).

Another goal is to install a smart monitoring system for 150 stormwater network metal grates. The purpose is to monitor the water level of each Safety alert monitoring of metal gratings and the possible drain or stormwater gully blockage, and to protect the metal gully from theft and accidents. The sensor gives an alarm, and the status of the metal grates and the exact location of the problematic grating are displayed in the software and guides, via a tablet, the cleaning crews to the specific problematic metal grate. Replacement of 26 blue recycling bins with 23 new, semi-subterranean bins for separate collection of 3 streams (paper, plastic, metals) will improve the Municipality's waste management. These bins will be equipped with a wireless fullness monitoring system, which will offer control of the fullness of the bins and central management of the collection routes while at the same time achieving a substantial increase in recycling rates and reducing management costs. Finally, a smart detection system for high temperatures, smoke, and flames based on the creation of a technologically advanced surveillance network using thermographic cameras, image analysis and video streaming algorithms so that the competent authorities can be informed immediately of any thermal event that is within or outside the agreed limits.

4.4 BG Cluster Local R&I Strategy

4.4.1 Introduction

The United Nations has proposed 17 sustainable development goals (SDGs) to be achieved by 2030, among which the establishment of "sustainable cities and human settlements" (Goal 11) relies on digital technology innovation and the support of policy-makers.

Transforming cities is a daunting task that requires long-term policies taking into account the increasing level of urbanization and the need simultaneously to meet the emerging economic, social and environmental demands of people in these settlements.

The functionally improved characteristics of cities make it possible to develop new economic activities that diversify the local economy and reduce risks to the environment.

This goal recognizes the critical role that cities play in achieving the European Green Deal objective of climate neutrality by 2050.

With the development of the Fourth Industrial Revolution, the path of urban development and transformation – where digital technology is the main driver and data is the core means of production – is becoming increasingly clear. Digital Twin technology is becoming a bridge between the physical and digital worlds, together with policy and mechanism reform, which help us to understand systems better and intervene more effectively. Innovation and empowerment of digital technology are critical to transforming our cities. Policy support and institutional change are also essential. Modern cities use all of them to reshape and optimize their urban planning and operations, governance and service models, and planning method.

Specifically, by focusing on the development of smart cities, Bulgaria has the chance to implement digital solutions to the above social, urban and environmental challenges, potentially transforming them into opportunities for social welfare and sustainable economic development for the citizens.

Research and Innovation (R&I) play a key role in this process. R&I drive sustainable part of the economic development and social prosperity, enhance social well-being and can provide significant political, technological, social and financial benefits.

4.4.2 National Level Strategies and Plans

Bulgarian R&I framework has been developed in compliance to the following strategic for the state documents:

- National Development Programme BULGARIA 2030;
- Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth;
- Declaration on joining forces to boost sustainable digital transformation in cities and communities in the EU;
- Innovation Strategy for Smart Specialization of Bulgaria 2021-2027;
- The National strategic document „Digital transformation of Bulgaria 2020-2030;
- Digital Bulgaria 2025 - Programme.

4.4.2.1 National Development Programme BULGARIA 2030

The National Development Program BULGARIA 2030 is the strategic framework document of the highest order, which engages all ministries and integrates conceptually the interplay of national priorities with the UN Sustainable Development Goals.

As a member of the European Union (EU) and the UN, Bulgaria shares the responsibility of governments and all stakeholders for the planning, development and adaptation of measures, actions and policies aimed at accomplishing the most ambitious road map for peace and sustainable development.

The Republic of Bulgaria shares the principles of multilateralism and participates fully in the EU and UN bodies on issues related to the global Sustainable Development Goals, to improving coordination, coherence and effectiveness of the repositioning of the development system and the reform of UN management. National legislation is harmonized with EU legislation. Strategies, national plans and programs have been adopted that reflect the fundamental principles of the 2030 Agenda in the areas of cooperation for the implementation of the 17 UN global Sustainable Development Goals. Collaboration is encouraged to implement projects aimed at one or more of the goals. Opportunities are sought for sustainable economic growth; attention is paid to vulnerable social groups.

According to NSI data, as of Dec. 31. 2021, 73.1% of the population live in cities. The challenges cities face are related to the improvement of the current housing conditions, supporting infrastructure and transport links, the construction of green urban spaces, recreation and sports areas, the involvement of different social groups in the active life of the city and the overcoming of the ghettoization of minority communities.

The majority of Bulgarian cities were designed and planned to maintain good living conditions for 10 times less population than today. Urbanization gained momentum in the second half of the 20th century and the population of Bulgarian cities increased.

Transforming Bulgarian cities to “smart cities” is a daunting task that requires long-term policies taking into account the increasing level of urbanization and the need to simultaneously meet the emerging economic, social and environmental demands of people in these settlements.

The functionally improved characteristics of cities make it possible to develop new economic activities that diversify the local economy and reduce risks to the environment.

This goal recognizes the critical role that cities play in achieving the European Green Deal objective of climate neutrality by 2050.

4.4.2.2 Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth, as well as the implementation of thematic objective 1 of Art. 9 of Regulation (RE) 1300/2013 – "Strengthening research, technological development and innovations";

Bulgaria’s support for the leading initiative: „Union for Innovations“ is aiming at redirecting the policies of Scientific and Research and Innovation towards the new challenges the society faces, and namely – climate change; need for energy efficiency and resource utilization, health and demography.

All the relations within the innovation chain from the phase in which there are still no physical implementations of the scientific results, to the phase of the commercialization of the results should be strengthened.

As EU member state, Bulgaria is reforming the national and regional R&I systems to speed up excellence achievements and intelligent specialization; bring to higher level the cooperation among universities, science, research, and business operators, and apply united project realization based on improved trans-border cooperation especially for spheres in which EC has added value by adapting their national procedures for financing and allowing the technological dispersion among all EC states.

4.4.2.3 Declaration on joining forces to boost sustainable digital transformation in cities and communities in the EU

Burgas and other Bulgarian Municipalities are among the 144 representatives of a public administration at local, regional, national or European level, that have signed the Declaration. One of the main statements is that digital solutions underpinned by locally-generated data are essential for delivering more informed, innovative and high-quality services to the public and to businesses. Cooperation across geographical areas and between sectors will boost innovation and allow cities and communities to develop efficient, cost-effective and citizen-centric services.

Principles laid down in this declaration are: a citizen-centric approach; a city-led approach at EU level; the city as a citizen-driven and open innovation ecosystem; ethical and socially responsible access, use, sharing and management of data; technologies as key enablers; interoperable digital platforms based on open standards and technical specifications, Application Programming Interfaces (APIs) and shared data models.

4.4.2.4 Innovation Strategy for Smart Specialization of Bulgaria 2021-2027

The Intelligent Specialization Strategy (IS3) is a policy instrument that has upgraded the achievements in the European Union since the 2014-2020 programming period. It is a policy concept to support regional prioritization in innovative sectors, areas or technologies through a "process of entrepreneurial discovery", thus implementing a bottom-up approach to maximize what a region develops or could develop best in terms of its scientific and technological assets and economic advantages. ISIS 2021-2027 focuses on the efforts to achieve the strategic objective of moving Bulgaria from the group of "emerging innovators" to that of "moderate innovators" as a prerequisite for increasing the competitiveness of the Bulgarian economy.

4.4.2.5 The National strategic document „Digital transformation of Bulgaria 2020-2030

Bulgaria follows the European policy for Digital Europe and digital transformation. The state has its own added value in making the digital European future happen – by investments in technologies, algorithms and instruments which make possible universal data sharing and data use with AI – the major component of modern time innovations which will find solutions for more and more economic, industrial, social, health challenges, and improve safety and security.

This document is upgrading the Concept for development of AI in Bulgaria with scope up to 2030, and incorporates the European vision for Reliable Artificial Intellect based on technological, legal and ethical framework that guarantees the security and rights of the citizens; measures for collection of reliable, open sourcing and access to data; equal rights to apply technologies based on AI.

4.4.2.6 Digital Bulgaria 2025 - Programme

This Programme aims at modernizing and increasing the widespread implementation of intelligent information technology (IT) solutions in all areas of the economy and social life. Another objective of the programme focuses on the strategic enhancement of digital competence and skills at all levels.

4.4.3 Local Strategic Documents

There is no specific guiding national document in the field of smart city policies. Multiple non-coordinated actions and initiatives for smart cities, have been guided separately/individually by several municipalities, each operating at different speeds and different models, emphasizing on different aspects of smart city or R&I policies.

Bulgarian cities have developed Plans for Integrated Municipal Development to wrap-up all the measures related to the implementation of the 2021-2027 programming period policies. These plans apply horizontally different principles of digital transformation and Smart city approach in dependency of the vision of each city.

Three Bulgarian cities (Sofia, Gabrovo and Burgas) have developed their own formalized strategic planning documents which prioritize implementation of digital solutions to boost the social, urban and environmental effects, transform them into opportunities for welfare and sustainable economic development for the citizens. Research and Innovation (R&I) play a key role in this process.

4.4.3.1 Smart Specialisation Strategy of Sofia

The Sofia Smart Specialization Strategy aims to increase the level of smart specialization of the capital city by establishing Sofia as a Smart City, which builds an environment with a high quality of life for citizens and good governance that supports the corporate sector by stimulating the creation of improved conditions for synergy and partnership in the innovation ecosystem and through the effective use of ICT.

The document contains areas of specialisation for Sofia at horizontal and vertical level. The horizontal policy is to strengthen the innovation ecosystem in the city and the region, while the focus in Sofia is on the development of two thematic areas for smart specialization, which are identified by the national ISIS, namely Informatics and ICT and new technologies in creative and recreational industries.

4.4.3.2 Digital Transformation Strategy of Sofia

Digital Transformation Strategy of Sofia focuses on smart growth. This is growth supported by digital systems, and affects both ICT companies located in Sofia, which are creators of digital products and services, and other sectors of the city`s economy, which are users of digital services. Sofia`s Digital Transformation Strategy is based on the digital dimension of Sofia`s Smart Specialisation Strategy (SSSS), which provides guidance for the operational objectives.

Sofia`s Digital Transformation Strategy looks at digitalization in a broader sense, encompassing not only the digitalization of existing processes, both in the administration and in the real economy of the city, but also the transformation of these processes and the creation of entirely new opportunities based on digital technologies.

4.4.3.3 Smart Specialisation Strategy of Gabrovo

A strategic goal of Gabrovo Municipality is to develop a strong economy based on science and innovation. There are three main areas in the field of economy:

Industry and Innovation - promoting the development of the local economy, with a focus on high-tech manufacturing and knowledge-intensive services, investment in technical and business infrastructure and improving the environment for innovation;

Science and education - cooperation of local businesses with educational institutions, with a focus on training and attracting staff, investment in scientific infrastructure and technology transfer, close cooperation between public science and technology units and local companies;

Digitalisation - digital transformation of the industry, development of Gabrovo as a smart city, increasing the efficiency of the administration, improving management processes and strengthening partnerships with citizens and businesses.

4.4.3.4 Plan for Integrated Municipal Development of Burgas 2021-2027

The Plan for integrated development of the Municipality of Burgas is the major strategic document for Burgas outlining a clear inspiring vision for the city:

"BURGAS - an attractive place to live and do business, effectively using its potential for balanced and sustainable integrated development, with preserved local identity and access to a modern, resource efficient, climate adaptive and competitive economy, providing smart economic growth, spatial connectivity and access to services."

The document defines the medium-term goals and priorities for sustainable development of the municipality. The document links the advantages and potential for development at the local level with a clearly defined vision, goals and priorities, linked together by the aspiration for a higher standard of living of the people in the municipality and sustainable development of the territory.

The set of priorities of Burgas clearly outline the adoption of smart city approach and smart specialization models:

- The priority 6 of the Plan "Burgas adapts. Sustainable management of natural and urban ecosystems" sets out measures to stimulate the blue economy, connectivity and integrated environmental management by implementing the smart city approach.
- The priority 7 "Burgas functions in partnership", supports R&I capacity building and collaborative governance measures to upgrade the city`s e-services and digital assets and create a Digital Twin of the territory to input baseline data, real-time data by domain, and develop tools of the Open Digital Twin Framework.

4.4.4 Digital Twin Initiatives

Smart cities use big data and the Internet of Things to provide a better life for citizens. As they are the most sophisticated human artifact, deploying such technologies becomes a complex task requiring continuous data collection, aggregation and analysis.

The “Gate” Center of Excellence at Sofia University is one of the initiatives developing and deploying technologies to digitize buildings and neighborhoods under the name of Smart Cities. Efforts are underway at “Gate” to build city information models to encode urban objects, their relationships and decision support. A common knowledge base is used, supported by rich vocabularies and ontologies that are able to cope with information diversity and overload.

The Technical University of Varna, through an award-winning project, is using new data provided by many different Earth observation sources, advanced computing infrastructures (cloud computing, high performance computing, IoT, big data, social networking, etc.) in an inclusive, virtual/extended and engaging way to address all Earth data challenges. The Digital Twin of Varna Bay brings together a large volume of diverse data, in a semantically rich and data agnostic approach, to enable

simultaneous communication with real world systems and models. The ontologies and standard descriptor with style layers that are used facilitate semantic information and intuitive discovery of underlying information and knowledge to provide a seamless experience. A combination of geovisualization, immersive visualization and virtual or augmented reality is used allowing users to explore, synthesize, present and analyse the underlying geospatial data in an interactive manner.

The Burgas city is the smart city leader of Bulgaria building up an integrated digital platform of the city which is prepared to visualize the data of the city into a 3D model of the city. Large amounts of data are been processed and prepared to bring up the first Digital Twin of Burgas, which will be in the domain of energy efficiency.

4.4.5 Summary of the National Level and Regional Level Strategies and Plans

In this section a short description of the major strategic plans on national and regional level of Bulgaria is presented, respectively in Table 10 and Table 11.

Table 10: National Level Strategies and Plans – Bulgarian Cluster

National Development Programme BULGARIA 2030
Vision: Bulgaria remains committed to achieving SDG 17 and will intensify its efforts in the framework of development assistance to the less developed countries. The vision of the municipalities for the 2021-2027 programming period is that our country should have a real national development programme and adequate national resources for its implementation instead of hundreds of strategies for each sector and subsector.
National Development Programme: Bulgaria 2020
Vision: In 2030, Bulgaria will be a country of high standards of living and a competitive, low-carbon economy. The country will be developing and implementing innovations in every sector of the economy, adapting to the transforming world through its highly educated, creative, supportive and healthy society. It will be a fertile ground for ideas and a magnet for investment and human capital. The unique cultural and natural resources of the Bulgarian regions will be used responsibly and sustainably. They will be integrated with each other and with the world through high-speed road and optical links, establishing the country's position as a crossroads of ideas and goods in Europe and beyond. Bulgarian citizens will play an active role in the future of their country, have rich opportunities for personal and professional development and live in a just and tolerant society, in which their voice is heard. The priority sectors are divided into 13 Modules: P1 Education and skills P2 Science and scientific infrastructure P3 Smart industry P4 Circular and low-carbon economy P5 Clean air and biodiversity P6 Sustainable agriculture P7 Transport connectivity P8 Digital connectivity P9 Local development

P10 Institutional framework
P11 Social inclusion
P12 Health and sport
P13 Culture, heritage and tourism

The Programme's (**The National Development Programme BULGARIA 2030**) vision and priorities outline three main goals:

- accelerated economic development;
- mitigating adverse demographic trends;
- achieving more inclusive and more sustainable growth by reducing social and territorial inequalities and promoting shared prosperity.

DIGITAL TRANSFORMATION OF BULGARIA FOR THE PERIOD 2020-2030

VISION: The digital transformation is a necessary process of technological development of Bulgaria in order to create conditions for innovation and business growth, increase the efficiency of the workforce, a competitive digital economy, and a high citizens' standard. Guided by the strategic goals of our country for accelerated economic development, demographic growth and reduction of social inequalities, set in the "National Development Program of Bulgaria 2030", by 2030 Bulgaria should build a functioning and secure environment to unlock the full potential of digital technologies for the digital transformation of all key sectors, reaching the average European values under the Digital Economy and Society Index DESI.

GOALS:

- Deployment of secure digital infrastructure
- Providing access to adequate technological knowledge and digital skills
- Research and innovation capacity strengthening
- Unlocking data potential
- Digitalization in favor of a circular and low-carbon economy
- Improving the public administration efficiency and the quality of public services

INNOVATION STRATEGY FOR SMART SPECIALISATION OF THE REPUBLIC OF BULGARIA 2021-2027

Vision: The strategy aims to transform Bulgaria into an innovative, smart, green, digital and connected country through a new common policy for interaction between research, innovation and technology, as well as increased international and cross-sectoral cooperation and intensive use of data for accelerated specialization in products and services with high technological and scientific intensity and significant economic impacts for sustainable competitiveness, technological transformation of the economy, increased resource efficiency and digital.

STRATEGIC OBJECTIVES:

1. To develop and position Bulgaria as a center of medium and high-tech innovations in strategic areas in which the country has established capacity and market positions, as well as recognized competences to compete in the global market, enhancing national and regional innovation performance of the country;
2. To support the deployment and validation of sustainable, modern, dynamic, inclusive, data-driven and globally connected research, innovative and entrepreneurial ecosystem in Bulgaria.

OPERATIONAL OBJECTIVES:

1. Improving the research system and innovation performance of enterprises.

With the realization of this goal, the ambition is to reach levels of 70% compared to the average for the EU, which will strengthen Bulgaria's position in the group of moderate innovators to 2027.

2. Increasing the technological capacity of enterprises, increasing the environmental friendliness and internationalization of Bulgarian products and Services.

The focus of Objective 2 is on priority thematic areas for smart specialization and technologies of Industry 4.0.

3. Improving the capacity of human resources in the field of new technologies and innovation.

Priority is given to improving the overall environment for the development of skills and high-tech human resources in the thematic areas for smart specialization and technologies of Industry 4.0 and Industry 5.0.

THEMATIC PRIORITY AREAS:

The Strategy defines five thematic areas where Bulgaria has a competitive advantage and capacity for smart specialization and should focus its efforts on their accelerated development. The scope of the strategy is thus broadened by increasing the focus on the existing ISSS 2014-2020 priority thematic areas and refining their sub-areas, including for individual regions and administrative areas. Thus defined, the thematic areas may be subject to change subject to proven stakeholder interest and capacity, which will require public and political will to unite around a common vision and actions for the prosperity of society and to address socio-economic challenges. The five areas are:

- Informatics and ICT;
- Mechatronics and microelectronics;
- Industry for healthy living, bioeconomy and biotechnology;
- New technologies in the creative and recreational industries;
- Clean technology, circular and low carbon economy.

Digitalization in the context of Industry 4.0 will be included as a horizontal priority and will be present in all five thematic areas of smart specialization.

Table 11: Regional Level Strategies and Plans – Bulgarian Cluster

Digital Transformation Strategy for Sofia-R220-2020
VISION: Sofia systematically achieves sustainable economic growth and develops an economy with high added value through the introduction and use of high technologies in all spheres of social and economic life. Sofia is developing as an innovative, intelligent, modern, progressive and high-tech city, an attractive center and a preferred place for living, business and development. To this end, the city actively interacts and develops solutions together with various stakeholders at local, national and international level. **MAIN PRIORITIES:**

1. To enable most companies in the ICT business ecosystem of Sofia to engage in the digital transformation of the city by developing and offering innovative products and e-services. In particular:

- Enhancing the readiness and capability of ICT companies for making products and services suitable for the digital transformation of the city.
- Providing e-services that facilitate the digital transformation of local industries and services in manufacturing, transportation, energy and water supply, and government.
- Moving ICT companies upstream, from outsourcing to higher added-value services, offering own services instead of promoting those of global ICT providers.
- Using hackathons and competitions as a way for developing new e-services.
- Developing e-services based on open data and promote the creation of a Big Data Center of Excellence.

2. To open markets or create new markets for e-services at local and national levels, by supporting and facilitating the provision of e-services to industries, the public administration, and utility organisations. In particular:

- Opening the public market for e-services and smart solutions at local and national levels. Promote the standardisation of e-government services across administration departments and cities of Bulgaria.
- Increase the awareness and inform ICT companies about digital services and solutions to be deployed by local and central governments.
- Opening the market of e-services to be used by utility organisations (water, waste, energy) and increase the awareness of utility companies about the benefits of digital transformation.
- Opening the market for digital services in transportation and the awareness about smart transportation and e-sharing mobility solutions that can be deployed locally.
- Monitor and document the added value of using digital services in sectors of the local economy and in daily conditions of safety, the quality of the environment, and other. DIGITAL CITIES CHALLENGE – Digital Transformation Strategy 15

3a. To enhance the local innovation ecosystem by funding mechanisms, investor networks and brokerage events, facilitating the digital transformation of the local economy. In particular:

- Providing funding for digital infrastructure, e-services and ICT start-ups.
- Increasing awareness about business models that can sustain the digital transformation of the city in the sectors of government, utilities, and transportation.
- Facilitate funding by increasing awareness and lowering innovation risks. Make universities more active in the start-up ecosystem.
- Providing business intelligence and awareness about products, e-services, and the market of digital solutions.
- Develop a public procurement that is friendly to the digital transformation of the city.

3b. To enhance the skills of the local ICT labor market and the start-up ecosystem for the creation of e-services and data sets by public and private organisations. In particular:

- Providing opportunities for training and business development open to all, over public infrastructure and open commons.
- Covering the needs of local ICT companies for skills in data science and analytics, mathematics, AI and deep learning, algorithms for optimisation, software programming and software engineering.

- Limit the fragmentation / separation between digital and non-digital skills and advance interdisciplinary training between ICT, business, and engineering.
- Open the infrastructure of the Sofia Technology Park to provide advanced training and experimentation over the Lab infrastructure available (e.g., cyber-security, rapid prototyping, 3D printing).
- Increase training on entrepreneurship and risk taking from an early age and education. Offer training in design thinking and innovation by design

INTEGRATED DEVELOPMENT PLAN OF BURGAS MUNICIPALITY 2021-2027

VISION FOR DEVELOPMENT: Burgas - an attractive place to live and business, effectively using its potential for balanced and sustainable integrated development, with preserved local identity and access to a modern, resource-efficient, climate-adaptive and competitive economy, providing smart economic growth, spatial connectivity and access to services.

STRATEGIC OBJECTIVES:

1. Accelerating the socio-economic development of the municipality through complex integrated impact, interventions and targeted investments on the economic ecosystem of the municipality.
2. Sustainable improvement of quality of life of the local community and mitigation of intra-municipal imbalances in access to critical public services (incl. health and education)
3. Improving regional integration, physical and digital connectivity between places and spaces in the municipality and the region
4. Sustainable use of natural resource potential of the municipality and territory adaptation climate change challenges.

4.4.6 Funding and Resources

The National Recovery and Resilience Plan (NRRP) includes reforms and investments in the Research and Innovation component, Smart and Digital growth, to strengthen the innovation potential and accelerate the internationalization of the Bulgarian research and innovation system, as well as in the Smart Industry component, where an Economic Transformation Programme is planned. Table 12 illustrates the financing of different pillars through the NRRP.

Table 12: Financing by NRRP component and pillar, '000 BGN

Pillar/Component	RRF	Share, %	National co-financing	
			Public	Private
Innovative Bulgaria	**3,413,963**	**25.3%**	**311,163**	**2,065,844**
Education and skills	1,434,668	10.61%	270,938	0
Research and innovation	413,242	3.06%	40,225	0
Smart industry	1,566,054	11.58%	0	2,065,844
Green Bulgaria	**5,659,939**	**41.9%**	**503,258**	**2,480,440**
Low carbon economy	5,109,649	37.79%	400,332	2,043,057
Biodiversity	92,957	0.69%	11,525	0
Sustainable agriculture	457,332	3.38%	91,402	437,383

Pillar/Component	RRF	Share, %	National co-financing	
			Public	Private
Connected Bulgaria	**2,469,348**	**18.3%**	**936,354**	**155,839**
Digital connectivity	753,435	5.57%	130,354	0
Transport connectivity	1,303,342	9.64%	783,741	63,000
Local development	412,571	3.05%	22,259	92,839
Fair Bulgaria	**1,978,315**	**14.6%**	**348,189**	**17,517**
Business environment	397,292	2.94%	72,482	0
Social inclusion	861,325	6.37%	131,768	17,121
Healthcare	719,698	5.32%	143,940	0
TOTAL	**13,520,565**	**100.0%**	**2,123,705**	**4,719,245**

The sustainability of the local measures will be sought in subsequent large-scale projects of Bulgarian Municipalities and other partners in the smart city ecosystem. Funding is expected to be covered from both Bulgarian sources and EU funds and programmes, such as ERDF, and other funding tools (Table 13). It should be emphasized that in the future, bringing additional competence in the form of local management units specialized to address the above issues is becoming more and more necessary.

On local level, municipal own-resources and utilization of local sponsors may finance such actions. On European level, there are several different financial schemes / programs dedicated to providing support to projects promoting such solutions (e.g., Horizon Europe, Interreg Programs etc).

Table 13: Funding opportunities from EU and national funds

Open call	EU/ National/ Cascade Funding	Beneficiaries	Deadline
Thermal management and energy optimisation of high energy demand IT systems equipment in tertiary buildings	EU	SMEs	19.9.2024
Robotics and other automated solutions for construction, renovation and maintenance in a sustainable built environment (Built4People Partnership)	EU		Forthcoming
EU Member States/Associated countries research policy cooperation network to accelerate zero-emission road mobility	EU	NGO SME, RTO	Forthcoming
Innovating for climate-neutral rural communities by 2050	EU	NGO SMEs, RTO, Public	22.2.2024
Develop innovative applications to support the European Green Deal, building on meteorological satellite data	EU	NGO RTOs,Public	28.2.2024
Enhancing working conditions and strengthening the work force through digital and data technologies – the potential of robotics and augmented reality in agriculture	EU	NGO, SMEs, RTOs	28.2.2024
Innovative technologies for zero pollution, zero-waste biorefineries	EU	NGO, SMEs, RTOs	22.2.2024

Open call	EU/ National/ Cascade Funding	Beneficiaries	Deadline
Startup Europe - Interconnected Innovation Ecosystems (2024.1) (HORIZON-EIE-2024-CONNECT-01)	EU	NGOs,	25.4.2024
Teaming for Excellence TOPIC ID: HORIZON-WIDERA-2023-ACCESS-01-01-two-stage	EU	NGO RTOs, Clusters	3.7.2024
Excellence HubsTOPIC ID: HORIZON-WIDERA-2023-ACCESS-07-01	EU	NGO, RTOs	3.7.2024
ICOS	Cascade Funding	SME	Forthcoming
Nephene	Cascade Funding	SME	Forthcoming
BG16RFPR001-1.001 - Development of innovations in entreprises	National	SME	Forthcoming
BG-RRP-4.024 - SUPPORT FOR SUSTAINABLE ENERGY RENOVATION OF THE RESIDENTIAL BUILDING FUND - STAGE II	National	Association of owners	16.1.2024

4.4.7 Guidelines of Local R&I Strategies Vision and Goals

There is still no unified approach for the implementation of solutions for ‘smart cities’; in Bulgaria, which led to multiple and non-coordinated actions and initiatives for smart cities, guided separately/individually from a few municipalities, at different speeds and models and with possible overlays.

The Bulgarian R&I approach is been developed in line with the thematic area "Clean Technology, Circular and Low Carbon Economy" of the RIS3 2021-2027 and the strategic focus is on ensuring smart development and reducing resource consumption in all economic sectors and spheres of public life. Thus, Bulgaria aims to ensure a sustainable contribution to achieving national and European targets within the European Green Pact and the UN Global Goals for Sustainable Development.

The actions are elaborated to increase the level of smart specialization of the Bulgarian cities as smart cities that create environment for better collaboration of local government, science, business and NGO’s in order to establish an example of modern local government focused on the efficient usage of ICT for a long term well-being of citizen, and to transform Bulgarian cities into innovative, smart, green, digital and connected through a new common policy for synergies between research, innovation and technology.

The Bulgarian R&I Strategy aims:

1. To develop and position Bulgaria as a centre of medium- and high-tech innovation in strategic areas where the country has established capacity and market positions, as well as recognized competences to compete in the global market, enhancing the country`s national and regional innovation performance;
2. To support the development and establishment of a sustainable, modern, dynamic, inclusive, data-driven and globally connected research, innovation and entrepreneurship ecosystem in Bulgaria.

This way the strategy:

- responds to the global challenges posed by the dynamics of technological and climate change
- identifies national and regional priorities and niches for strategic development,
- reinforces the focus on sustainable growth and social development. Technological change, digitization and ensuring sustainability through a green economy will be key to achieving economic growth.

Table 14: Bulgarian cluster vision, mission, and goals

VISION	MISSION	GOALS	PRIORITY AREAS	USES CASES
Our clear vision and **direction, aims to ensure** that Bulgarian cities and regions improve the quality of life and experience of their citizens by supporting theoretical and applied science and Smart city innovations that stimulate investments and development of low energy systems, efficient resource management, that build on the strengths, competitive advantages, and potential of stakeholder involvement, and that emphasize different	Develop, implement, and support cutting edge technology, applied science, and smart city innovations in order to stimulate investments into low-energy systems, and efficient resource management ultimately making Bulgarian cities truly smart with a high quality of life based on a sustainable, resilient, and competitive economy, ensuring stable growth, continued innovation and	***Digital and connected*** Bulgarian cities leverage • innovative technologies • intensive use of data for accelerated specialization in products and services with high technological and scientific intensity • cross-sectoral synergies between industry and academia in order to provide citizens with better services and improve the resilience of the city. ***Green*** To reduce the carbon footprint of Bulgarian cities by: • increasing the share of renewable energy; • supporting climate adaptation measures in urban environment; • decreasing of the total use of primary non-renewable energy; • introducing smart systems for resource management in buildings ***Inclusive*** • support the development and establishment of a sustainable, modern, dynamic, inclusive, data-driven	Green and climate adaptive resource management	• Building energy performance analysis • Budget planning for energy usage and building renovation • Renewable (PV) potential and performance analysis

specialization for each region.	access to services for all.	and globally connected research, innovation and entrepreneurship ecosystem in Bulgaria ensuring that the needs of all parts of society are met		

4.4.8 BG Cluster Priority Areas in the Scope of METACITITIES project

Priority Area 1: Green and climate adaptive resource management

The Bulgarian cluster in the METACITIES Project efforts are focused to upscale knowledge and know-how in the priority area "Green and climate adaptive resource management". The achievements from the pilot implementations of the pilot city Burgas should be further on shared and replicated in other Bulgarian cities. Within this domain Burgas has worked for several years and established the digital foundations of the Resource and energy management platform of Burgas. The Smart Burgas city platform already has some working functionalities showing the data of the city related to solar potential and smart integrated management of the city lightning and energy consumption of some public buildings. Through the pilot use case implementations, it is expected that the Digital Twin framework of the city is enriched and refined as follows:

- For the **"Renewable (PV) potential and performance analysis**" case, our objective is to identify the PV systems existing in the city as well as create Digital Twin models to assess and determine accurately their production potential. At the first stage, the goal will be to identify and locate the PV systems installed in the city and evaluate their current energy production performance and model the city's PV adoption curve through time. These analytics will be made by using different datasets, including orthophotomaps, satellite images, as well as those provided by existing platforms. At the second stage, this priority area should provide users with the ability to monitor PV energy production potential, including consideration of different scenarios as to how to achieve the goals of the city for 2030, as well as to inform building owner(s) and citizens about the economic feasibility of PV installations on the buildings.
- For the **"Buildings Energy Performance Analysis"** case, our objective is to provide users with the ability to better understand the buildings' energy performance by means of a Digital Twin of a public building. Considering the data availability, the focus will be on defining buildings insulation capacity at the roof level (i.e., thermal insulation performance) and to assess how external variables (e.g. temperature, humidity, solar exposure) influence buildings energy performance/consumption. The goals are manifold and include: understanding energy performance of existing buildings that will drive the analysis on city's investment needs, and (possibly) support definition of potential financial mechanisms; to understand how energy consumption varies with meteorological variables through root cause analysis; and to better understand about the impacts of different energy related interventions performed in the buildings (monitoring analysis), which can be used to better plan future interventions for public buildings and buildings with non-public ownership.
- For the **"Budget Planning for Energy Usage and Buildings Renovation"** case, our objective is to focus on using the Digital Twin models to provide users with tools for policy making decisions on budget planning and effective use of resources, recoupment of initial investments and managing the costs of energy use both for public and private users. Additionally, it will help the city of Burgas to better estimate the investment needs regarding the city's building stock and support the definition of priorities for potential local financial mechanisms aimed at increasing buildings energy efficiency and city's overall energy performance.

The insights derived from the METACITIES project will play a critical role in informing and shaping the implementation strategies for this priority area, ensuring that the transformation towards smart urban solutions in the Excellence Hub of Bulgarian, Cyprus and Greek clusters are as effective, efficient, and beneficial as possible.

4.5 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 (this is described in chapter 3).

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.

4.5.1 Identification of Overlapping/Common Objectives

In Table 15 are identified all the goals and objectives that are extracted from the National Level Strategies of each cluster, presented in the sections above.

Table 15: 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

4.5.2 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 Joint R&I Strategy for the METACITIES Project

The development of a joint Research and Innovation (R&I) strategy for the METACITIES project is of paramount importance to ensure the alignment of local strategies, foster collaboration among participating clusters, and maximize the overall impact of the project. In the context of smart cities and smart regions, the joint R&I strategy serves as a guiding document that outlines the shared vision, objectives, and collaborative actions of the project partners. This strategy is vital in addressing the complex challenges and harnessing the opportunities presented by Digital Twins and Metaverse technologies for sustainable urban development.

This chapter aims to provide a comprehensive overview of the joint R&I strategy for the METACITIES project, outlining key components, establishing a framework for cooperation and coordination, and identifying potential areas for cross-border collaboration and knowledge exchange.

5.1 Shared Vision, Objectives, Priorities and Goals

Based on the identification of the common goals and objectives among the clusters' R&I strategies made in Chapter 4 the shared vision for the future of smart cities and smart regions within the context of the METACITIES project has been defined.

The METACITIES Joint vision: To improve quality of life and experience of citizens, enhance urban efficiency and create a more connected, responsive, inclusive and environmentally conscious urban environment, through integration of innovative Smart city technologies, digital connectivity, data-driven solutions and sustainable practices, optimizing the use of resources and services that foster economic growth.

Within the METACITIES project an Excellence Hub is being established by mobilizing the forces of the partners of the three clusters. Formulating the “unified” METACITIES **Joint R&I strategy for adoption of Digital Twins and Metaverse technologies** for smart cities and smart regions aims to define a framework to join the efforts of the different clusters for speeding up the process of smart city development, addressing the challenges, seizing the cross-border collaboration opportunities, and ultimately contributing to the vision for the development of more sustainable, efficient, and resilient urban systems in the region.

The collaborative setting of goals and the priority areas through showcasing by implementing the pilots will prove the common digital R&I strategic approach.

Goals of the Excellence Hub:

The Local R&I Strategies developed by the three clusters contain objectives that are common to the countries of South East Europe. After discussion among the project partners, commonalities and objectives have been identified as the basis for building a Joint R&I Strategy.

- **Digital Transformation and Innovation** - Improve research and innovation capacity and foster a culture of innovation and technological development, focusing on the development of digital infrastructure, skills and a competitive digital economy, as well as modernising public administration, promoting the uptake of digital technologies in business and improving the digitalisation of services for citizens.
- **Connectivity and Infrastructure Development for Digital Transformation -** Developing and deploying secure digital infrastructure, providing access to digital skills and knowledge and

strengthening digital connectivity and thereby achieving high-speed connectivity and improving digital competitiveness, digital infrastructure and technology deployment.

- **Sustainable Economic Growth and Social Inclusion** - Reducing social and territorial inequalities and promoting shared prosperity to achieve sustainable economic growth by diversifying the economies of the three countries and fostering competitiveness.
- **Environmental Sustainability, Low-Carbon Economy and Green Transition** - Promoting the use of clean energy, mitigating climate change and transitioning to a low carbon economy. This highlights the importance of clean air, biodiversity and resource efficiency, as well as the importance of climate change mitigation and environmental protection.
- **Transport and Digital Connectivity -** Improve transport connectivity by strengthening smart urban mobility and digital connectivity, including high-speed road and digital connections**.**
- **Enhancing Education, and Digital Skills and Human Resources** - A shared commitment to improving education and skills development to better adapt people to technological change and participate in the digital economy. 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.
- **Entrepreneurship regarding Research Innovation -** Strengthening research and innovation ecosystems, encouraging public and private investment in R&D and supporting the science-business nexus.
- **Research, Innovation, and Education** - Strengthen research and innovation capacities, enhance skills development, and improve human resources in the fields of new technologies and innovation.

In Table 16 the priority areas of the clusters are consolidated and related to the goals of the excellence hub. The table frames the scope of activity of the METACITIES Excellence Hub and drives the definition of the Implementation Plan that is presented in Chapter 7.

5.2 SWOT Analysis for the METACITIES Excellence Hub

Having analysed all the commonalities and differences in the three clusters participating in the project, and in the view of the common R&I Strategy of the Excellence Hub, the following table summarizes all the important SWOT points that need to be addressed in the Joint R&I Strategy.

STRENGTHS

- Strong academic record in all project priority areas
- Important excellence pockets and local ecosystems
- High success rates and level of participation in R&I projects
- Common concerns in most of the objectives
- Smart city background and infrastructure /hardware and digital/ under speeded improvement

WEAKNESSES

- Low level of usage of digital infrastructure and applications in the majority of the areas involved
- Disparities between R&I leading and lagging countries
- Latency in the application of R&I strategies in local communities
- Slow adoption of digital twin technologies by enterprises and local authorities
- Territorial inequalities

OPPORTUNITIES

- Development of a more inclusive approach in terms of QH participation through the R&I Strategy
- Networking of the excellence pockets and local R&I ecosystems
- Connections to broader excellence networks
- Institutional reforms and digital transformation processes supporting Smart city development policies
- Mobilization of national differently sourced investments and funds
- Establish stronger incorporation of innovation achieved in various large-scale thematic projects

THREATS

- Sustainability issues in terms of financing of the new digital twin solutions
- Strong financial dependency of innovation from projects funded through various programmes and financial instruments.
- Establishing a lasting trend of shortage of skilled labour and imbalances in the provision of human resources for high-tech activities.
- National issues concerning connectivity and access to spectrum
- Isolated, closed access digital infrastructures functioning in local silos currently with low interoperability among platforms

Table 16: Relation of priority areas to the goals of METACITIES excellence hub

Goals	Priority Areas			
	Smart and Safe Mobility	Smart environment	Smart urban planning	Green and climate adaptive resource management
	Objectives			
Digital Transformation and Innovation	• Create user-friendly and interoperable digital platforms for access to real-time traffic and incident information for citizens.	• Implement digitization of citizen services to provide real-time information on air pollution and weather conditions within the city.	• Develop a competitive digital economy by providing a digital platform showing existing and future municipality topography (iNicosia).	• Improve research and innovation capacity; • Improve the digitalization of services for citizens.
Connectivity and Infrastructure Development for Digital Transformation	• Implement a digital infrastructure and network system, based on open data and technologies, to monitor and traffic flow and manage incidents.	• Develop connectivity and infrastructure for digital transformation, including the implementation of smart energy metering, consumption, and saving systems for public buildings.	• Deploy digital infrastructure and technology such as IoT sensors and IoT gateways.	• Development of the digital infrastructure.
Sustainable Economic Growth and Social Inclusion	• Promote smart mobility initiatives to enhance social inclusion for socially sensitive groups (e.g. smart parking) and foster sustainable economic growth.	• Promote smart environment initiatives for social inclusion and sustainable economic growth.	• Achieve sustainable economic growth by promoting smart parking.	• Achieve sustainable economic growth.

Goals	Priority Areas			
	Smart and Safe Mobility	Smart environment	Smart urban planning	Green and climate adaptive resource management
	Objectives			
Environmental Sustainability, Low-Carbon Economy and Green Transition	• Encourage the adoption of eco-friendly transportation options and promote the use of public transit systems for all.	• Implement innovative environmental solutions, such as smart recycling systems, to facilitate the shift towards a more eco-friendly and environmentally conscious economy.	• Enable a green digital transition through smart transportation and smart city development. • Transition to a low carbon economy through eco-friendly transportation using smart parking.	• Promote the use of clean energy, mitigating climate change; • Transition to a low carbon economy; • Resource efficiency; • Environmental protection.
Transport and Digital Connectivity	• Enhance and advocate for digital connectivity to provide real-time mobility information and data.	• Enhance and advocate for digital connectivity to provide real-time environmental information.	• Improve transport connectivity and digital connections by providing real-time data such as traffic, regarding the municipality.	• Improve digital connectivity;
Enhancing Education, and Digital Skills and Human Resources	• Strengthen education and digital skills development initiatives to build a skilled human resource base supporting smart mobility solutions.	• Enhance education, digital skills, and human resources development to support and advance smart environment initiatives.	• Improve education and skills deployment to better adapt people to technological and environmental change.	• Skills development to better adapt people to technological and environmental changes; • Promote a culture for innovation.

©METACITIES, 2023

Goals	Priority Areas			
	Smart and Safe Mobility	Smart environment	Smart urban planning	Green and climate adaptive resource management
	Objectives			
Entrepreneurship regarding Research Innovation	• Foster entrepreneurship in research and innovation to drive advancements in smart mobility solutions.	• Promote entrepreneurship in research and innovation to drive sustainable solutions for a smart environment.	• Promote innovation regarding city development. • Support science and business cooperation for the city development.	• Support research and innovation ecosystems; • Promote investments and links between science and business.
Research, Innovation, and Education	• Promote research, innovation, and education to drive progress and excellence in these fields.	• Promote research, innovation, and education to drive progress and excellence in these fields.	• Enhance skills development • Improve human resources in the fields of new technologies and innovation.	• Improve human resources in the fields of new technologies and innovation

©METACITIES, 2023

6 Quadruple Helix Collaboration

The present chapter is devoted to the definition of a Reference Model for Collaboration, based on the Quadruple Helix (QH) Approach, applied in the context of Smart Cities. This model will be followed and properly adapted to the smart city cases to be addressed by each of the three regional innovation ecosystems in the context of the METACITIES project. The smart city cases to be pursued require the realization of specific interventions in the priority areas defined as part of the work in T2.1 and documented in chapters 4 and 5. For each such priority area, comprehensive agendas for research and innovation (R&I) are developed and are outlined the key research topics, methodologies, and activities that will be undertaken to achieve relevant identified goals and objectives.

For the development of the R&I agendas according to the Quadruple Helix (QH), a participatory approach will be followed involving four major actors (stakeholders): Academia (science), Public (policy), Business (industry), and Citizens (society). The QH approach necessitates that the public and private sector, providers and consumers align their priorities for regional development. In the following section we elaborate on the four major actor types and the role(s) they can play in shaping smart city interventions. In Section 6.2 the QH-based Model of Collaboration in the context of a Smart City within each regional innovation ecosystem is presented, while Section 6.3 extends the model to address QH-based Cross-border Collaboration of innovation ecosystems, taking due account of the METACITIES Excellence Hub, always in the context of smart cities.

6.1 Stakeholder Types and Involvement

Today's smart city movement is a bottom-up approach through which the perspectives of various stakeholders are considered in arriving at a consensus, in contrast to a public-led top-down method that dictates a particular vision of the city to all people involved [28]. Stakeholders are defined as agents that are interested, affected or that have power to influence the development of Smart Sustainable Cities [29]. Application of the QH requires the establishment of a horizontal cooperative system among all stakeholders in each smart city intervention. The types of possible involvement of stakeholders are quite diverse ranging from deriving service demand to service supply and operation management. Identifying the unspoken needs and respecting the aspiring expectations of diverse stakeholders are important priorities of policy-makers and strategic planners. The four major types of stakeholders are identified as the Public, Businesses, Citizens, and Academia, and exemplified in the Table 17 [28], [29].

Table 17: Stakeholder Types

Public	Business	Academia	Citizens - NGOs
Portfolio level **Policy makers who initiate, plan, execute smart city development e.g., Central, City & Local government such as Municipalities, city councils and city administrations, different government institutions** **Program level**	• Business firms in various industries that participate in smart city development such as construction, energy, healthcare, IT, transportation, etc., and services	• University • Research Institute • Industry Associations • Experts who provide professional	Beneficiaries and end-users of smart city services: • Existing and Prospective residents • Local businesspeople in the smart city

• **Managers who are in charge of planning & implementing smart city domain programs.** • **Department directors in city and local government** **Project level** **Managers who are in charge of plan, execution, and delivery of solutions.**	• Investors • Utility providers (e.g., for smart grid or smart water management) • Standardization Bodies	knowledge and advice for smart city development .	• Societal Organizations involved in social sustainability initiatives.

Following the ITU-T Y.4000 series recommendation [29], Stakeholders can be categorized according to their role and participation in project(s) related to the development of smart, sustainable cities into Influencers, Beneficiaries and Affected.

Influencers include all stakeholders that have the authority and resources to influence the smart city research strategy and agenda. In the Quadruple Helix approach all four stakeholder types are considered influencers.

Beneficiaries are the stakeholders who directly benefit from the smart city developments.

Affected includes all stakeholders that are somehow affected by smart city developments and they can be either potential supporters or potential opponents.

The role and participation in smart city development of each of the four stakeholder categories are summarized in the following:

Public Sector:

The Public (policy) actor is present at several levels. The most active public level is the city government, but smart cities are also being supported on a regional level. In today's smart cities, the role of the public takes the form of pursuing a project promotion system through public-private or private-oriented cooperation. The central government and the public sector play the role of amending laws and providing budget support. Local governments supervise smart city-related policy projects in cooperation with the central government, establish and operate public services, and build infrastructure. The central government has several committees under its umbrella for the creation and diffusion of smart cities from a national strategic point of view to advise, deliberate, and adjust government policies such as legal systems, standardization, external cooperation, and smart city promotion strategies. Local governments also form a council between local governments that promote the construction and operation of smart cities to ensure mutual cooperation and strategies for the spread of smart cities and industrial promotion.

Businesses:

Private companies play an important role in providing a range of ideas related to smart city technology and developing comprehensive solutions to solve city-wide problems based on these ideas. They are the main agents of implementing various new technologies incorporating ICT in a wide variety of fields (e.g., transportation, safety, energy, medical care, education, tourism, etc.), provided as city services

in smart cities. Therefore, the participation of innovative companies is recognized as an important success factor of smart city implementation. Private companies can also play a role in providing utilities and public services in areas such as safety and the environment, while also applying a sustainable profit business model. Through this, qualitative growth can be promoted as a part of corporate social responsibility (CSR) and environmental, social and governance (ESG) management required by companies these days.

Academia:

At the academic level, smart cities have been looked at from different scientific domains and backgrounds. The Smart City concept is a cross-disciplinary one which covers urban studies, economics, political studies, city planning, engineering, sociology, communications as well as user research and professional manpower training. The group supports smart city projects through various activities such as fact-finding, research and development, and policy discovery using professional manpower and facilities to activate smart city services. Another important role is to participate as the main body of the business that develops, tests, and demonstrates technologies and solutions provided as actual smart city services.

Citizens and Citizens' Organizations:

Citizens are the actual beneficiaries and users of all services and technologies provided by smart cities. The goal of a smart city is for citizens to participate as members with a sense of ownership. No matter how advanced technology is applied to a city, it is meaningless if it does not provide benefits or convenience to the citizens. This is why people-centered smart cities are gaining increasing importance and interest. The essence of a smart city is that citizens directly use and interact with smart technologies as they become familiar with them. Without citizen participation, the sustainability of smart cities cannot be guaranteed. A characteristic that can be seen in many examples of smart city implementations today is that users' opinions are collected through citizen surveys, and citizens directly participate in the smart city development project. In the domain of new product development, R&D departments rely increasingly on user input and collaboration. Innovations are no longer (solely) developed top-down but are increasingly shaped bottom-up.

Active involvement of all stakeholders who can provide substantial input for developing a more accessible, information based, interactive and participatory urban environment has been facilitated by Web 2.0 which offers the online resources (tools, platforms, and social processes) to facilitate new forms of interaction, engagement, collaboration, open innovation, crowd sourcing and collective creativity.

6.2 QH Collaboration Approach within regional innovation ecosystems

As discussed in the previous section, various stakeholder groups with different goals and inclinations are involved in smart city development, and these groups must work together to form a cross-functional team. For these diverse groups to collaborate and work effectively, they need a strategic framework in the initial joint planning stage. The strategic framework will bring these diverse groups of stakeholders together by providing a clear sense of direction and focus on the form of vision and mission for smart city development projects. The regional R&I strategies of Sections 4.2 to 4.4 are instances of such strategic frameworks.

Once a strategic framework is established, it should be communicated to all the members of the stakeholder groups. This process will have the effect of achieving shared understanding of the core values among the members of the cross-functional teams. The perception of the goals, core values, and vision of a smart city intervention differs according to each person's interests and inclinations, so it is important to develop a common understanding of the strategic framework that is agreed upon.

Effective communication is possible only when the responsibilities for implementing the strategy are clearly defined and the roles of each stakeholder group are understood. Implementing a strategy requires each stakeholder group to share values and to make commitments to the developed and agreed-upon strategy. Commitment as a process may involve several steps, such as committing resources, setting up organizational structures and control systems.

One cannot emphasize enough the importance as well as challenge to coordinate diverse stakeholder groups in the early stages of planning, to combine and align multiple and conflicting strategic choices through stakeholder participation and to systematically link the higher-level missions and visions with the lower-level strategic goals of the various functional areas of a smart city.

Towards the definition of the QH Smart City Reference Collaboration Model, a smart city is envisaged as a collaborative ecosystem allowing for the co-creation of sustainable, future proof innovations that improve life in the city and boost the economy, in which technology plays an enabling role. The collaborative nature of smart cities is related to the quadruple helix-model. These collaborative ecosystems promise to contribute to the facilitation of knowledge exchange among the ecosystem actors. Smart cities serve as an innovation broker, connecting different stakeholders, allowing for real-life ideation, co-creation and validation.

In the smart city as a collaborative ecosystem conceptual model, values are offered and gained between the stakeholders (indicated with O and G in Figure 3).

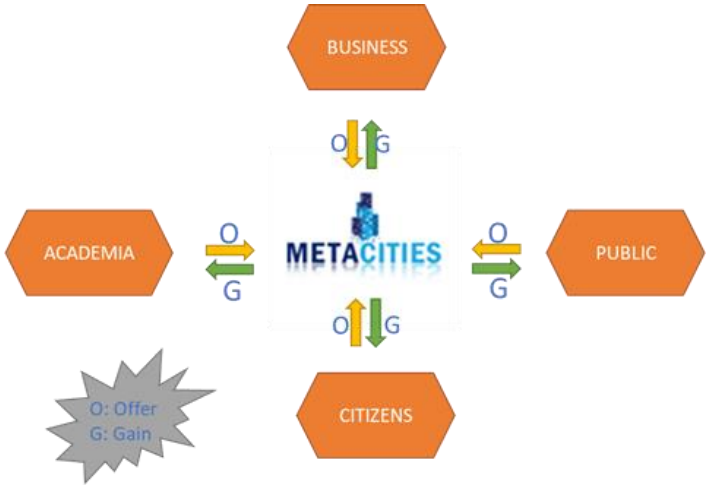

FIGURE 3: SMART CITY AS A COLLABORATIVE ECOSYSTEM

In our conceptual framework, value gained can be conceptualized as what a city system provides to its users, its citizens and other smart city stakeholders. An illustration in a smart city context could be the online co-creation of a city service, which enables citizens to interact with their city easily and

conveniently on-line (Value Gained 1), while opening the same service to local entrepreneurs, may enable them to generate business out of this (Value Gained 2).

We also distinguish between Social Value that is generated (e.g., safer streets) and Economic Value (e.g., generation of revenue). The concept of Social Value refers to the value that is generated through the creation and implementation of services and technologies that adequately harness opportunities within the city, tackle societal challenges and/or realize policy goals [28]. It refers to, for example, reducing traffic jams, reducing pollution, increasing neighbourhood cohesion, etc. Economic Value on the other hand covers economic metrics such as the annual economic growth of cities and companies within the city, a decrease in unemployment, the extent to which new businesses (start-ups) are being generated and able to survive, a reduction of bankruptcies, an increased competitive advantage, attracting existing businesses to the city, etc.

Applying the proposed Reference Collaboration Model and Value Analysis to the specific Smart City priority areas, which will be dealt with by the innovation ecosystems in the context of the METACITIES project and have been identified in Chapter 5 can be facilitated with the use of Table 18 which collects ''Values Offered" and ''Values Gained" by each stakeholder type and flowing among stakeholders in a smart city ecosystem. Most of the flows enable other stakeholders to perform certain tasks and can therefore be considered as Values gained. These Enabling Value Flows differ in nature, depending on the smart city intervention, and may include: enabling funding (financial support), enabling environments (a digital hub, an ecosystem or working space), enabling services (activities), enabling knowledge (data and expertise), enabling networks (brokerage) and enabling policy (stimulation by policy makers).

For each specific smart city priority to be addressed in the context of the METACITIES project, each of the four stakeholder categories will be populated with the actual entities, organizations to be involved, and Value Analysis, in terms of Values Offered, Values Gained and Enabling Value Flows among stakeholders, will be performed for each specific involved entity. Compiled results will be summarized in Table 18, as exemplified for the stakeholder category Public Sector.

Table 18: Public Sector - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Businesses	• Funding opportunities • Regulation and legal guidelines • Access to public data for planning • Initiation of infrastructure projects for Business participation	• Innovative technology solutions for smart city projects; • Valuable resources, and professional expertise; • Sustainable and efficient operational models.
Academia	• Access to public sector data for research, • Funding for academic projects • Endorsement of academic insights in policy-making	• Comprehensive scientific research; • Evidence-based insights to guide policy and planning; • Innovative and theoretically grounded models.
Citizens	• Improved public services, • Open data for citizen use, • Enhancements to urban living conditions	• Validation and valuable feedback on public services; • Citizen support and acceptance of smart city projects;

		• Community-led initiatives and ideas.

Each chain of Values exchange starts with the instigation of the public actor (regional and/or municipal authority) and evolves as follows:

The Public seeks enabling funding at the European level or local (regional and/or municipal) resources, brings together relevant smart city actors (enabling network or environment) and sometimes provides enabling information (e.g., open governmental data).

Cities pursue creation of Social and Economic value through implementing city improvements.

Citizens pursue creation of social value and contribute to the generation of social value themselves (providing input such as new ideas and validation feedback, co-creating apps or services).

Businesses pursue creation of Economic value but also generate social value (co-creation of free apps, platforms and services).

Academia pursues creation of social value, but generate no direct social or economic value in the smart city context, as the role of this stakeholder is an enabling one.

Values in typical smart city contexts are citizen-centred, encourage public-private cooperation and alignment of priorities as well as citizen engagement and involvement. They relate to the quite exhaustive list of key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals of the Recommendation ITU-T Y.4903 [30]. The KPIs provided by the Recommendation are designed to evaluate the role and performance of information communication technologies (ICTs) in the three dimensions of a city: economics, environment, and society and culture. The indicators are uniquely coordinated to allow cities to measure their progress on reaching the ambitious targets set by the SDGs. The Recommendation provides a means to benchmarking and disseminating best practices in utilizing ICTs and other technologies to enhance cities' sustainability and connect their smart strategies to the SDGs through an inclusive process.

In subsections 6.2.1 to 6.2.3, the proposed QH-based collaboration model for smart city development is applied and exemplified in selected priority areas and use cases addressed in each of the three regional innovation ecosystems.

6.2.1 CY Cluster Priority Areas in the Scope of METACITITIES project

Within the METACITIES project the activities demonstrating the CY priority areas are related to two use cases.

6.2.1.1 Priority Area 1: Smart Urban Planning Use Case

The goal of implementation of Use case 1 is to develop an integrated platform for analysing and predicting large-scale geospatial information (GIS), local demographic data, and other geo-critical datasets from multiple sources. This platform will use advanced machine learning and deep learning techniques to perform geospatial object detection by combining terrestrial datasets, remote sensing data, and Synthetic Aperture Radar (SAR) imagery. The primary focus of this platform is to extract meaningful information such as building stock analysis, noise maps, real estate prices, green cover, urbanization, sprawl, and other critical markers to estimate urban growth trends. The project will also explore the potential of real-time environmental awareness and information in promoting sustainable behaviour. This use-case/ will focus on the development of: i) an integrated urban environmental

monitoring and sensing tool with remote sensing and IoT sensors; ii) a database with analytics and predictions for large-scale urban data collected from different sources; and iii) the use of positioning as a tool for environmental decision making, assessment, and urban impact analysis. The goal is to create an integrated system that enables accurate prediction of environmental impacts on urban areas and provides information that can be used for planning and decision-making in urban development. The platform's use of advanced machine learning and deep learning techniques will facilitate the analysis and interpretation of large data sets, enabling a better understanding of urbanization and environmental trends and promoting the development of more sustainable cities.

6.2.1.1.1 QH Stakeholder Analysis and Value Flows

In the context of smart urban planning in Cyprus, the Quadruple Helix (QH) model could be applied as follows:

Public Sector:

In addition to Deputy Ministry of Research, Innovation and Digital Policy (DMRID) which is the main public actor of the Cypriot participation and the primary stakeholder for the creation of strategies and policies in the Cypriot R&I ecosystem, other governmental organizations such as the Cyprus Ministry of the Interior and local municipalities (guided by Union of Cyprus Municipalities (UCM)) can lead the initiative. Specifically, the Cyprus Ministry of the Interior (Department of Town Planning and Housing), plays a pivotal role in setting the strategic direction for urban development and growth. Simultaneously, local municipalities like those of Nicosia, Larnaca, Limassol, or Paphos have jurisdiction over their urban planning, playing a key role in executing and managing localized smart city initiatives. These entities have access to European funding programs such as the European Regional Development Fund or the Horizon Europe programme, or utilize local resources (depending on the scale of the project) to financially support smart urban planning projects. Moreover, these public bodies hold extensive data repositories, encompassing aspects such as population demographics, existing infrastructure layouts, traffic patterns, or zoning regulations. This information is invaluable when creating data-driven smart urban solutions.

Businesses:

In addition to eBOS and Primetel, the business group can also encompass a wide range of entities, from large-scale corporations to innovative start-ups, all of which can provide vital resources and expertise and have a role in shaping the smart city landscape. For example, construction firms like Joannou & Paraskevaides (J&P) can bring expertise in infrastructure development and contribute to the design and implementation of smart, sustainable buildings, or upgrading existing infrastructure to align with smart city goals. Tech companies like Logicom [31] or SignalGeneriX Ltd [32] contribute with their proficiency in IT, IoT-based or digital solutions. These entities can develop and manage digital systems that optimize resource distribution, manage data flows, or automate various urban processes.

Academia:

The contribution of this group to smart urban planning is vital, especially through research and innovation. In addition to CYENS – Centre of Excellence which is a core member of the METACITITES consortium, the Cyprus University of Technology, the University of Cyprus, and the Frederick University can also be considered as potential stakeholders. These institutions are all well-known for their strong departments related to urban planning, environmental studies, architecture, and engineering and can contribute valuable research and innovation to the planning process. For

instance, they could conduct studies on sustainable city planning or develop algorithms for efficient resource distribution or conduct studies exploring the environmental impact of different urban layouts.

Citizens:

The active participation of citizens is essential for the success of smart urban planning. Residents of urban areas, citizen groups, and non-profit organizations need to be engaged in the planning process. This engagement can be achieved with the intervention of Cyprus Consumers Association (CCA) which is expected to offer unique insights into the needs of Citizens, consumers, users of the different services to be designed and planned for deployment within the project. Citizens provide valuable insights based on their lived experiences, preferences, and needs. Local community groups, neighbourhood associations and online citizen forums can be invaluable sources of feedback and ideas. For instance, the views of residents of Nicosia can be sought regarding the layout of bike lanes, preferences for public transport options, or the introduction of smart waste management systems. This engagement process ensures that the urban solutions designed are not just smart but also sensitive to the community's diverse needs. In a smart city, citizens transition from passive users to active co-creators of their urban environment.

6.2.1.1.2 Value analysis within the Quadruple Helix (QH) approach

Public Sector - Governmental Entities:

- **Values Offered:** The public sector, represented by bodies such as the Cyprus Ministry of Interior, is a crucial provider of regulatory guidance, ensuring the planning and implementation of smart urban projects align with national laws and regulations. Moreover, these entities control access to public funding and data. By providing data, which may include data on demographics, infrastructure, environmental factors, and more, the public sector offers valuable insights that shape the direction of smart urban planning projects. In addition, through their authoritative position, they have the unique ability to convene diverse stakeholders, establishing a platform for collaborative decision-making.
- **Values Gained:** As initiators and facilitators of such initiatives, governmental bodies can benefit in several ways. The most apparent is feedback on their services and infrastructures, leading to improved urban planning that more effectively meets public needs. Specifically, the consequent social value can be significant: i) better infrastructure; ii) improved public satisfaction; iii) increased safety; and iv) potentially significant economic growth. In addition, they gain from knowledge and innovation exchange with businesses, academia, and citizens, which can lead to more sustainable and forward-thinking urban strategies.

Businesses:

- **Values Offered:** Businesses offer an extensive range of expertise, resources, and innovative technologies. For example, tech firms could propose and implement advanced IoT technologies for intelligent transport systems or energy management, while construction companies could incorporate smart technologies in building designs to enhance energy efficiency or safety.
- **Values Gained:** Engaging in smart urban planning projects provides to the business sector opportunities for growth, innovation, and access to new markets, potentially leading to increased revenue. Additionally, these projects give them access to new data, insights, and collaborative research, helping them refine their products or services. This can provide an opportunity for businesses to position themselves as leaders, key contributors and innovators

in sustainable development and urban planning. This participation not only strengthens their professional reputation but also can lead to an expanded market presence.

Academia:

- **Value Offered**: Academic institutions, bring a wealth of research capacity, theoretical expertise, and novel ideas, that can significantly contribute to smart urban planning projects. Their involvement can include everything from the conception of sustainable urban planning strategies to the development of data-driven algorithms for efficient resource distribution. They can produce insightful research to guide the creation of sustainable urban planning policies, including environmental impact studies and sociological analyses on the effect of urbanization. They can also leverage their technical expertise to develop cutting-edge solutions, such as AI-driven systems applicable in a smart city context.
- **Value Gained:** Academic institutions can gain critical insights on how their theoretical research applies in practice, linking their academic pursuits with practical implications and societal impact. The feedback loop from practical application often offers new research questions and provides data to drive further their academic exploration, pushing the boundaries of their research work. Furthermore, these engagements can increase opportunities for funding, cross-institutional collaboration, and elevate their societal impact, thereby enhancing their institutional reputation.

Citizens:

- **Value Offered:** The value offered by citizens extends far beyond their role as end-users of urban services. With their unique, on-the-ground experiences, they provide essential feedback and local knowledge that can inform the design, implementation, and refinement of urban planning initiatives. Participatory platforms can engage citizens in co-creating apps or services, contributing to the data collection process, and voicing their needs and preferences, ensuring projects stay user-centric.
- **Value Gained:** The most significant value citizens gain is the direct improvement to their lived environment and the enhancement of public services, which can lead to a higher quality of life. An inclusive, transparent urban planning process also enables citizens to influence the shape of their urban environments, leading to increased civic satisfaction, a sense of ownership, and stronger community bonds.

6.2.1.1.3 Interconnections and value flows among the four stakeholder groups

Based on what was discussed above, below we examine the intricate dynamics among the four core stakeholder groups within the Quadruple Helix model: the public sector, businesses, academia, and citizens. As we navigate the realm of smart urban planning in Cyprus, it's imperative to understand the value each stakeholder offers and the reciprocal value they gain within this interconnected ecosystem. This reciprocal and multi-dimensional exchange not only fosters a collaborative environment but also drives innovative, efficient, and sustainable urban solutions. The tables below (Table 19, Table 20, Table 21 and Table 22) provide a detailed depiction of the values offered and received amongst these groups, highlighting the symbiotic relationships and value flows that are integral to the success of smart urban planning initiatives. It is through these value flows and interactions that a smart city initiative like Smart Urban Planning can be effectively implemented and managed.

Table 19: Public Sector - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Businesses	• Funding opportunities • Regulation and legal guidelines • Access to public data for planning • Initiation of infrastructure projects for Business participation	• Innovative technology solutions for urban projects • Valuable resources, and professional expertise, • Sustainable and efficient operational models
Academia	• Access to public sector data for research, • Funding for academic projects • Endorsement of academic insights in policy-making	• Comprehensive scientific research • Evidence-based insights to guide policy and planning • Innovative and theoretically grounded models for urban development
Citizens	• Improved public services (transport, waste management, etc.), • Open data for citizen use, • Enhancements to urban living conditions (parks, pedestrian zones, etc.)	• Valuable feedback on public services • Citizen support and acceptance of urban projects, • Community-led initiatives and ideas

Table 20: Businesses - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Development and application of innovative solutions • Resource allocation for public projects • Industry expertise for planning and implementation	• Financial support through funding • Regulatory guidelines for operation • Public sector data for business planning
Academia	• Real-world application scenarios for academic research • Financial support for academic projects • Industry expertise and insights	• Research-based solutions to business challenges • Innovative ideas and concepts • Access to skilled talent pool
Citizens	• Cutting-edge products and services to improve urban life • Job opportunities, • Investments in local communities	• Direct feedback to improve products and services • Market information for business planning, • Revenue through product/service sales

Table 21: Academia - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Thorough scientific research, evidence-based insights to support policy • Theoretical models for urban planning	• Access to public sector data for research • Funding for academic projects • Policy support in academic goals
Business	• Research-driven business insights • Innovative ideas for business operation • Trained talent for recruitment	• Real-world scenarios for research application • Financial support for academic projects • Business expertise for practical orientation
Citizens	• Dissemination of knowledge • Innovations that benefit public life • Engagement in research studies	• Insights and feedback to drive research • Participation in data collection • Societal relevance of academic pursuits

Table 22: Citizens - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Feedback on public services, • Participation in public initiatives • Community-based ideas for urban planning	• Improved public services • Open data for personal use • Enhancements to urban living conditions
Business	• Direct feedback on products/services • Market information through purchasing patterns • Participation in business initiatives	• Access to innovative products/services • Job opportunities • Investments in local communities
Academia	• Participation in research studies • Insights from lived experience • Local knowledge for research application	• Knowledge generated by academia • Innovations that improve urban life • Involvement in shaping urban futures

6.2.1.2 Priority Area 2: Smart Parking Use Case

People struggle to find parking on a daily basis, particularly in densely populated cities. Driving in circles around the metropolis for a parking spot is a daily occurrence. Any destination, whether for work, personal meetings at specific locations, recreation, or emergency visits to places such as hospitals, must be reached for the least amount of money possible. The increasing number of automobiles and vehicles in a city also contributes to the difficulty and expense of finding a parking

space. Frequently, people enter a parking lot without knowing if a spot is available, making navigation problematic. In addition, the incorrect location may be chosen without the driver's knowledge based on cost considerations such as time, money, or fuel consumption. Another significant issue is the driver's disregard for parking spaces that are closer to his or her destination or have a lower cost in terms of price, distance from the vehicle's current location, or distance to be walked from the parking space. In addition, parking is a $25 billion industry that has been stagnant for decades! Moreover, urban traffic is responsible for 40% of CO2 emissions and 70% of other pollutant emissions from road transport, and over 30% of urban traffic is caused by drivers looking for a parking space.

Our aim is to solve these problems by significantly reducing parking time, thus playing a major role in creating a better, less stressful and environment-friendly urban environment. Smart parking targets to offer a mobile and a web application that: i) acts as a Smart Parking assistant to help drivers find the best available parking spot, reserve it, guide them there, act as an authentication measure and let them pay in the end; and ii) assist parking lot owners and parking seekers to fully automating this procedure. A further objective is to take into account the user's preferences as they are set, as well as any other necessary data such as the desired destination and the user's current location, as well as the data manipulation and use of all the available resources, which will then be processed by a machine learning algorithm based on the user's preferences and provide the user with a list of the best available options.

6.2.1.2.1 QH Stakeholder Analysis and Value Flows

In the context of smart parking in Cyprus, the Quadruple Helix (QH) model could be applied as follows:

Public Sector:

In addition to Deputy Ministry of Research, Innovation and Digital Policy (DMRID) which is the main public actor of the Cypriot participation and the primary stakeholder for the creation of strategies and policies in the Cypriot R&I ecosystem, other governmental organizations such as the Cyprus Ministry of the Interior, Cyprus Ministry of Transport, Communications and Works and local municipalities (guided by Union of Cyprus Municipalities (UCM)) can lead the initiative as they are key public entities in shaping smart parking strategies. The Traffic Department under the Cyprus Police Force also plays a significant role in this case, providing vital traffic data and enforcing parking regulations. Public sector entities have access to diverse funding avenues, including European programmes such as the European Regional Development Fund or Horizon Europe programme, or local resources. These bodies can also provide crucial data, such as existing parking infrastructure, traffic volumes, parking lot locations, vehicular traffic patterns, peak hour statistics and violation statistics, that can guide the design and implementation of smart parking solutions.

Businesses:

In addition to eBOS and Primetel, a variety of businesses can be instrumental in deploying smart parking solutions. Tech firms like Logicom [31] or SignalGeneriX Ltd [32] can contribute with their expertise in IT and IoT-based solutions for parking management, or for developing and managing digital systems that efficiently direct drivers to available parking spaces or automate payment processes. Construction firms like Joannou & Paraskevaides (J&P), could be engaged in integrating smart parking infrastructure into their developments. Telecom companies like Cyta could offer a platform for a mobile app that guides citizens to available parking spaces.

Academia:

In addition to CYENS – Centre of Excellence, Academic institutions like the Cyprus University of Technology, University of Cyprus, and Frederick University, are instrumental in smart parking initiatives. Their research and innovation can guide the development of efficient parking strategies. For instance, they could explore the impact of smart parking systems on traffic congestion, develop algorithms for efficient parking space allocation, or study user satisfaction and behavioural patterns in response to smart parking solutions.

Citizens:

The active engagement of citizens is crucial for the success of smart parking solutions. In the smart parking context, citizens can be significant contributors in shaping the smart parking landscape. The Cyprus Consumers Association (CCA) could play a significant role in collecting citizen feedback and ensuring their needs are met. Citizens (i.e., drivers and residents), local community groups, etc., can provide valuable feedback on their experiences with the existing parking infrastructure, preferences for smart parking solutions, issues they face in parking as well proposed solutions. The insights derived from citizen engagement can ensure that the smart parking solutions developed are not only efficient and innovative but also the system designed is user-friendly and that meets their needs and expectations.

6.2.1.2.2 Value analysis within the Quadruple Helix (QH) approach

Public Sector - Governmental Entities:

- **Value Offered:** Public sector entities like the Ministry of Transport, Communications and Works, and local municipalities offer their authoritative powers in the implementation of new technologies. This might involve the creation and adaptation of new policies and regulations that accommodate and support smart parking initiatives. They also have access to vast repositories of public data, such as traffic patterns, parking violations, and urban planning blueprints that can aid in the strategic placement and operation of smart parking systems. Furthermore, they offer public spaces and infrastructure that can be retrofitted or upgraded with smart parking technologies. Additionally, they have the ability to tap into national and European funding for sustainability and digital transformation projects, providing the financial resources necessary for such initiatives.
- **Value Gained:** In return, public sector entities gain data-driven and efficient technology-driven solutions for managing parking issues in urban areas, thereby addressing a common public complaint and improving overall citizen satisfaction. They can also benefit from the data generated by smart parking systems to gain a real-time understanding of parking usage and demand, aiding in urban planning and traffic management efforts. In addition they can use the feedback received from citizens to improve parking management and effectively address public needs.

Businesses:

- **Value Offered**: Companies in the technology sector offer their technological expertise, resources, and innovative technologies in smart parking projects. This might involve the design and implementation of sensor-based IoT networks for detecting parking space occupancy, or the creation of user-friendly mobile applications for real-time parking availability updates and digital payments. Additionally, businesses can also provide services related to the installation, maintenance, and troubleshooting of the deployed smart parking technology.
- **Value Gained:** Businesses stand to gain significantly from their involvement in smart parking projects. Not only do they get access to new business opportunities and markets, but they can

also utilize the data generated through the smart parking systems for improving their products and services. Furthermore, their active involvement in public service initiatives allows them to have access to new data and customer bases, and benefit from enhancing their corporate image showcasing them as leaders in smart city solutions.

Academia:

- **Value Offered:** Academic institutions such as the University of Cyprus can leverage their research capabilities, scientific expertise and innovation potential to offer new ideas and theoretical models for smart parking. They can contribute with research on urban mobility, statistical analysis of parking demand, drivers' behavioral analysis, algorithms development for optimal real-time parking management and space allocation, or even research on the social and environmental impacts of smart parking.
- **Value Gained:** For academia, participation in smart parking initiatives offers an opportunity to apply their theoretical knowledge in practical, real-world scenarios, thereby enhancing the relevance and applicability of their research. They also gain access to a wealth of new data, both from the public sector and from the implemented smart parking systems, that can be utilized for further research. Collaborations with public and business entities can also pave the way for more research funding and partnership opportunities.

Citizens:

- **Value Offered:** Citizens can offer their real-life experiences, insights, valuable feedback and local knowledge on the city's parking situation and issues. They can participate in surveys and focus groups to identify high-demand parking areas or problematic zones. They can also be involved in the development and testing phases of the smart parking system, offering their feedback on the user interface and functionality of smart parking apps, and their overall experience with the new system.
- **Value Gained:** In return, citizens benefit from improved parking services (no longer having to waste time and fuel searching for parking spaces). They can enjoy a more seamless and stress-free parking experience, which can also reduce traffic congestion and contribute to a cleaner urban environment. Additionally, citizens' involvement in their city's development can foster a greater sense of community ownership and pride.

6.2.1.2.3 Interconnections and value flows among the four stakeholder groups

Based on what was discussed above, below we examine the intricate dynamics among the four core stakeholder groups within the Quadruple Helix model: the public sector, businesses, academia, and citizens. As we explore the landscape of smart parking in Cyprus, it's essential to comprehend the value each stakeholder contributes and the reciprocal value they obtain within this interconnected ecosystem. This multi-dimensional and reciprocal exchange encourages a collaborative environment while propelling innovative, efficient, and sustainable parking solutions. The tables below (Table 23, Table 24, Table 25 and Table 26) provide a comprehensive overview of the values offered and received within the Quadruple Helix model in the context of smart parking in Cyprus, highlighting the symbiotic relationships and value flows that are paramount to the success of smart parking initiatives. It is through these value flows and interactions that a smart city initiative like Smart Parking can be effectively implemented and managed.

Table 23: Public Sector - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Businesses	• Public data related to parking usage, • Regulatory support for smart parking initiatives, • Potential funding for smart parking projects	• Technological solutions to enhance parking management, • Business expertise in implementing smart parking systems, • Innovative business models
Academia	• Access to public data for research on smart parking solutions, • Potential funding for academic projects, • Application of academic findings in policy-making	• Evidence-based insights to optimize parking policies, • Sustainable and efficient models for smart parking, • Academic expertise in urban planning
Citizens	• Implementation of smart parking solutions for better urban living, • Access to open data for citizen use, • Engagement in policy-making related to smart parking	• Valuable feedback on smart parking systems, • Citizen participation in smart parking initiatives, • Creative ideas to enhance smart parking solutions

Table 24: Business - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Development and implementation of smart parking systems, • Professional expertise, • Innovative business models	• Regulatory guidelines and support, • Public data related to parking usage for business planning, • Potential public sector partnerships
Academia	• Real-world scenarios for academic research on smart parking, • Funding for academic projects, • Business insights	• Research-driven insights to enhance smart parking solutions, • Innovative concepts, • Access to a skilled talent pool
Citizens	• Smart parking solutions to improve urban life, • Job opportunities, • Enhancements to local communities	• User feedback to improve smart parking systems, • Market information for business planning, • Revenue through service provision

Table 25: Academia - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Comprehensive research on smart parking,	• Access to public data for research, • Funding for academic projects,

QH Group	Values Offered	Values Received
	• Evidence-based insights to guide policy, • Academic models for smart parking	• Policy support for academic initiatives
Businesses	• Research-based solutions to smart parking challenges, • Innovative concepts, • Trained talent for business operation	• Real-world application scenarios for research, • Funding for academic projects, • Business expertise
Citizens	• Dissemination of knowledge, • Innovative ideas that benefit public life, • Citizen engagement in research studies	• Insights and data to drive research, • Societal relevance of academic pursuits, • Participation in academic initiatives

Table 26: Citizens - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Feedback on smart parking systems, • Participation in public initiatives, • Creative ideas for improving smart parking	• Enhanced parking solutions, • Open data for personal use, • Involvement in shaping parking policies
Businesses	• Direct feedback on smart parking services, • Market information through usage patterns, • Participation in smart parking initiatives	• Access to improved parking services, • Job opportunities, • Improved local communities
Academia	• Participation in research studies, • Local knowledge for research application, • Insights from lived experience	• Knowledge generated by academia, • Involvement in shaping smart parking systems, • Benefit from academic innovations

6.2.2 GR Cluster Priority Areas in the Scope of METACITIES project

Within the METACITIES project the activities demonstrating the GR priority areas are related to the following two use cases.

6.2.2.1 Priority Area 1: Smart Mobility

Smart mobility, fortified by the integration of digital and more specifically Digital Twin technology, establishes itself as a vital force propelling urban development into new dimensions. The utilization of Digital Twins in the context of smart mobility offers a dynamic platform for in-depth analysis and

predictive capabilities. By mirroring the physical urban environment in a digital replica, decision-makers gain a comprehensive understanding of mobility systems. This becomes particularly potent when multiple data sources, interconnected with existing smart city projects, are brought into the fold. The interconnected web of data allows for a holistic examination of mobility patterns, enabling authorities to discern trends, anticipate challenges, and optimize transportation networks. The fusion of Digital Twin technology with diverse data sources not only enhances the efficiency of smart mobility solutions but also lays the groundwork for proactive, data-driven decision-making in the context of urban planning and development. This innovative approach underscores the commitment to leveraging cutting-edge technologies to create more sustainable, safe, efficient, and resilient urban landscapes.

6.2.2.1.1 QH Stakeholder Analysis and Value Flows

In the context of smart mobility in Greece, the Quadruple Helix (QH) model could be applied as follows:

Public Sector:

Within the intricate framework of smart mobility in the Quadruple Helix, the public sector, comprising the Municipality of Patras, the Region of Western Greece, Patras Hospitals, and the Chamber of Commerce of Achaia, engages in a detailed stakeholder analysis, exploring technical dimensions. The Municipality of Patras, pivotal in this collaboration, leads European funding programs for urban infrastructure and technological integration, utilizing smart city initiatives to enhance transportation systems. The Region of Western Greece, with a focus on demographics, tailors policies to the diverse needs of its populace, ensuring inclusivity in smart mobility solutions. Patras Hospitals contribute a technical perspective by integrating advanced medical transportation technologies, optimizing emergency response systems, and supporting telemedicine for remote healthcare. Simultaneously, the Chamber of Commerce of Achaia engages in economic analyses, identifying opportunities for technology-driven businesses and aligning them with smart mobility initiatives. This technical orchestration manifests in a fluid value flow, where European funding supports infrastructure, demographic considerations inform tailored solutions, healthcare technology improves medical transport, and economic analyses drive business innovation. In this technologically driven collaboration, each public sector stakeholder plays a crucial role, harmonizing European funding, demographics, and technology to propel smart mobility forward in Patras.

Businesses:

The Federation of Industries of Peloponnese and Western Greece, of which p-NET is a member, is one of the five Regional Federations of the country. The majority of its members are classified as SMEs. The Federation could play an important role in representing a large sector of businesses and industry by providing input and contributing towards practical solutions to mobility issues.

In addition, the Trade and Import Association of Patras, made up of entrepreneurs, retailers and SMEs, could also, in its efforts to assist in the development of their members' business development, contribute towards mobility issues.

Under the umbrella of the associations mentioned above, as well as the Chamber of Commerce of Achaia, referred to in the public sector, various types of businesses can play a role in smart mobility.

In addition to METACITIES partners p-NET and Yodiwo, the business group could also be comprised of large-scale corporations, SMEs and innovative start-ups, that relate to digital infrastructure, city

infrastructure, applications and mobility like for example Mobility related businesses (Parking owners, car / scooter/bike renting companies, car / scooter/bike selling/retail companies, courier and transportation companies), Retailers in the city of Patras, Smart mobility enterprises , Smart parking app developers, some ICT companies like Irida Labs (camera/computer vision technology), Sensor technology providers, the general ICT innovation ecosystem like IT enterprises and Innovation Hubs and start up communities (eg Pos4Work). The Taxi Association of Patras, and Public Transportation providers (such as KTEL Achaias SA) and Logistics companies (such as Med Frigo) could also play a role. In addition, the Patras Science Park is one of the six Science and Technology Parks established in Greece and where p-NET is based. PSP supports the growth of innovative, technology based companies across several sectors contributing to the city's knowledge economy. Home to innovation hubs and start-ups, companies based at the PSP could contribute accordingly.

In summary, the rich business and digital ecosystem of the City of Patras, comprises a long list of internationally renowned and/or locally active businesses that cover a large spectrum of the digital supply chain but also a long list of businesses that relate to the transport/mobility domain directly or indirectly. The digital ecosystem is represented in METACITIES through p-NET that brings together the expertise of the competence center and a large network, where large communication vendors (INTRACOM) and IT solution providers (Uni Systems) are beneficiaries. It is also represented by Yodiwo, active in the field of IoT and digital platform technologies with many partnerships around the globe. Large IT (Dynacomp)and technology (Renesas) companies that work in the domain of application and data base development in Patras and smaller SMEs that work in the domain of smart parking solutions and computer vision with emphasis on mobility and transportation (eg IRIDAlabs, MEASON, etc.) are important stakeholders for smart mobility solutions. Innovation hubs and startuppers are benefiting from open data initiatives that can assist in application optimization and further development.

Finally, all transport and micro mobility related companies in Patras, together with parking owners, retailers and city center placed businesses, that recognize various traffic and parking problems becoming obstacles in their everyday business development may play a key role in identifying and recognizing the importance of smart mobility solutions in the city.

Academia:

The contribution of this group to smart mobility is very important with many active Departments and Universities in the area (University of Patras – ECE, University of Patras – All engineering Departments, University of Peloponnese – ECE , University of Peloponnese – All engineers , Research Institutes with vast experience in data science and smart city issues (Industrial Systems- Athena, CTI).

University of Patras as well as University of Peloponnese and other Academic institutions in the region like Industrial Systems- Athena and CTI can significantly contribute to smart mobility activities, research and service provision. Respective initiatives will focus on issues like traffic management through traffic light monitoring and control, parking strategies (concerning both optimum parking space allocation as well as optimized guidance of drivers as to the best parking space position based on data already acquired and analyzed), optimized driver response to traffic conditions (traffic lights, traffic congestion) through real time and accurate guidelines and provision of services indicating (automatically or manually) specific situations affecting mobility (traffic light malfunction, road blockage, road potholes etc.) Towards this direction contribution from all Greek cluster partners will be instrumental.

Citizens:

The active participation of citizens is essential for the success of smart mobility, Specifically for the GR cluster represented by Road Safety Institute there are various groups of Citizens/Commuters, other Non-Governmental organisations like Road Safety Institute, Bikers and scoouter rider associations, Student unions , School Associations of parents, Red Cross – Patras Section, Hellenic Rescue Team – Patras – NGO , Ambulance drivers association, National Centre of Direct Help (EKAB), Administration of Fire Fighting Services of Patras. The latter are concerned specifically to the emergency issues.

The active participation of citizens is essential for the success of smart mobility. Residents of urban areas, citizen groups, and non-profit organizations need to be engaged in the planning process. This engagement can be achieved with the intervention of Consumers' Association "The Quality of Life" which is expected to offer unique insights into the needs of Citizens, consumers, users of the different services to be designed and planned for deployment within the project. Citizens provide valuable insights based on their lived experiences, preferences, and needs. Local social community groups, neighborhood associations and online citizen and news forums can be invaluable sources of feedback and ideas. For instance, the views of residents of Patras can be sought through the connection of the university to the city with cycle paths, the new cycle path network, the new train network under construction, smart parking spaces for disabled people, or the introduction of smart waste management systems. This engagement process ensures that the urban solutions designed are not just smart but also sensitive to the community diverse needs. In a smart city, citizens transition from passive users to active co-creators of their urban environment.

In the pursuit of smart mobility within the METACITITIES project, it is imperative to foster diversity and inclusivity in stakeholder engagement. By actively seeking representation from various demographics, socio-economic backgrounds, and cultural groups, we ensure that the smart mobility solutions developed are inclusive and considerate of the entire community. Moreover, an emphasis on education and awareness campaigns will empower citizens to make informed contributions, fostering a deeper understanding of the benefits associated with smart mobility initiatives. To address potential barriers, a commitment to technological literacy initiatives will be essential, ensuring that all citizens can comfortably navigate and utilize the proposed smart solutions. Establishing a continuous communication framework, including regular town hall meetings, online forums, and surveys, will further strengthen the feedback loop, keeping stakeholders informed and engaged throughout the project. Additionally, collaboration with local educational institutions presents an opportunity to tap into the innovative perspectives of students and researchers, enriching the planning process with fresh ideas and a sense of community involvement. Through these measures, the METACITITIES project aims not only to deploy cutting-edge technologies but also to co-create a smart urban environment that truly reflects and serves the diverse needs of its residents.

6.2.2.1.2 Value Analysis within the Quadruple Helix (QH) approach

Public Sector - Governmental Entities:

- **Values Offered:** In the Quadruple Helix model, the public sector brings forth a spectrum of values crucial to smart mobility initiatives. As the primary driver of urban policies and infrastructure development, the public sector contributes invaluable funding programs, regulatory frameworks, and strategic planning. Furthermore, its engagement in demographic considerations ensures that smart mobility solutions are inclusive, meeting the diverse needs of the local populace. Through technological integration and the implementation of

healthcare advancements, the public sector introduces innovative solutions for medical transportation, emergency response systems, and telemedicine. In economic terms, the public sector provides a stable and supportive environment, attracting businesses and fostering innovation through collaborations in the smart mobility sector.

- **Values Gained:** Conversely, the public sector reaps substantial benefits from the collaborative engagement within the Quadruple Helix. Through partnerships with academia, industry, and civil society, the public sector gains access to cutting-edge technologies, research insights, and innovative solutions. Collaboration with the academic sphere brings forth research findings and knowledge that inform evidence-based policymaking. Engaging with industry, particularly through the Chamber of Commerce, provides the public sector with economic insights, business innovation, and job creation opportunities. Interaction with healthcare stakeholders, like Patras Hospitals, ensures improved healthcare services. This reciprocal relationship results in a dynamic exchange of expertise, resources, and innovations, positioning the public sector as a key beneficiary in the collaborative ecosystem of the Quadruple Helix.

Businesses:

- **Values Offered:** The digital ecosystem of Patras covers the whole spectrum of technologies, infrastructures and application required for the development of cutting-edge smart mobility solutions in the city. Their vast international experience in some cases can prove beneficial to the evolution of smart city priorities and implementation plans, and or in some cases may have applied specific technical solutions and/or business models in other related ecosystems, hence bringing in both their experience, expertise and resources.
- **Values Gained:** Businesses outlook for growth and increased revenue can be supported by getting involved as stakeholders. They may get access to additional opportunities for collaboration, new markets and in some cases new resources (data, platforms etc.) that will support their growth and expand their business development.

Academia:

- **Value Offered**: Academic institutions such as the Universities of Peloponnese and Patras can make use of their potential for creativity, scientific knowledge, and research skills to present fresh concepts and conceptual frameworks for smart mobility. They can also contribute state of the art relative infrastructures (sensors, actuators, backed platforms, car/driver simulators) to yield novel technologies, techniques, algorithms and end-to-end services for smart mobility. They can also provide with research on handling congestion in real time, algorithms for the optimization of traffic, pedestrian and cyclists flows, public transport alternatives calculation, optimizing parking management, and algorithms for decision making in case of incidents that affect the traffic.
- **Value Gained**: For academia, participation in smart mobility R&I activities offers an opportunity to apply their research knowledge, expertise and developments in practical, real-world scenarios, thereby enhancing the relevance and applicability of their research. This will significantly strengthen their position in the respective ecosystems and enable them to pursue more actively additional collaboration, funding as well as dissemination to prestigious scientific forums and publications. Collaborations with public and business entities can also pave the way for more research funding and partnership opportunities. They will also gain access to a wealth of new data, both from the public sector and from the implemented smart mobility systems, that can be utilized for further research particularly related to AI based techniques and algorithms development in relation to traffic management, increase traffic safety and others.

Citizens:

- **Value Offered:** The value offered by citizens that are involved in the city issues and are participating in the evolution of their city environment is very valuable to the smart mobility solution design and implementation. Citizens can offer valuable insights, experience and local knowledge can form specific policies that will be beneficial for all. Engaged citizens can be involved in the co-design of specific pilots, in the specification of requirements and the initial proof of concept trials.
- **Value Gained:** The most significant value citizens gain is the direct improvement to their lived environment and the enhancement of public services, which can lead to a higher quality of life. An inclusive, transparent mobility framework that has been co-designed by citizens enables citizens to influence the shape **of t**heir urban living, leading to increased civic satisfaction, a sense of ownership, and stronger community bonds.

6.2.2.1.3 Interconnections and value flows among the four stakeholder groups

In the Quadruple Helix (QH) model adopted for the METACITITIES project, the interconnections and value flows among the four stakeholder groups—Public Sector, Business, Academia, and Citizens—are integral to the success of smart mobility initiatives. Public Sector act as orchestrators, setting policies and regulations that guide the development of urban mobility solutions. Business partners, encompassing technology providers and urban service developers, leverage these regulations to innovate and implement cutting-edge solutions. Academia plays a vital role by contributing research, knowledge, and expertise, helping to bridge the gap between theoretical advancements and practical implementation. Citizens, as active participants, offer real-world insights and feedback, influencing decision-making and ensuring that the solutions align with community needs. This interconnected ecosystem creates a dynamic flow of value—information, expertise, and resources—enabling a collaborative and holistic approach to smart mobility. The symbiotic relationships among these stakeholders not only facilitate the co-creation of innovative solutions but also ensure that the resulting smart mobility initiatives are adaptive, sustainable, and responsive to the evolving needs of the community. Table 27, Table 28, Table 29 and Table 30 illustrate the value flows within the Quadruple Helix (QH) approach.

Table 27: Public Sector - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Businesses	• Opportunities for businesses to pioneer and implement cutting-edge technologies in smart mobility solutions. • Encouragement of partnerships and collaborative projects, fostering innovation in the smart mobility sector.	• Businesses contribute cutting-edge technologies and innovative solutions to enhance smart mobility initiatives. • Private sector investments contribute to the enhancement of infrastructure, including charging stations and smart traffic systems.

QH Group	Values Offered	Values Received
	• Investment in smart infrastructure, including intelligent transportation systems and charging stations. • Investment in electric vehicle charging infrastructure to support the adoption of electric mobility.	• Collaborative projects with businesses foster job creation in the smart mobility sector.
Academia	• Extensive opportunities for academic research and development in the field of smart mobility. • Availability of real-world data generated by smart mobility projects for academic research. • Collaborative development of educational programs to equip students with skills relevant to smart mobility. • Utilization of data analytics for traffic pattern analysis, route optimization, and system efficiency improvement.	• Academia provides valuable research insights and data analytics expertise for informed decision-making. • Collaboration with academia results in a skilled workforce, ready to contribute to the evolving smart mobility landscape. • Development of educational programs prepares students for future roles in smart mobility.
Citizens	• Improved transportation services for citizens, offering efficient and sustainable commuting options. • Promotion of eco-friendly transportation modes, contributing to a reduction in environmental impact. • Provision of real-time information on transportation options for citizens' convenience. • Implementation of ITS for improved traffic management and congestion reduction. • Incorporation of emerging technologies, like autonomous	• Citizens contribute real-time data through smart devices, aiding in traffic pattern analysis and mobility planning. • Citizen feedback provides valuable insights for the improvement of transportation services and infrastructure. • Public sector initiatives lead to increased citizen adoption of sustainable and efficient transportation options.

QH Group	Values Offered	Values Received
	vehicles and smart sensors, for enhanced safety and efficiency.	

Table 28: Business - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Development and implementation of smart parking and ITS systems, sensing technology and digital infrastructure technology • Professional expertise and consultation • Innovative business models	• Regulatory guidelines and support, • Public data related to parking usage and traffic for business planning, • Access to real data for application/solution development • Potential public sector partnerships • Understanding requirements
Academia	• Real-world scenarios for academic research on smart parking and traffic models • Funding for academic projects, and students • Business insights and market developments and trends	• Research-driven insights to enhance smart mobility solutions, • Innovative concepts, and cutting-edge tech solutions • Understanding market requirements • Possibility to affect course description and academic curricula • Access to a skilled talent pool of engineers and ICT professionals
Citizens	• Smart mobility solutions to improve urban life, • Job opportunities, • Safety and quality of life enhancement • Enhancements of local communities	• User feedback to improve smart mobility systems, • Market information for business planning, • Revenue through service provision

Table 29: Academia - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Studies on smart mobility and multifaceted traffic management • Contributions to strategic guide policies and roadmaps • Open models for smart parking and traffic management	• Access to real and wealthy data for research, • Access to widescale requirements and national/international guidelines, • Support towards additional funding
Businesses	• Research-based solutions to smart mobility challenges, • Beyond state-of-the-art technologies and innovation, • Trained engineers for smart mobility challenges	• Real-world application scenarios for research, • Opportunities for collaborations, • Expertise on business plan development
Citizens	• Dissemination of knowledge, • Innovative services that benefit public life, • Engagement of focused target groups in research studies	• Insights on real life requirements to drive research, • Alignment of research objectives to societal needs, • Participation in academic initiatives

Table 30: Citizens - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Feedback on smart parking systems, • Participation in public initiatives, • Creative ideas for improving smart parking	• Enhanced parking solutions, • Open data for personal use, • Involvement in shaping parking policies
Businesses	• Direct feedback on smart parking services, • Market information through usage patterns, • Participation in smart parking initiatives	• Access to improved parking services, • Job opportunities, • Improved local communities
Academia	• Participation in research studies, • Local knowledge for research application, • Insights from lived experience	• Knowledge generated by academia, • Involvement in shaping smart parking systems, • Benefit from academic innovations

6.2.2.2 Priority Area 2: Smart environment

The integration of smart environmental initiatives, coupled with the innovative application of Digital Twin technology, holds profound significance in the realm of urban development and sustainability.

By harnessing the capabilities of Digital Twin models, which intricately replicate the physical environment in a digital space, the analysis and prediction of smart environments are elevated to unprecedented levels. This sophisticated technology allows for a comprehensive examination of environmental factors by assimilating data from multiple interconnected sources, drawing insights from existing smart environment projects. The interconnected web of data enables a holistic understanding of environmental dynamics, encompassing factors such as air and water quality, energy consumption, and waste management. Through this analytical lens, decision-makers can not only assess the current state of the environment but also predict future trends, facilitating proactive measures for sustainable urban development. The marriage of smart environmental strategies with Digital Twin technology propels cities towards a future where data-driven insights pave the way for informed decision-making and resilient, eco-friendly urban landscapes.

6.2.2.2.1 QH Stakeholder Analysis and Value Flows

In the context of smart environment in the Greek cluster, the Quadruple Helix (QH) model could be applied as follows:

Public Sector:

Amidst the intricate dynamics of the Quadruple Helix framework for smart environmental initiatives, the collaborative efforts of the public sector, encompassing the Municipality of Patras, the Region of Western Greece, the Chamber of Commerce of Achaia, and the Ministry of Environment and Energy in Greece, reveal a detailed technical landscape. The Municipality of Patras, being central, not only allocates European funds for environmental infrastructure but also takes the lead in integrating cutting-edge technologies for environmental monitoring and management. The Region of Western Greece, drawing insights from demographic considerations, adapts strategies to meet the diverse environmental needs of its populace, encouraging inclusivity in smart environmental solutions. Simultaneously, the Chamber of Commerce of Achaia, through economic analyses, identifies opportunities for sustainable, technology-driven enterprises and aligns them with smart environmental initiatives. Concurrently, the Ministry of Environment and Energy in Greece injects specialized environmental science and policy expertise, aligning national regulations with local initiatives. This coordinated collaboration results in a value flow where European funding supports environmental infrastructure, demographic considerations inform solutions, economic analyses drive sustainable innovation, and specialized environmental expertise guides policy development. Each public sector stakeholder, in this detailed interplay of funding, technology, and environmental science, assumes a crucial role, propelling smart environmental strategies in Patras and contributing to broader sustainable urban development objectives.

Businesses:

In addition to pNet and Yodiwo, the business group can also comprise large-scale corporations, SMES and innovative start-ups. The digital ecosystem of Patras includes many startups, SMEs and larger scale enterprises that have a business portfolio related to smart environment solutions and practices. Furthermore, many companies in the area recognize sustainability and green solutions as part of their business market area and in some cases part of their processes. p-NET that brings together the expertise of the competence center, where large communication vendors (INTRACOM) and IT solution providers (Uni Systems) are beneficiaries. It is also represented with Yodiwo, that is very active in the field of IoT and digital platform technologies facilitating data gathering and analysis for smart

environment solutions. Large IT (Dynacomp) and technology (Renesas) companies that wok in the domain of application and data base development in Patras but also in the sensor technology and development respectively. MEASON targets smart energy metering IoT devices and many start-ups working in the field of green buildings and green critical infrastructure.

Academia:

The contribution of this group to smart environment initiatives is important. Specifically University of Patras – ECE, and all engineering Departments, University of Peloponnese – ECE, and all engineers, Research Institutes, and other Academic institutions in the region like Industrial Systems- Athena and CTI can offer an important contribution in smart environment solutions. These institutions are well-known for their activities and research in monitoring air and water quality, energy consumption management, waste management and noise pollution monitoring. For instance, they could conduct studies on the correlation of the traffic and /or incidents and the environmental indices of a part of a city. They could also develop algorithms for the environmental and noise monitoring in real time and train air quality forecasting models.

Citizens:

In the pursuit of smart environmental initiatives within Priority Area 2 of the METACITITIES project, the active participation of citizens emerges as a cornerstone for success. Citizens play a vital role in the sustainable development of urban landscapes, and their engagement is essential for the effective implementation of smart environment strategies. By involving citizens, including commuters, biking and scooter rider associations, and dedicated NGOs such as the Road Safety Institute and the Ecological Movement of Patras (OIKIPA), the project gains a diverse and comprehensive perspective on environmental dynamics. This active involvement extends to the SDGHouse Patras, particularly in the context of the Orange Grove, where citizens contribute valuable insights into sustainable practices. The collaboration with citizens goes beyond traditional boundaries, fostering a sense of shared responsibility for environmental well-being. Through such engagement, citizens become not only recipients of smart environmental solutions but active contributors to shaping a resilient, eco-friendly urban landscape. The METACITITIES project recognizes the pivotal role of citizens in achieving its smart environment goals and aims to create a symbiotic relationship wherein citizens are empowered to co-create a sustainable future for their city.

6.2.2.2.2 Value analysis within the Quadruple Helix (QH) approach

Public Sector - Governmental Entities:

- **Value Offered:** In the collaborative ecosystem of the Quadruple Helix, the public sector, including the Municipality of Patras, the Region of Western Greece, and the Ministry of Environment and Energy in Greece, contributes essential values to the partnership. The public sector functions as the cornerstone for funding and policy implementation, offering financial support and regulatory frameworks that guide smart environmental initiatives. Additionally, it provides a platform for dialogue and collaboration, nurturing a conducive environment for knowledge exchange and the seamless integration of technological advancements. By aligning policies with environmental goals, the public sector ensures a holistic approach that prioritizes sustainability and the well-being of the community.
- **Value Gained:** Reciprocally, the public sector gains significant values from the other partners within the Quadruple Helix—academia, industry, and civil society. Academia contributes cutting-edge research, scientific expertise, and a pool of innovative ideas, enriching the public

sector's knowledge base and fostering continuous learning. Industry brings technological advancements, practical solutions, and economic opportunities, aiding the public sector in implementing sustainable and efficient environmental strategies. Civil society provides invaluable insights into community needs, preferences, and concerns, ensuring that the public sector's policies and initiatives align with the aspirations of the local population. This reciprocal exchange of values creates a synergistic collaboration where each partner enhances the overall effectiveness of smart environmental initiatives within the Quadruple Helix framework.

Businesses:

- **Value Offered:** For the specific priority, businesses that are involved may offer their technological expertise, resources, and innovative technologies in smart environment projects and product development. Some of the businesses that have applied low carbon emission solutions or smart emission/energy metering solutions for data analysis may convey the experience of applicability. In some cases, entrepreneurs may impact-driven innovations and/or new approaches and bring them to the market with the potential to accelerate the transition towards a more sustainable, resilient and equitable future.
- **Value Gained:** Businesses stand to gain significantly from their involvement in smart environment projects, as this may give them access to new business opportunities and markets, and in some cases, they may also gain access to data generated through the smart systems for improving their products and services (for example a routing application may offer suggestions for bikers through greener routes etc.). Furthermore, their active involvement in public service initiatives allows them to have access to new customer bases, and benefit from enhancing their corporate image showcasing them as leaders in smart city solutions. Last but not least businesses that seek to engage sustainable solutions and support transition to such process will be able to promote sustainability into the culture and business model they are currently developing.

Academia:

- **Value Offered**: Academic institutions bring theoretical expertise, novel ideas and research background that can significantly contribute to smart environment initiatives. Their involvement can include energy consumption management, waste management and noise monitoring. They can conduct studies on the correlation of the traffic and /or incidents and the environmental indices of a part of a city. They could also develop algorithms and services for the environmental and noise monitoring in real time and train air quality forecasting models.
- **Value Gained:** Academic institutions can connect their research with real-world applications and societal impact. By pushing the boundaries of their research, the feedback loop from practical application frequently presents new research topics and gives data to advance their academic exploration. These interactions can also improve their institutional reputation by expanding financing prospects, fostering cross-institutional collaboration, and elevating their social influence.

Citizens:

- **Value Offered**: Citizens contribute significant value to the smart environmental initiatives within Priority Area 2 of the METACITITIES project. Through active participation, citizens offer a wealth of insights into sustainable practices, environmental concerns, and community-specific needs. Commuters provide firsthand observations on transportation patterns, while biking and scooter rider associations bring a unique perspective on eco-friendly mobility solutions. NGOs such as the Road Safety Institute and the Ecological Movement of Patras

(OIKIPA) contribute specialized knowledge in road safety and recycling, respectively. This diverse range of inputs forms a valuable reservoir of information, enriching the decision-making process and ensuring that smart environmental strategies are both effective and tailored to the community's distinct requirements.

- **Value Gained**: In return for their active involvement, citizens stand to gain significant value from the smart environmental initiatives championed by the METACITITIES project. The adoption of Digital Twin technology and smart environmental strategies enhances citizens' quality of life by providing real-time insights into environmental factors such as air and water quality, energy consumption, and waste management. Through their participation, citizens become integral contributors to the co-creation of a sustainable urban landscape. The knowledge gained from the project empowers citizens with a deeper understanding of their environment, enabling informed decision-making about their daily lives. Moreover, citizens benefit from a sense of shared responsibility for the community's well-being, fostering a stronger connection to their city. The METACITITIES project recognizes citizens not just as recipients of smart environmental solutions but as active partners in building a resilient, eco-friendly urban environment.

6.2.2.2.3 Interconnections and value flows among the four stakeholder groups

In the Quadruple Helix (QH) model adopted for the METACITITIES project, the interconnections and value flows among the four stakeholder groups—Public Sector, Business, Academia, and Citizens—are integral to the success of smart environment initiatives, that may have longer term impact than other initiatives. Public Sector act as orchestrators, setting policies and regulations that guide the development of such solutions that echo the European and national frameworks. Business partners, leverage upon these regulations and initiatives to innovate and implement cutting-edge solutions and change their mind-set and business plans. Academia plays a pivotal role by contributing research, knowledge, and expertise, helping to bridge the gap between theoretical advancements and practical implementation. Citizens, as active participants, offer real-world insights and feedback, influencing decision-making and ensuring that the solutions align with community needs and experiences. This interconnected ecosystem creates a dynamic flow of value—information, expertise, and resources as will be explained in the Table 31,

Table 32, Table 33 and Table 34.

Table 31: Public Sector - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Businesses	• Businesses gain opportunities to pioneer and implement innovative environmental technologies. • The public sector encourages collaborative innovation, fostering partnerships between businesses and environmental initiatives. • Investment in smart environmental infrastructure, creating a foundation	• Businesses contribute cutting-edge environmental technologies and sustainable solutions. • Private sector investments contribute to the enhancement of environmental infrastructure, including waste management and energy-efficient systems.

QH Group	Values Offered	Values Received
	for businesses to deploy sustainable technologies.	• Collaborative projects with businesses foster job creation in the smart environment sector.
Academia	• Extensive opportunities for academic research and development in the field of smart environmental solutions. • Availability of real-world environmental data for academic research and data-driven insights. • Collaborative development of educational programs to prepare students with skills relevant to the evolving smart environment. • Utilization of data analytics for analyzing and predicting environmental patterns.	• Academia provides valuable research insights and data analytics expertise for informed decision-making in environmental policies. • Collaboration with academia results in a skilled workforce, ready to contribute to evolving smart environment initiatives. • Academic partnerships contribute to the development of educational programs for environmental sustainability.
Citizens	• Smart environmental initiatives contribute to a better quality of life for citizens through cleaner air, water, and a healthier environment • Public sector initiatives raise awareness among citizens about environmental issues and sustainable practices. • Citizens benefit from access to real-time environmental data, enabling informed decisions for a sustainable lifestyle. • Incorporation of sustainable technologies for waste management, energy efficiency, and conservation.	• Citizens contribute real-time environmental data through smart devices, aiding in monitoring and decision-making. • Public sector initiatives based on citizen feedback result in a healthier and more sustainable living environment. • Citizens actively participate in and support smart environment initiatives, fostering community engagement. • Citizen contributions provide valuable data for data-driven decision-making in environmental policies.

Table 32: Business - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Development and implementation of smart environment solutions	• Regulatory guidelines and support, • Public data related environment

QH Group	Values Offered	Values Received
	• Professional expertise and consulting • Innovative business models • Involvement in pilot design and implementation	• Potential public sector partnerships
Academia	• Real-world scenarios for academic research on environment • Funding for academic projects, • Business insights	• Research-driven insights and models to enhance proposed solutions, • Innovative concepts, • Access to a skilled talent pool
Citizens	• Data that can lead to solutions to improve urban life, • Job opportunities, • Enhancements to local communities	• User feedback to improve developed systems, • Market information for business planning, • Revenue through service provision

Table 33: Academia - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Studies on smart environment • Contributions to strategic guide policies and roadmaps • Open models for smart environment monitoring • Involvement in pilot design and implementation	• Access to real and wealthy data for research, • Access to wide scale requirements and national/international guidelines, • Support towards additional funding
Businesses	• Research-based solutions to smart environment challenges, • Beyond state-of-the-art technologies and innovation, • Trained engineers for smart environment challenges	• Real-world application scenarios for research, • Opportunities for collaborations, • Expertise on business plan development
Citizens	• Dissemination of knowledge, • Innovative services that benefit public life, • Engagement of focused target groups in research studies	• Insights on real life requirements to drive research, • Alignment of research objectives to societal needs, • Participation in academic initiatives

Table 34: Citizens - Values Offered to QH Groups and Values Received from QH Groups

QH Group	Values Offered	Values Received
Public Sector	• Environment issues based on local knowledge and experience • Feedback on pilots • Participation in public initiatives, • Creative ideas for improving environmental solutions	• Enhanced urban environment • Open data for personal use, • Involvement in shaping parking policies • Enhanced sustainability and quality of life
Businesses	• Direct feedback on services and solutions • Market information through usage patterns, • Participation in initiatives	• Access to improved spaces • Job opportunities, • Improved local communities
Academia	• Participation in research studies, • Local knowledge for research application, • Insights from lived experience	• Knowledge generated by academia, • Involvement in shaping future systems, • Benefit from academic innovations

6.2.3 BG Cluster Priority Areas in the Scope of METACITITIES project

Within the METACITITIES project the activities demonstrating the Bulgarian priority area is Green and climate adaptive resource management. The pilot activities demonstrate three use cases.

6.2.3.1 Priority Area: Green and climate adaptive resource management

As stated in the DIGITAL Europe Program "making Europe greener and more digital are the twin challenges for our generation, and our success in meeting them will define our future." That is why the Bulgarian cluster strives for innovative research and smart solutions **to protect environment and introduce measures supporting climate adaptation for cities.**

The activities in the priority area can adequately respond to climate change, support zero-carbon development, and build more efficient and resilient cities by enhancing the benefits of Digital Twin technologies. The overall efficiency of city operations is expected to be improved, and labour input, material input, and urban energy consumption significantly reduced, forming a greener, more intensive, and more efficient development model.

To tap into this potential, the Bulgarian cluster will inform citizens, companies, and public institutions about the potential of their properties, especially unused roof spaces, for solar energy production. In addition, the partners of the Bulgarian cluster have access to a digital platform aiming to provide useful information to home owners and investors on the economic feasibility of a PV installation.

According to the results of the METACITIES project the Bulgarian cluster wants to upgrade the existing in Burgas tools using innovative research from the Open Digital Twin Framework in order to automate

the analysis and incorporate it in the investment strategy and planning of energy efficiency solutions for the city.

The implemented pilot project for Burgas will use the tools of the Open Digital Twin Framework to upgrade the existing GIS platform of Burgas and the Integrated Urban Platform *SmartBurgas* with new functionalities related to the solar potential of the city and energy efficiency of public buildings.

The activities will focus on gathering relevant and valid data sources to make 3D Digital Twins of one or more public buildings. Those will then be used to show how AI and machine learning algorithms can be used to detect patterns and solve problems regarding energy efficiency, air quality, or climate conditions. This will lead to improvement of the ability of the participants of the QH to formulate data-driven policies and investment strategies, which will ensure a more sustainable and efficient urban environment.

Proof-testing in this domain of a Digital Twin may benefit all Bulgarian cities and shareholders of the QH approach.

6.2.3.1.1 QH Stakeholder Analysis and Value Flows

Smart cities serve as an innovation intermediary, connecting different stakeholders, and allowing for real-life validation, ideation, and co-creation. In the context of Green and climate adaptive resource management, the QH model could be applied for the Burgas use cases as follows:

Public Sector:

The Burgas Municipality which is the main public actor and the primary stakeholder in the creation of strategies and policies in the Bulgarian R&I ecosystem, represented in the METACITITIES project. Similarly, local municipalities in Bulgaria have jurisdiction, and they are playing a key role in executing and managing localized smart city initiatives. These entities have access to European funding programs such as the European Regional Development Fund or the Horizon Europe programme or utilize local resources (depending on the scale of the project) to financially support green and climate adaptive resource management projects. Moreover, there are strategic government initiatives and institutions involved. These authorities hold extensive data repositories, encompassing aspects such as population demographics, existing infrastructure layouts, energy efficiency, regulations, and others. This information is invaluable when creating data-driven energy efficiency solutions. There are regulatory organisations which are directly involved in validation and control processes.

Businesses:

The business group can also encompass a wide range of entities, from large-scale companies to innovative start-ups, all of which can provide vital resources and expertise and have a role in shaping the smart city ecosystem activities. For example, construction companies can bring expertise in infrastructure development and contribute to the design and implementation of smart, sustainable, and energy efficient buildings, or upgrade existing infrastructure to align with energy efficiency and resource management goals. Tech companies contribute with their proficiency in advanced IT, IoT-based, or digital solutions. Such companies can develop and manage digital systems that optimize resource distribution, manage data flows, or automate various urban processes.

Academia:

The contribution of this group to green and climate-adaptive resource management is vital, especially through research and innovation. In addition to TUS, which is a core member of the METACITITES consortium, the University Prof. Asen Zlatarov Burgas and the Burgas Free University can also be considered important stakeholders. These institutions are all well-known for their strong departments related to energy efficiency, environmental studies, and engineering and can contribute valuable research and innovation to the planning process and creation of machine learning processes. They also could conduct studies on sustainable city resource management or develop algorithms for efficient resource distribution or explore the environmental impact of different urban layouts.

Citizens:

The active participation of citizens is essential for the success of green and climate-adaptive resource management. Residents of urban areas, citizen groups, and non-profit organizations need to be engaged in the planning and validation processes. This engagement can be achieved with the support of different associations for energy efficiency and environmental protection, which are expected to offer unique insights into the needs of citizens, and users of the different services to be designed and planned for deployment within the project. Citizens provide valuable insights based on their living experiences, preferences, and energy needs. Local community groups, neighbourhood associations, and online citizen forums can be invaluable sources of feedback and ideas. For instance, the views of residents of Burgas can be sought regarding the Renewables (PV) potential_usage for Burgas or the implementation of smart resource management systems in households and public buildings. This engagement process ensures that the urban solutions designed are not just smart but also sensitive to the community's diverse needs. In a smart city, citizens transition from passive users to active co-creators of their urban environment is very important.

6.2.3.1.2 Value analysis within the Quadruple Helix (QH) approach

Public Sector - Governmental Entities:

- **Values Offered:** In the QH model the public sector, represented by the Burgas Municipality, supported by district level government play important role in the process of shaping the investment projects for improvement of the energy efficiency in buildings as well as ensuring that the planning and implementation of smart urban projects align with national laws and regulations. Moreover, these entities have access to public funding and data. By providing data, which may include data on demographics, infrastructure, environmental factors, and more, the public sector offers valuable insights that shape the direction of green and climate adaptive resource management in the city. In addition, through their authoritative position, they have the unique ability to convene diverse stakeholders, establishing a platform for collaborative decision-making using the public communication channels and forums for open discussions.
- **Values Gained:** As initiators and facilitators of such initiatives, governmental and local administration bodies can benefit in several ways. The most apparent is feedback on their services and project implementations, leading to improved urban planning and energy efficiency on city level that more effectively meets the needs for climate adaptation and net-zero economy. Specifically, the consequent social value can be significant: i) better energy efficiency for private and public buildings and infrastructure; ii) improved public satisfaction; iii) increased energy savings; and iv) potentially significant economic growth. In addition, they gain from knowledge and innovation exchange with businesses, academia, and citizens, which can lead to more sustainable and forward-thinking energy efficiency strategies.

Businesses:

- **Values Offered:** Businesses offer an extensive range of expertise, resources, and innovative technologies applied in projects realized locally in Burgas (as for example the Digital Twin of Central Park Complex in Burgas- a totally private business investment). Tech firms offer and implement most advanced IoT technologies for intelligent energy management, while construction companies incorporate smart materials and technologies into building designs and constructions to enhance energy efficiency or safety.
- **Values Gained:** Engagement in green and climate-adaptive resource management projects provides the business sector with opportunities for growth, innovation, and access to new markets, potentially leading to increased revenue. Additionally, projects related to energy efficiency and resource management give them access to new data, insights, and collaborative research, helping them refine their products or services. This can provide opportunities for the businesses to position themselves as market leaders, key contributors, and innovators in energy efficiency and climate adaptation and sustainable environment management and urban planning.

Academia:

- **Value Offered**: Academic institutions bring a wealth of research capacity, theoretical expertise, and novel ideas, that can significantly contribute to green and climate- adaptive resource management projects. Their involvement can include everything from the conception of sustainable resource management practises to the development of Digital Twin models and data-driven algorithms for efficient resource distribution and utilizations. They can produce insightful research to guide the creation of sustainable energy efficiency policies, including environmental impact studies and sociological analyses on the effect of urbanization. They can also leverage their technical expertise to develop cutting-edge solutions, such as AI-driven systems applicable in a smart city context.
- **Value Gained:** Academic institutions can gain critical insights on how their theoretical research applies in practice, linking their academic pursuits with practical implications and societal impact. The feedback loop from practical application often offers new research questions and provides data to drive further academic exploration, pushing the boundaries of their research work. Furthermore, these engagements can increase opportunities for science and research funding, foster cross-institutional collaboration, and elevate their societal impact, thereby enhancing their institutional reputation.

Citizens:

- **Value Offered:** The value offered by citizens extends far beyond their role as end-users of energy management services. With their unique, on-the-ground experiences, they provide essential feedback and local knowledge that can inform the design, implementation, and refinement of energy efficiency and climate adaptation initiatives. Participatory platforms can engage citizens in co-creating apps or services, contributing to the data collection process, and voicing their needs and preferences, ensuring projects stay user-centric. In the cases for executing energy efficiency rehabilitation of household or public buildings savings have direct effect on the everyday life. That is why after first measures implemented the recipients of the measures tend to become more active in assessing the results and participating in new energy related projects.
- **Value Gained:** The most significant value citizens gain is the direct improvement to their living environment and the enhancement of public access to data on energy and resources, which can lead to a higher quality of life and better appreciation of the led by the local administration policies. An inclusive and transparent the participation in the planning process also enables

citizens to influence the shape of their urban environments, leading to increased civic satisfaction, a sense of ownership, and stronger community bonds.

6.2.3.1.3 Interconnections and value flows among the four stakeholder groups

We explore the intricate dynamics among the four core stakeholder groups within the Quadruple Helix model: the public sector, businesses, academia, and citizens. As we navigate the realm of green and climate-adaptive resource management in Bulgaria, it's imperative to understand the value each stakeholder offers and the reciprocal value they gain within this interconnected ecosystem. This reciprocal and multi-dimensional exchange not only fosters a collaborative environment but also drives innovative, efficient, and sustainable solutions. The tables below (Table 35, Table 36, Table 37 and Table 38) provide a detailed depiction of the values offered and received among these groups, highlighting the symbiotic relationships and value flows that are integral to the success of green and climate adaptive resource management initiatives.

Table 35: Public Sector - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Businesses	Funding opportunities, regulation, control and legal guidelines; access to public data for energy efficiency.	Innovative technology solutions for green and climate adaptive resource management projects, valuable resources and professional expertise, sustainable and efficient operational models, information about the economic feasibility of energy efficiency measures on the buildings and resource management.
Academia	Access to public sector data for research, funding for academic projects, and endorsement of academic insights in policy-making.	Comprehensive scientific research, evidence-based insights to guide policy and planning, and innovative and theoretically grounded models for energy efficiency. The feedback loop from practical application often offers new research questions and provides data to drive further academic exploration, pushing the boundaries of their research work
Citizens	Improved public services (energy management, etc.), open data for citizen use, and providing users with the ability to monitor PV energy production potential and get dashboards with predictive models based on real data.	Valuable feedback on local administration efforts to improve life of citizens, citizen support and acceptance of energy efficiency and resource management projects, community-led initiatives and ideas, and inform building owner(s) and citizens about the economic feasibility of energy efficiency investments in buildings.

Table 36: Businesses - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Public Sector	Development and application of innovative solutions; resource allocation for PV systems	Financial support through funding, regulatory guidelines for operation,

QH Group	Values Offered	Values Received
	projects and other energy efficiency investment projects; industry expertise for the planning and implementation of energy efficiency and resource management.	and public sector data for business planning. Organizational support for business development. Opportunities for join projects
Academia	Real-world application scenarios for academic research, financial support for academic projects, industry expertise, and insights.	Research-based solutions to business challenges, innovative ideas and concepts, and access to a skilled talent pool and technical facilities for ground testing.
Citizens	Cutting-edge products and services to improve urban life, job opportunities, and investments in local communities	Direct feedback to improve products and services; information for the economic feasibility of energy efficiency projects, potential market for the business

Table 37: Academia - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Public Sector	Thorough scientific research, evidence-based insights to support policy, and create theoretical and data-driven models for energy efficiency and resource planning.	Access to public sector data for research, funding for academic projects, and policy support for academic research goals.
Business	Research-driven business insights, innovative ideas for business operation, and trained talent for recruitment.	Real-world scenarios for research applications, financial support for academic projects, and business expertise for practical orientation.
Citizens	Dissemination of knowledge, innovations that benefit public life, engagement in research studies.	Insights and feedback to drive research, participation in data collection, and the societal relevance of academic pursuits.

Table 38: Citizens - Values Offered and Values Received to/from the rest of the QH Groups

QH Group	Values Offered	Values Received
Public Sector	Participation in public initiatives, and community-based initiatives related to green and climate-adaptive resource management.	Improved environment, better digital services, open data for personal use, and enhancements to urban living conditions.
Business	Direct feedback on products and services, market information through energy utilization patterns, participation in business initiatives.	Access to innovative products and services, job opportunities, and investments in local communities.

Academia	Participation in research studies, insights from lived experience, and local knowledge for research application.	Knowledge generated by academia, innovations that improve urban life, and involvement in shaping climate adaptive urban infrastructure

6.3 QH Collaboration Approach across regional innovation ecosystems

In the context of the METACITIES project, the three place-based innovation ecosystems in Cyprus, Greece, and Bulgaria partner together to create an Excellence Hub for Future Cities and Regions in South-east Europe (SEE). The METACITIES Excellence Hub is view as a sustainable network that offers a common platform for collaboration, cross-fertilization, and best practices sharing across borders, sectors, and disciplines on knowledge production, circulation, and use. The thematic focus on future and Metaverse cities necessitates the definition of ambitious R&I agendas and the uptake of advanced digital technologies. Founded upon a joint R&I strategy, a nexus of collaborative links across sectors, joint research, innovation, and outreach activities, as well as business modelling and sustainability plans, the Excellence Hub aims to benefit all stakeholder types of the Quadruple Helix Model, regional ecosystems, and the whole SEE region.

The activity of the Excellence Hub is framed by the Joint R&I Strategies and Agendas defined and agreed upon by the three involved place-based innovation ecosystems. The joint R&I Strategy Chapter 5, and the Implementation Plan detailed in Chapter 7 frame the Hub's operation and outline the shared vision, mission, objectives, approaches and collaborative actions of the involved regional innovation ecosystems. In the context of the METACITIES project, the joint R&I strategy is expected to address the complex challenges and harness the opportunities presented by Digital Twins and Metaverse technologies, as well as the benefits of cross-border collaborations for sustainable smart city development.

Despite the growing interest in Digital Twins and Metaverse in Southeast Europe, there are several challenges that the region must overcome to embrace this emerging technology fully. These challenges include, among others, limited access to high-speed internet, the need for significant investments in digital infrastructure, and the development of local talent and skills in immersive (XR) technologies. However, these challenges also present opportunities for regional cooperation, knowledge exchange, and joint investments to advance the development and adoption of the Metaverse in Southeast Europe. Overcoming the regional challenges and fostering collaboration will be essential in unlocking the full potential of the Metaverse and driving innovation in Southeast Europe. Cross-border collaboration is crucial to addressing the challenges and improving the regional 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 aligning goals, sharing resources, and leveraging each other's strengths, they can create innovative solutions that address shared challenges and maximize the potential of Digital Twin and Metaverse technologies.

Municipalities, city councils, and city administrations are responsible for city management and therefore are the main promoters of Smart City initiatives in each specific city, while national and regional governments have control over policies that can affect smart city implementations. These public entities also have the authority and power to assemble and establish a horizontal cooperative

system among all stakeholders and align the aspiring expectations of all stakeholder categories in the QH collaboration sense at a regional level. Therefore, they are also the entities that can play a leading role in the deliberations towards the definition of joint, cross-border R&I strategies and agendas for the collaborating regional innovation ecosystems.

In the process of defining the Joint R&I Strategies and Agendas, a Task Force is created (Figure 4) comprised of the public entities of the involved regional innovation ecosystems. They represent the aligned interests, aspirations and values of all stakeholders in place-based ecosystems and deliberate towards the definition of shared vision, mission, objectives, and collaborative actions. The defined joint actionable research agendas are implemented collaboratively, capitalizing on the realization of a number of collaborative measures, as introduced below.

The joint actionable R&I agenda for the Excellence Hub is proposed to evolve around both:

1. Technical Excellence in areas such as smart networks and services, big data, IoT, Digital Twins, XR and Metaverse. This entails establishing cooperation for information exchange and alignment of research work programmes.
2. Sustainable development capturing economic, societal and environmental aspects. This entails developing a framework for the quantitative evaluation of solutions designed to support environmental, societal and economical sustainability measured by key value indicators.

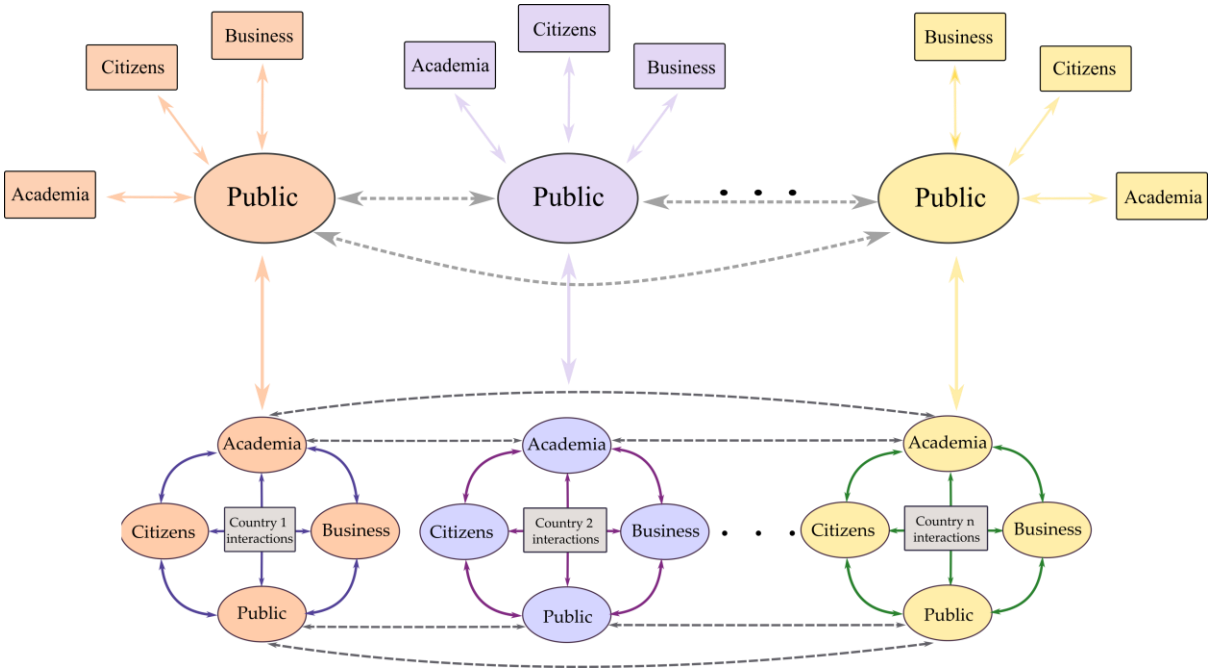

FIGURE 4: CROSS BORDER QH COLLABORATION

For the agenda implementation the project aims to pool academic/research/business resources, mobilize all stakeholder categories, and strengthen collaboration within, across and beyond the involved regional innovation ecosystems. To that aim it will define:

A. A multi-faceted collaboration approach to create value for all members of the Excellence Hub.
B. A most efficient implementation plan of the Strategic R&I Agenda and of the cross-border QH-based collaboration model.

C. Sets of Key Performance and Value Indicators vis-à-vis the strategic goals and priorities.

While items B. and C. will be thoroughly addressed in Chapters 5 and 6 respectively, in the following we present the various potential forms of cross-border collaboration among the three innovation ecosystems:

- Create a repository of project assets (expertise, resources, technologies and best practices) that can be shared among the regional innovation ecosystems.
- Establish a framework for coordination and cooperation and work together on shared standards and frameworks (such as the Open Digital Twin Framework - ODTF), to enhance interoperability and collaboration across the participating teams and countries.
- Facilitate the development of digital infrastructure and promote technological readiness within the region by supporting collaborative infrastructure projects, sharing best practices in infrastructure development, and identifying gaps in regional connectivity.
- Set up shared resources, in laboratories or in the field, for R&I experimentation,
- Promote the exchange of researchers, students, and professionals among countries to foster cross-border knowledge sharing and collaboration. This can be achieved through international conferences, exchange programs, and collaborative research projects. Set up a framework for staff mobility.
- Build-up of a solid knowledge base by formulating and offering accumulated knowledge and experiences into educational and capacity building packages to be offered in the METACITIES community. Create joint capacity-building initiatives and facilitate knowledge exchange among the three clusters to promote regional talent development.
- Empower individuals and organizations to excel in Digital Twin and Metaverse technologies by offering workshops, training programs, and research opportunities
- Exchange best practices in policy and regulation among the CY, BG, and GR clusters and collaborate with policymakers to develop progressive regulations that facilitate the expansion of Digital Twin and Metaverse technologies in the region
- Promote equality, diversity and gender balance in the joint R&I community and working environment.
- Support entrepreneurs scale their businesses across borders by fostering regional networks and providing cross-border access to funding resources
- Attraction of talent.

Cross-border collaboration is crucial in addressing the challenges and improving the regional 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. Planned activities of WP6 play an instrumental role in the effect as they aim to facilitate and empower engagement, collaboration, knowledge transfer and capacity building.

7 Methodology and Implementation Plan

7.1 Introduction

This chapter is devoted to the definition of the methodology and the implementation plan the METACITIES project's partners should follow to reach the objectives of this Joint Strategy. It outlines the strategic approach and practical steps to be taken in order to achieve the Joint Strategy's objectives. This section serves as a roadmap for guiding the partners through the various stages of the Joint Strategy, from conceptualization to execution.

The methodology can also serve as a roadmap for the design and implementation of future Joint Strategies of other research and innovation ecosystems, as a part of the Toolbox to be created by METACITIES project.

7.2 Common Methodology

Implementing such a strategy requires a systematic approach that aligns various elements and stakeholders. The methodology for designing and implementing the METACITIES Joint Strategy could be aligned as illustrated in Figure 5.

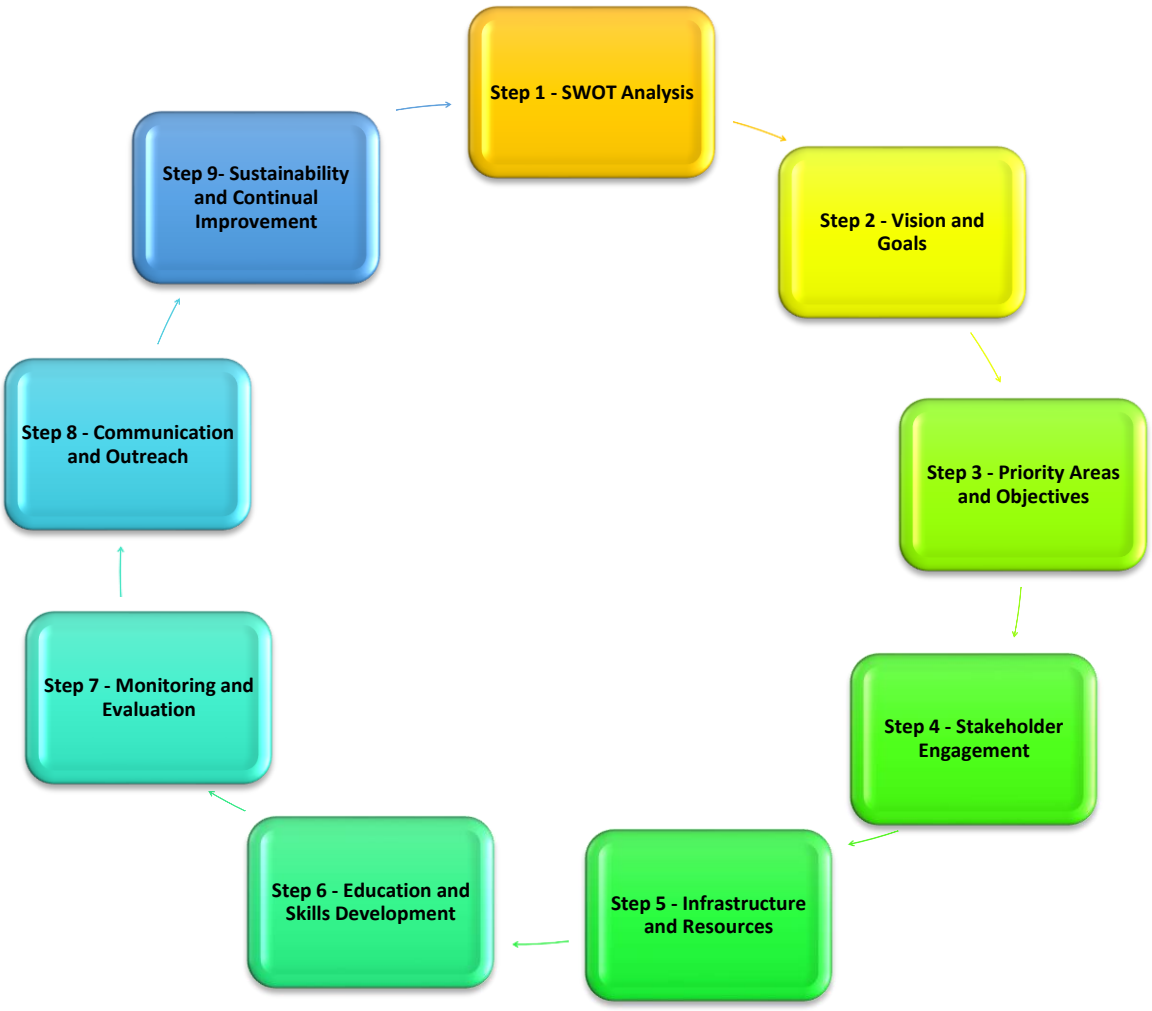

FIGURE 5: METHODOLOGY FOR THE METACITIES JOINT STRATEGY

Step 1 - SWOT Analysis:

Conducting a comprehensive Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to assess the current R&I landscape in the intervention area for each ecosystem. A comprehensive SWOT analysis involves evaluating the sector's[7] internal strengths and weaknesses, as well as opportunities and threats. This analysis is a strategic planning tool that helps researchers/stakeholders understand their current position and make informed decisions. The main elements and outcomes of this step are already described thoroughly in Chapter 3 where the 3 Clusters analyse in detail their region's characteristics concluding to commonalities that constituted the basis for the formation of the common priorities and goals, and in Chapter 5 after the definition of the shared vision, objectives, priorities and goals of the excellence hub.

Step 2 - Vision and Goals:

The vision and goals of a strategy are essential components that guide in achieving its long-term aims. The vision is a compelling and aspirational statement that describes the desired future state or outcome that an organization aims to achieve. It is an overarching concept that provides direction and purpose. A vision should inspire and motivate stakeholders, all other engaged parties, and partners. It focuses on the long-term and paints a picture of what success looks like in the future. The vision statement should be easy to understand and communicate.

The vision of the METACITIES Strategy has been defined as follows and it is aligned with broader economic and societal goals:

"*to improve quality of life and experience of citizens, enhance urban efficiency and create a more connected, responsive, inclusive and environmentally conscious urban environment, through integration of innovative Smart city technologies, digital connectivity, data-driven solutions and sustainable practices, optimizing the use of resources and services that foster economic growth.*"

Following a common agreement on the vision of this integrated Strategy, the METACITIES partners proceeded in further outlining specific, measurable, achievable, relevant, and time-bound (SMART) goals to guide the strategy's implementation. These goals have been derived from the analysis made earlier[8] on each clusters' local characteristics and priorities in the sector of Digital Twins and Metaverse Development in South-east Europe and the merging of their common elements. They provide a roadmap for achieving the broader vision.

The common goals identified as the basis for building this Joint R&I Strategy are:

1) **Digital Transformation and Innovation** - Improve research and innovation capacity and foster a culture of innovation and technological development, focusing on the development of digital infrastructure, skills, and a competitive digital economy, as well as modernising public administration, promoting the uptake of digital technologies in business and improving the digitalisation of services for citizens.

[7] In our case, the sector of 'Digital Twins and Metaverse Development in Southeast Europe'

[8] Please see Chapter 5

2) **Connectivity and Infrastructure Development for Digital Transformation -** Developing and deploying secure digital infrastructure, providing access to digital skills and knowledge, and strengthening digital connectivity and thereby achieving high-speed connectivity and improving digital competitiveness, digital infrastructure, and technology deployment.
3) **Sustainable Economic Growth and Social Inclusion** - Reducing social and territorial inequalities and promoting shared prosperity to achieve sustainable economic growth by diversifying the economies of the three countries and fostering competitiveness.
4) **Environmental Sustainability, Low-Carbon Economy, and Green Transition** - Promoting the use of clean energy, mitigating climate change, and transitioning to a low carbon economy. This highlights the importance of clean air, biodiversity, and resource efficiency, as well as the importance of climate change mitigation and environmental protection.
5) **Transport and Digital Connectivity -** Improve transport connectivity by strengthening smart urban mobility and digital connectivity, including high-speed road and digital connections**.**
6) **Enhancing Education and Digital Skills and Human Resources** - A shared commitment to improving education and skills development to better adapt people to technological change and participate in the digital economy. 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.
7) **Entrepreneurship regarding Research Innovation -** Strengthening research and innovation ecosystems, encouraging public and private investment in R&D and supporting the science-business nexus.
8) **Research, Innovation, and Education** - Strengthen research and innovation capacities, enhance skills development, and improve human resources in the fields of new technologies and innovation.

Step 3 - Priority Areas and Objectives:

Usually a R&I strategy encompasses various priority areas and sectors to foster economic development, competitiveness, and sustainability within a specific geographic region. The specific priorities may vary, based on the region's strengths, challenges, and developmental goals. Based on the three cluster's areas' characteristics and local priorities, METACITIES partners identified the following four common Priority Areas: A) Smart and Safe Mobility, B) Smart Environment, C) Smart Urban Planning and D) Green and climate adaptive resource management.

These Priority Areas were then crossed with the Goals described in Step 2 above resulting to the following common objectives:

PRIORITY AREA A) Smart and Safe Mobility

1) Digital Transformation and Innovation

Objective A1: Create user-friendly and interoperable digital platforms for access to real-time traffic and incident information for citizens.

2) Connectivity and Infrastructure Development for Digital Transformation

Objective A2: Implement a digital infrastructure and network system, based on open data and technologies to monitor and traffic flow and manage incidents.

3) Sustainable Economic Growth and Social Inclusion

Objective A3: Promote smart mobility initiatives to enhance social inclusion for socially sensitive groups (e.g. smart parking) and foster sustainable economic growth.

4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective A4: Encourage the adoption of eco-friendly transportation options and promote the use of public transit systems for all.

5) Transport and Digital Connectivity

Objective A5: Enhance and advocate for digital connectivity to provide real-time mobility information and data.

6) Enhancing Education and Digital Skills and Human Resources

Objective A6: Strengthen education and digital skills development initiatives to build a skilled human resource base supporting smart mobility solutions.

7) *E*ntrepreneurship regarding Research Innovation

Objective A7: Foster entrepreneurship in research and innovation to drive advancements in smart mobility solutions.

8) Research, Innovation, and Education

Objective A8: Promote research, innovation, and education to drive progress and excellence in these fields.

PRIORITY AREA B) Smart environment

1) Digital Transformation and Innovation

Objective B1: Implement digitization of citizen services to provide real-time information on air pollution and weather conditions within the city.

2) Connectivity and Infrastructure Development for Digital Transformation

Objective B2: Develop connectivity and infrastructure for digital transformation, including the implementation of smart energy metering, consumption, and saving systems for public buildings.

3) Sustainable Economic Growth and Social Inclusion

Objective B3: Promote smart environment initiatives for social inclusion and sustainable economic growth.

4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective B4: Implement innovative environmental solutions, such as smart recycling systems, to facilitate the shift towards a more eco-friendly and environmentally conscious economy.

5) Transport and Digital Connectivity

Objective B5: Enhance and advocate for digital connectivity to provide real-time environmental information.

6) Enhancing Education and Digital Skills and Human Resources

Objective B6: Enhance education, digital skills, and human resources development to support and advance smart environment initiatives.

7) Entrepreneurship regarding Research Innovation

Objective B7: Promote entrepreneurship in research and innovation to drive sustainable solutions for a smart environment.

8) Research, Innovation, and Education

Objective B8: Promote research, innovation, and education to drive progress and excellence in these fields.

PRIORITY AREA C) Smart urban planning

1) Digital Transformation and Innovation

Objective C1: Develop a competitive digital economy by providing a digital platform showing existing and future municipality topography (e.g., iNicosia).

2) Connectivity and Infrastructure Development for Digital Transformation

Objective C2: Deploy digital infrastructure and technology such as IoT sensors and IoT gateways.

3) Sustainable Economic Growth and Social Inclusion

Objective C3: Promote initiatives such as smart parking to achieve sustainable economic growth within the framework of promoting social inclusion.

4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective C4: Foster a green digital transition by (a) promoting sustainable practices in urban development, including initiatives such as smart transportation and smart city development, while (b) facilitating a shift towards a low carbon economy through the adoption of eco-friendly solutions.

5) Transport and Digital Connectivity

Objective C5: Improve transport connectivity and digital connections by providing real-time data such as traffic, regarding the municipality.

6) Enhancing Education and Digital Skills and Human Resources

Objective C6: Improve education and skills deployment to better adapt people to technological and environmental change.

7) Entrepreneurship regarding Research Innovation

Objective C7: a) Promote innovation regarding city development, and b) Support science and business cooperation for the city development.

8) Research, Innovation, and Education

Objective C8: a) Enhance skills development, and b) Improve human resources in the fields of new technologies and innovation.

PRIORITY AREA D) Green and climate adaptive resource management

1) Digital Transformation and Innovation

Objective D1: a) Improve research and innovation capacity, and b) Improve the digitalization of services for citizens.

2) Connectivity and Infrastructure Development for Digital Transformation

Objective D2: Development of the digital infrastructure.

3) Sustainable Economic Growth and Social Inclusion

Objective D3: Achieve sustainable economic growth.

4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective D4: a) Promote the use of clean energy, mitigating climate change, b) Transition to a low carbon economy, c) Resource efficiency, and d) Environmental protection.

5) Transport and Digital Connectivity

Objective D5: Improve digital connectivity.

6) Enhancing Education and Digital Skills and Human Resources

Objective D6: a) Skills development to better adapt people to technological and environmental changes, and b) Promote a culture for innovation.

7) Entrepreneurship regarding Research Innovation

Objective D7: a) Support research and innovation ecosystems, and b) Promote investments and links between science and business.

8) Research, Innovation, and Education

Objective D8: Improve human resources in the fields of new technologies and innovation

Step 4 - Stakeholder Engagement:

Stakeholder engagement is important for the successful implementation of territorial strategies, as it involves actively the various stakeholders who have an interest or are affected by the strategy. This step towards a strategy's implementation includes the identification and engagement of key stakeholders, including government agencies, businesses, research institutions, and local

communities. In addition, specific measures need to be designed and applied to foster collaboration and communication channels to ensuring stakeholders' active participation and a shared vision.

A detailed in-depth analysis for the scope of this document is made in Chapter 6 where all important stakeholders per cluster, per priority and per objective are clearly aligned, respecting the Quadruple Helix Approach. Complementarity, Task 6.3 works on the definition of the most appropriate means to engage the different types of involved stakeholders and at the identified stages of stakeholder involvement; a) awareness-raising; b) co-creation; c) validation; and d) adoption.

Step 5 - Infrastructure and Resources:

Smooth implementation of a Strategy requires the appropriate deployment of infrastructure and resources. It is therefore essential to assess and enhance the cooperation area's research and innovation infrastructure, including laboratories, technology parks, and collaborative spaces. On the other hand, it is also critical to be able to allocate resources efficiently. To effectively execute a strategy's plan and achieve desired outcomes, various types of resources should be examined and utilised such as:

- Financial Resources: Adequate funding is essential to support activities such as infrastructure development, marketing campaigns, and community engagement efforts.

- Human Resources: Skilled personnel are needed to manage and execute various aspects of the strategy, including project management, data analysis, community outreach, and stakeholder engagement.

- Physical Resources: This includes infrastructure such as transportation networks, utilities, buildings, and land, which are necessary for economic development and quality of life improvements.

- Technological Resources: Utilizing technology tools and platforms can enhance communication, data analysis, and productivity. This may include software for GIS mapping, data analytics, communication tools, and project management systems. In METACITIES Digital Twins and Metaverse technologies lie in the core of the technology resources required for pursuing the vision.

- Collaborative Resources: Building partnerships and alliances with other organizations, businesses, government agencies, and community groups can provide access to additional expertise, resources, and support.

- Educational and Training Resources: Providing education and training opportunities for stakeholders, including businesses, workers, and community members, can help build capacity and enhance the effectiveness of the strategy's implementation.

- Cultural and Social Resources: Recognizing and leveraging the unique cultural assets and social capital within the territory can contribute to community cohesion, identity, and resilience. In the case of the present integrated R&I Strategy, this type of resource gains more value since the effort by the excellence hub refers to collaboration between different clusters coming from different EU member states, with different cultural and social background[9].

[9] The three clusters might be representing the common wider area of SE Europe, however each of them represents a different region, with unique characteristics, different regulatory framework and technological advancements.

Infrastructure and resources of the Excellence Hub will be discussed in detail in the framework of the design of the Business Model of the Excellence Hub and the Smart Cities, in WP5.

Additionally, infrastructure and resources required for the implementation of specific actions, will be discussed in detail in the relevant WPs.

Step 6 - Education and Skills Development:

By investing in education and fostering collaboration between academia and industry, regions can ensure that their workforce remains competitive and capable of driving innovation and economic growth in an increasingly technology-driven world.

Investing in education and skills development programs to build a skilled workforce that meets the demands of emerging technologies and industries contributes to boosting adaptability to technological advancements, enhanced innovation, addressing skills gaps, increased productivity, and efficiency. To foster collaboration between academia and industry, it is essential to establish partnerships and initiatives that facilitate knowledge exchange and collaboration. This is the case of METACITIES project's partnership and this is one of the objectives of WP6 whereby Task 6.2 is devoted to knowledge and technology transfer, to the development of training programs to elevate skills and to capacity building initiatives focused on business acumen and entrepreneurship.

Step 7 - Monitoring and Evaluation:

Monitoring and evaluation of a strategy is central for assessing its effectiveness, identifying areas for improvement, and ensuring that it achieves its intended outcomes. In other words, it involves systematically tracking and assessing the progress and performance of the strategy throughout its life-cycle.

Monitoring and evaluation allow stakeholders to measure the effectiveness of the strategy in achieving its stated goals and objectives. By collecting relevant data and analysing key performance indicators (KPIs), decision-makers can determine whether the strategy is making the desired impact on interregional cooperation, economic development, social cohesion, or any other targeted outcomes.

Additionally, through continuous monitoring and evaluation, weaknesses or challenges within the interregional strategy can be identified early on. This enables stakeholders to address issues promptly and make necessary adjustments to improve the strategy's effectiveness. Whether it's revising implementation plans, reallocating resources, or refining intervention strategies, M&E provides valuable insights for optimizing the strategy's performance. Monitoring and evaluation promote transparency and accountability among stakeholders involved in the strategy. By establishing clear performance metrics and regularly reporting on progress, responsible entities can be held accountable for their contributions to the strategy's success or shortcomings. This accountability fosters a culture of responsibility and encourages stakeholders to fulfil their roles and commitments effectively.

Data and insights gathered through monitoring and evaluation activities provide valuable information for evidence-based decision-making. By understanding what works well and what doesn't, decision-makers can make informed choices about resource allocation, policy adjustments, and strategic

priorities. Hence, monitoring and evaluation help ensure that decisions are grounded in empirical evidence rather than assumptions or speculation, thereby increasing the likelihood of achieving desired outcomes.

Monitoring and evaluation provide a platform for engaging stakeholders throughout the implementation process. By involving relevant actors in data collection, analysis, and interpretation, ownership is fostered for the strategy. Stakeholder engagement ensures that diverse perspectives are considered, priorities are aligned, and interventions are tailored to meet the needs of those directly affected by the strategy.

To put it briefly, monitoring and evaluation are integral components of an interregional strategy, providing critical insights for assessing effectiveness, driving improvement, ensuring accountability, informing decision-making, facilitating learning, and enhancing stakeholder engagement. By investing in robust monitoring and evaluation processes, stakeholders can maximize the impact and sustainability of their interregional cooperation efforts. Regularly reviewing and updating the strategy based on changing circumstances and emerging opportunities is crucial for ensuring continued relevance and effectiveness.

Project KPIs are presented in detail in the next Chapter (Chapter 8) and are measured in the relevant WPs, following the fulfilment of the respective objectives and Actions.

Step 8 - Communication and Outreach:

A communication plan needs to be developed to raise awareness about the R&I strategy among stakeholders and the broader public. Communication and outreach refer to the processes and approaches used to transfer information, messages, or ideas to a targeted audience with the aim of reaching specific goals. This may contain various means and methods such as written, verbal, visual, or digital communication channels. Effective communication and outreach require a clear understanding of the target audience. This involves identifying demographics such as age, gender, location, interests, and socio-economic status, as well as psychographic factors like values, beliefs, attitudes, and preferences. Tailoring messages to resonate with the intended audience increases the likelihood of successful engagement.

Crafting compelling messages is essential for capturing the attention of the target audience and conveying information effectively. Messages should be clear, concise, relevant, and tailored to the needs and interests of the audience. They may incorporate storytelling, statistics, testimonials, visuals, or other persuasive techniques to resonate with the intended recipients. Communication and outreach efforts may utilize a variety of channels to reach the target audience. These could include traditional channels such as print media, broadcast media, direct mail, and in-person events, as well as digital channels like websites, social media, email, blogs, podcasts, and online advertising. Choosing the right mix of channels depends on factors such as audience preferences, accessibility, reach, and budget constraints.

METACITIES project's WP6 entitled 'Dissemination, Engagement and Knowledge Transfer' will facilitate all necessary actions to substantially communicate the integrated Strategy's actions, objectives and results.

Step 9 - Sustainability and Continual Improvement:

Embedding sustainability into long-term development plans ensures that a strategy is not just a temporary programme but a guiding principle for potential development and progress. By integrating the strategy into these plans, policy-makers can ensure that sustainability considerations are regularly prioritized and addressed. Additionally, encouraging a culture of continual improvement is fundamental for making sure that the strategy stays operational and applicable over time. This involves actively seeking feedback, monitoring progress, and learning from both successes and challenges. In the case of METACITIES project, sustainability and continual improvement are ensured through the actions of WP5 entitled "Business, Investment and Sustainability Plans".

Sustainability Plans form integral part of WP5, of the Project.

Steps 1, 2, 3 and 4 have been analysed in the previous Chapters of this Strategy. Steps 5 & 6 are briefly analysed above and are further translated into proposed actions in section "Implementation Plan" that follows. Step 7 is analysed in the last section of this Strategy where KPIs are defined and explained. Steps 8 and 9 are ensured through respective METACITIES Work Packages, as follows: WP6 - 'Dissemination, Engagement and Knowledge Transfer' and WP5 "Business, Investment and Sustainability Plans".

7.3 Implementation Plan

Planning is necessary to map out what you need to do in order to achieve your goals. When referring to a Strategy's Implementation Plan, we mean the process used to ensure a strategic plan is executed. It involves translating the high-level goals and objectives outlined in the strategic document into specific actions and initiatives that can be carried out by the relevant stakeholders. Once a strategic plan is prepared, an implementation plan is necessary to map out how to bring the strategic plan to life. The implementation plan then breaks down tasks into identifiable actions, assigns tasks and responsibilities to the people involved, and creates a timeline.

Similarly, in the case of the METACITIES' Joint Strategy, the present chapter aims at defining and specifying actions as a means to reach the objectives set out above. Moreover, this Chapter goes one step further setting the framework for the METACITIES Excellence Hub to define their Action Plan(s).

7.3.1 Formulation of Proposed Activities

Below a specific set of actions are proposed for each Objective described under each Priority Area's Goal:

PRIORITY AREA A) SMART AND SAFE MOBILITY

Goal 1) Digital Transformation and Innovation

Objective A1: Create user-friendly and interoperable digital platforms for access to real-time traffic and incident information for citizens. The digital platforms should interoperate with Digital Twin technologies and Metaverse as they can enable decision making.

Proposed Actions:

A1.1 Develop a centralized mobile application providing real-time traffic updates, incident notifications, and alternative routes (possibly leverage upon visualization capabilities offered by Digital Twin and Metaverse technologies).

A1.2 Develop and support a common architecture and an open framework that can inter operate with all digital platforms and services Establish open APIs for collaboration with third-party developers to enhance and expand digital platforms and Digital Twins.

A1.3 Conduct user experience (UX) studies to ensure the accessibility and user-friendliness of the digital platforms.

Goal 2) Connectivity and Infrastructure Development for Digital Transformation

Objective A2: Implement a digital infrastructure and network system, based on open data and technologies, to monitor and traffic flow and manage incidents.

Proposed Actions:

A2.1 Invest in the deployment of smart sensors and IoT devices for real-time monitoring of traffic conditions (pilot and large scale).

A2.2 Develop a centralized command and control center to manage incidents efficiently using data analytics and AI. This should include Digital Twins for the city transport system that enables imposing application scenarios (pilot and large scale).

A2.3 Collaborate with private sector partners and academia to build and maintain a robust digital infrastructure.

A2.4 Support the common adaption of technical requirements for digital platform and data interoperability

Goal 3) Sustainable Economic Growth and Social Inclusion

Objective A3: Promote smart mobility initiatives to enhance social inclusion for socially sensitive groups (e.g. smart parking) and foster sustainable economic growth.

Proposed Actions:

A3.1 Implement smart parking solutions to improve accessibility for differently abled individuals (pilot and large scale).

A3.2 Develop subsidy programs or incentives for businesses adopting sustainable mobility practices.

A3.3 Launch awareness campaigns to promote the economic and social benefits of smart mobility solutions.

Goal 4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective A4: Encourage the adoption of eco-friendly transportation options and promote the use of public transit systems for all.

Proposed Actions:

A4.1 Incentivize the adoption of electric/green vehicles through subsidies and charging infrastructure development.

A4.2 Expand and improve public mobility networks to increase accessibility and reduce reliance on personal vehicles.

A4.3 Develop and implement awareness campaigns promoting the environmental benefits of green transportation.

A4.4 Utilise digital platforms (e.g. Digital Twins and models) to analyse environmental impacts under various traffic congestion and/or public transportation scenarios.

Goal 5) Transport and Digital Connectivity

Objective A5: Enhance and advocate for digital connectivity to provide real-time mobility information and data.

Proposed Actions:

A5.1 Collaborate with telecommunication companies to improve and expand digital connectivity infrastructure.

A5.2 Develop partnerships with technology companies to enhance data-sharing capabilities and platform interconnection between different mobility stakeholders.

A5.3 Advocate for policies that support the integration of digital connectivity solutions in transportation systems and/or provide Digital Twin solutions that can visualize and evaluate the effect of various mobility policies.

Goal 6) Enhancing Education and Digital Skills and Human Resources

Objective A6: Strengthen education and digital skills development initiatives to build a skilled human resource base supporting smart mobility solutions.

Proposed Actions:

A6.1 Establish training programs for current and future professionals in smart mobility technologies.

A6.2 Organise hackathons evolving all stakeholders for smart mobility solutions

A6.3 Collaborate with educational institutions to integrate smart mobility concepts into relevant curricula.

A6.4 Provide scholarships and grants to individuals pursuing education and training in digital skills for smart mobility.

Goal 7) Entrepreneurship regarding Research Innovation

Objective A7: Foster entrepreneurship in research and innovation to drive advancements in smart mobility solutions.

Proposed Actions:

A7.1 Create innovation hubs or accelerators focused on smart mobility solutions.

A7.2 Offer grants and funding opportunities for startups working on innovative smart mobility projects.

A7.3 Establish partnerships between research institutions, startups, and established companies to encourage collaboration and knowledge transfer.

Goal 8) Research, Innovation, and Education

Objective A8: Promote research, innovation, and education to drive progress and excellence in these fields.

Proposed Actions:

A8.1 Establish research grants to support studies on emerging trends and challenges in smart mobility.

A8.2 Organize conferences and workshops to facilitate knowledge exchange among researchers, industry professionals, and policymakers.

A8.3 Develop partnerships with universities and research institutions to promote ongoing research and education in smart mobility.

PRIORITY AREA B) SMART ENVIRONMENT

Goal 1) Digital Transformation and Innovation

Objective B1: Implement digitization of citizen services to provide real-time information on air pollution and weather conditions within the city.

Proposed Actions:

B1.1 Develop a mobile application that citizens can use to access real-time information on air quality and weather conditions.

B1.2 Implement sensors and IoT devices across the city to gather accurate and up-to-date environmental data (pilot and large scale).

B1.3 Establish a centralized platform to analyze and display the collected data in an easily understandable format (virtualisation and modelling through Digital Twin platforms).

B1.4 Develop and support a common architecture and an open framework that can inter operate with all digital platforms and services.

Goal 2) Connectivity and Infrastructure Development for Digital Transformation

Objective B2: Develop connectivity and infrastructure for digital transformation, including the implementation of smart energy metering, consumption, and saving systems for public buildings.

Proposed Actions:

B2.1 Upgrade public buildings with smart energy metering systems to monitor and manage energy consumption (pilot and large scale).

B2.2 Support the adaption of technical requirements for digital platform and data interoperability

B2.3 Establish a city-wide network for efficient data transfer and communication between smart devices.

B2.4 Integrate renewable energy sources and energy-saving technologies in public buildings to promote sustainability.

Goal 3) Sustainable Economic Growth and Social Inclusion

Objective B3: Promote smart environment initiatives for social inclusion and sustainable economic growth.

Proposed Actions:

B3.1 Launch awareness campaigns to educate citizens about the benefits of smart environmental initiatives.

B3.2 Implement community engagement programs to involve citizens in sustainable practices.

B3.3 Collaborate with local businesses to integrate smart environmental solutions and promote economic growth.

Goal 4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective B4: Implement innovative environmental solutions, such as smart recycling systems, to facilitate the shift towards a more eco-friendly and environmentally conscious economy.

Proposed Actions:

B4.1 Introduce smart recycling bins equipped with sensors to optimize waste collection routes.

B4.2 Implement a reward system for citizens who actively participate in recycling initiatives.

B4.3 Collaborate with technology companies to develop innovative solutions for waste management.

Goal 5) Transport and Digital Connectivity

Objective B5: Enhance and advocate for digital connectivity to provide real-time environmental information through Digital Twin platforms.

Proposed Actions:

B5.1 Establish partnerships with telecommunications companies to improve digital connectivity and support interoperability requirements.

B5.2 Conduct awareness campaigns to promote the use of digital platforms/Digital Twins for accessing/predicting environmental information.

B5.3 Implement policies to ensure that all citizens have access to digital tools and information.

Goal 6) Enhancing Education and Digital Skills and Human Resources

Objective B6: Enhance education, digital skills, and human resources development to support and advance smart environment initiatives.

Proposed Actions:

B6.1 Integrate smart environmental education into school curricula.

B6.2 Provide training programs for public officials and workers on the use of smart technologies and Digital Twins in environmental management (data acquisition, modelling, prediction and virtualisation) .

B6.3 Collaborate with educational institutions to conduct research on smart environmental technologies/modelling.

Goal 7) Entrepreneurship regarding Research Innovation

Objective B7: Promote entrepreneurship in research and innovation to drive sustainable solutions for a smart environment.

Proposed Actions:

B7.1 Organize innovation challenges and hackathons to encourage entrepreneurs to develop smart environmental solutions.

B7.2 Provide funding and support for startups focused on sustainable technologies.

B7.3 Establish a mentorship program connecting experienced entrepreneurs with those working on smart environment projects.

Goal 8) Research, Innovation, and Education

Objective B8: Promote research, innovation, and education to drive progress and excellence in these fields.

Proposed Actions:

B8.1 Establish research grants for institutions working on smart environment projects and Digital Twins.

B8.2 Host conferences and seminars to facilitate knowledge exchange and collaboration in the field.

B8.3 Develop partnerships with research institutions to ensure ongoing advancements in smart environmental technologies.

PRIORITY AREA C) SMART URBAN PLANNING

Goal 1) Digital Transformation and Innovation

Objective C1: Develop a competitive digital economy by providing a digital platform showing existing and future municipality topography (e.g. iNicosia).

Proposed Actions:

C1.1 Implement a comprehensive digital mapping system, showcasing current topography and future development plans.

C1.2 Establish a user-friendly online platform for businesses and residents to access and explore digital maps, promoting transparency and engagement.

C1.3 Conduct workshops and training programs to educate local businesses on leveraging digital platforms for economic growth.

Goal 2) Connectivity and Infrastructure Development for Digital Transformation

Objective C2: Deploy digital infrastructure and technology such as IoT sensors and IoT gateways.

Proposed Actions:

C2.1 Install IoT sensors across the city to gather real-time data e.g. traffic flow, air quality, and other relevant parameters.

C2.2 Implement IoT gateways to facilitate seamless communication between devices, ensuring a robust and interconnected digital infrastructure.

C2.3 Collaborate with technology companies to pilot innovative solutions, such as smart street lighting or waste management systems.

Goal 3) Sustainable Economic Growth and Social Inclusion

Objective C3: Promote initiatives such as smart parking to achieve sustainable economic growth within the framework of promoting social inclusion.

Proposed Actions:

C3.1 Introduce smart systems that utilize sensors and mobile applications to provide real-time information.

C3.2 Encourage businesses to adopt digital payment methods to reduce reliance on cash transactions.

C3.3 Implement incentives for eco-friendly solutions such as discounted or free parking for environmentally friendly vehicles.

Goal 4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective C4: Foster a green digital transition by (a) promoting sustainable practices in urban development, including initiatives such as smart transportation and smart city development, while (b) facilitating a shift towards a low carbon economy through the adoption of eco-friendly solutions.

Proposed Actions:

C4.1 Promote sustainable transportation infrastructure such as the development of electric vehicle charging infrastructure and provide incentives for electric vehicle adoption.

C4.2 Implement management strategies such as smart traffic management systems to optimize traffic flow, reduce congestion, and minimize carbon emissions.

C4.3 Introduce green building standards and incentives for sustainable construction in the city.

Goal 5) Transport and Digital Connectivity

Objective C5: Improve transport connectivity and digital connections by providing real-time data such as traffic, regarding the municipality.

Proposed Actions:

C5.1 Establish a centralized information hub for real-time traffic data accessible to residents and businesses (Digital Twin?).

C5.2 Implement intelligent traffic management systems synchronized with real-time traffic patterns to mitigate congestion such as smart traffic lights.

C5.3 Collaborate with transportation agencies to integrate public transport data into digital platforms for seamless multimodal connectivity.

Goal 6) Enhancing Education and Digital Skills and Human Resources

Objective C6: Improve education and skills deployment to better adapt people to technological and environmental change.

Proposed Actions:

C6.1 Develop digital literacy programs for residents of all ages to enhance their understanding and use of technology.

C6.2 Collaborate with educational institutions to integrate technology and environmental studies into the curriculum.

C6.3 Offer training and upskilling programs for the workforce to adapt to emerging technologies and sustainability practices.

Goal 7) Entrepreneurship regarding Research Innovation

Objective C7: a) Promote innovation regarding city development, and b) Support science and business cooperation for the city development.

Proposed Actions:

C7.1 Organize innovation challenges such as hackathons to encourage local businesses and startups to propose innovative solutions for city development.

C7.2 Establish a collaborative platform for scientists, researchers, and businesses to share knowledge and collaborate on innovative projects.

C7.3 Provide grants and incentives for research and development projects focused on smart city solutions.

Goal 8) Research, Innovation, and Education

Objective C8: a) Enhance skills development, and b) Improve human resources in the fields of new technologies and innovation.

Proposed Actions:

C8.1 Develop training programs in collaboration with industry experts to enhance skills in emerging technologies such as artificial intelligence, data analytics, and IoT.

C8.2 Establish partnerships with educational institutions to create specialized courses and degrees in technology and innovation.

C8.3 Create mentorship programs connecting experienced professionals with individuals seeking to enter the fields of new technologies and innovation.

PRIORITY AREA D) GREEN AND CLIMATE ADAPTIVE RESOURCE MANAGEMENT

Goal 1) Digital Transformation and Innovation

Objective D1: a) Improve research and innovation capacity, and b) Improve the digitalization of services for citizens.

Proposed Actions:

D1.1 Establish policy for initiating innovative projects related to green and climate adaptive resource management.

D1.2 Foster collaboration between research institutions, local governments, state agencies, and private sector entities to enhance innovation capacity.

D1.3 Develop and implement digital platforms supporting citizen engagement in environmental sustainability initiatives.

D1.4 Upgrade and streamline public services through digital channels to enhance accessibility and efficiency.

Goal 2) Connectivity and Infrastructure Development for Digital Transformation

Objective D2: Development of the digital infrastructure.

Proposed Actions:

D2.1 Invest in the expansion of high-speed internet and digital connectivity in rural and undeserved areas to ensure equal access to digital resources.

D2.2 Establish open APIs for collaboration with third-party developers to enhance and expand digital platforms.

D2.3 Implement smart infrastructure projects, such as IoT-enabled devices, to monitor and manage environmental conditions and energy efficiency.

Goal 3) Sustainable Economic Growth and Social Inclusion

Objective D3: Achieve sustainable economic growth.

Proposed Actions:

D3.1 Support and incentivize businesses that adopt sustainable practices and contribute to the green economy of the city.

D3.2 Develop policies to encourage circular economy, the creation of green jobs and industries.

Goal 4) Environmental Sustainability, Low-Carbon Economy, and Green Transition

Objective D4: a) Promote the use of clean energy, mitigating climate change, b) Transition to a low carbon economy, c) Resource efficiency, and d) Environmental protection.

Proposed Actions:

D4.1 Invest in renewable energy projects and provide incentives for businesses and households to adopt clean energy solutions.

D4.2 Implement awareness campaigns to educate the public about the benefits of renewable energy and energy efficient lifestyle.

D4.3 Enforce local regulations and guidelines to promote resource efficiency and reduce carbon emissions.

D4.4 Implement energy management programs for public and private buildings and initiatives to reduce environmental impact.

Goal 5) Transport and Digital Connectivity

Objective D5: Improve digital connectivity.

Proposed Actions:

D5.1 Invest in interconnected digital systems and Digital Twins, the development of - sustainable big data management systems smart city platforms.

D5.2 Implement digital solutions for efficient energy management and adoption of climate adaptation measures.

D5.3 Support the development of common technical requirements for interoperability and interconnections of digital platforms and twins.

Goal 6) Enhancing Education and Digital Skills and Human Resources

Objective D6: a) Skills development to better adapt people to technological and environmental changes, and b) Promote a culture for innovation.

Proposed Actions:

D6.1 Promote training programs and courses focused on climate adaptive technologies and environmental sustainability.

D6.2 Collaborate with educational institutions to integrate climate adaptation and resource management into curricula.

D6.3 Organize innovation competitions and hackathons focused on green, energy efficiency and resource management solutions.

D6.4 Foster partnerships between academia, industry, and local government to drive innovation in energy efficiency and resource management technologies.

Goal 7) Entrepreneurship regarding Research Innovation

Objective D7: a) Support research and innovation ecosystems, and b) Promote investments and links between science and business.

Proposed Actions:

D7.1 Support innovation hubs and incubators focused on green and climate adaptive technologies.

D7.2 Provide financial support, data sharing and mentoring for start-ups and entrepreneurs in the green sector.

D7.3 Facilitate networking events and forums to connect researchers with potential investors and industry partners.

D7.4 Create incentive programs involving businesses which invest in research and development activities related to climate adaptation and environmental sustainability.

Goal 8) Research, Innovation, and Education

Objective D8: Improve human resources in the fields of new technologies and innovation

Proposed Actions:

D8.1 Establish partnerships between local public bodies, educational institutions and businesses to align education with the needs of the green and circular economy.

D8.2 Conduct workshops and training programs together with academy to educate local businesses on leveraging digital platforms for climate adaptation for economy growth.

7.3.2 Implementation Plan Guidelines

An implementation plan of a Strategy allocates available resources to use and creates a tactical plan to perform the strategic initiative. It thus plays a significant role in the accomplishment of the general strategic objective. Even if a partnership produces the greatest plan or strategy, it's totally meaningless if they don't manage to put it into action. Some of the benefits of an implementation plan are therefore the following:

- It provides clarity: an implementation plan provides better clarity of thought and improves the understanding of the initiative.

- It keeps everyone involved and on track: an implementation plan lays down exactly what tasks need to be done, how to do them, who needs to do them, keeping everyone on board, and removing any sort of confusion or doubts. When everyone knows their roles and responsibilities, it's easier to stay on track and keep everyone accountable.

- Improved cooperation: working on common objectives requires cooperation and collaboration of many and different human force. The better the cooperation amongst team members, the better the synergy and the overall execution. An implementation plan not only assigns responsibilities to team members but can also educate them about how their work affects the work of their peers and how it all fits in the broader organizational vision.

The template below has been drafted to guide the present Joint Strategy's implementing partner organizations through defining their Action Plans to ensure smooth implementation of the proposed actions to reach the defined objectives.

For doing so, the cooperation of the 3 Clusters forming "The Excellence Hub" of the METACITIES project should go through the following stages that characterize the formation of an implementation plan:

Stage 1 - Outline Goals and Objectives: Goals and Objectives have already been defined earlier and are clearly aligned in 'Step 3 - Priority Areas and Objectives' described in the previous Chapter.

Stage 2 - Translate Goals and Objectives into Proposed Actions: Goals and Objectives have been converted into specific proposed actions in the previous chapter.

Stage 3 - Detect (out of this list of actions) and select the most appropriate activities which are matching better to the commonly identified project's needs: To facilitate this task, a clear list of the drafted proposed actions is provided below (please see point 7.3.2.1).

Stage 4 - Assign Roles and Responsibilities: The Excellence Hub should assign member or stakeholders roles and responsibilities within the implementation plan. Excellence Hub's members'/stakeholders' competences, strengths and experience should be considered when assigning tasks, as well as their availability during the implementation plan's duration.

Stage 5 - Schedule Work on a Timeline: In the context of an implementation plan, a timeline is a visual illustration or a chronological plan that outlines the actions or tasks, deadlines, and their dependencies. It serves as a roadmap for the implementation team, stakeholders, and other involved parties to understand the sequence of activities and the estimated time required to complete them.

Stage 6 – Allocate Resources: One of the main purposes of an implementation plan is to make sure that the implementation team has access to enough resources for executing the plan effectively and efficiently.

Stage 7 - Monitor Performance: Key performance indicators (KPIs) or other metrics reveal how well the team is accomplishing the implementation plan. The establishment of measurable indicators and a method of tracking them over the course of the implementation plan is required. This stage is examined and analysed in detail in the dedicated following Chapter 8 of the present document.

7.3.2.1 List of Proposed Actions

PRIORITY AREA A) SMART AND SAFE MOBILITY

A/A	Action Title
A1.1	Develop a centralized mobile application providing real-time traffic updates, incident notifications, and alternative routes (possibly leverage upon visualization capabilities offered by Digital Twin and Metaverse technologies).
A1.2	Develop and support a common architecture and an open framework that can inter operate with all digital platforms and services. Establish open APIs for collaboration with third-party developers to enhance and expand digital platforms and Digital Twins.
A1.3	Conduct user experience (UX) studies to ensure the accessibility and user-friendliness of the digital platforms.
A2.1	Invest in the deployment of smart sensors and IoT devices for real-time monitoring of traffic conditions (pilot and large scale).
A2.2	Develop a centralized command and control center to manage incidents efficiently using data analytics and AI. This should include Digital Twins for the city transport system that enables imposing application scenarios (pilot and large scale).

A2.3	Collaborate with private sector partners and academia to build and maintain a robust digital infrastructure.
A2.4	Support the common adaption of technical requirements for digital platform and data interoperability
A3.1	Implement smart parking solutions to improve accessibility for differently abled individuals (pilot and large scale).
A3.2	Develop subsidy programs or incentives for businesses adopting sustainable transportation practices.
A3.3	Launch awareness campaigns to promote the economic and social benefits of smart mobility solutions.
A4.1	Incentivize the adoption of electric/green vehicles through subsidies and charging infrastructure development.
A4.2	Expand and improve public mobility networks to increase accessibility and reduce reliance on personal vehicles
A4.3	Develop and implement awareness campaigns promoting the environmental benefits of green transportation.
A4.4	Utilise digital platforms (e.g. Digital Twins and models) to analyse environmental impacts under various traffic congestion and/or public transportation scenarios.
A5.1	Collaborate with telecommunication companies to improve and expand digital connectivity infrastructure.
A5.2	Develop partnerships with technology companies to enhance data-sharing capabilities and platform interconnection between different mobility stakeholders.
A5.3	Advocate for policies that support the integration of digital connectivity solutions in transportation systems and/or provide Digital Twin solutions that can visualize and evaluate the effect of various mobility policies
A6.1	Establish training programs for current and future professionals in smart mobility technologies.
A6.2	Organise hackathons evolving all stakeholders for smart mobility solutions.
A6.3	Collaborate with educational institutions to integrate smart mobility concepts into relevant curricula.
A6.4	Provide scholarships and grants to individuals pursuing education and training in digital skills for smart mobility.
A7.1	Create innovation hubs or accelerators focused on smart mobility solutions.
A7.2	Offer grants and funding opportunities for startups working on innovative smart mobility projects.
A7.3	Establish partnerships between research institutions, startups, and established companies to encourage collaboration and knowledge transfer. Facilitate partnerships between

	research institutions, startups, and established companies to encourage collaboration and knowledge transfer.
A8.1	Establish research grants to support studies on emerging trends and challenges in smart mobility.
A8.2	Organize conferences and workshops to facilitate knowledge exchange among researchers, industry professionals, and policymakers.
A8.3	Develop partnerships with universities and research institutions to promote ongoing research and education in smart mobility.

PRIORITY AREA B) SMART ENVIRONMENT

A/A	Action Title
B1.1	Develop a mobile application that citizens can use to access real-time information on air quality and weather conditions.
B1.2	Implement sensors and IoT devices across the city to gather accurate and up-to-date environmental data (pilot and large scale).
B1.3	Establish a centralized platform to analyze and display the collected data in an easily understandable format (virtualisation and modelling through Digital Twin platforms).
B1.4	Develop and support a common architecture and an open framework that can inter operate with all digital platforms and services.
B2.1	Upgrade public buildings with smart energy metering systems to monitor and manage energy consumption (pilot and large scale).
B2.2	Support the adaption of technical requirements for digital platform and data interoperability
B2.3	Establish a city-wide network for efficient data transfer and communication between smart devices.
B2.4	Integrate renewable energy sources and energy-saving technologies in public buildings to promote sustainability.
B3.1	Launch awareness campaigns to educate citizens about the benefits of smart environmental initiatives.
B3.2	Implement community engagement programs to involve citizens in sustainable practices.
B3.3	Collaborate with local businesses to integrate smart environmental solutions and promote economic growth.
B4.1	Introduce smart recycling bins equipped with sensors to optimize waste collection routes.
B4.2	Implement a reward system for citizens who actively participate in recycling initiatives.
B4.3	Collaborate with technology companies to develop innovative solutions for waste management.
B5.1	Establish partnerships with telecommunications companies to improve digital connectivity and support interoperability requirements.
B5.2	Conduct awareness campaigns to promote the use of digital platforms/Digital Twins for accessing/predicting environmental information.

B5.3	Implement policies to ensure that all citizens have access to digital tools and information.
B6.1	Integrate smart environmental education into school curricula.
B6.2	Provide training programs for public officials and workers on the use of smart technologies and Digital Twins in environmental management (data acquisition, modelling, prediction and virtualisation).
B6.3	Collaborate with educational institutions to conduct research on smart environmental technologies/modelling.
B7.1	Organize innovation challenges and hackathons to encourage entrepreneurs to develop smart environmental solutions.
B7.2	Provide funding and support for startups focused on sustainable technologies.
B7.3	Establish a mentorship program connecting experienced entrepreneurs with those working on smart environment projects.
B8.1	Establish research grants for institutions working on smart environment projects and Digital Twins.
B8.2	Host conferences and seminars to facilitate knowledge exchange and collaboration in the field.
B8.3	Develop partnerships with research institutions to ensure ongoing advancements in smart environmental technologies.

PRIORITY AREA C) SMART URBAN PLANNING

A/A	Action Title
C1.1	Implement a comprehensive digital mapping system, showcasing current topography and future development plans.
C1.2	Establish a user-friendly online platform for businesses and residents to access and explore digital maps, promoting transparency and engagement.
C1.3	Conduct workshops and training programs to educate local businesses on leveraging digital platforms for economic growth.
C2.1	Install IoT sensors across the city to gather real-time data e.g. traffic flow, air quality, and other relevant parameters.
C2.2	Implement IoT gateways to facilitate seamless communication between devices, ensuring a robust and interconnected digital infrastructure.
C2.3	Collaborate with technology companies to pilot innovative solutions, such as smart street lighting or waste management systems.
C3.1	Introduce smart systems that utilize sensors and mobile applications to provide real-time information.
C3.2	Encourage businesses to adopt digital payment methods to reduce reliance on cash transactions.
C3.3	Implement incentives for eco-friendly solutions such as discounted or free parking for environmentally friendly vehicles.
C4.1	Promote sustainable transportation infrastructure such as the development of electric vehicle charging infrastructure and provide incentives for electric vehicle adoption.

C4.2	Implement management strategies such as smart traffic management systems to optimize traffic flow, reduce congestion, and minimize carbon emissions.
C4.3	Introduce green building standards and incentives for sustainable construction in the city.
C5.1	Establish a centralized information hub for real-time traffic data accessible to residents and businesses.
C5.2	Implement intelligent traffic management systems synchronized with real-time traffic patterns to mitigate congestion such as smart traffic lights.
C5.3	Collaborate with transportation agencies to integrate public transport data into digital platforms for seamless multi-modal connectivity.
C6.1	Develop digital literacy programs for residents of all ages to enhance their understanding and use of technology.
C6.2	Collaborate with educational institutions to integrate technology and environmental studies into the curriculum.
C6.3	Offer training and upskilling programs for the workforce to adapt to emerging technologies and sustainability practices.
C7.1	Organize innovation challenges such as hackathons to encourage local businesses and startups to propose innovative solutions for city development.
C7.2	Establish a collaborative platform for scientists, researchers, and businesses to share knowledge and collaborate on innovative projects.
C7.3	Provide grants and incentives for research and development projects focused on smart city solutions.
C8.1	Develop training programs in collaboration with industry experts to enhance skills in emerging technologies such as artificial intelligence, data analytics, and IoT.
C8.2	Establish partnerships with educational institutions to create specialized courses and degrees in technology and innovation.
C8.3	Create mentorship programs connecting experienced professionals with individuals seeking to enter the fields of new technologies and innovation.

PRIORITY AREA D) GREEN AND CLIMATE ADAPTIVE RESOURCE MANAGEMENT

A/A	Action Title
D1.1	Establish research grants and funding programs for innovative projects related to green and climate adaptive resource management.
D1.2	Foster collaboration between research institutions, government agencies, and private sector entities to enhance innovation capacity.
D1.3	Develop and implement digital platforms supporting citizen engagement in environmental sustainability initiatives.
D1.4	Upgrade and streamline public services through digital channels to enhance accessibility and efficiency.
D2.1	Invest in the expansion of high-speed internet and digital connectivity in rural and undeserved areas to ensure equal access to digital resources.

D2.2	Establish open APIs for collaboration with third-party developers to enhance and expand digital platforms.
D2.3	Implement smart infrastructure projects, such as IoT-enabled devices, to monitor and manage environmental conditions and energy efficiency.
D3.1	Support and incentivize businesses that adopt sustainable practices and contribute to the green economy of the city.
D3.2	Develop policies to encourage circular economy, the creation of green jobs and industries.
D4.1	Invest in renewable energy projects and provide incentives for businesses and households to adopt clean energy solutions.
D4.2	Implement awareness campaigns to educate the public about the benefits of renewable energy and energy efficient lifestyle.
D4.3	Enforce local regulations and guidelines to promote resource efficiency and reduce carbon emissions.
D4.4	Implement energy management programs for public and private buildings and initiatives to reduce environmental impact.
D5.1	Invest in interconnected digital systems and Digital Twins, the development of - sustainable big data management systems smart city platforms.
D5.2	Implement digital solutions for efficient energy management and adoption of climate adaptation measures.
D5.3	Support the development of common technical requirements for interoperability and interconnections of digital platforms and twins
D6.1	Promote training programs and courses focused on climate adaptive technologies and environmental sustainability.
D6.2	Collaborate with educational institutions to integrate climate adaptation and resource management into curricula
D6.3	Organize innovation competitions and hackathons focused on green, energy efficiency and resource management solutions.
D6.4	Foster partnerships between academia, industry, and local government to drive innovation in energy efficiency and resource management technologies.
D7.1	Support innovation hubs and incubators focused on green and climate adaptive technologies.
D7.2	Provide financial support, data sharing and mentoring for startups and entrepreneurs in the green sector.
D7.3	Facilitate networking events and forums to connect researchers with potential investors and industry partners.
D7.4	Create incentive programs involving businesses which invest in research and development activities related to climate adaptation and environmental sustainability.
D8.1	Establish partnerships between local public bodies, educational institutions and businesses to align education with the needs of the green and circular economy.
D8.2	Conduct workshops and training programs together with academy to educate local businesses on leveraging digital platforms for climate adaptation for economy growth.

7.3.2.2 Action Plan Templates

The template in Table 39 combines all stages described in point 7.3.2 above, outlining the path to reaching the Joint Strategy's goals and objectives. The METACITIES Excellence Hub's members may use this template as a reference for the decision and definition of the implementation plan to be applied and followed in the framework of the project.

Table 39: Action Plan – General Template

Action Number	Action Title	Deliverable	STATUS	ASSIGNED TO	START DATE	END DATE	KPIs	COMMENTS
	(Fill in the title of the Action)	**(Fill in the name of the expected output)**	**For example: - Not Started - In Progress - On Hold - Completed**	**Name of partner organization or person**	**date**	**date**	**Relevant KPI(s)**	

For a more detailed description of the actions the METACITIES Partners could also use the template in Table 40 to specify the information concerning each action separately.

Table 40: Detailed Description of the Action (Template)

ACTION Number and Title:	
Description of the action. *(Please list and describe the actions to be implemented and, if applicable, its most important phases)*	
Stakeholders involved. *(Please indicate the organizations who are involved in the development and implementation of the action and explain their role)*	
Expected output/deliverable. *(Please describe the result(s) and/or product(s) of the action)*	
Timeframe. *(Please describe the expected starting and ending date of the action and, if applicable, mention important milestones)*	
Cost.	

(Please indicate the budget required to implement this action)	
Funding Sources. *(Please mention potential funding schemes or means of financing to be exploited for funding the cost of the action)*	
KPIs. *(Please describe the relevant KPIs and/or other means of monitoring the effectiveness and impact of the action)*	

7.3.2.3 Implementation Plan's Timetable General Template

The most frequently used method to present an Implementation Plan's Timetable is through a Gantt Chart, even though many other tools and methods are available. Below is an example of such a chart which the METACITIES project partners may use to prepare this Joint Strategy's time-plan.

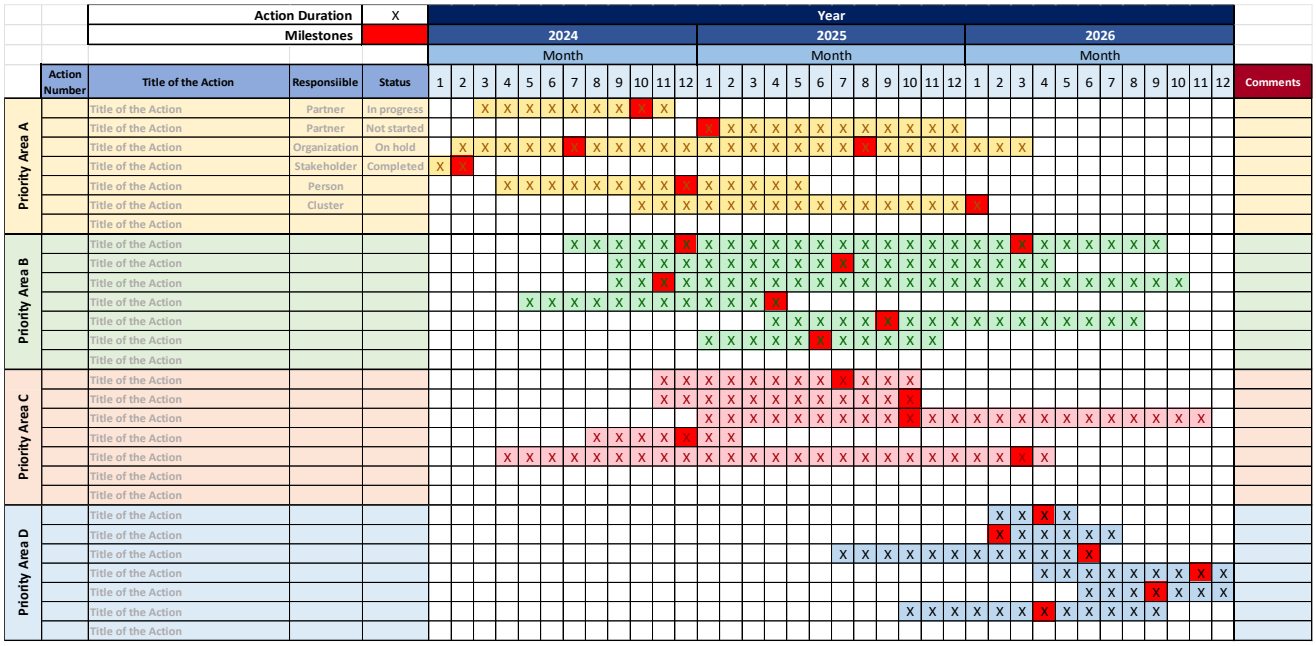

FIGURE 6: IMPLEMENTATION PLAN'S TIMETABLE - GENERAL TEMPLATE

7.4 METACITIES Implementation Plan

7.4.1 Indicative action plan implementation

Table 41, Table 42, Table 43, and Table 44 show an indicative plan of the actions to be implemented throughout the duration of the METACITIES projects based on the corresponding WP for all priority areas. It is anticipated some actions will be defined and evaluated in more than one WP for their

completeness. Specifically, some actions may span more than two WPs (e.g. some actions may start as pilots in WP4, however for a large scale deployment WP5 needs to be mobilised).

Table 41: PRIORITY AREA A) SMART AND SAFE MOBILITY - Indicative ACTION PLAN

WP #	Actions
3	A1.1, A1.2, A1.3, A3.1
4	A2.1
5	A1.1, A1.4, A2.1, A2.3, A2.4, A3.1, A3.2, A4.1, A4.2, A4.3, A4.4, A5.1, A5.2, A5.3, A6.4, A7.1, A7.2, A7.3. A8.1, A8.2
6	A3.3, A5.2, A6.1, A6.2, A6.3, A8.3

Table 42: PRIORITY AREA B) SMART ENVIRONMENT - Indicative ACTION PLAN

WP #	Actions
3	B1.4, B2.2
4	B1.2, B2.1
5	B1.1, B1.2, B1.3, B1.4, B2.1, B2.3, B2.4, B3.1, B3.2, B3.3, B4.1, B4.2, B4.3, B5.1, B5.2, B5.3, B6.1, B6.2, B6.3, B7.1, B7.2, B7.3, B8.1, B8.2, B8.3
6	B5.2, B8.2

Table 43: PRIORITY AREA C) SMART URBAN PLANNING - Indicative ACTION PLAN

WP #	Actions
3	C1.1, C2.1, C2.2, C3.1, C5.1, C5.2, C7.2
4	C1.2, C2.1, C2.2, C3.1, C5.1, C5.2
5	C2.3, C3.2, C3.3, C4.1, C4.2, C4.3, C5.3, C6.1, C6.2, C7.2, C7.3, C8.2, C8.3
6	C1.3, C2.3, C4.1, C6.1, C6.2, C6.3, C7.1, C7.2, C8.1, C8.2, C8.3

Table 44: PRIORITY AREA D) GREEN AND CLIMATE ADAPTIVE RESOURCE MANAGEMENT - Indicative ACTION PLAN

WP #	Actions
3	D1.3, D4.4, D5.2
4	D1.3, D1.4, D2.2, D4.4, D5.1, D5.2
5	D1.1, D3.1, D4.1, D4.3, D7.1, D7.2, D7.4
6	D1.2, D2.1, D3.2, D4.1, D4.2, D6.1, D6.2, D6.3, D6.4, D7.1, D7.3, D7.4, D8.1, D8.2

The Action Plan General Template and a more detailed Implementation Plan for the R&I project will be developed in the framework of WP3 before the start of WP4. The METACITIES Implementation Plan will be fully developed in WP5, along with the BM of the Hub and the Sustainability and Investment

Plans. The different actions will be implemented and monitored in the METACITIES framework during the implementation of WP3, WP4, WP5, and WP6.

8 KPIs and Milestones for R&I Strategy Implementation

In this chapter a set of indicators and important milestones to track progress and measure the impact towards the implementation of the R&I strategy are defined. The selection of the KPIs is done in such a way to allow an easy estimation of the progress and performance of the strategy in the context of achieving its goals and objectives. The strategy, methodology and action plan are a cross-border collaborative effort that aims to increase the R&I capacities of all actors in the regional ecosystems and improve their outreach to international scale. In this context, the KPIs should be related to the implementation of the major goals of the joint strategy, and reflect its outcomes.

8.1 Key Performance Indicators

8.1.1 Introduction

Key Performance Indicators (KPIs) are quantifiable metrics (values that can be measured) that reflect the performance of a business or project in the context of achieving its wider goals and objectives [33]. KPIs are used to implement strategies by linking various levels of an organization or a project with clearly defined targets and benchmarks. Gradually the use of the term Key Performance Indicators has extended beyond business and industry also to administrations. The difference between all kinds of other indicators or progress measures is that Key Performance Indicators are directly related to an organization's strategy or project implementation and are critical for their successful execution [34]. KPIs are always tied to a goal, a target or an objective.

8.1.2 General Principles for KPI Definition

In general, KPIs should express as precisely as possible to what extent an aim, a goal or a standard has been reached or even surpassed. Data that are not linked to standards or specific goals defined in a project can be used as quantitative background information, but are not suited for evaluative purposes. Often, however, various indicators are available to assess the progression towards a certain goal [35].

The approach for selection of KPIs in the METACITIES project is based on the analysis of the frameworks and the principles described in [36], [37], [38], [39]. They are based on the following criteria:

- *Independence:* The KPIs should be independent or almost-orthogonal (i.e., overlap of the KPIs should be avoided as much as possible) and small changes in the measurement results of an indicator should not impact the evaluation of or preferences given to other indicators.
- *Reliability:* The concept of each indicator should be clear and simple. A widely-accepted definition of the KPI not open to different interpretations assists different users to interpret it in the same way. Also, the calculation of the associated data should be intuitive and simple.
- *Measurable*: The KPIs should be defined in a way that the value should be capable of being measured, preferably as objectively as possible and comparable scientifically between different phases of urban development, which means the KPIs should be comparable over time and space. The measurement should be as objective as possible. The historic and current data should be either available or easy to collect.
- *Achievable*: The goal of the KPIs should be achievable and the set of indicators should cover relevant aspects of the METACITIES project. It should also be possible to extend and amend the set of KPIs according to the actual stage of development.

- *Relevance*: The KPIs should provide insight into the progress of the project in obtaining goals and executing its strategy. The indicators for evaluation should be aligned to the measured subject. Each indicator should have a significant importance for the evaluation process.
- *Timeliness*: It is important to express the value of the KPI over time. Every KPI has a meaning only if the time dimension in which it is realized is known. KPIs should be also able to deal with emerging issues in the process of the realization of the METACITIES project.
- *Completeness*: the set of indicators should consider all aspects of the implementation of the METACITIES project.
- *Availability:* Data for the indicators should be easily available. As the inventory for gathering the data for the indicators should be kept limited in time and effort, the indicators should be based on data that are available from the project partners, could easily be compiled from public sources, or can easily be gathered from interviews, maps, or terrain observations.
- *Non-redundancy:* indicators within a system/framework should not measure the same aspect of a sub theme.

8.2 Project objectives, outcomes, and KPI selection

The strategic goal of the METACITIES excellence hub is to increase the R&I capacities of all actors in the regional ecosystems and improve their outreach to international scale effectively utilizing across-border collaboration. For the achievement of this goal in the project and the goals and objectives from the joint R&I strategy (Chapter 7) a set of objectives are outlined that are related to their implementation. In general, these objectives are related to the joint definition of long-term R&I strategies and implementation guidelines on DTs and Metaverse technologies for smart cities, the identification of reference ICT architectures of upcoming technologies and infrastructures required to support METACITIES and the specification of an Open Digital Twin Framework (ODTF). The OTDF will be used to instantiate specific smart city and smart region Digital Twins as proposed by the different clusters. The development of the ODTF will be one of the major objectives of METACITIES and the driving force behind defining, implementing, validating, and evolving regional innovation strategies for smart specialization in various domains, and will provide the architecture and the framework to the pilots in the project. Based on the OTDF and pilot implementation an integrated business framework and different business models that may be applied to the smart cities and regions will be proposed. The latter are important as they will dictate the model of investments and developments (e.g., public vs private vs PPP) necessary to realize the strategy and guide the business and social expectations of the various stakeholders (e.g., profit vs non-profit businesses). Other objectives are related to strengthening local ecosystems and accelerating the digital transformation of cities and regions so that they become attractive to new businesses and investments and the opening of new ways for innovating and creating new business opportunities, and maximising the impact of the project through wide dissemination, communication, capacity building, economic and civil engagement, networking, standardisation and exploitation measures.

For a quantitative and qualitative illustration of the expected potential impact of the realization of the strategy, project objectives, and implementation, a set of expected outcomes are defined in the project proposal. They are in terms of the realization of new local and international research and innovation partnerships, institutional and/or R&I system changes, increased research and innovation intensity, business opportunities, etc., which are listed and commented in Table 45. Further, Table 46 illustrates the relation between the overall objectives of the project and the expected outcomes.

Table 45: Expected outcomes of the project

№	Expected outcomes	Comments
EO1:	Excellent and sustainable place-based innovation ecosystems in Widening countries and beyond in relevant domains of cutting-edge science and innovation.	The focus will be on the application of a place-based approach locally and at the same time work together and create sustainable policies and implementation actions towards excellent and sustainable place-based ecosystems in GR, BG and CY through local and cross-border collaboration in the selected domain of cutting-edge science and innovation.
EO2:	Long term joint R&I strategies underpinned by concrete action plans of European relevance.	METACITIES will create a "map" of the smart cities and smart regions landscape in the form of recommendations and implementation guidelines to serve regional and national authorities to specify their long-term R&I strategies, direct investments, and guide the involved stakeholders to implement them. METACITIES will contribute towards convergence of the localised strategic plans, thus facilitating cross-border cooperation, knowledge exchanges, and joint implementation undertakings.
EO3:	Common investment plans for R&I including infrastructures leveraging national, regional and European funds as well as private capital in a synergetic manner.	METACITIES Excellence Hub will develop a common platform for collaboration, best practice sharing and implement strategies underpinned by concrete action plans and an investment strategy to bring cities, industries, SMEs, investors, researchers as well as private venture capitalists and many other smart city actors together. This will enable the METACITIES Excellence Hub to mobilize the communities of the three innovation ecosystems to collaborate and to progress faster in joined efforts rather than working in silos.
EO4:	R&I pilot projects alongside a joint strategy and in line with regional and national strategies, notably regional innovation strategies for smart specialisation (RIS3).	The R&I pilot projects should be coupled with effective evaluation mechanisms leading to sound appraisal of success and feasibility as mainstream RIS3 projects. METACITIES will support future R&I funded projects through joint clustering activities in alignment with national and the EU Smart Specialization Strategies (RIS3) and the Digital Agenda of Europe.
EO5:	New competencies and skills for researchers, entrepreneurs and professionals in R&I intensive domains.	Through METACITIES, scientists and researchers will spread knowledge among their peers and colleagues by sharing their activities through a wide range of social networks, co-organized workshops, seminars and international conferences and forums, thus spearheading new competencies and skills for international researchers, entrepreneurs and professionals in R&I domains. Through publicly available e-Trainings/Courses online tutorials METACITIES will maximise reuse of the knowledge. Thus, METACITIES knowledge enrichment and upskilling in R&I intensive domains will contribute towards applying these new skills in real world scenarios for and consequently high TRL R&I outcomes.
EO6:	Strengthened linkages between science and business.	METACITIES consortium partners will be encouraged through the project to closely collaborate and to transform the role of the research community, anchoring it as a vital center of

№	Expected outcomes	Comments
		competence to help tackle social challenges and drive economic growth. METACITIES clustering and collaboration activities will be designed to run longer, invest more, look farther ahead and hone the competitiveness of companies, universities and regions.
EO7:	Poles of attraction for talents in catching up regions and countries.	The know-how to be created, and the new relationships that will be forged within the consortium and beyond, through wide clustering activities will be pivotal for the future sustainability of the SEE region as the reference Excellence Hub for meta-cities of the future. This will trigger the interest and attract the engagement of new talents from the wider EU region.
EO8:	Improved knowledge transfer and development of entrepreneurial skills.	METACITIES promote and support knowledge and technology transfer, and will spread know-how in the region via its training and visitors' programs, provision of access to advanced infrastructure and participation in collaborative projects, as well as initiate innovation-related activities. METACITIES plans to develop a strong capacity building programme for providing improved knowledge transfer, empowering young professionals to develop new skills, thus enabling them to apply the project's technological innovations in their future products and services.
EO9:	Uptake of innovative technologies.	METACITIES will implement wide impact maximization activities as per the project's dissemination and communication strategy, develop new skills and competences and entrepreneurial aptitude, actively engage with the business and civic worlds to create business opportunities and strengthen societal acceptability of innovation, get involved in extensive networking activities and reinforce interconnection and interoperability of cross-border innovation ecosystems.
EO10:	New business opportunities especially for SMEs and new employment.	The collaboration between the three METACITIES clusters will use local entrepreneurial knowledge to recognize domains for future growth and participation in the global markets and create an understanding of new business opportunities. Though the development of new products and services "ready to deploy" solutions will be generated to address smart cities challenges while creating business opportunities for SMEs.

Table 46: Relation between the objectives and expected outcomes of the project

STRATEGIC GOAL	***Increase of the R&I Capacity of the Excellence Hub***										
№	**Expected outcomes / Objectives**	**EO 1**	**EO 2**	**EO 3**	**EO 4**	**EO 5**	**EO 6**	**EO 7**	**EO 8**	**EO 9**	**EO 10**
1	R&I strategies	X	X								
2	ODTF	X		X							
3	Project pilots/implemented use cases	X			X						

STRATEGIC GOAL	*Increase of the R&I Capacity of the Excellence Hub*										
№	**Expected outcomes / Objectives**	**EO 1**	**EO 2**	**EO 3**	**EO 4**	**EO 5**	**EO 6**	**EO 7**	**EO 8**	**EO 9**	**EO 10**
4	Increased cooperation between the clusters and QH actors	X	X								
5	Increased attractiveness for talents	X				X		X	X	X	
6	Increased investment funds	X	X	X					X		X
7	Increased R&I outcomes	X	X		X	X		X		X	
8	Stronger cooperation and links among the actors of the QH	X	X	X			X				
9	Stronger involvement of regional actors in R&I processes	X	X	X	X		X		X	X	X
10	Strengthened local ecosystems	X					X	X			
11	Acceleration of the digital transformation of cities	X							X		
12	Attraction of new businesses and investments	X					X				
13	Opening of new ways for innovating	X		X			X		X	X	
14	Creating new business opportunities	X		X			X				X
15	Implemented Dissemination, Exploitation & Communication	X			X	X	X	X	X	X	

In METACITIES, the indicators should be selected and defined in such a way as to define important milestones and to allow tracking the progress towards the achievement of the joint strategy, objectives, and outcomes of the project. A number of indicators that will allow tracking progress and measuring the impact of the project have been selected and defined in relation with the project objectives and mapped to the actions from the implementation plan of the joint strategy (Chapter 7). They are given accordingly in Table 47 and Table 48. It should be noted that the KPIs are selected in such a way that during the implementation of the strategy and project a clear signal will be provided if there is a change of the indicator value. Indicators that are influenced by other factors than the implementation of the project are not suited. Indicators that provide ambiguous signals (if there is doubt on the interpretation of e.g. an increase in the indicator value) are equally not suited. Another main consideration in the determination of the KPIs is that their calculation should be easily understood by all the project partners from the QH. For a number of indicators, we have relied on indicators defined in the project proposal.

Table 47: KPI and their relation to the project objectives

№	**Objectives / KPI**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	Common regional R&I Strategy	X									X	X	X	X	X	X
2	OTDF specification and pilots		X	X	X							X	X	X	X	X
3	Scientific publications					X		X	X		X			X		X
4	Joint training events				X	X	X				X					X
5	Technical Publications & white papers	X	X	X	X			X	X	X						X
6	Joint Project Proposals				X		X	X	X	X						X
7	Funding opportunities				X		X		X	X	X	X	X	X	X	

№	Objectives / KPI	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	Smart Cities Products and services			X	X							X	X	X	X	

Table 48: KPIs and their relation to the objectives from the Joint R&I Strategy

a) *PRIORITY AREA A. Smart and Safe Mobility*

№	Objectives / KPI	A1	A2	A3	A4	A5	A6	A7	A8
1	Regional and common R&I Strategies	X	X	X	X	X	X	X	X
2	OTDF specification and pilots	X	X	X	X	X	X	X	X
3	Scientific publications						X		X
4	Joint training events						X		X
5	Technical Publications & white papers		X	X					X
6	Joint Project Proposals					X			X
7	Funding opportunities				X			X	
8	Smart Cities Products and Services	X	X	X	X				

b) *PRIORITY AREA B. Smart environment*

№	Objectives / KPI	B1	B2	B3	B4	B5	B6	B7	B8
1	Regional and common R&I Strategies	X	X	X	X	X	X	X	X
2	OTDF specification and pilots	X	X	X	X	X	X	X	X
3	Scientific publications					X			X
4	Joint training events			X			X		X
5	Technical Publications & white papers			X					X
6	Joint Project Proposals							X	X
7	Funding opportunities							X	
8	Smart Cities Products and Services	X	X		X	X			

c) *PRIORITY AREA C. Smart urban planning*

№	Objectives / KPI	C1	C2	C3	C4	C5	C6	C7	C8
1	Regional and common R&I Strategies	X	X	X	X	X	X	X	X
2	OTDF specification and pilots	X	X	X	X	X	X	X	X
3	Scientific publications							X	X
4	Joint training events			X			X		X

5	Technical Publications & white papers			X				X	X
6	Joint Project Proposals							X	X
7	Funding opportunities							X	
8	Smart Cities Products and Services	X	X		X	X			

d) *PRIORITY AREA D. Green and climate adaptive resource management*

№	Objectives / KPI	D1	D2	D3	D4	D5	D6	D7	D8
1	Regional and common R&I Strategies	X	X	X	X	X	X	X	X
2	OTDF specification and pilots	X	X	X	X	X	X	X	X
3	Scientific publications	X			X			X	X
4	Joint training events				X		X		X
5	Technical Publications & white papers	X		X	X			X	X
6	Joint Project Proposals	X						X	X
7	Funding opportunities			X		X		X	
8	Smart Cities Products and Services	X	X			X			

8.3 KPIs description

The definition and approach for the design of the KPIs, their description and presentation, follows the principles described in Section 8.2. The description of all the eight KPIs is given in Table 49. The rationale of choosing each KPI and relation to the project objectives is outlined accordingly, together with the methodology and the units in which they are measured. In the "Comments" sections in the table, additional information regarding the interpretation and evaluation of the KPIs is given. Finally, to enable tracking their evaluation and achievement, the KPIs with their respective milestones are presented in Table 50.

Table 49: List of KPIs to track progress and impact

KPI No.	1	Type	Regional and common R&I Strategies
Definition/ Description	R&I strategies, including recommendations and implementation guidelines on Digital Twins and Metaverse for smart cities and smart regions in SEE.		

Rationale/ Interpretation/ Relation to Project Objectives	Regional and common R&I strategies related to the digital transition of cities. The common strategy should define the methodology, guidelines and implementation plan the project partners should follow to reach its objectives. The common R&I Strategy will outline the strategic approach and practical steps that are to be taken in order to achieve the strategic objectives and outcomes of the project. This KPI is related to project objectives 1, 10 - 15.		
Methodology	Calculate as: Developed regional and common R&I Strategies related to the digital transition of cities.		
Unit	Number of strategies		
Comments	The developed strategies should be described in deliverable D2.1, together with a report on the key elements of the cross-border R&I toolbox, the model of QH collaboration and support mechanisms, the joint methodology, action plan and performance and impact indicators. In the Joint Strategy, a definition of the methodology and the implementation plan the project partners should follow to reach its objectives, should be considered.		
Target goal/value	Regional guidelines for R&I Strategies: 3 (one per regional cluster) Common regional R&I Strategy: 1 (joint for the three clusters)		
Milestones	M14		
KPI No.	**2**	**Type**	**OTDF specification and Pilots**
Definition/ Description	Requirements and Specification of the Open Digital Twin Framework and the realization of pilots.		
Rationale/ Interpretation/ Relation to Project Objectives	The development of the ODTF will provide the architecture and the framework to the pilots in the project. It is considered as an important element of the project performance and is related to objectives 2-4, 10-15.		
Methodology	Calculate as: ODTF should include a description of at least 5 state-of-the-art technologies employed, a specification of more than 10 components, and three reference architectures (M24). Realization of the pilots should be based on these specifications and architectures as to demonstrate the usefulness of the ODTF.		
Unit	Number of realized pilots		
Comments	Pilots in three domains: smart mobility (GR), green city (BG) and urban planning (CY). Each one of them will produce the specifications of their Digital Twins, how they can be implemented, and proof of concepts (PoCs). These PoCs will be tested, validated and the received feedback will be used to refine the ODTF.		
Target goal/value	3 pilots (1 per cluster) demonstrating the usefulness of the ODTF.		
Milestones	M24, M42		

KPI No.	3	Type	Scientific publications
Definition/ Description	Publications in scientific journals and conferences, preferably submitted to high impact journals and conferences.		
Rationale/ Interpretation/ Relation to Project Objectives	Publications demonstrate the increased joint capacity and efficiency of R&D performed in research and academic organizations, joint research and innovation activities, and the strengthening of the links among the partners. This KPI is related to project objectives 5, 7, 8, 10, 13, 15.		
Methodology	Calculate as: Total Number of publications per year.		
Unit	Number of papers accepted for publication in journals, proceedings and presentations in conferences.		
Comments	The publications should be visible in major databases such as Scopus; WOS, Google Scholar, etc. Preference should be given to submission to open access journals or conferences with higher impact and related to the scope of the WPs in the project.		
Target goal/value	Scientific papers in peer-reviewed Journals: ≥15; Presentations in Scientific Conferences ≥20.		
Milestones	M24, M36, M48		
KPI No.	**4**	**Type**	**Joint training events**
Definition/ Description	Workshops, webinars, hackathons, trainings, events.		
Rationale/ Interpretation/ Relation to Project Objectives	Such events are the prerequisite for stronger linkages among the actors of the QH and a stronger involvement of regional actors in R&I processes. These are means of knowledge and technology transfer and contribute to the sustainability of the project results. These events will raise visibility, citizen engagement, entrepreneurship training, staff exchange, mutual learning etc. This KPI is related to project objectives 4-6, 10, 15.		
Methodology	Calculate as: Total Number of events per year. Total number of enrolled users in all the events.		
Unit	Number in total.		
Comments	The technical workshops, training sessions, webinars summer schools will be organized by the scientific partners in an online and/or physical way. Hackathons on ODTF will be organised by each ecosystem (CY, GR, BG). The training events will be related to the competencies and skills developed in the context of project.		
Target goal/value	Technical Workshops: 6 in 3 countries. Online Training Tutorials: 4. Summer schools: 6. Webinars: 10. Smart City Hackathons/Pitching events organized: 3. Total number of enrolled users: ≥1000.		
Milestones	M30, M48		

KPI No.	5	Type	Technical Publications & white papers
Definition/ Description	Technical blogs, presentations, posts, fact-sheets, articles, position/white papers, policy recommendations, catalogs, books, or any other reference from technology providers.		
Rationale/ Interpretation/ Relation to Project Objectives	Technical publications demonstrate the increased joint capacity of the project partners, strengthening of the links among them, the efficiency of the dissemination of the results from the implementation of the pilots, and are part of the measures towards the sustainability of the project. This KPI is related to project objectives 1-4, 7-9, 15.		
Methodology	Calculate as: Total Number per year.		
Unit	Number of : technical publications and presentations; position/white papers, fact-sheets, articles, posts and blogs; standards contributions, catalogues and books; policy recommendations and references.		
Comments	The technical publications, position/white papers, fact-sheets, articles, standards contributions, catalogues and books, policy recommendations should be visible and available at the web page of the project.		
Target goal/value	Technical Publications and presentations: ≥15 White papers, fact-sheets, articles: ≥10 Standards Contributions, catalogues and books: ≥3 Policy recommendations and references: ≥3. Posts and Blogs: ≥4		
Milestones	M30, M42, M48		
KPI No.	**6**	**Type**	**Joint Project Proposals**
Definition/ Description	Project proposals submitted jointly by partners.		
Rationale/ Interpretation/ Relation to Project Objectives	Submissions of joint proposals demonstrate the increased, joint research and innovation activities, the strengthening of the links among the partners, and sustainability of the project results. Funding of future projects is important for strengthening the ecosystems, accelerating digital transformation, networking and cooperation, and the attraction of investments. This KPI is related to project objectives 4, 6-9, 15.		
Methodology	Calculate as: Number of submitted proposals after the second year of the project.		
Unit	Number in total.		
Comments	These should be expected to be submissions of proposals for future projects that build on the outcomes of the project, strategy realization, and results from the implementation of the ODTF and pilots.		
Target goal/value	Projects submitted to build on the results of METACITIES: ≥10		
Milestones	M30, M48		
KPI No.	**7**	**Type**	**Funding opportunities**

Definition/ Description	Funding opportunities from national and regional bodies.		
Rationale/ Interpretation/ Relation to Project Objectives	Funding opportunities reflect the Integrated Business Process Framework (IBPF) and Business Models (BMs) that may be applied to the smart cities and regions. Together with the strategies for digital transition of cities they are the way towards the increase of investment funds and the perspective of the Digital Twins to serve business requirements and strategic goals. This KPI is related to project objectives 4, 6-9, 15.		
Methodology	Calculate as: Number of opportunities analyzed and described.		
Unit	Number in Total		
Comments	The development of the IBPF, BMs, and strategies for Digital Transition of cities is important as they will dictate the model of investments, consolidating academia business linkages, and will be a guide towards new funding opportunities. At least 5 external entities will be involved in the development of IBPF and BMs. Through the participation in industrial exhibitions and showcasing events, connection to other DIH and associations or organisations, more than 1000 Southeastern European stakeholders will be informed about the strategies for Digital Transition of cities.		
Target goal/value	Funding opportunities: ≥5.		
Milestones	M36; M42; M48.		
KPI No.	**8**	**Type**	**Smart Cities Products and Services**
Definition/ Description	Products, prototypes, and services developed and proposed to the QH ecosystem related to smart cities, and reflecting the domains accommodated by each cluster, i.e. smart mobility, green city, and urban planning.		
Rationale/ Interpretation/ Relation to Project Objectives	These will demonstrate the successful implementation and validation of designs, guide future R&I directions, and serve as evidence to pursue investment funds. They will be within the scope of the developed integrated business framework and corresponding business models which will dictate the developments necessary to realize the joint strategy and guide the business and social expectations of the various stakeholders.		
Methodology	Calculate as: Number of products developed and services offered by the partners.		
Unit	Number in Total		
Comments	Mandatory is the development of specific smart city and smart region Digital Twins by the different clusters, including guidelines and definition of roadmaps for the their implementation. In addition other products and services include, but are not limited to: interactive 4D maps that can be used to forecast expected and predicted actions and behaviors of the environment and of other users; ICT and sensor infrastructures contributed by the partners; databases build on		

	collecting data from platforms and sensor infrastructures; services build upon use case analysis and implementation scenarios; computer models and applications; integrated business framework; use cases and business models for METACITIES; etc.
Target goal/value	Total: ≥ 9 including: • Digital Twins for the smart cities and regions: ≥ 3. • Other product and services: ≥ 6.
Milestones	M30, M42, M48

Table 50: KPI and evaluation milestones

№	Milestones KPI	M14	M24	M30	M36	M42	M48
1	Regional and common R&I Strategies	X					
2	OTDF specification and pilots		X			X	
3	Scientific publications		X		X		X
4	Joint training events			X			X
5	Technical Publications & white papers			X		X	X
6	Joint Project Proposals			X			X
7	Funding opportunities				X	X	X
8	Smart Cities Products and Services			X		X	X

9 Conclusion

The present deliverable addressed the first objective of the METACITIES project which relates to the definition of joint long-term R&I strategies and implementation guidelines on Digital Twins and Metaverse technologies for smart cities and smart regions in SEE applicable to regional innovation strategies for smart specialization. It summarises the work and results of WP2, analyses potential obstacles and problems, and presents a picture of the state of Digital Twins and Metaverse technologies in Southeast Europe. To build a collaborative research and innovation (R&I) strategy, the regional R&I strategies for each place-based innovation ecosystem are examined. In light of this, a Reference Model for Collaboration was developed, especially for Smart Cities, based on the idea of the Quadruple Helix (QH) Approach. The cross-border, cooperative R&I strategy's strategic goals are transformed into a portfolio of complementary actions engaging all QH actors, advancing the process from conception to implementation, based on a systematic approach. The Excellence Hub's Action Plan is built around the specified Actions. In order to track the development of the joint R&I strategy's goals and project outcomes, key performance indicators are lastly created.

With the submission of the present deliverable the work in WP2 concludes and its planned continuation is also within the scope of the other work packages. Work packages 3 and 4 will address technological and validation actions. In WP5 the business model and action plan of the Excellence Hub will be defined and detailed together with the Hub's Business Model and Sustainability and Investment Plans. Work package 6 will take care of actions related to Capacity Building, Knowledge Transfer, Support for Entrepreneurship, Community Creation and Engagement towards awareness raising, co-creation, validation and adoption, and empowered Collaboration among the regional innovation ecosystems towards innovation and growth.

References

[1] Z. Lv, W.-L. Shang, and M. Guizani, "Impact of Digital Twins and Metaverse on Cities: History, Current Situation, and Application Perspectives", *Applied Sciences*, vol. 12, no. 24, p. 12820, Dec. 2022.

[2] Correia D, Marques JL, Teixeira L., "The State-of-the-Art of Smart Cities in the European Union", *Smart Cities*, vol. 5, no. 4, pp. 1776-1810, 2022.

[3] Deren, L., Wenbo, Y. & Zhenfeng, S., "Smart city based on Digital Twins", *Computational Urban Science*, vol. 1, 2021.

[4] Ville V. Lehtola, Mila Koeva, Sander Oude Elberink, Paulo Raposo, Juho-Pekka Virtanen, Faridaddin Vahdatikhaki, Simone Borsci, "Digital Twin of a city: Review of technology serving city needs", *International Journal of Applied Earth Observation and Geoinformation*, vol. 114, 2022.

[5] Z. Allam, A. Sharifi, S. E. Bibri, D. S. Jones, and J. Krogstie, "The Metaverse as a Virtual Form of Smart Cities: Opportunities and Challenges for Environmental, Economic, and Social Sustainability in Urban Futures", *Smart Cities*, vol. 5, no. 3, pp. 771-801, Jul. 2022.

[6] Al-Sehrawy, Ramy & Kumar, Bimal, "A Digital Twin Uses Classification System for Urban Planning & City Infrastructure Management", *Electronic Journal of Information Technology in Construction*, vol. 26, 2021.

[7] G. Caprari, G. Castelli, M. Montuori, M. Camardelli, and R. Malvezzi, "Digital Twin for Urban Planning in the Green Deal Era: A State of the Art and Future Perspectives", *Sustainability*, vol. 14, no. 10, p. 6263, May 2022.

[8] European Commision, "People, technologies & infrastructure – Europe's plan to thrive in the Metaverse I Blog of Commissioner Thierry Breton," Available at: https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_22_5525, 14 September 2022.

[9] GSMA, "The Mobile Economy 2023 ," Available at: https://www.gsma.com/mobileeconomy/wp-content/uploads/2023/03/270223-The-Mobile-Economy-2023.pdf.

[10] Cláudia Ribeiro, "Six European cities to experiment with 'Digital Twins' for urban logistics," Available at: https://www.eltis.org/in-brief/news/six-european-cities-experiment-digital-twins-urban-logistics, Jun 2020.

[11] Jaume Ferré-Bigorra, Miquel Casals, Marta Gangolells, "The adoption of urban Digital Twins", *Cities*, vol. 131, 2022.

[12] M. Trunfio and S. Rossi, "Advances in Metaverse Investigation: Streams of Research and Future Agenda", *Virtual Worlds*, vol. 1, no. 2, pp. 103-129, Oct. 2022.

[13] [Online]. https://therecursive.com/top-8-Metaverse-games-startups-southeast-europe/

[14] V. Crespo-Pereira, E. Sánchez-Amboage, M. Membiela-Pollán, "Facing the challenges of Metaverse: a systematic literature review from social sciences and marketing and communication", *Profesional de la información*, vol. 32, no. 1, 2023.

[15] Yogesh K. Dwivedi, Laurie Hughes, Abdullah M. Baabdullah, Samuel Ribeiro-Navarrete, Mihalis Giannakis, Mutaz M. Al-Debei, et all., "Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy", *International Journal of Information Management*, vol. 66, 2022.

[16] Technology Foresight Center (TFC), "Metaverse Technology, Past and Future," Available at: https://www.mcit.gov.sa/sites/default/files/2023-02/Meatverse%20EN%20Report.pdf, 2023.

[17] Lau Christensen, Alex Robinson, *The Potential Global Economic Impact of the Metaverse*. Available at: https://www.analysisgroup.com/globalassets/insights/publishing/2022-the-potential-global-economic-impact-of-the-Metaverse.pdf.

[18] D. M. Botín-Sanabria, A.-S. Mihaita, R. E. Peimbert-García, M. A. Ramírez-Moreno, R. A. Ramírez-Mendoza, and J. de J. Lozoya-Santos, "Digital Twin Technology Challenges and Applications: A Comprehensive Review", *Remote Sensing*, vol. 14, no. 6, p. 1335, Mar. 2022.

[19] Ning, Huansheng & Wang, Hang & Lin, Yujia & Wang, Wenxi & Dhelim, Sahraoui & Farha, Fadi & Ding, Jianguo & Daneshmand, Mahmoud, "A Survey on Metaverse: the State-of-the-art, Technologies, Applications, and Challenges", 2021.

[20] Council of the European Union, General Secretariat, "Metaverse – Virtual World Real Challenges," Available at: https://www.consilium.europa.eu/media/54987/Metaverse-paper-9-march-2022.pdf, 9 March 2022.

[21] 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.

[22] Recovery and Resilience Facility. [Online]. https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

[23] Cohesion Policy's Funds. [Online]. https://ec.europa.eu/regional_policy/funding/available-budget_en

[24] [Online]. https://digital-strategy.ec.europa.eu/en/news/proposal-european-interoperability-framework-smart-cities-and-communities-eif4scc

[25] [Online]. https://www.dmrid.gov.cy/dmrid/research.nsf/euprogramms02_el/euprogramms02_el?OpenDocument

[26] [Online]. https://www.dmrid.gov.cy/dmrid/research.nsf/planning01_el/planning01_el?OpenDocument

[27] [Online]. https://www.dmrid.gov.cy/dmrid/research.nsf/euprogramms04_el/euprogramms04_el?OpenDocument

[28] Dirk Helbing and Javier Argota Sánchez-Vaquerizo, "DigitalTwins: Potentials, Ethical Issues,and Limitations," Available at: https://arxiv.org/ftp/arxiv/papers/2208/2208.04289.pdf, 2022.

[29] ITU-T Y.4000 series, "Smart sustainable cities - Setting the stage for stakeholders' engagement".

[30] Recommendation ITU-T Y.4903, "Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals".

[31] [Online]. https://solutions.logicom.net/offerings/infrastructure-solutions-and-services/

[32] [Online]. https://www.signalgenerix.com/

[33] DEFRA, "Environmental Key Performance Indicators. Reporting Guidelines for UK Business," Department for Environment, Food and Rural Affairs Report PB 1132. 1, 2006.

[34] Kellen, V., "Business Performance Measurement: At the Crossroads of Strategy, Decision-Making, Learning and Information Visualization," 2003.

[35] P. Bosch, S. Jongeneel, V. Rovers, H. Neumann, M. Airaksinen, A. Huovila, "CITY keys indicators for smart city projects and smart cities," Technical Report DOI: 10.13140/RG.2.2.17148.23686, January 2017.

[36] Rooijen, T., Nesterova, N. & Guikink, D., "Applied framework for evaluation in CIVITAS PLUS II," Deliverable 4.10 of CIVITAS WIKI of CIVITAS initiative. Cleaner and better transport in cities (CIVITAS WIKI), 2013.

[37] M. Serrano, E. Griffor, D. Wollman, M. Dunaway, M. Burns, S. Rhee, C. Greer, "Smart Cities and Communities: A Key Performance Indicators Framework," NIST Technical Series Publication DOI: 10.6028/NIST.SP.1900-206, February 2022.

[38] Rec. ITU-T Y.4903, "Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals," 03/2022.

[39] Abeyasekera, S., "Quantitative analysis approaches to qualitative data: why, when and how?," in *Methods in Development Research; Combining Qualitative and Quantitative Approaches*, J. D. a. C. J. Holland, Ed. ITDG Publishing, Warwickshire, 2005, pp. 97-106.

[40] Correia, D.; Marques, J.L.; Teixeira, L., "The State-of-the-Art of Smart Cities in the European Union", *Smart Cities*, vol. 5, pp. 1776-1810, 2022.

[41] Kim, S.-C.; Hong, P.; Lee, T.; Lee, A.; Park, S.-H., "Determining Strategic Priorities for Smart City Development: Case Studies of South Korean and International Smart Cities", *Sustainability*, vol. 14, 2022.

[42] Bastiaan Baccarne, Peter Mechant and Dimitri Schuurman, "Empowered Cities? An Analysis of the Structure and Generated Value of the Smart City Ghent," in *Smart City: How to Create Public and Economic Value with High Technology in Urban Space*, 2014, pp. 157-182.