Local Digital Twins for Smart Sustainable Communities

LDT4SSC Impact Assessment Framework

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Abbreviations and acronyms

Abbr.	Description	Abbr.	Description
AI	Artificial Intelligence	**SMART**	Methodology for defining objectives, which refer to Specific, Measurable, Achievable, Relevant and Time-bound
CA	Consortium Agreement	**LDT**	Local Digital Twins
DEP	Digital Europe Programme	**DS4SSCC-DEP**	Deployment project for the European Data Space for Smart Communities
EDIC	European Digital Infrastructure Consortium	**LDT4SSC**	Local Digital Twins for Smart and Sustainable Communities project
GA	Grant Agreement	**KPIs**	Key Performance Indicators
ToC	Theory of Change	**SIMPL**	SIMPL is the open-source smart middleware platform that enables cloud-to-edge federations and all major data initiatives funded by the European Commission
U4SSC	United for Smart Sustainable Cities	**SDGs**	Sustainable Development Goals
UN	United Nations	**DDPP**	Digital Decade Policy Programme
WP	Work Package		

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Executive Summary

The LDT4SSC project focuses on three interrelated objectives designed to enhance LDT networks, address shared urban needs, and deliver advanced AI services:

1. **Connecting existing data platforms and LDTs from cities and communities to create a federation of LDTs across the EU**. Reinforced interoperability through the aggregation of LDTs at a larger scale (cross-sector, cross-cities, and cross-borders) will help to scale up EU common data sets and open-source solutions, and facilitate less advanced cities and communities to join the existing EU LDT ecosystem.

2. **Expanding existing local data platforms and LDTs with new open-source LDT services based on shared needs of cities and communities**. These services should aim to improve decision-making processes and citizen interaction, reduce risks, costs, and downtime, enhance resilience and sustainability of LDT platforms and enable new value creation.

3. **Complementing the EU LDT Toolbox launched under WP2021-22 with additional AI-based and innovative services** (e.g. for adaptable multi-sector considerations, advanced simulation and modelling approaches including bottom-up self-organised models). The AI services will be developed and tested within existing cities/communities and be replicable in other contexts.

In support of this work, and building on the DS4SSCC-DEP project, this document defines an **Impact Assessment Framework** with two main purposes:

- First, it provides a clear framework to track and assess the pilot initiatives selected through three waves of open calls, ensuring their quality and contribution to LDT4SSC's overall goals.

- Second, it examines the wider effects of the LDT4SSC initiative, bringing together insights from all pilots to assess their potential for scaling and long-term sustainability.

Whereas long-term impact looks beyond the timeframe of the project and pilots, the framework offers a robust methodology to assess outputs, short-term outcomes and their contributions towards broader impact. In turn, it provides recommendations to the development of an interoperability blueprint and the LDT ecosystem. Hence, the framework helps to strengthen the initiative's efforts to create economic and social value of LDTs at local, regional, national, and European levels.

The structure of the document is outlined as follows:

- **Chapter 1** outlines the introduction to the document, including the scope and key definitions applied.

- **Chapter 2** sketches out the methodology and literature review, thereby outlining the type of data consulted to inform the conceptual framework.

- **Chapter 3** presents the conceptual framework for the impact assessment framework. It comprises a presentation of Theory of Change and intervention logic, components of the LDT4SSC impact framework and the application of the LDT4SSC impact framework.

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- **Chapter 4** covers a description of the key performance indicators (KPIs) that are recommended to be used in the impact assessment.
- **Chapter 5** summarises the next steps for the impact assessment framework, including the refinement process.
- **Chapter 6** introduces the annexes.

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1 Introduction

1.1 About the Local Digital Twins for Smart and Sustainable Communities

The Local Digital Twins for Smart and Sustainable Communities (LDT4SSC) project is set out to build a robust, scalable network of LDTs and stimulate the use of innovative, AI-driven LDT services across European local communities. As a Digital Europe Programme (DEP) funded project, it contributes to two main goals/directives from the EC:

1. Improving the digitalisation of Europe as a whole, and
2. Improving citizens' lives through sustainability and projects to better preserve and protect the environment.

This project builds on and integrates outputs from related European Union (EU) funded projects and initiatives, such as the deployment project for the European data space for smart communities (DS4SSCC-DEP)[1], the EU LDT Toolbox[2], Living-in.EU[3], CitCom.ai[4], and the Smart Middleware Platform (SIMPL)[5] leveraging existing knowledge, tools and stakeholder networks. In doing so, LDT4SSC operates not as a standalone initiative, but as a strategic liaison within a broader European ecosystem of digital infrastructure, data spaces and governance frameworks.

This project contributes directly to DEP objectives of enhancing technological sovereignty, promoting ethical AI, and fostering an inclusive digital market, while integrating ongoing initiatives including the Networked Local Digital Twins towards the CitiVERSE European Digital Infrastructure Consortium (LDT CitiVERSE EDIC)[6], as well as supporting policy goals like the New European Bauhaus[7], the European Green Deal[8] and the Digital Decade[9] (see more in the following section). In particular, through close alignment with the LDT CitiVERSE EDIC, the project accelerates the deployment of interoperable digital infrastructures across Member States, fostering cross-border collaboration. In doing so, it contributes to the DEP's vision of a resilient, unified digital landscape.

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[1] The European data space for smart communities is an EU-wide action creating a cross-sectorial data space for governments on all levels and their providers to deliver the best possible services to their citizens by enabling interoperability to reach critical goals. Source: https://www.ds4sscc.eu/.

[2] The EU Local Digital Twin Toolbox is a flagship initiative of the European Commission that provides a modular, standards-based suite of tools designed to help cities and communities across Europe simulate, analyse, and plan urban environments more effectively. Source: https://interoperable-europe.ec.europa.eu/collection/ldttoolbox

[3] Living-in.EU is an EU initiative for local and regional leaders who believe that technology can help them make their town, city, or region a better place to live. Source: https://living-in.eu/

[4] Testing AI in Smart Cities and Communities. Source: https://citcomtef.eu/

[5] Simpl is an open source, secure middleware that supports data access and interoperability in European data initiatives. Source: https://simpl-programme.ec.europa.eu/

[6] Source: https://ldtcitiverse-edic.eu/

[7] Source: https://new-european-bauhaus.europa.eu/index_en

[8] Source: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[9] Source: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

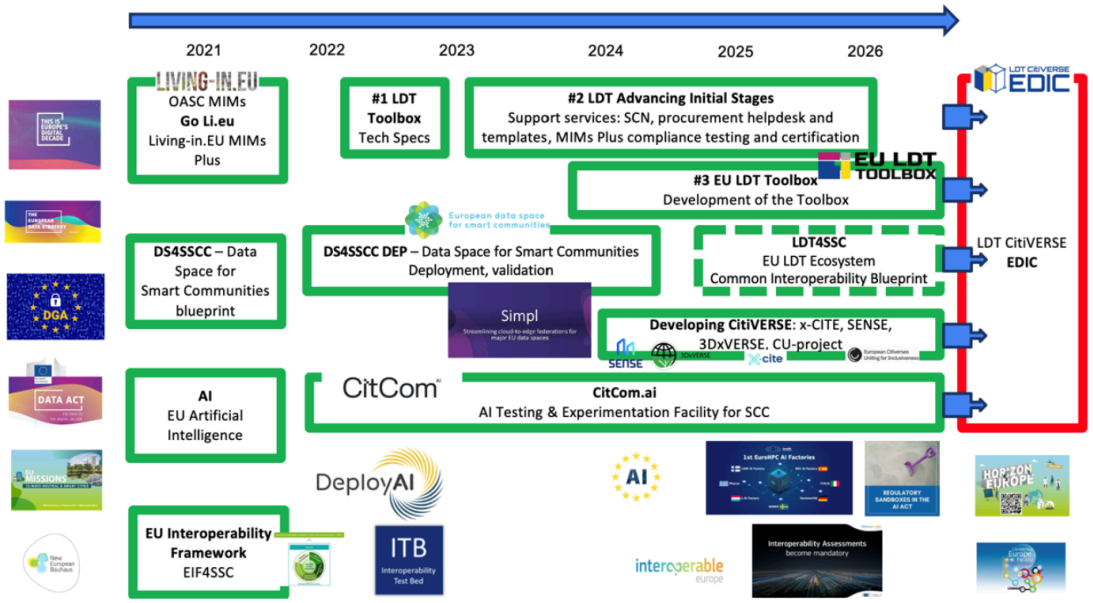

Figure 1. The Smart Communities Ecosystem

Figure 1 shows how LDT4SSC is positioned in the wider network of initiatives and the evolution from the Data Space for Smart and Sustainable Cities and Communities project (DS4SSCC) to LDT4SSC. Together, these efforts will establish a resilient LDT infrastructure that enables European communities to optimise urban services, share resources and tackle shared challenges such as climate change, air quality, waste management and energy efficiency, among others.

The project also addresses broader barriers to AI adoption in Europe, which include limited investment, regulatory complexity and gaps in expertise. By pooling public sector demand and ensuring a fair, competitive environment for innovators, it supports the development of advanced AI-driven digital twin solutions. This approach benefits both the public and private sectors, aligns with the EU's priorities for ethical AI and open standards and reduces dependence on foreign technologies.

The LDT4SSC project is implemented by 9 partners, outlined in Table 01. Furthermore, it aims to establish 15 - 20 pilot projects through three rounds of open calls[10] (for more information, see D4.1 Pilot application package covering call text template, evaluation concept, and evaluation criteria), onboarding a community of practitioners from European local communities to reach envisioned objectives and build an open and collaborative LDT ecosystem.

Table 1: LDT4SSC project partners

OPEN & AGILE SMART CITIES & COMMUNITIES	LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST	Cerema CLIMAT & TERRITOIRES DE DEMAIN

[10] https://ldt4ssc.eu/opencalls/

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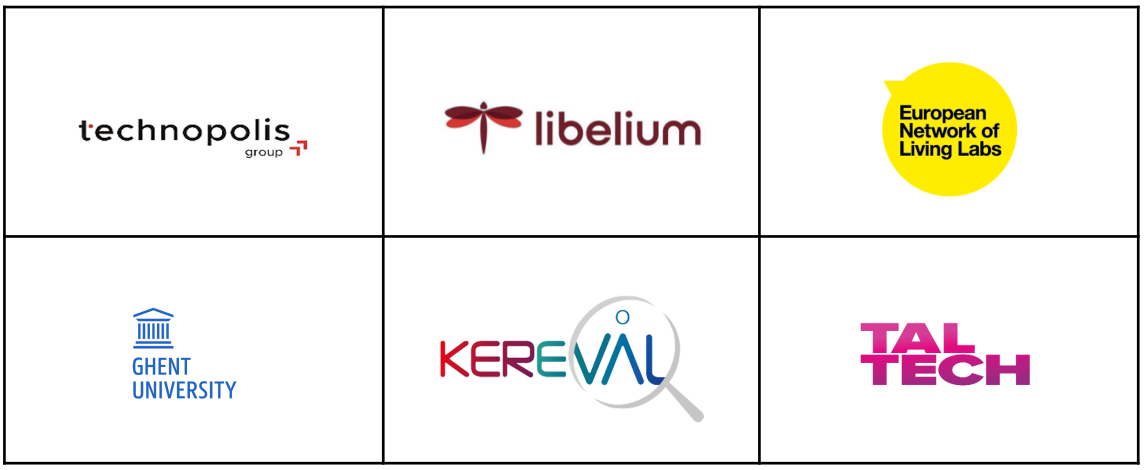

To achieve this, the project pursues three objectives:

1. **Connecting existing data platforms and LDTs from cities and communities** to create a federation of LDTs across the EU. Reinforced interoperability through the aggregation of LDTs at a larger scale (cross sectors, cross cities, and cross borders) will help to scale up the EU common data sets and open-source solutions. It will also facilitate less advanced cities and communities joining the existing EU LDT ecosystem.
2. **Expanding existing local data platforms and LDTs with new open-source LDT services based on shared needs of cities and communities**. These services should aim to improve decision-making processes and citizen interaction, reduce risks, costs, and downtime, enhance resilience and sustainability of LDT platforms and enable new value creation.
3. **Complementing the EU LDT Toolbox launched under WP2021-22 with additional AI-based and innovative services** (e.g. for adaptable multi-sector considerations, advanced simulation and modelling approaches including bottom-up self organised models). The AI services will be developed and tested within existing cities/communities and be replicable in other contexts.

These objectives form the foundation of an LDT ecosystem that empowers communities to collaborate effectively while advancing Europe's digital transformation.

1.2 Scope of the Impact Assessment Framework

To support LDT4SCC's objectives, and building on the DS4SSCC-DEP project, the LDT4SSC defines and follows a robust **Impact Assessment Framework**, which has two main purposes:

- First, it provides a clear framework to track and assess the pilot initiatives selected through three waves of open calls, ensuring their quality and contribution to LDT4SSC's overall goals.
- Second, it examines the wider effects of the LDT4SSC initiative, bringing together insights from all pilots to assess their potential for scaling and long-term sustainability.

For the purpose of this project, Simister's (2017) definition of impact assessment is used: "*Impact assessment involves the assessment of long-term and/or significant changes brought about through a development intervention or series of interventions. It can be carried out through different tools, methodologies and approaches. Impact assessment is always focused on change, and pathways towards change, rather than on activities or deliverables.*"

As noted by Veenstra and Timan (2022) impact assessment has frequently been used in the field of digital transformation to analyse policy implications or to assess the impact of technologies such as big data and AI on public services and public value. They emphasise that, within these impact assessments, impact is expected to include *economic* impact as well as *social* and *environmental* impacts, focusing on *public value* and addressing *societal challenges*. They write that impact assessments in this arena "need to take into account a broad, and sometimes conflicting, range of impacts, requiring tailored impact indicators and frameworks for measurement." These are some of the guiding principles behind the impact assessment framework presented in this report.

Whereas long-term impact looks beyond the timeframe of the LDT4SSC project and its pilots, the framework offers a robust methodology to assess outputs, short-term outcomes and their contributions towards broader impact. In turn, it provides recommendations to the development of an interoperability blueprint and the LDT ecosystem. Hence, the framework helps to strengthen the initiative's efforts to create economic and social value of LDTs at local, regional, national, and European levels.

In practice, **this Impact Assessment Framework will set out the objectives and procedures for monitoring prospective impacts of the LDTs engaged and/or developed through the pilots.** It explains the overall approach and Key Performance Indicators (KPIs) to be used, based on relevant literature and practical experience, including past initiatives such as the DS4SSCC-DEP Impact Assessment Framework[11] and the CitCom.ai European AI Market Report[12]. Furthermore, the framework is designed to evolve over time, adapting to feedback from stakeholders and lessons learned through implementation, resulting in an updated framework at the end of the project (D2.4) providing an overview of the assessed outputs and outcomes as well as guidance on measuring impacts beyond the end of the project.

Finally, the Impact Assessment Framework is structured relative to the three key work strands of the LDT4SSC project:

- **Work Strand 1: Technical Inter-connection of Existing LDTs**

  WS1 is dedicated to **connecting and federating LDTs** across cities, communities and regions to create a **unified, interoperable and reusable EU LDT ecosystem**. In doing so, WS1 will support communities in accessing a comprehensive set of technical open specifications and open-source software components to interconnect their LDTs through Data Spaces, with most solutions expected to align with the SIMPL framework where appropriate. These efforts are expected to draw on the European Data Space for Smart and Sustainable Cities and Communities (DS4SSCC) as well as relevant thematic data spaces such as those for tourism, mobility and other domains, with which data exchange is envisaged.

  By leveraging standards, pilots will break down silos, scale up EU-wide datasets and onboard less-advanced communities into the LDT network. The goal is hence to **enhance decision-making** (particularly in key EU policies(like mobility, energy efficiency, or environmental)**, reduce redundancies and foster a collaborative data economy**, ultimately laying the foundation for a resilient, interconnected digital infrastructure that supports Europe's green and digital ambitions.

[11] Impact assessment in the European Data Space for Smart Communities (Data Space Symposium, 2024)

[12] Citcom.AI: test and experimentation facilities for AI startups and SMEs to test or experiment AI models and/or robots for the smart and sustainable cities and communities.

Through real-world use cases, such as cross-border traffic management or multi-city resource optimisation, it is expected that WS1 will transform fragmented local initiatives into a **cohesive, replicable, scalable and reusable federation of LDTs**, driving collective innovation and efficiency.

- **Work Strand 2: Creation of LDTs Based on Common Needs**

  Focused on addressing shared urban challenges such as mobility, climate change, energy, air pollution, waste, and water management, this strand aligns technology development with high-demand policy areas. By targeting these priorities, technology providers can refine their offerings and accelerate market adoption. Citizens benefit from improved public services, while cities gain better tools for managing infrastructure and services. The result is more efficient urban management and a stronger competitive edge for European tech solutions in global markets.

- **Work Strand 3: Adding New Advanced AI-Based Tools to the LDTs Toolbox**

  This strand introduces cutting-edge AI and open-source tools – such as generative AI, virtual worlds, and advanced simulation – to enable immersive, innovative use cases. These enhancements support critical urban sectors such as energy, transport, and infrastructure, and encourage citizen engagement and community resilience. The integration of AI-driven modelling and simulation services helps cities manage risks and optimise resources, while also promoting democratic, citizen-focused solutions.

Figure 2 below outlines the wider meta-architecture of the project, including the roles of the three work strands.

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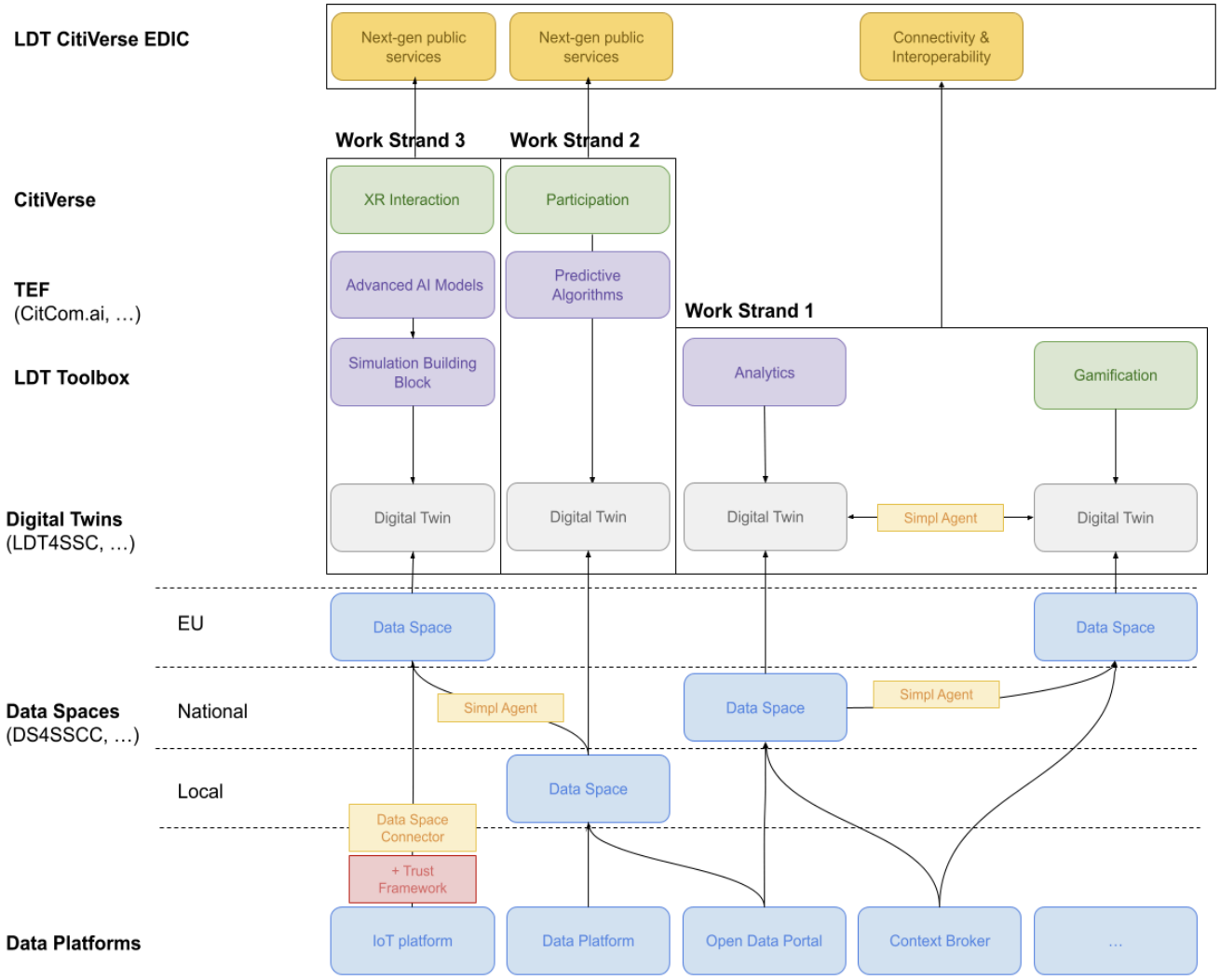
Figure 2. Part of the Meta-architecture for AI-based LDTs



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2 Identifying best practices for Impact Assessment

In its mission to establish a European wide LDT ecosystem, LDT4SSC also seeks to provide a tangible impact assessment method for any smart city LDT initiative. This was done with the scope of consolidating existing results, as well as moving towards an ecosystem of mature LDT-based infrastructures and services across the EU and helping cities and communities achieve economies of scale for the access and deployment of (open) data platforms, data spaces, and LDT-based services.

To this end, the following sources of information were reviewed through desk research:

- Sources that investigate **the digital transformation of smart cities and communities overall.** Smart cities use digital technologies to enhance their urban services, sustainability, and citizen engagement. A central component of this evolution is represented by LDTs, which serve as crucial decision-support tools for urban planners and policymakers by integrating heterogeneous data sources, and in some cases simulation models, that reflect the multifaceted nature of urban environments.
- Sources that investigate **specific segments of LDTs,** including **existing policies and regulations, business models, technical and impact assessment frameworks, and LDTs for Smart Sustainable Communities**. Documentation for LDT policies and regulations principally consists of legal frameworks, regulatory standards at EU levels, and governance models that shape digital twin deployment. The business and operational dimension of LDTs encompass diverse models ranging from public-private partnerships to fully public or commercial ventures. LDT4SSC focuses on applying digital twin technology to advance sustainability goals within urban contexts.
- Sources that investigate the necessity to **integrate advanced AI-driven services and enhancements within cities already equipped with LDT**. This can reinforce and add to the existing EU LDT Toolbox ecosystem, improving decision-making processes and operational efficiency, thereby advancing toward the EU's vision of a federated, innovative smart city landscape.

Table 2 below outlines the sources identified covering the wider digital transformation of communities.

Table 2. Mapping covering digital transformation of cities/communities and LDTs

Topic	Identified sources
Smart cities digital transformation	• LORDIMAS: A digital maturity assessment tool for regions and cities • DS4SSCC: European Data Space for Smart Communities • Living-in.EU: EU movement for local and regional leaders who believe that technology can help them make their town, city, or region a better place to live

Topic	Identified sources
	• Toolkit on Digital Transformation for People-Oriented Cities and Communities (Living-in.EU) • DIGIREG Territorial perspectives of digital transition in European regions • IDC MaturityScape: Smart Cities and Communities 3.0 • GovTech Maturity Index: The State of Public Sector Digital Transformation (Dener, Nii-Aponsah, Ghunney, and Johns) • eGovernment Benchmark Study: Towards a Digital Citizen-Centric City (Capgemini, 2022) • Online Procurement Helpdesk for smart communities: Support service to advance digital maturity of EU cities and communities in early stages of digital transformation • European CitiVerse Uniting for Inclusiveness • Systematic literature review of the smart city maturity model (Aljowder, Ali, Kurnia) • Smart Cities Maturity Model – A Multicriteria Approach (Velozo Aragao, De Genaro Chiroli, Cavicchioli Zola, Velozo Aragao, Nogueira Marinho, Cascales Correa, and Colmenero) • SHOW: Digital transformation in mobility infrastructure, supporting the deployment of shared, connected and electrified automation in urban transport, to advance sustainable urban mobility • ULaaDs: Urban logistics solutions, including test platforms for on-demand city logistics and integrated management of urban logistics. • Sense: Connecting cities through immersive VR/AR and metaverse technology to enhance urban life • 3DxVerse: Harnessing the potential of Digital Twins to foster sustainable travel and living communities, with a focus on key use cases from airports to living communities, encompassing sustainability, economic growth, societal development, safety, security, resilience, and corporate sustainability responsibility. • X-cite: Using Extended Reality (XR) and Artificial Intelligence (AI) to make cities smarter, greener, and more inclusive, with the CitiVerse at the core.
Local Digital Twins	• Local Digital Twins for Cities and Regions: The Way Forward (Charalabidis, Kontos, Zitianellis) • Gemini Papers: What are Connected Digital Twins? (Cdbb Report) • Mapping EU-based LDT providers and users CNECT/2022/OP/0098 – Procurement of the Technical Specifications for the Local Digital Twins (LDTs) Toolbox (EC

Topic	Identified sources
	Directorate-General for Communications Networks, Content and Technology) • EU LDT Toolbox: Development of the Local Digital Twins (LDT) Toolbox for Advancing the transformation of Smart Communities (CNECT Data Spaces Symposium, 2023). • Leveraging Local Digital Twins for planning age-friendly urban environments (Merino, Uriarte, Izkara, Campos-Cordobes, Aranguren, Molina-Costa) • EuroCities Lab: Creation of the Guidelines for Developing Digital Twins (Currently restricted access to EuroCities' members) In terms of impact assessment frameworks relevant to communities and local digital twins, the following works have been identified: • Digital Twin Cities: Framework and Global Practices (World Economic Forum, April 2022). • Impact assessment in the European Data Space for Smart Communities (Data Space Symposium, 2024). • Digital Twin Framework Analysis Report (IOWN Global Forum, 2022). • Consolidated analysis and impact assessment of Smart Cities and Community projects (European Commission, 2024). • Evaluating Social Impact of Smart City Technologies and Services: Methods, Challenges, Future Directions (Multimodal Technologies and Interaction, 2023). • Force Multiplier: Realising the Benefits of Open and Re-usable Local Digital Twins (Decide Better: Open and Interoperable Local Digital Twins, March 2025). • Evaluation framework for domain-specific digital twin platforms (Tang, Zhuang, Zhang. March 2025).

Table 3 below outlines identified literature that is specific to each work strand.

Table 3 Mapping per work strand

Work strand	Identified sources
1: Technical inter-connection of existing LDTs	• European Digital Infrastructure Consortium: instrument made available to Member States under the Digital Decade Policy Programme 2030 to speed up and simplify the setup and implementation of multi-country projects (*Including CitiVerse*) • Digital Europe Programme (DEP): Foster the adoption of digital technologies, local digital twins and other digital solutions across rural and urban areas, ensuring that technology is accessible to all – in line with the *New* European Interoperability Framework

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Work strand	Identified sources
	• European Interoperability Framework: Promoting seamless services and data flows for European public administrations (European Commission) • European Interoperability Framework for Smart Cities and Communities (EIF4SCC) • The Interoperable Europe Act: What should public sector leaders know? (Efe) • OASC Network: Open & Agile Smart Cities & Communities – focused on interoperability (technical, semantic, organisational, legal), support for local/regional administrations in digital transformation journey & • MIMs (Minimum Interoperability Mechanisms): minimal but sufficient level of interoperability for data, systems and services specifically in the context of smart city solutions. • Userchi.EU: Part of the Mediterranean and Scandinavian-Mediterranean Trans European Network-Transport (TEN-T). Solutions for deployment of electrical vehicles, including an interoperability platform for charging across EU • Policy Brief: Implementing Local Digital Twins – A How-to Guide (Interoperable Europe Academy, June 2025) • FIWARE Smart Cities Solutions: FIWARE4Cities Book: collection of officially referenced cities from around the world that use solutions based on FIWARE open-standards technologies and often open data to make the cities and territories smarter and more sustainable • Gaia-X & Fiware: Implementation of a Federated Data Platform in Smart Cities (Lopes, Guimarães, Pereira, Machado) • ITB: Interoperability Test Bed • SIMPL: SIMPL is an open source, smart and secure middleware platform that supports data access and interoperability among European data spaces.

Work strand	Identified sources
2: Creation of LDTs based on common needs	• DEUT (Digital Urban European Twins): LDTs Policy Brief (December 2022). • Digital Europe: Towards Networked Local Digital Twins in Europe – Objective of creating LDTs based on common needs. Example: Developing open-source pilots of LDTs services, based on shared needs of cities and communities that already have a local data platform and/or a LDT and want to expand them with new real-life use case services. • LEAD Project: Introducing Digital Twins in last mile logistics is to improve the operation and efficiency of parcel delivery. The project aims at helping create innovative business models, make freight storage and distribution more agile, encourages the use of low emission delivery vehicles and develops smart, data-driven logistics solutions. • ENoLL: Living Labs are open innovation ecosystems in real-life environments based on a systematic user co-creation approach that integrates research and innovation activities in communities and/or multi-stakeholder environments, placing citizens and/or end-users at the centre of the innovation process. Training within ENoLL's Living Lab management methodology, especially within the Digital Twins context can be particularly useful. • Twins4Resilience (T4R) Project: Twin4Resilience (T4R) enhances the understanding and usage of Local Digital Twins (LDT) among stakeholders, while democratically deploying them in decision-making. T4R aims to bridge the LDT adoption gap, developing strategies, pilots, and training for inclusive planning. • DestinE Platform: Destination Earth is a flagship initiative of the European Commission to develop a highly accurate digital model of the Earth to monitor and simulate natural phenomena, hazards and the related human activities.
3: Added new advanced AI-based tools to the LDT Toolbox	• Citcom.AI: test and experimentation facilities for AI startups and SMEs to test or experiment AI models and/or robots for the smart and sustainable cities and communities. • Cityverse • ETHZurich AI-driven insights on decarbonisation for built environments • CityFM: ML Approaches for Spatial Data • Twinsity: AI-assisted damage analysis and automatic defects detection • Intemic: Data optimisation platform utilising AI and simulation models to understand, predict, and make decisions • Artificial Intelligence in smart cities and urban mobility (European Parliament Think Tank. 2021, July 23)

Work strand	Identified sources
	• Gen4AIEU: EU funding opportunities to integrate generative artificial intelligence (AI) into Europe's strategic sectors and maintain their competitive edge • DeployAI: Enterprise-grade AI agents with customisability and fast time to production • EuroHPC AI Factories: dynamic ecosystems that will build around AI-optimised supercomputers, offering computing resources and support services to the European industry • Scalable Cities expert report: Empowering EU Cities – Harnessing AI for Smart Urban Transformation (European Commission, 2025). • AI and GenAI Adoption by local and regional administrations (Living-in.EU)

Within the aforementioned desk research, several gaps emerge in relation to the literature covering LDTs at local and regional community levels. This is mostly due to the fact that the study of LDTs is relatively new and emerging. Most LDT projects are still in their initial phases of funding and development. Thus, they are not yet implemented to a degree that allows for empirical observation or evaluation of concrete outcomes. Hence, the evaluation of governance models and regulatory norms that might impact (Local) Digital Twins is challenging.

A last element worthy of consideration is the availability of information when it comes to initiatives in early development stages, where the results are as yet inaccessible to the public at large and are currently restricted to selected bodies and authorities.

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3 Conceptual framework

This section introduces the logic and conceptual roots behind the LDT4SSC Impact Assessment Framework, specifically, the integration of a Theory of Change (ToC) model, building on the work of the DS4SSCC-DEP project. ToCs are widely used and recognised in several disciplines including community and urban development[13].

The different elements of the Impact Assessment Framework are then explained in detail. The chapter also highlights how the framework will be applied for measuring the impact of the pilots versus the impact of the LDT4SSC initiative as a whole.

3.1 Theory of Change and intervention logic

The concept of ToC first emerged in the 1990s from the fields of social change theory and evaluation theory as a way to assess the impact of complex social and political initiatives and programmes[14]. One of the first definitions was established by Weiss (1995), describing ToC as a "hypothesis of how and why an intervention is intended to bring about change. It can be used as a programme design, implementation and evaluation tool"[15]. One of the most common forms of a ToC model is the *causal chain* linking *inputs*, *activities*, *outputs*, *outcomes* and *impacts*[16]. It is this causal chain model that has been adopted for the LDT4SSC impact assessment framework – illustrated by the intervention logic in Figure 3. Another common element of a ToC is the context of the initiative, looking at the *economic*, *social*, *political* and *environmental* conditions influencing, either positively or negatively, the causal chain[17].

This approach enables stakeholders to map out and connect interventions with expected long-term goals in order to enable:

- **Better planning** by understanding how change happens throughout the entire process, from the launch of pilots to the achievement of long-term goals.
- **Better evaluation** by measuring progress of the LDT4SSC pilots throughout the full cycle.

[13] Maysuoun, I; El-Zaart, A; and Adams, C. (2017) Theory of Change for the Transformation Towards Smart Sustainable Cities. Sensors Network Smart and Emerging Technologies, November 2017, IEEE.

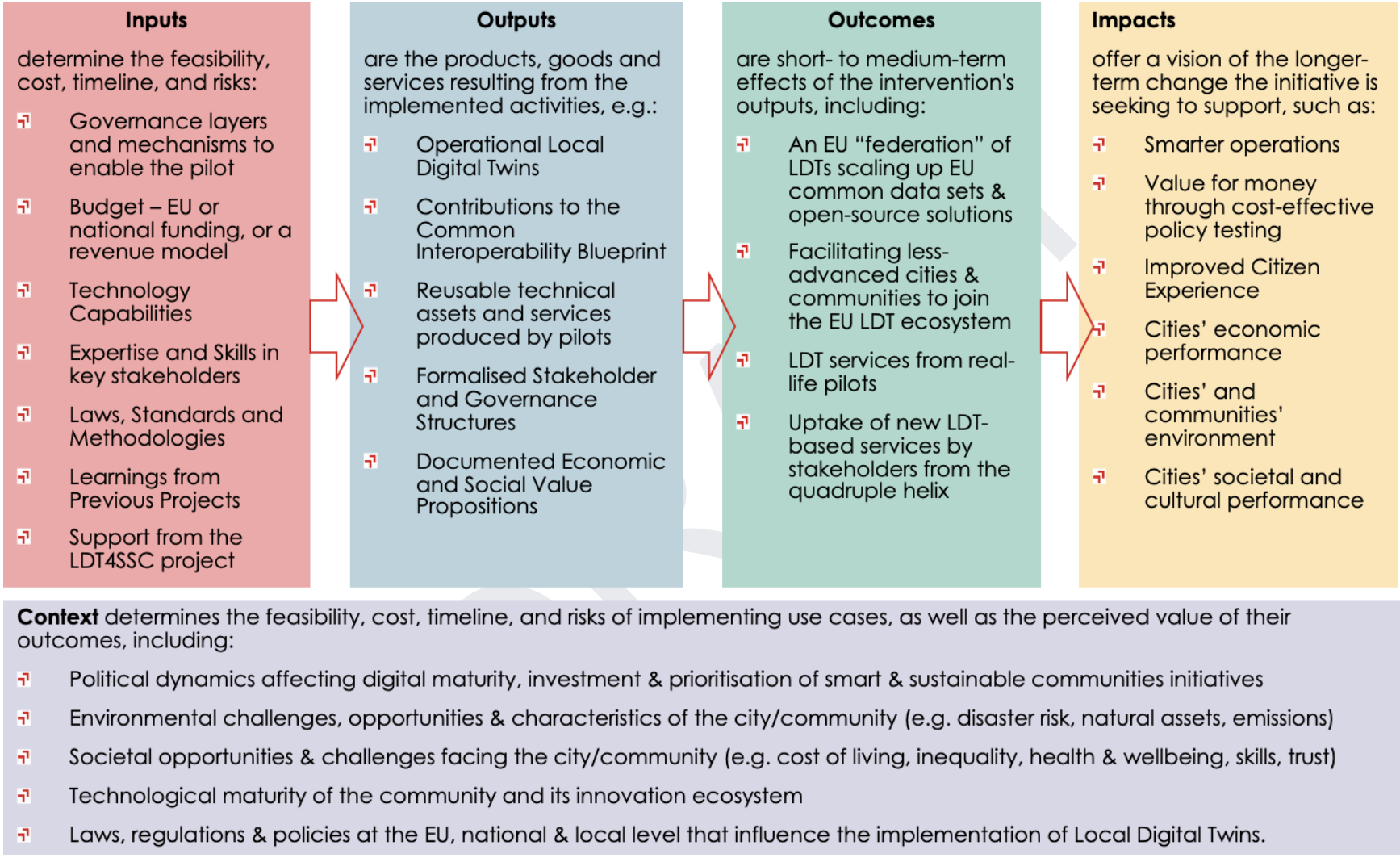
[14] O'Flynn, M (2012). Theory of Change: What's it all about? INTRAC, 2012

[15] C. H. Weiss, "Nothing as Practical as Good Theory: Exploring Theory-Based Evaluation for Comprehensive Community-Based Initiatives for Children and Families" in New Approaches to Evaluating Community Initiatives: Concepts Methods and Contexts, Washington, DC: Aspen Institute, vol. 1, pp. 65-92, 1995.

[16] Jones, H (2010). The Monitoring and Evaluation of Policy Influence, A scoping review for the Department for International Development. ODI, July 2010

[17] Maysuoun, I; El-Zaart, A; and Adams, C. (2017) Theory of Change for the Transformation Towards Smart Sustainable Cities. Sensors Network Smart and Emerging Technologies, November 2017, IEEE

Figure 3. An intervention logic illustrating the Theory of Change for LDT4SSC pilots



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3.2 Components of the LDT4SSC Pilots Impact Assessment Framework

The components of the proposed Impact Assessment Framework for the pilot activities, shown in Figure 3, are described below. Since the LDT4SSC project aims to support the development and interconnection of LDT pilots, the pilots' activities are downstream of the project's: so, for example, activities and outputs from the project (such as calls for pilots) may be considered as inputs to pilots, and outputs of the pilots can be considered as outcomes of the project.

Long-term impact will be possible to measure only beyond the LDT4SSC project's short lifetime, but *expected measurable impact and value creation* will be considered as one of the key requirements for assessing pilot applications, and will be assessed during the pilots' implementation[18].

This conceptual framework, of a Theory of Change translated into an Impact Assessment Framework, can be applied to multiple use cases, allowing for customisation across the different stages of pilot development, as set out in the LDT4SSC Knowledge Hub, such as:

- Explore: Ideation
  - Designing/drawing up a use case
  - Questioning the why
  - Questioning the project from the perspective of digital responsibility
  - Carrying out a cost-benefit analysis
- Validate: Specifications
  - Deepening the functional scope
  - Describing the dashboard and indicators
  - Implementing data governance
  - Defining the lifecycle and interoperability of the data
  - Raising awareness and putting interoperability into practice
- Define: Prototyping
  - Produce a prototype of the project
- Implement: Deployment
  - Onboard, train, and involve agents
  - Designing and drafting an action plan
  - Defining your business model
  - Refinement of business model and legal framework.

Local Context

The local context of a community – encompassing political, environmental, social, technological, and legal dimensions – shapes how data-driven initiatives deliver impact. These attributes determine the feasibility, cost, timeline, and risks of implementing use cases, as well as the perceived value of their outcomes. The LDT4SSC Impact Assessment Framework builds on established research[19] [20] to define these critical factors:

[18] See Output indicators: OP5: Documented Economic and Social Value Propositions, Evidence packages supporting sustainability and transferability.

[19] Maysuoun, I; El-Zaart, A; and Adams, C. (2017) Theory of Change for the Transformation Towards Smart Sustainable Cities. Sensors Network Smart and Emerging Technologies, November 2017, IEEE. https://ieeexplore.ieee.org/document/8125067

[20] Christopoulou, E., Ringas, D., & Garofalakis, J. (2014). The vision of the sociable smart city. Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 8530 LNCS, 545–554. https://doi.org/10.1007/978-3-319-07788-8_50

- **Political:** the political dynamics impacting the digital maturity and investment of the city and the prioritisation of smart and sustainable communities initiatives
- **Environmental:** the main environmental challenges, opportunities and characteristics of the city or community (e.g. disaster risk, natural assets, GHG emissions)
- **Social:** the core societal characteristics, opportunities and challenges facing the city or community (e.g. cost of living crisis, inequality, health and wellbeing, skills, trust)
- **Technological:** the digital maturity of the community and its innovation ecosystem
- **Economic:** the investment in local digital twins and the potential LDTs present for economic development
- **Legal:** the laws, regulations and policies at the EU, national and local level that influence the implementation of Local Digital Twins.

Inputs

Inputs in a ToC model are the "required set of resources needed for a transformation process"[13]. Hence, for the LDT4SSC Impact Assessment Framework, **inputs** specify *what* the essential resources are and *who* provides those for implementing the LDTs, referring to both the **inputs** the project gives to pilots, as well as **inputs** pilots get from their context:

- **LDT4SSC** – actions in support of the pilots by the project itself.
- **Governance** – the governance layers and mechanisms in place that enable participation in the pilot
- **Budget** – How the development and sustainment of the LDT and its services are being funded – whether through EU or national funding mechanisms, or a revenue model (e.g. membership fees)
- **Technical Capabilities** – that stakeholders have that contribute to the functioning of the LDT and the development of new services, for example, IoT and sensor networks, processing platforms, APIs for service developers, etc.
- **Expertise and Skills** – that key stakeholders hold that contribute to the functioning of the LDT and new services, for example, such as data science, software development and cybersecurity, etc. In the case of LDT4SSC, this includes the project's work in on-boarding less developed cities.
- **Laws, Standards and Methodologies** – being leveraged for operationalisation of LDTs, for example, data privacy and protection, urban planning legislation, interoperability and connectivity, etc.
- **Learnings** from Previous Projects – that can be applied for the LDT4SSC, such as the DS4SSCC and the three LDT tenders[21] [22].

Activities

Activities here refer to pilot-level **activities**, such as:

- **Interconnecting LDTs** – pilots should share both data and services through LDT interconnection, e.g. enabling one authority's twin service to be used by another through data sharing, enrichment, and the adoption of common data governance practices.
- **Engaging with relevant stakeholders** – pilots should engage with and build a community of stakeholders based on the Quadruple Helix model, integrating public

[21] https://living-in.eu/news/co-design-local-digital-twins-ldt-toolbox-technical-specifications-advancing-transformation
[22] https://interoperable-europe.ec.europa.eu/collection/ldttoolbox/news/introduction-eu-ldt-toolbox-project

authorities, private sector entities, academia and research institutions, and civil society (including citizens), with an aim to ensure that LDT-based solutions are user-centric, socially inclusive, and aligned with real-world needs. In addition, they will conduct continuous iteration of business and organisational models for sustaining the LDT and the community of stakeholders around it.

- **Developing new services** – pilots should create new local digital twin services, including by using the LDT Toolbox, and develop AI-driven value-added services within digital twin networks.
- **Using open-source technical components** – including interoperable and open-source tools from the LDT toolbox.
- **Adopting common data descriptions and defining shared data models** – to enable semantic interoperability.

Outputs

Outputs are the *products, goods and services* which result from the pilots' implemented **activities** including new policies, legislation, technological solutions, infrastructure etc.[23] Five categories of **outputs** (OPs) have been defined within the LDT4SSC Impact Assessment Framework. These **output** categories have been drawn from the direct **activities** of the LDT4SSC-supported pilots:

- **OP1: Operational Local Digital Twins – LDT instances delivered and made operational by pilots,** implementing European interoperable building blocks based on the Common Interoperability Blueprint
- **OP2: Contributions to the Common Interoperability Blueprint – technical artefacts enabling interoperability across LDTs**, consolidating existing State of the Art in Data Spaces and Local Digital Twins, proven and honed in real-life pilot use cases, and informed by pilots' contributions from their experiences and learnings.
- **OP3: Assets and Services Delivered – reusable technical assets and services produced by pilots**, including:
    - **Pilot-developed AI services,** iterated upon with the LDT4SSC community of Stakeholders in the LDT Toolbox
    - **Additions to the LDT services marketplace** – aiming to improve decision-making processes and citizen interaction; reduce risks, costs, and downtime; enhance resilience and sustainability of LDT platforms and enable new value creation
    - **New complex AI-based and innovative services** (e.g. for adaptable multi-sector considerations, advanced simulation and modelling approaches including bottom-up self-organised models)
- **OP4: Formalised Stakeholder and Governance Structures – institutional and contractual arrangements enabling LDT operation**, including end-users, particularly public authorities, provided with the skills to use LDT services and assets for digital transformation – supporting knowledge-based decision-making in urban

[23] Maysuoun, I; El-Zaart, A; and Adams, C. (2017) Theory of Change for the Transformation Towards Smart Sustainable Cities. Sensors Network Smart and Emerging Technologies, November 2017, IEEE.

policy across various domains like energy, mobility, and safety - by the LDT4SSC Capacity Building (CB) program

- **OP5: Documented Economic and Social Value Propositions – evidence packages supporting sustainability and transferability** – studies, projections and calculations of estimated economic, social and environmental value, on the road to creating a sustainable European Market for LDT components and solutions.

Outcomes

An **outcome** is a likely or achieved short- to medium-term *effect of an intervention's output*[24]. The key difference between '**impact**' and '**outcomes**' is the reach and the scope. An **outcome** is a finite and often measurable change. For the LDT4SSC Impact Assessment Framework, categories of **outcomes** (OCs) are based on the expected **outputs** of the pilots within the framework of the project, organised around the three main objectives and work streams of the project:

- **OC1: An EU federation of LDTs**, through interconnection, improved interoperability and aggregation of LDTs at a larger scale (cross sectors, cross cities, and cross borders) – including interconnection of LDTs by the pilots – scaling up the EU common data sets and open-source solutions
- **OC2:** Less advanced cities and communities facilitated to **join the existing EU LDT ecosystem**
- **OC3: Implementation of LDT services from real-life pilots**
- **OC4: Uptake of new LDT-based services** by stakeholders from the quadruple helix.

Impacts

Impacts capture the overall vision of the longer-term change the initiative is seeking to support and its expected benefits and beneficiaries. **Impacts** can be positive, negative, primary and secondary **long-term effects** produced by an intervention, directly or indirectly, unintended or intended[25].

LDTs empower cities to enhance inclusion, sustainability, and resilience by providing a risk-free, virtual environment for testing policies and operations. This helps decision-makers optimise both long-term policy outcomes and short-term actions in the real world. Key expected **impacts** include:

- **Smarter Operations** – Make data-driven decisions using a real-time, unified view of city processes and predictive simulations.
- **Cost-Effective Policy Testing for Value for Money** – Experiment with different scenarios digitally, avoiding the need for expensive, real-world pilots.
- **Improved Citizen Experience** – Respond quickly and transparently to citizen needs and clearly communicate the rationale behind planning and operational decisions.

For assessing **impact**, our approach aligns with the Sustainable Development Goals (SDGs), not just Goal 11 (Sustainable Cities and Communities), but all relevant SDGs – from peace,

[24] Simister, N, 2015, Outputs, Outcomes and Impact, INTRAC
[25] Ibid

justice, and strong institutions to gender equality, economic growth, quality education, and beyond. This ensures the pilots support a broad, integrated vision for urban development.

We use the SDGs to maintain consistency with established city frameworks and objectives, such as indicators from the United for Smart Sustainable Cities (U4SSC) KPI catalogue[26], which is already implemented by over 150 cities[27] worldwide. These indicators, aligned with the relevant SDGs, will be detailed in Chapter 4.

In addition, LDT **impacts** should be assessed against progress toward the EU Green Deal and New European Bauhaus goals, such as:

- Cutting greenhouse gas emissions (with an EU-wide target of 55% reduction by 2030) and progress towards making the EU climate-neutral by 2050, including by increasing use of renewables
- Cutting pollution to improve air, water, and soil quality
- Restoring habitats in poor condition (EU-wide goal of 30% by 2030, 60% by 2040, and 90% by 2050)
- Protecting workers and communities that are vulnerable to climate impacts.

3.3 Application of the LDT4SSC Impact Framework

We expect the pilot projects to describe in their applications the tangible changes that their initiatives are expected to bring to the participating communities and the long-term impact. This includes the description of the *broader socio-economic and environmental effects* of the pilot that extend beyond the project's direct scope. This is to help ensure that onboarded pilots are working towards expected impact, although evaluation of the pilot applications would not be considered part of the impact assessment.

The pilot projects are expected to provide information related to **context** and **inputs** and also specify and track **output** indicators.

To demonstrate longer-term impact the pilot projects should also identify desired **outcomes** and link these **outcomes** to overall longer-term **impact**. Where feasible and appropriate, local administrations should also select some measurable short-term **outcomes** that correspond to the pilot project's **outputs**. In addition, the outputs from earlier implemented pilots – such as experience gained or services developed – may become inputs for later pilots.

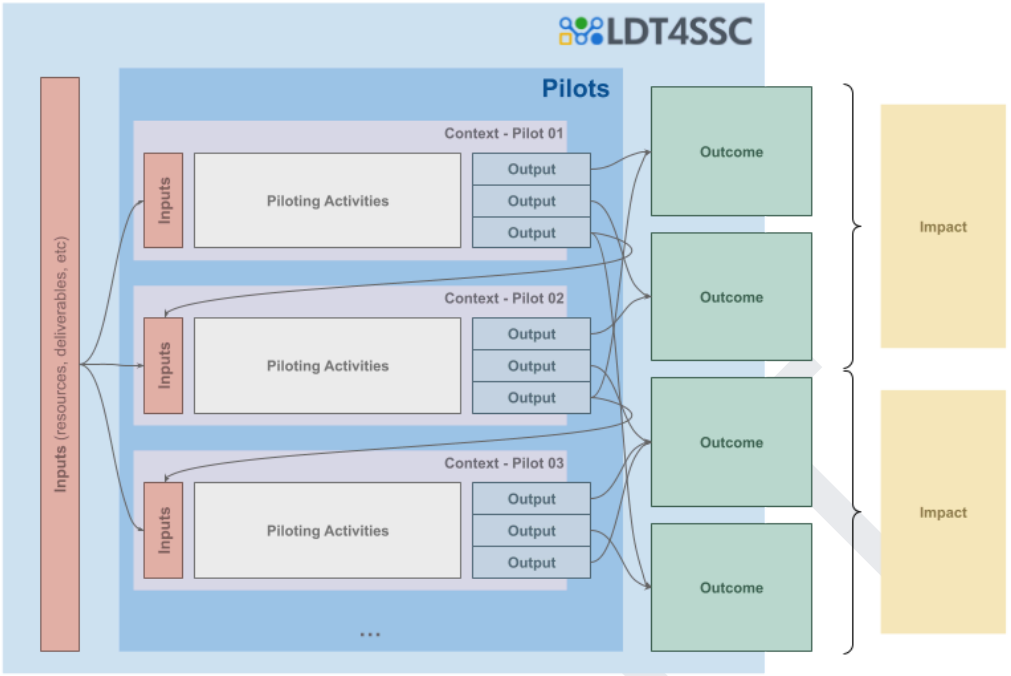
As illustrated in Figure 4 below, therefore:

- **Inputs** refer to the **inputs** to pilots from the project and from their context;
- **Activities** are pilot-level **activities**;
- **Outputs** are pilot-level **outputs**, that connect to
- **Outcomes** which, being more broad, are related to project-level and lead to
- **Impacts**, which link to EU-goals, such as those in the EU Green Deal, and the UN Sustainable Development Goals.

[26] The United for Smart Sustainable Cities (U4SSC) is a global UN initiative coordinated by the ITU, UNECE and UN-Habitat, and supported by CBD, ECLAC, FAO, UNDESA, UNDP, UNECA, UNESCO, UNEP, UNEP-FO, UNFCCC, UNIDO, UNOPS, UNU-EGOV, UN-Women, UN Tourism and WMO. U4SSC provides an international platform for information exchange and partnership building to guide cities and communities in achieving the UN SDGs.

[27] 2 United for Smart Sustainable Cities (U4SSC) – United for Smart Sustainable Cities (U4SSC) (itu.int)

Figure 4. Linking pilot outputs to project outcomes in the LDT4SSC Impact Assessment Framework



The leaders of each pilot consortium will submit an interim and a final report on behalf of the consortium. In the reporting, pilots are expected to provide an outline of the **activities** carried out by consortium members, the use of resources, and providing updates on the key performance indicators (KPIs) described in the application phase and agreed with the LDT4SSC consortium. The input obtained from the monitoring of the pilots regarding **activities**, **outputs** and **outcomes** will inform the broader implication of the pilots' future **impact**.

4 Indicators

This chapter presents, in the following tables, the Key Performance Indicators (KPIs) that enable stakeholders to establish a baseline and monitor progress towards the desired **outputs**, **outcomes** and **impacts**. Suggested methods for measurement and data collection are also indicated where appropriate.

This list is intended to offer a starting point, but the Impact Assessment Framework will be updated twice more during the LDT4SSC project's duration (June 2025 - 2028 December). The list of KPIs may evolve iteratively with the lessons learned from the pilot projects, including merging and combination of KPIs to align with other parts of the project (e.g. overlaps between **output** indicators and performance indicators defined by the project).

The definition of impact assessment metrics was informed by:

- The intervention logic, illustrating the Theory of Change, above;
- The LDT4SSC project's defined Key Performance Indicators (KPIs), as a guide to pilot **outputs** and project **outcomes**;
- The LDT4SSC project's SMART objectives, which refer to the KPIs per specific objective and inform pilot **outputs**;
- The Call for Pilots, which sets out requirements for the pilots; and
- The UN Sustainable Development Goals (SDGs), as a guide to desired **impacts**.

4.1 Outputs

The products, goods, and services resulting from the pilot activities will have targets largely drawn from the KPIs set for the LDT4SSC project overall, such as the following:

- Pilots are to use and iterate upon the common interoperability blueprint, with 6 of them interconnecting their LDTs, to form the basis of a LDT Ecosystem. Major associated KPIs include:
    - **21** European communities (defined as NUTS2 entities) engaged (KPI 1.3) via **15** pilots (KPI 1.2),
    - **6** pilots having **12** LDTs interconnected using SIMPL (KPIs 3.1 and 3.2), and at least **9** pilots reusing the LDT Toolbox assets and tools (KPI 4.1 + KPI 5.1).

Indicators are presented as the main bullet, with sub-bullets indicating dimensions of analysis where data is available. Targets are indicated where appropriate.

Table 4. Pilot output indicators for LDT4SSC Impact Assessment Framework

OP1: Operational Local Digital Twins	
LDT instances delivered and made operational by pilots.	
Indicator	**Target**
Number of operational LDT instances delivered	≥ 2
Number of policy or planning domains covered per LDT (cross-sectoral scope)	≥ 2
LDT digital maturity level achieved (LORDIMAS)	'Digitally Optimised'

OP1: Operational Local Digital Twins	
Number of (dynamic) data sources integrated per LDT	≥ 2
Publicly accessible demonstrator or reference	≥ 1
Measurement: Pilot self-assessment (6-monthly), Validation via demonstrators and technical deliverables	

OP2: Contributions to the Common Interoperability Blueprint	
Technical artefacts enabling interoperability across LDTs.	
Indicator	**Target**
Use of LDT4SSC blueprint	Yes
Number of LDTs interconnected (via SIMPL)	≥ 2
Number of shared datasets exposed to other LDTs	≥ 1
Number of shared or reused data models	≥ 2 (1/sector)
Percentage of exposed data aligned with agreed semantic standards (e.g. NGSI-LD)	100%
Number of interoperability-related components contributed back (code, specs, mappings)	50%
Measured by: technical documentation review & compliance and integration evidence	

OP3: Assets and Services Delivered	
Reusable technical assets and services produced by pilots.	
Indicator	**Target**
Number of services[28] or tools delivered	1 service per pilot
Number of assets integrated into the LDT Toolbox	1 asset integrated
Number of services developed/deployed reusing common project infrastructure (SIMPL, EU data cloud)	1

[28] In this context is a means for a public administration to support public activities and/or help the decision-making processes. It should not be confused with the technical definition of a service: in the context of the LDT Toolbox, a service is defined as a deployable software building block that encapsulates a specific capability (e.g., interaction handling, messaging, data access, model control) and exposes it through standard interfaces (Application Programming Interfaces (API)s and/or event-based messaging). It may be delivered as software or Software as a Service (SaaS) and is used to compose LDT functions that support decision-making.

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OP3: Assets and Services Delivered	
Nr of open-source assets	≥ 1
Nr of technical documentation	≥ 1
Measured by: Repository inspection & deliverable and demonstrator validation	

OP4: Formalised Stakeholder and Governance Structures	
Definition: Institutional and contractual arrangements enabling LDT operation.	
Indicator	**Target**
Existence of a formal governance or collaboration agreement (yes/no)	≥ 1 governance agreement per pilot
Number of stakeholder organisations formally involved	≥ 4
Number of signed data-sharing and/or IP agreements	To be set by pilots
Number of Quadruple Helix actor groups represented	≥ 4 stakeholder types represented
Number of formal coordination events held (workshops, consultations)	≥ 4
Measured by: Legal and administrative documentation & project records	

OP5: Documented Economic and Social Value Propositions	
Evidence packages supporting sustainability and transferability.	
Indicator	**Target**
Availability of a post-project business/operational model for sustaining the LDT	Yes
Demonstrable proof of value creation across the quadruple helix.	Yes/Partly, based on value creation assessment per pilot's service)
Number of transferability or replication studies produced	≥ 1 transferability study across pilots
Number of external policy or strategy documents referencing the pilot's outputs, namely the developed LDT	≥1
Demonstrable proof of the strategic alignment with EU objectives for Green Deal and/or New European	≥ 1

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OP5: Documented Economic and Social Value Propositions	
Bauhaus per pilot	
Measured by: Project Deliverables, Sustainability and ethics as well as external documentation	

4.2 Outcomes

The likely short-to-medium-term effects of the pilots' **outputs**, with data to be measured and collected at the pilot level but aggregated to **outcomes** at the project level:

These indicators measure expected **outcomes** resulting from the deliverables of the pilots against a baseline defined by the selected pilots in their first self-assessment:

- Uptake in the number of local platforms and digital twins, with associated services compatible with the EU data cloud infrastructure, reusing interoperable and open-source tools from the LDT Toolbox. LDT4SSC will provide guidance and the resources for pilots to create sustainable, scalable and replicable services by liaising with instruments including the EDIC LDT CitiVerse and the EU LDT Toolbox Marketplace.
- New AI-based services extending and supplementing the marketplace of the EU LDT Toolbox for cities and communities
- Increasing and maturing the AI services offering in the public domain with new predictive and modelling services and immersive solutions, paving the way to the CitiVerse.

Table 5. Outcome indicators of LDT4SSC Impact Assessment Framework

OC1: An EU "federation" of interconnected LDTs	
LDTs scaling up EU common data sets & open-source solutions	
Indicator	**Target**
No. of EU communities (NUTS2 entities) engaged by the pilot	≥2
Improved data sharing efficiency: ○ % reduction in data duplication across pilots ○ avg. time saved per data request	to be set by pilots
How many LDTs are interconnected through SIMPL as a result of the pilot?	≥2
Does the project use the LDT Toolbox assets and tools	Yes

OC1: An EU "federation" of interconnected LDTs
Measurement: Self-assessment by the pilots (6-monthly survey) Validated by analysis of technical documentation of pilot deliverables / demonstrators, such as technical logs, system analytics, etc.

OC2: Facilitating less-advanced cities & communities to join the EU LDT ecosystem	
Indicator	**Target**
No. of new cities and communities capitalising on the pilot experience	≥2
No. of new cities and communities in the networked LDT ecosystem community.	≥2
No. of best practices adopted elsewhere	≥2
No. of new pilots adopting outputs	≥2
No. of EU communities expressing interest in joining a new pilot	≥2
Measurement: Monitoring by the LDT4SSC project Self-assessment by the pilots (6-monthly survey) Validated by analysis of technical documentation of pilot deliverables / demonstrators	

OC3: LDT services from real-life pilots	
Indicator	**Target**
No. of local platforms and digital twins, with associated services compatible with the EU data cloud infrastructure, reusing interoperable and open-source tools from the LDT Toolbox	≥2
No. of services developed/deployed by the pilot (with reference to the LDT maturity model[29]): ○ No. of AI-based services	≥2

[29] Digital twin maturity levels: a theoretical framework for defining capabilities and goals in the life and environmental sciences, B. Metcalfe et al. (2023) https://f1000research.com/articles/12-961/v1

○ No. of AI-based services for data improvement (e.g. aggregation, visualisation, etc.) ○ No. of AI-based services including predictive modelling ○ No. of AI-based services providing simulations of "what if" scenarios ○ No. of AI-based services including CitiVerse components	
No. of open-source contributions to the LDT4SSCC common interoperability blueprint	≥2
No. of downloads/reuses of outputs published as open source	To be set by pilots
No. of cross-sectoral use cases implemented	To be set by pilots
No. of shared services in use	To be set by pilots
No. of sectors integrated per use case	To be set by pilots
No. of datasets shared across sectors	To be set by pilots
Measurement: Self-assessment by the pilots (6-monthly survey) Validated by analysis of technical documentation of pilot deliverables / demonstrators, such as compliance reports	

OC4: Uptake of new LDT-based services	
LDT-based services taken up by stakeholders from the quadruple helix	
Indicator	**Target**
Increase in community engagement - i.e. the increase in engaged external stakeholders	50%
Improvements in in-house capacity building	50%
Links to other EU projects	≥2
No. of new mature AI-based services being used from the EU LDT Toolbox	≥2
No. of new predictive modelling services supporting CitiVerse being used from the EU LDT Toolbox	≥2
No. of supporting materials being produced for each service, such as documentation, tutorials, guidelines,	≥2 per service

and other resources designed to assist users and assure replicability, scalability	
No. of local champions trained	To be set by pilots
No. of end-users per service	To be set by pilots
% of services meeting user needs	100%
Measurement: Self-assessment by the pilots (6-monthly survey), including by use of stakeholder surveys by the pilots Validated by analysis of technical documentation of pilot deliverables / demonstrators	

4.3 Impact

The primary and secondary long-term effects produced as a result of the pilots – directly or indirectly – related to the pilots' objectives, the longer-term change they seek to support and their expected benefits and beneficiaries. In this case, such longer-term **impacts** refer to **impacts** for citizens and for the cities' services:

Table 6. Impact indicators of LDT4SSC Impact Assessment Framework

Category	Indicators	Means of measurement
Smarter operations	• Water infrastructure, e.g. basic supply • Waste infrastructure, e.g. collection frequency and efficiency • Electricity infrastructure, e.g. access or outages • Transport infrastructure, e.g. network convenience, mode availability, emissions intensity • Buildings, e.g. public building sustainability • Urban planning, e.g. pedestrian infrastructure	Baseline set and data collected by the pilots
Value for money through cost-effective policy testing	• Policies successfully developed through LDTs • € saved through efficiency gains	Baseline set and data collected by the pilots
Improved Citizen Experience	• Ranking in Global Liveability Index (EIU) • Ranking in Quality of Living City Ranking	Baseline set and data collected by the pilots

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Category	Indicators	Means of measurement
Communities' economic performance	• Ranking in Innovation Cities Index • Ranking in Cities in Motion Index • ICT infrastructure, e.g. WIFI in public spaces • Innovation, e.g. R&D, SMEs or patents • Employment, e.g. unemployment rate in different sectors and demographics • No. of jobs created/supported	Baseline set and data collected by the pilots
Communities' environmental sustainability	• Air quality, air pollution • Water, e.g. water consumption • Waste, e.g. waste treatment • Environmental quality, e.g. noise pollution • Public space and nature, e.g. green spaces • Energy, e.g. renewables • % reduction in carbon footprint • No. of eco-design criteria met	Baseline set and data collected by the pilots
Communities' societal and cultural performance	• Education, e.g. adult literacy, school ICT access • Health, e.g. life expectancy, public health coverage • Culture, e.g. expenditure, infrastructure • Housing, e.g. expenditure, informal settlements • Social inclusion, e.g. poverty, Gini coefficient, voter participation • Safety, e.g. police service, resilience plans, violent crime rate, traffic fatalities • Food security, e.g. local food production	Baseline set and data collected by the pilots

To measure **impact**, two approaches were considered: rankings and standards:

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- City rankings are created by third-party organisations using their own methodologies. They select indicators – such as safety, health, mobility, and economic growth – based on publicly available data and, sometimes, additional surveys. While rankings help cities benchmark performance and gain visibility for their smart city investments, they often lack the granularity needed to track detailed progress or inform specific local improvements. Some examples include:
  - The Global Liveability Index (EIU)[30]
  - Quality of Living City Ranking 2023 (Mercer)[31]
  - Innovation Cities Index (2ThinkNow)[32]
  - Cities in Motion Index (IESE)[33]
  - The Sustainable Cities Index (Arcadis)[34].

- Standards ensure high granularity and reliability, enabling cities to track progress against strategic goals and monitor advancements consistently – both year-over-year and across departments – through:
  - Detailed KPIs for every city domain
  - Tailored data collection guidelines for local contexts
  - Optional certification and audits for validation.

- Given the need for granularity and reliability, we recommend adopting existing international standards. Among the leading frameworks (ITU and ISO), the United for Smart and Sustainable Cities (U4SSC)[35] stands out for its direct alignment with the UN SDGs. The U4SSC framework features 91 KPIs, offering a comprehensive assessment of urban performance across three key dimensions: economic, environmental and societal. The U4SSC KPIs support cities and communities worldwide in evaluating the role and contribution of ICTs and digital technologies in enabling smartness and sustainability, and to provide cities with the tools for self-assessment with the objective of achieving the UN SDGs.

By providing a common set of metrics to benchmark a community's performance, the indicators will also enable communities to compare their performance, allowing for the dissemination of best practices and setting the standards for progression in meeting the Sustainable Development Goals (SDGs) at the city level. As well as these core indicators, the ITU approach recognises that each community may consider additional indicators according to their economic capacity, population growth, geographic situation, etc.

4.4 Data collection and limitations

The data collection to track the KPIs should consider the following:

- Data should be collected to define a baseline and then define a timeline to monitor progress. The timeline should balance feasibility of data collection with actionability of insights.
- Data collection should be automated as much as possible. In the design of the LDT services, architects and developers should include observability features.

[30] https://www.eiu.com/n/campaigns/global-liveability-index-2023/
[31] https://www.mercer.com/insights/total-rewards/talent-mobility-insights/quality-of-living-city-ranking/
[32] https://innovation-cities.com/worlds-most-innovative-cities-2022-2023-city-rankings/26453/
[33] https://www.iese.edu/insight/articles/smart-sustainable-cities-in-motion/
[34] https://www.arcadis.com/en/knowledge-hub/perspectives/global/sustainable-cities-index
[35] https://u4ssc.itu.int/u4ssc-kpi/

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- Data collection for **output** KPIs should be the responsibility of the LDT product owner, i.e. the project consortium at the pilot stage, and the LDT technology solution provider at the deployment stage.
- Data collection for **outcome** KPIs should be the primary responsibility of the LDT product owner, but will require other stakeholders, including cities to provide input.
- Data collection for **impact** KPIs should be the primary responsibility of cities but will require other stakeholders to provide input to investigate the causal relationship between LDTs and impact KPIs.

The lack of information and empirical evidence on **impact** is due to the following factors:

- This kind of information is not always documented in publicly available documents.
- Data on the impact of these initiatives is not systematically collected.
- "Productivity gains from technological innovation occur with a time lag."
- Impact is the result of many interdependent inputs and changes, whereby it is difficult to demonstrate what is induced by the application of certain technology solutions, particularly emerging solutions, like LDTs.

The tools that will be used to gather data from the pilots will be designed with the aim of facilitating this work to the stakeholders involved in the pilots and will include, for example, surveys and questionnaires, as well as cost-benefit analysis.

Indicators related to the Impact Assessment Framework will be integrated and merged with other indicators (e.g. performance) so that an overall KPI ensemble is available for the project at cross-WP level. Beyond a full understanding of all the measures that will be available at internal level, this will contribute to reducing overlaps in data collection.

5 Next steps

Under the LDT4SSC Work Package 4, and in particular the task on Impact Assessment, the next steps will be the following:

- Providing the pilots with the Impact Assessment Framework for them to apply through the lifetime of the pilot deployment and beyond.
- Data collection, led by WP4, to design a self-assessment questionnaire to send to the pilots for them to report baselines against the identified indicators at pilot kick-off
- Review and revision of the Impact Assessment Framework after 6 months of pilot operation.
- Data collection, led by WP4, to send a self-assessment questionnaire to the pilots for them to report data against the identified indicators.
- Data collection, led by WP4, to request relevant documentation on the pilots, their LDTs, and the services developed, to complement the self-assessment questionnaire.
- Review and revision of the Impact Assessment Framework at the end of the LDT4SSC project.
- Data collection, led by WP4, to send a self-assessment questionnaire to the pilots for them to report final data against the identified indicators.
- Data collection, led by WP4, to request relevant documentation on the pilots, their LDTs, and the services developed, to complement the self-assessment questionnaire.

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6 Annex

6.1 Annex 1: The project's initial SMART objectives, as set out in the proposal, used as a guide for the impact assessment indicators:

Objectives	Measurements
General Objective 1: Connecting data platforms and LDTs from cities and communities that already have a LDT in place, to create an EU "federation" of LDTs. Reinforced interoperability through the aggregation of LDTs at a larger scale (cross sectors, cross cities, and cross borders) will help to scale up the EU common data sets and open-source solutions. It will also facilitate less advanced cities and communities joining the existing EU LDT ecosystem.	The impact of this network of federated LDTs will be measured by the size of the network KPI 3.2.
Specific Objective 1.1: Consolidate European data-sharing and LDT blueprints into a Common Interoperability Blueprint	The quality of the blueprint will be measured through the number of relevant contributions, reviews, and implementations, see KPI 3.3.
Specific Objective 1.2: Launch a community of stakeholders that will serve as primary stakeholders of an LDT Ecosystem; and as such of potential applicants to open calls as well as the environment to provide input for project outputs (WP5).	Size of the community Engagement of the community members
Specific Objective 1.3: Launch 15-20 LDT Pilots of a cross-border consortium with cross-sectoral use cases implementing European interoperable building blocks as defined by the LDT4SSC Consolidated Common Interoperability Blueprint to form the base of the LDT Ecosystem	Number of eligible applications (WP4). See KPI 1.2
General Objective 2: Developing open-source pilots of LDT services based on shared needs of cities and communities that already have a local data platform and/or an LDT and want to expand them with new real-life use case services. These services should aim to improve decision-making processes and citizen interaction; reduce risks, costs, and downtime; enhance resilience and sustainability of LDT platforms and enable new value creation.	See KPIs 3.3, 4.3, 5.2, 5.3, 6.1 and 6.2
Specific Objective 2.1: Benchmarking European stakeholders' LDT technology related trends, needs, challenges, and requirements	Extent of dissemination of the Community Collaboration and Engagement Report (WP2).
Specific Objective 2.2: Source relevant LDT services from real-life pilots and use them to further populate the LDT services marketplace	Measurable through the number of newly developed services in KPI 3.3, 4.3, 5.2 and 6.1
Specific Objective 2.3: Stimulate the uptake of new LDT-based services by Communities of Stakeholders with representatives of the quadruple helix.	Measurable through the number of newly developed services in KPI 5.2.
Specific Objective 2.4: Create a sustainable European Market for LDT components and solutions by demonstrating LDTs economic and social value	Impact assessment framework and validated common consolidated interoperability framework.
General Objective 3: Complementing the EU LDT Toolbox launched under WP2021-22 with additional complex AI-based and innovative services (e.g. for adaptable multi-sector considerations, advanced	Repository of Services and Assets with comprehensive documentation in the LDT4SSC standardised templates, the number of such services is measured

simulation and modelling approaches including bottom-up self-organised models). The AI services will be developed and tested within existing cities/communities and be replicable in other contexts.	by Key Performance Indicators (KPIs) 4.3 and 5.2.
Specific Objective 3.1 Launch 3 LDT Pilots with the target of adding new advanced AI-based tools to the LDT Toolbox	This objective is clearly measurable through KPIs 5.1 and 5.2
Specific Objective 3.2: Publish 6 AI services developed by LDT4SSC Pilots and iterated upon with the LDT4SSC community of Stakeholders in the LDT Toolbox	measurable through KPI 5.2

6.2 Project KPIs set in the proposal, and used as a guide for impact assessment indicators:

Nr.	KPI	Target	Means of Verification
1	**Number of cities or communities (geographical coverage) involved in the pilots**		
1.1	Number of received proposals for the Open Call	50	Various tasks throughout the project will ensure community engagement and awareness of the open calls and their objectives. First of all, Task 2.3 is created for ensuring community engagement and collaboration by bringing together stakeholders from the quadruple helix, whereby the open calls will be disseminated widely. This task will be supported by Task 6.3 launched to create an engagement campaign with the goal of engaging relevant stakeholders, promote participation in pilot open calls, and build strong networks to enhance collaboration and innovation within the project WP3 and WP4 will ensure sound call and pilot definitions and management
1.2	Number of pilots	> 15	
1.3	Number of cities and communities	> 21	
1.4	EU regional coverage (EuroVoc regions)	4	
1.5	EU regional coverage (EUROSTAT regions)	12	
2	**Number of LDTs using the Data Space for Smart Cities and Communities' blueprint**		
2.1	Number of pilots reusing Priority Datasets from the DS4SSCC-DEP	6	Analysis of technical documentation of pilot deliverables and demonstrators, validating the use of the cited technologies and platforms
2.2	Number of pilots building on selected use-cases and recipes of the DS4SSCC-DEP	6	
2.2	Number of LDTs involved in all pilots	> 21	
3	**Number of LDT network members using the common interoperability LDT4SSC blueprint, compatible with SIMPL (An EU ecosystem of LDTs sharing a common blueprint. - WS1)**		
3.1	Number of pilots using the evolving LDT4SSC blueprint, and tailored to the requirements of LDT networks	6	The framework will align with the interoperability guidelines outlined by the MIMs. Once finalised, the consolidated guidelines will be promoted across Europe to support replicability and scalability (Task 5.1)
3.2	Number of interconnected LDTs relying on SIMPL	12	At least 2 LDTs will be involved in each of the Work Strand 1 Pilots
3.3	Number of services available through the interconnected LDTs	12	Review of technical documentation of pilot deliverables and demonstrators, along with analysis of metrics from the Services and Assets Repository developed under Task 5.2
3.4	Number of members of the LDT community established around LDT4SSC	100	The community brings together stakeholders from the quadruple helix, drawing on communities from SIMPL, DS4SSCC, CitCom.ai, the EU Data Cloud Infrastructure, the EU Local Digital Twin Toolbox (incl. the Smart Communities Network, the LDT CitiVerse EDIC (Task 2.3)

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3.5	Number of relevant contributions, reviews, and implementations by the LDT community to the LDT4SSC common interoperability blueprint	12	The framework will align with the interoperability guidelines outlined by the MIMs. Once finalised, the consolidated guidelines will be promoted across Europe to support replicability and scalability (Task 5.1)
4	**Number of national and local platforms and LDTs with services compatible with SIMPL, with the EU data cloud infrastructure and reusing tools from the LDT Toolbox. Number of local platforms and digital twins, with associated services compatible with the EU data cloud infrastructure, reusing interoperable and open-source tools from the LDT Toolbox. - WS2**		
4.1	Number of pilots reusing the LDT Toolbox repository	> 6	Analysis of technical documentation of pilot deliverables and demonstrators, validating the use of the cited technologies and platforms
4.2	Number of pilots relying on the EU Digital Infrastructure Consortium LDT (CitiVerse EDIC)	> 4	
4.3	Number of new shared needs based common services added to catalogue of the EU LDT Toolbox, aiming to improve decision-making processes and citizen interaction; reduce risks, costs and downtime; enhance resilience and sustainability of LDT platforms and enable new value creation.	> 6	
5	**New AI-based services extending and supplementing the catalogue of the EU LDT Toolbox for cities and communities - WS3**		
5.1	Number pilots focussing on the creation of new AI-based services	3	Review of technical documentation of pilot deliverables and demonstrators, along with analysis of metrics from the Services and Assets Repository developed under **Task 5.2**
5.2	Number of AI-based services available in the LDT4SSC repository	6	
5.3	Number of supporting materials provided for each AI-based service, including documentation, tutorials, guidelines, and other resources designed to assist users	2	Review of available materials in the Services and Assets Repository developed under **Task 5.2** along with the information provided by the Capacity Building Program (**D5.4**)
6	**Increasing and maturing the AI services offering the public domain with new predictive and modelling services and immersive solutions, paving the way to the CitiVerse. - WS3**		
6.1	Number of new predictive modelling services supporting CitiVerse available in the LDT4SSC Repository and through the catalogue of the EU LDT Toolbox	2	Review of technical documentation of pilot deliverables and demonstrators, along with analysis of metrics from the Services and Assets Repository developed under **Task 5.2**
6.2	Number of supporting materials provided for each service including immersive solutions, such as documentation, tutorials, guidelines, and other resources designed to assist users	2	Review of available materials in the Services and Assets Repository developed under **Task 5.2** along with the information provided by the Capacity Building Program (**D5.4**)

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6.3 Pilot requirements set in the Call for Pilots, and used as a guide for impact assessment indicators:

The LDT4SSC project has invited applicants to submit their project proposal with reference to the Requirements (Rq) and Recommendations (Rc) provided for each of four dimensions: *Pilot Details*, *Relevance*, *Implementation*, and *Impact.* Along wit the project KPIs, thee pilot requirements have been used to inform the Impact Assessment Framework indicators.

Pilot Details

Rq1	Each pilot must include **at least two public authorities operating 'digitally mature' LDTs** to be interconnected. These LDTs must **already provide digital and data services** within their respective cities or communities. 'Digitally mature' means having an existing LDT (can be supported by a DS) with **at least descriptive-level capabilities** (see explanation under Annex 2) **and dynamic data integration.**
Rq2	**Pilots must include at least two cross-sectoral[36] use cases, each featuring one shared service.** ● The developed services integrate datasets from two or more sectors (e.g. mobility, energy…); or ● The LDTs provide data services that span at least two sectors within a single use case. Describe these and specify the data-based services to be delivered.
Rq3	For each pilot member operating an LDT to be interconnected, provide a high-level description of the existing LDT and its main capabilities. Specify which dynamic data sources are currently integrated and what digital or data services are offered within the city or community. Where available, include a public reference (e.g., URL link) to the platform; if not publicly accessible, provide representative screenshots of the platform's front-end.
Rq4	For each pilot member operating an LDT to be interconnected, provide a high-level description of the current architecture covering technical and functional aspects. Provide a diagram for each aspect. Specify the main tools, standards, and software components used, and illustrate the data lifecycle (from collection to use and sharing).
Rq5	Describe the current data governance (see explanation under Annex 2) scheme of each pilot site and the target data governance scheme of the pilot consortium across the political, technical, legal, and organisational dimensions.
Rq6	Describe project management and coordination, including resource allocation. Provide an overview of the project teams, their collaboration approach, and any planned recruitment. If additional skills or resources are needed, explain how they will be secured through consortium partners, subcontractors, or other means, and specify the roles or profiles involved. **Each participating public authority must ensure both technical capacity (e.g., designated technical staff for implementation and continuity) and political support.**
Rq7	Describe whether AI and/or XR technologies are used in the services, how, for what

[36] See list of sectors here: https://single-market-economy.ec.europa.eu/sectors_en

	purpose, and how ethical/legal considerations are managed.
Rc1	For each local authority/government involved in the pilot, please give the score obtained at the LORDIMAS digital maturity assessment[37] (see explanation in Annex 2). The pilot lead is recommended to be at the 'Digitally Optimised' stage assessment, while all other participating authorities should be at least at the 'Moderate' stage in the LORDIMAS self-assessment upon application. All public authorities participating as pilot members are recommended to reach the 'Digitally Optimised' stage in the assessment, or to demonstrate further progress if they have already attained this level by the end of the project.

Relevance

Rq8	**Describe how the pilot addresses local and European priorities as well as the objectives of the LDT4SSC initiative and its ecosystem (for example, by advancing shared knowledge, tools, or methodologies).**. . The use cases should align with the **European Green Deal Objectives**[38] or the **New European Bauhaus**[39] **priorities, or tackling key challenges identified by LDT4SSC)** (see explanation under Annex 2).
Rq9	**Describe the political endorsement** (see *Letter of Commitment*) of your pilot, specifying the type and extent of support. Where available, reference published or online materials (with links) or attach supporting documents that substantiate this endorsement .
Rq10	**Pilots must actively engage end-users.** **Describe the end-users of the services** developed in the two use cases **and how they will be engaged throughout the project lifecycle** through workshops, consultations, or other participatory activities. List the involved and expected stakeholders across the four Quadruple Helix categories outlining their roles, responsibilities, and engagement approach. **Each pilot must involve at least three of the four Quadruple Helix stakeholder groups** (public sector, private sector, academia/research, and civil society) in these engagement processes.
Rq11	Explain the broader applicability and **relevance of your pilot** –how its approach and/or results could be transferred to other EU communities.
Rq12	Describe which EU technology stacks (SIMPL, DSSC, …) and infrastructure providers (LDT CitiVERSE EDIC, Gaia-X, …) are likely to be involved in the interconnection of LDTs.

Implementation

Rq13	The project description should adopt the following phases: Explore, Validate, Define and Implement, and cover the following key activities:

[37] MaturityAssessment-help | LORDIMAS_EN
[38] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[39] See https://new-european-bauhaus.europa.eu/index_en

	• Define data governance (including legal management of interoperability); • Design a Business Model to ensure the sustainability of the service after the pilot project; • Draft a contract among the consortium stakeholders to enable management; • Perform a Cost-Benefit analysis to measure the impact of the solution in relation to the objectives set at the outset (to resolve the use case); • Defend a responsible use of digital technology (eco-design/frugal AI, etc.); • Assess and measure impacts (including economic impact as well as social and environmental impacts).
Rq14	Describe how the pilot consortium will technically interconnect their LDTs, specifying the tools, software, and standards selected for each component (e.g. data catalogue, management system, identity and authorisation mechanisms (IAM), data policies, connectors, and knowledge models). **Demonstrate integration with the SIMPL Data Space Governance Authority Agent[40] that is required to be used**.
Rq15	For each use case, **provide 2 draft diagrams**: one of the intended technical, and one of the intended functional architectures. The first showing the interconnection of LDTs, and the second illustrating the pilots' data lifecycle.
Rq16	Describe how pilot members will adopt common data descriptions and define the shared data models that will enable semantic interoperability across the interconnected LDTs. • **All data collected and shared within the pilot ecosystem should be mapped to a Linked Data Ontology** (MIM1)[41] to ensure semantic consistency (like NGSI-LD or SPARQL, etc.)
Rq17	Specify what data, assets, or services will be shared, the sectors involved, and the main providers and beneficiaries.
Rq18	Indicate which **MIMs Plus (MIM0–MIM8)[42]** the project will engage with (e.g., *contribute to*, *implement*, or *comply with*) and provide a brief justification for this choice —such as existing capabilities, planned developments, or limitations. For each selected MIM Plus, estimate the current and planned level of compliance (e.g., *Initial*, *Partial*, or *Full*)[43]. **The pilot must engage with at least the five foundational MIMs Plus**.
Rc2	Pilots are encouraged to use open-source technical components to promote transparency, reduce costs, and foster community collaboration. Any enhancements or customisations developed during the pilot should likewise be shared back with the open-source community to support collective progress and reusable innovation.
Rc3	Pilots are encouraged to include in their consortium agreement provisions for the non-exclusive transfer of Intellectual Property or exploitation rights, as well as clear rules for protecting and sharing know-how among consortium members and beyond.
Rc4	Pilots are strongly encouraged to establish, as appropriate to their project scope: • A data catalogue using the W3C Data Catalog Vocabulary (DCAT) for

[40] https://code.europa.eu/simpl/simpl-open/development/agents/governance-authority
[41] https://mims.oascities.org/NzWXOO1Fttw4wtqv1Wys/mim1-interlinking-data
[42] https://living-in.eu/group/7/commitments/mims-plus-version-8-2025
[43] **Initial (1)** – The solution only partially addresses this MIM Plus, with limited features or early-stage implementation. **Partial (2)** – The solution implements key aspects of this MIM Plus but still lacks some elements for full compliance. **Full (3)** – The solution fully complies with this MIM Plus, meeting all major requirements.

	semantic interoperability. • A data management system (e.g., context broker) capable of handling contextualised metadata descriptions (ontologies) such as JSON-LD, RDF, or NGSI-LD for semantic and technical interoperability. • An identity and access management system based on OAuth2, OpenID Connect, or W3C Verifiable Credentials for legal and organisational interoperability. • An ODRL-based data policy to support legal interoperability.
Rc5	Pilots are encouraged to pursue alignment with the forthcoming LDT Toolbox as its specifications become available.
Rc6	Describe if and how the pilot's project will comply with the following frameworks: Gaia-X trust framework, IDSA specification[44], DSBA recommendation[45], DSSC Blueprint[46], DS4SSCC-DEP Blueprint[47].

Impact

Rq19	Explain the ambition and rationale for interconnecting the LDTs across pilot members, detailing how shared data and services will improve governance, efficiency, and innovation within and across pilots.
Rq20	Describe the tangible benefits and long-term impacts expected for the participating of communities, outlining the immediate value proposition, sustainability potential, and measurable indicators to track progress.
Rq21	Describe the wider socio-economic and environmental effects of your pilot beyond their direct scope, explaining how the eco-design approach contributes to these broader impacts and long-term sustainability.
Rq22	All pilot activities must include a contractual framework that guarantees the sustainability of the digital twins (legal clauses that guarantee for instance the right to use the data, to manage Intellectual Property or the analyses carried out, the post-pilot exploitation rights, etc.)
Rq23	Describe the main expected outputs of the project (e.g. services, tools, data models, or other assets) and specify their intended level of openness or accessibility after the pilot end (e.g., Open Source, Limited Access, or Proprietary). • Note that **created or adapted data models should be published in open repositories under an open licence,** and **developed services shared through the LDT Toolbox Marketplace for reuse by others.** • Note that **pilots are expected to maintain regular documentation and**

[44] See https://internationaldataspaces.org/wp-content/uploads/dlm_uploads/IDSA-Data-Space-Connector-Report-1_October_2025-1.pdf

[45] See https://data-spaces-business-alliance.eu/wp-content/uploads/dlm_uploads/Data-Spaces-Business-Alliance-Technical-Convergence-V2.pdf

[46] See https://dssc.eu/space/BVE2/1071251457/Data+Spaces+Blueprint+v2.0+-+Home

[47] See https://static1.squarespace.com/static/63718ba2d90d0263d7fc1857/t/6527a36ea3fd1470ffc95fec/1697096639359/D4.1_DS4SSCC_Data+Space+Blueprint+and+Priority+Data+Sets.pdf

	updates for the Knowledge Hub. ● Note that the inclusion of **proprietary components** must be justified and accompanied by a plan demonstrating how an equivalent solution can be achieved with open-source technologies.
Rq24	Outline your strategy for maintaining and expanding the developed services and pilot activities beyond the project's duration, explaining how results will be sustained and scaled up after the pilot phase.
Rc7	Pilots are advised to record all relevant baseline data, including socio-economic, environmental, and organisational aspects, before starting the project to enable meaningful comparisons in the final Cost-Benefit Analysis.
Rc8	Pilots are advised to assess their level of maturity in eco-design thanks to the General policy framework for the ecodesign of digital services version 2024[48] at least for the 30 highest-priority criteria at the start of the pilot implementation and then towards the end.

[48] See https://www.arcep.fr/uploads/tx_gspublication/general_policy_framework_for_the_ecodesign_of_digital_services_version_2024.pdf for more

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