DATA SPACE FOR
SMART AND SUSTAINABLE
CITIES AND COMMUNITIES

Deliverable 4.1

Data Space Blueprint and Priority Data Sets

WP 4 – Implementation

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Abbreviations

WP	*Work Package*		
MIM	*Minimal Interoperable Mechanism*		
SSCC	*Smart and Sustainable Cities and Communities*		
GDPR	*General Data Protection Regulation*		
EC	*European Commission*		
EU	*European Union*		

DS4SSCC	*Data Space for smart and sustainable cities and communities*		
SSCC	*Smart and sustainable cities and communities*		

Table of Contents

Executive Summary

This deliverable presents the findings of an in-depth study on usage and importance of priority data sets as defined by the European Commission[1] [2](EC), and technologies related to real-world use cases relevant to the Data Space for Smart and Sustainable Cities and Communities, to detect possible overlaps and gaps to shape the blueprint of DS4SSCC.

The document describes the methodology (desk research and stakeholder interviews) that was used to prioritise and to finally identify a shortlist of seven European use cases. The first selection respects an even distribution among geographic location as well as the data space topics relevant to the development of smart communities. These selected use cases were examined employing an interview-approach with relevant stakeholders between March and May 2023. The interview results outline technological standards, specifications and data sets that have been used, reference implementations, scope and maturity, as well as their relation to Minimal Interoperability Mechanisms (MIMs). The results were completed and/or confirmed by the DS4SSCC stakeholder group during an online workshop in March 2023. Whilst the results consider the priority datasets defined by the EC, it was found that communities focus on datasets that have not been covered, related to mobility, energy, health and the green deal.

Findings of this deliverable will be used in D3.2 to develop the Technical Blueprint architecture models for DS4SSCC, by customising the proposed high-level architecture for SSCC data spaces into 3, out of the 7 selected use cases.

The document is structured into five main chapters:

- **Chapter 1 "Introduction"** provides an outline about the blueprint for DS4SSCC and priority data sets, describing how this deliverable relates to the other deliverables of this project's WP2 (governance) and WP3 (technical blueprint). The chapter further provides an outline of the current EU-defined priority data sets, including the EC High-value datasets and INSPIRE Geo Data Portal, that have been used as a base for evaluation.
- **Chapter 2 "Use Cases Workshop and Interview Results"** provides a short description about the methodological approach, before presenting the

[1] EC High Value Datasets: https://digital-strategy.ec.europa.eu/en/news/commission-defines-high-value-datasets-be-made-available-re-use

[2] INSPIRE Geo Data Portal: https://inspire-geoportal.ec.europa.eu/

findings of the interviews of our short-listed seven use cases and our findings from the stakeholder workshop, complementing the picture.

- **Chapter 3 "Key Findings"** presents the findings of the detected prio detected priority datasets, gaps, technical overlaps and specifications (Catalogue of Specifications D3.1) as well as the detected gaps of existing reference architectures and common challenges, mechanisms and capabilities to solve them with the introduction of Minimum Interoperability Mechanisms (MIMs).
- **Chapter 4 "Data Space Blueprint"** presents an actionable blueprint, based on our findings.
- **Chapter 5 "Conclusions and Next Steps"** provides an outlook on how these findings will contribute in next working steps, together with findings of other work packages as presented in their deliverables, to define a blueprint and action plan for DS4SSCC.

The following documents are provided in Annex to this document:

- **Annex A** - Use Case list
- **Annex B** - Priority Datasets from Workshops
- **Annex C -** Interview question template

1 Introduction

1.1 Blueprint for DS4SSCC

Following the definition of the blueprint provided by the Data Spaces Support Center in their glossary[3], a *Data Space Blueprint is a consistent, coherent and comprehensive set of guidelines to support the implementation, deployment and maintenance of data spaces*. Thus, DS4SSCC blueprint defines the guidelines and mechanisms required for the upcoming deployment of the data space. Although this document is aiming at describing the DS4SSCC blueprint, the required elements are spread across other work packages and deliverables of the DS4SSCC initiative. The picture below shows all the elements which form part of the blueprint.

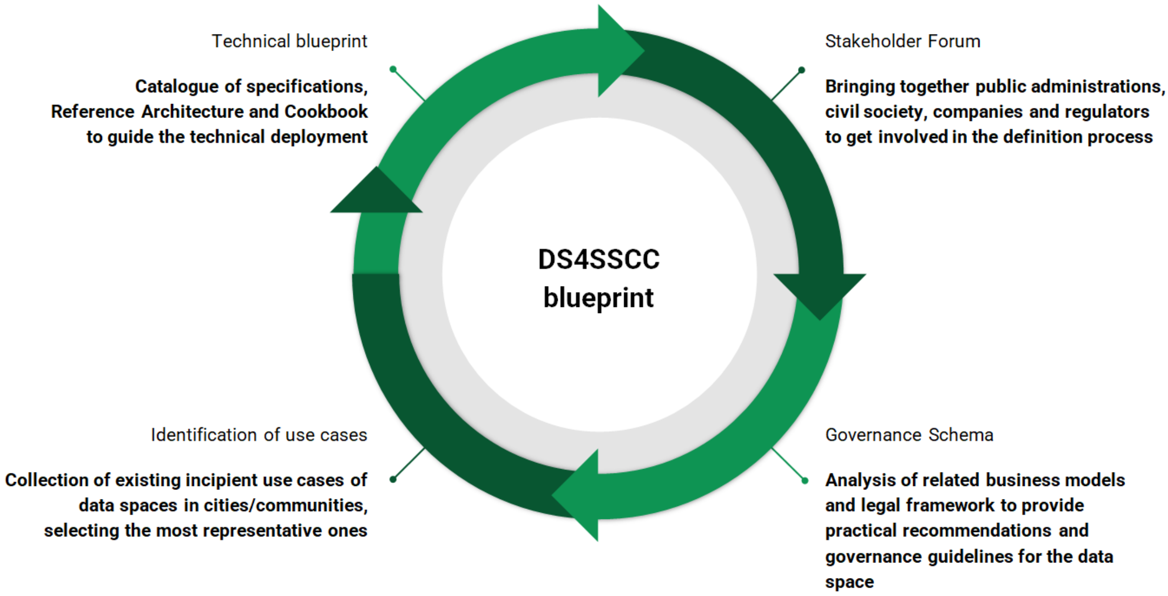

Figure 1. Development of the DS4SSCC blueprint

The stakeholders forum is an important part of the data space ecosystem bringing together relevant players in data spaces. This allows for collaboration and coordination between stakeholders to create a useful blueprint and the success of the data space deployment. The *Stakeholders Forum* is the emerging smart and sustainable cities and communities **data space ecosystem** which is coordinated by

[3] https://dssc.eu/wp-content/uploads/2023/03/DSSC-Data-Spaces-Glossary-v1.0.pdf

WP5 and WP1. It builds on the community of the Living-in.eu movement that brings together communities (the demand) with organisations (the supply). In doing so, it expands this community with relevant players in the data spaces ecosystem.

The *Governance Scheme* developed under the coordination of WP2 establishes the **principles and rules** to govern the data space and its ecosystem for the benefit of cities and local communities.

The *Technical Blueprint* developed by WP3 contributes to the overall blueprint with the Catalogue of **Building Blocks**, **Reference Architecture** and **CookBook** to deploy the technical infrastructure for the data space.

WP4 identified the relevant and representative *Use Cases* in Europe that may bring tangible examples of incipient data spaces. The selected use cases showcase their **priority data sets** and commonly used technologies to bring to the data space.

Therefore, the DS4SSCC blueprint is formed by all the above mentioned elements (the ecosystem, the data, the governance, the technology) and all need to be used and followed to deploy a data space for smart and sustainable cities.

1.2 Priority Datasets and Use Cases

As various public sector data (such as weather or air quality data) are particularly interesting for third-party creators of value-added services and applications and have important benefits for society, the environment, and the economy, they should be made available to the public. Too often, this is still not the case. With data being a cornerstone of EU's industrial competitiveness, the EC defined a catalogue of high value datasets[4] and the Inspire Geo Data Portal[5], focusing on high value geo-data. Such specific high-value datasets are available free of charge, machine readable, provided via APIs and provided for bulk download, where relevant and become even more useful when accessible via data spaces, allowing their use for applications on a large European level. Six domains have been identified and datasets attached accordingly, as shown in Table 1.

Domain	Datasets

[4] EC High Value Datasets: https://digital-strategy.ec.europa.eu/en/news/commission-defines-high-value-datasets-be-made-available-re-use

[5] INSPIRE Geo Data Portal: https://inspire-geoportal.ec.europa.eu/

GEOSPATIAL	Administrative units
	Geographical names
	Addresses
	Buildings
	Cadastral parcels
	Reference parcels
	Agricultural parcels
EARTH OBSERVATION AND ENVIRONMENT	Hydrography (I)
	Protected sites (I)
	Elevation (II)
	Geology (II)
	Land cover (II)
	Orthoimagery (II)
	Area management / restriction / regulation zones & reporting units (III)
	Bio-geographical regions (III)
	Energy Resources (III)
	Environmental monitoring Facilities (III)
	Habitats and biotopes (III)
	Land Use (III)
	Mineral Resources (III)
	Natural risk zones (III)
	Oceanographic geographical features (III)
	Production and industrial facilities (III)
	Sea regions (III)
	Soil (III)
	Species distribution (III)
METEOROLOGICAL	Observations data measured by weather stations
	Climate data: validated obser-vations
	Weather alerts
	Radar data
	NWP model data
STATISTICS	Industrial production
	Industrial producer price index breakdowns by activity
	Volume of sales by activity

	EU International trade in goods statistics – exports and imports breakdowns simultaneously by partner, product and flow
	Tourism flows in Europe (see Tables 1 and 2 below for variables in scope)
	Harmonised Indices of consumer prices
	National accounts – GDP main aggregates (see Tables 6-7 below for variables in scope)
	National accounts – key indicators on corporations (see Table 8 below for variables in scope)
	National accounts – key indicators on households (see Table 9 below for variables in scope)
	Government expenditure and revenue (see Table 10 below for variables in scope)
	Consolidated government gross debt (see Tables 11 and 12 below for variables in scope)
	Environmental accounts and statistics
	Population, Fertility, Mortality
	Population (see Table 3 below for variables in scope)
	Fertility (see Table 4 below for variables in scope)
	Mortality (see Table 5 below for variables in scope)
	Current healthcare expenditure
	Poverty (see Table 13 below for variables in scope)
	Inequality (see Table 14 below for variables in scope)
	Employment (see Tables 15-16 below for variables in scope)
	Unemployment (see Table 17 below for variables in scope)
	Potential labour force (see Table 18 below for variables in scope)
COMPANIES AND COMPANY OWNERSHIP	Basic company information: key attributes
	Company documents and accounts
MOBILITY	Transport networks
	Inland waterways datasets

Table 1: EC High-Value Datasets

Being defined by the European Commission, a first step of the project was to align these datasets with implemented and existing use cases to identify possible gaps of datasets that have not been included while being frequently used in the wild. In the next chapter we will outline the methodological approach to collect and select use cases relevant to the DS4SSCC and present findings of our in-depth studies.

Finally, we will identify which datasets were found to be highly valuable for implementation purposes, despite their absence in the official high-value datasets lists.

2. Use Cases Workshop & Interview Results

As part of this work, use cases that are relevant in the context of DS4SSCC were explored, evaluated, and shortlisted to identify priority datasets and to gain detailed insights on technological specifications, technical readiness, challenges and limitations. Furthermore, a workshop was organised with the stakeholder forum to collect additional, possibly missing input that has not been detected during the interviews. In this chapter we outline methodological steps taken and share insights from our findings.

2.1 Methodological outline

To identify priority data sets, technical overlaps and specifications throughout real world implemented use cases, as well as to find common challenges and mechanisms to solve those, a methodology was developed to identify and analyse relevant use cases in depth. The selection of relevant use cases and their priority datasets consisted of three steps:

1. Desk Research:

Source such as Lighthouse Projects[6], Scalable Cities[7], Eurocities[8] and the project's own DS4SSCC Survey (WP2, WP3, WP4, WP5) were used to identify use cases relevant to smart cities and communities related topics. These efforts ensured the representation of an even geographic spread and even data space sector distribution and helped to identify 92 use cases across Europe covering 18 countries, forming a solid base for the next prioritisation process steps. The gathered information included *type* of data space sector, *location*, a short *description*, *name of project* the use case is part of (if applicable) and *online link* to the webpage. Table 2 shows that in the context of smart cities and communities related topics most use cases come from cross, health, energy, mobility and public administration sectors. (For a complete list of discussed use cases, see Annex A).

[6] European Commission Lighthouse Projects: https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects?f%5B0%5D=project_type%3Alighthouse

[7] Scaleable Cities: https://smart-cities-marketplace.ec.europa.eu/scalable-cities

[8] Eurocities Projects: https://eurocities.eu/projects/

Cross	19
Health	10
Agriculture	3
Manufacturing	1
Energy	9
Mobility	23
Financial	2
Public administration	12
Skills	1
European Open Science Cloud	1
meeting the Green Deal objectives	1

Table 2. Selected use case distribution by Data Space strategic fields

2. Prioritisation / Short Listing:

A score scheme was developed to prioritise the use cases to be taken further using the following variables: *Minimum Interoperability Mechanism (MIMs)*[9] coverage, *Technology Readiness Level (TRL)*[10] and *technology pervasiveness*, *number of technologies used*, *contact for interview* established and available. Scores have been assigned leading to a general score for each use case (colour coded - green/high to red/low - last table column, as seen in Table 3). Overall, higher scores were assigned to projects that cover more MIMs and technologies and have a high TRL. The general score allowed the identification of a short list that had been further refined to define a total of seven use cases.

3. In-depth Interviews:

During the third step, the identified seven use cases were discussed in detail by conducting interviews. The interviews took place online from March to May 2023, and lasted a maximum of 45 minutes. (For a complete list of questions see Annex C.) Interviews revealed the priority data sets and technologies that have been used and limitations that were experienced. Below table (Table 3) shows the final selection of seven use cases which will be presented and discussed in detail.

ID	Type	Location	Description	Project name	Link	Points Total

[9] Minimal Interoperability Mechanisms - MIMs: https://mims.oascities.org/

[10] European Commission Technology Readiness Level: https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

14	Green Deal	Florence	GoalGreen App	Replicate	https://replicate-project.eu/ict-florence/	16
25	Mobility	Flanders	Flanders Smart Data Space Data Integration for Smart Mobility Flanders Water Dataspace	DCAT AP-VL	https://www.vlaanderen.be/digitaal-vlaanderen/onze-oplossingen/open-data/dcat-ap-vlaanderen-profiel-en-validator	17
45	Energy	Helsinki	Energy and Climate Atlas		https://kartta.hel.fi/3d/heating/Apps/Helsinki/view.html , https://kartta.hel.fi/3d/atlas/#/	16
59	Urban Planning	Eindhoven	Smart Urban Planning, with tools like Digital Twinning & VR and also an Integrated Impact Assessment Model (IIAM) in cooperation with the UDI (Urban Development Initiative)		https://brainporteindhoven.com/udi/en/digital-city	17
77	Health	Barcelona, Göteberg, Amersfoort	SCOREwater develops and tests three large-scale demonstrations cases for collecting, computing and presenting various data tailored to needs of our stakeholders. In Barcelona we initiate a new domain “sewage sociology” mining biomarkers of community-wide lifestyle habits from sewage. In Amersfoort we develop new water monitoring techniques and data-adaptive storm water treatment and apply to water resource protection and legal compliance for construction projects within the Göteborg-case. We enhance resilience against flooding by sensing and hydrological modelling coupled to urban water engineering. We will identify best practices for developing and using the digital services, thus addressing water stakeholders beyond the project partners. The project will also develop technologies to increase public engagement in water management.		https://www.scorewater.eu/	18
88	Mobility	Amsterdam	IDEA predictive mobility based on floating car data	IDEA project		17
90	Green Deal	Slovenia	Farm2Fork	Farm2Fork		18

Table 3: Shortlist of final use cases, selected for interviews

2.2 Interview Results

Flanders Smart Data Space

The Flemish Smart Data Space project (Vlaamse Smart Data Space/VSDS) aims to realise a data space for different domains on a regional level, facilitating cities and communities to exchange data by defining standards and best practices. For now, the Flemish data space is focusing on use cases related to sensor data on mobility and water management. The VSDS' future plans are to include crowd management (retail) and roadworks into the data space.

The Digital Agency of the Flemish region has created a technical infrastructure and a support framework which will allow data sharing between cities and communities. This infrastructure is still in its infancy, but Use Cases are already being implemented, for instance, in the city of Antwerp. In time, the ambition is to facilitate all Flemish communities, without requiring a high level of expertise within those communities, still based on the most innovative technologies currently available. The Flemish Smart Data Space is currently providing services to communities and agencies to help them publish their data in line with the framework it has set forward. Currently, they are working on two Use Cases, specifically mobility and water.

On a technical level, the Flemish Data Space introduces Linked Data Event Streams (LDES) as the core mechanism through which sensor measurements are stored and retrieved. These streams allow the retrieval of measurements in a semantic way, which allows a more fluid definition of the type of data that is recorded.

Flanders has adopted a set of vocabularies which have been co-created with relevant authorities to describe these semantics, the OSLO vocabularies. These vocabularies are developed as an Open Standard, allowing anyone to contribute and evolve them. They find their origins in the ISA^2 "Core Vocabularies" developed by DG DIGIT (SEMIC). Importantly, these vocabularies maximally link to existing work, and the Digital Flanders agency is taking great care to re-use prior work when defining them.

A similar and relevant approach is taken by the Smart Data Models program, which gathers semantic data models for any type of occurrence. Some Smart Data Models have been already included to map to OSLO vocabularies[11].

[11] Smart Data Model Oslo on github: https://github.com/smart-data-models/dataModel.OSLO/tree/33cec8ac29bfab01bad878aeefc1927bb8130036

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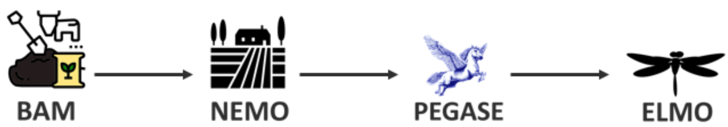
Any semantic ontology may be referenced to provide more information about the occurrences that make up the Linked Data Event Stream.

Standards	**Specs**	**Reference Implementations**
• OSLO • ISA² Core Vocabularies • Smart Data Models • ISO19156 (water measurement)	• LDES • SOSA • TREE Spec	• VSDS
• **MIMs**	• **Scope**	• **Maturity**
• MIM1 • MIM 2	• Water Management • Mobility	• TRL 7
Data Sets	Datavindplaats , Telraam	
• VMM (The Flemish Environmental Agence) Water Quality • Telraam (Mobility Counting)		

Energy & Climate Atlas Helsinki

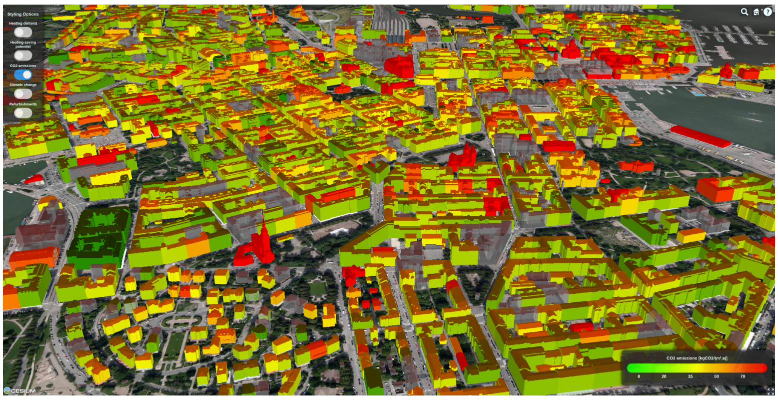
Helsinki's Energy and Climate Atlas' initiation started in 2011, when other cities in Finland, such as Turku, had developed a platform to show heat loss in the city. The question evolved on what else, other than heat loss, can be evaluated and shown on a large scale and in a similar manner for the city of Helsinki, benefitting to the city's sustainability? First actions towards the establishment of the Energy & Climate Atlas were taken in 2015 due to the course of a research project on thermal mapping of the Helsinki urban area in 2D. In a next step, the 2D map had been extended into the third dimension to make the outcome more visible, using Helsinki's CityGML model as baseline. The model was developed following an open source approach and enriched with building registry data, including heating mode, building materials, contained square metres and number of building stories, resulting in a total of over 50.000 buildings included in the model, of which 20.000 were found not to be heated.

Using building registry data, among other data, led to a number of challenges to the project, based on the format of used datasets. For instance, while most datasets were available in machine-readable format (i.e. .csv, .xls or .shp files) others were available in text formats only (i.e. .pdf). The close cooperation with local universities and the involvement of students at master level, who translated such data into machine-readable formats by hand as part of their theses, allowed the inclusion of such data after a pre-processing step into the model on a quantitative level. However, this process also led to the detection of errors in the data that had to be corrected before inclusion. Other limitations resulted from partially poor data quality. Various significant variables highly interesting to stakeholders, such as the renovation history of the building for instance, did not become clear from gathered data. Furthermore, the rather coarse level of granularity for district heating led to data averaging, which might have biassed the outcome. Besides data format and quality related problems, the project faced challenges based on GDPR regulations, especially when including energy data. In these cases, data was available aggregated per building and only with owners' permits. In general, accessing energy data was difficult, even though the owner was the city-owned energy company.

Besides building registry and CityGML the atlas currently includes energy data (district heating, electricity, water consumption, energy efficiency level) and information about building supervision administration. With this information, the atlas aims to suggest actions to improve energy performance on building level and is being used in the currently ongoing mySmartLife Project[12], to model energy demand and effects of heating mode changes for greater Helsinki. Priority datasets have been identified as any dataset that helps to reach carbon neutrality targets, such as datasets containing information about the building stock (including renovation history) and energy performance (including energy consumption in kWh / building), as used in this project. Furthermore, information on investments and cost of renovations have a high priority, same as the contact details to building owners.

Standards	**Specs**	**Reference Implementations**
• CityGML, • Virtual System	• Open source	• Helsinki Energy Atlas
• **MIMs**	• **Scope**	• **Maturity**
• MIM 2 • MIM 7 • MIM 8	• Energy • Climate	• TRL 8

[12] mySmartLife project: https://www.mysmartlife.eu/mysmartlife/

• MIM 9		
Data Sets	**Link**: https://kartta.hel.fi/3d/atlas/#/	
• 3D City Model (CityGML), • Building registry (heating mode, building materials, contained square metres, number of building stories), • Energy data (district heating, electricity, water consumption, energy efficiency level)		

Urban Development Initiative Eindhoven

The UDI, which stands for Urban Development Initiative, is an organisation that aims to address the complex urban challenges of the 21st century. Within the unique innovation climate of Brainport Eindhoven, they collaborate to find solutions for societal challenges in areas such as health, mobility, energy, food, housing, and safety.

The founders of UDI include the municipalities of Eindhoven and Helmond, the Eindhoven University of Technology (TU/e), Brainport Development, and the Fraunhofer Research Institute. These entities have come together to establish UDI and foster a collaborative environment for tackling the urban challenges of the region.

UDI strives to develop new ideas, technologies, and approaches that can contribute to the sustainable development and improvement of cities. They achieve this through research, collaboration with various stakeholders, the implementation of innovative projects, and the promotion of entrepreneurship in urban development.

The city of Helmond is set to undergo a Leap of Scale and will grow towards 115,000 inhabitants by 2040, a 25% increase from its current population of roughly 90,000 inhabitants. This will require 15.000 additional houses, and 35,000 additional jobs. Such a transformation must be carefully planned and simulated, and this is why departments, the research center TNO and developers from all over the region are coming together to set out a strategy. Data is a key component of this strategy, and Helmond is setting up its Open Urban Platform to be able to exchange information from different sources to realise different objectives. Some of these are for internal analysis and decision-making, some other focus on collaboration and co-creation with citizens and businesses. The Open Urban Platform manages both public and private sector data, and aims to publish all the gathered data as open data.

The City of Helmond is compiling this data to:

- Create a Decision Support Tool for Strategic City Planning
- Translate complex urban challenges and ambitions into planning and land use

TNO is creating an Urban Strategy which entails

- The creation of a predictive digital twin (for mobility and emissions)
- Combining various scientific models and HPC
- Scenario exploration

Argaleo, a provide company, provides a Digital Twin that will allow:

- Inner City Management / Events
- Visitor Monitoring / Real Estate Developments

Urban Development Initiative (UDI)
Eindhoven, Helmond, TU/e, Brainport Development

- Digital City
- Energy Transition
- Futureproof Building & Housing

Dutch Societal Innovation Hub (EDIH)

- VNG, IPO + 5 Regional Ecosystems
- European Digital Innovation Hub Public Sector
- Mission drive program (twin transitions)
- Rethink, Reshape, Reconnect

Standards	**Specs**	**Reference Implementations**
• GLTF	• GLTF (Argaleo)	• DigiTwin (Argaleo)

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• **MIMs**	• **Scope**	• **Maturity**
• MIM 7 MIM 2	• Urban Development • Crowd Management	• TRL 8
Data Sets		
• Base Registry Addresses and Buildings • Base Registry Topography • Height Register • Base Registry Land Use • Demographics • National Database Roads • Demographic Database • Database Spatial Planning • Base Registry Hydrographic Data • OpenStreetMap Roadnet • Energylabels	All these datasets are managed by the "Rijkswaterstaat" and are available on either their open data portal or GeoWeb portal  *Digital City Program as part of UDI Framework*	

IDEA: Intelligent Data Exchange Alliance

Road and tunnel closures due to constructions are managed and monitored by the city, enabling necessary actions to continue a traffic flow as smooth as possible. However, reality shows that collected data about planned roadworks can be very broad and not accurate (due to last minute changes and delays of construction for instance) and hence, can not be trusted by routing providers. Led by the Amsterdam City Council, IDEA (Intelligent Data Exchange Alliance) brings together public and private sector in the Netherlands (Amsterdam being one of two current use cases) aiming to provide more precise and trustworthy information for service providers (i.e. for routing application) and cities on road and tunnel closures to avoid unforeseen challenges for city traffic.

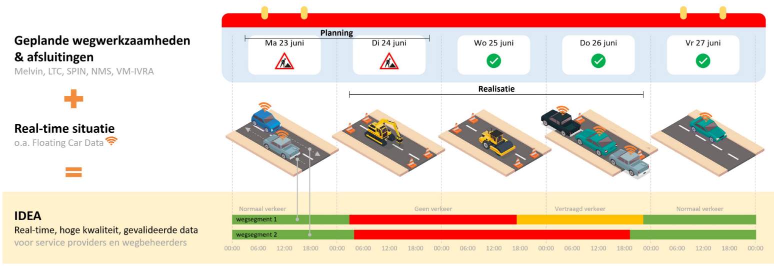
The platform combines floating car data (as collected by BeMobile or Waze, for instance) and official data on road construction and tunnel closures provided by the

City of Amsterdam to establish a trusted environment for navigation system providers to incorporate such data in their routing systems. The trusted environment is being created by the creation of an API sending automatically a data package with the information of road closure, triggered by the action of closure of it. The information is being sent as trusted by the API to all navigation system providers (such as Google or TomTom). IDEA is based on National *Data* Warehouse for Traffic Information (NDW)[13] data platform, a database of both real-time and historic traffic data in the Netherlands and uses DATEX2 standards. Developed data scientific machine learning (ML) algorithmic procedures are provided to NDW via containers and provide increasingly accurate results the more frequently a road is being used due to increased machine learning effects.

As a platform, IDEA is not limited to a city or a city size. Besides Amsterdam, and The Hague, the system is currently being extended to 15 other cities in the NEtherlands, which potentially can be scaled up to European level, nested within the NAPCORE (National Access Point Coordination Organisation for Europe) environment), coordinating and harmonising more than 30 mobility data platforms across Europe.

Standards	**Specs**	**Reference Implementations**
• DATEX2 • NAPCORE	• NDW (National Data Warehouse for Traffic Information data platform)	• IDEA
MIMs	**Scope**	**Maturity**
• MIM1 • MIM 2 • MIM 7 • MIM 8	• Mobility	• TRL 8
Data Sets	**Link**: https://www.ndw.nu/onderwerpen/idea	
• BeMobile Floating Car data, • Amsterdam / The Hague City CouncilPlanning data (Official data on road		

[13] NDW National Data Warehouse for Traffic Information: https://company.intertraffic.com/?a=qSXzuB2EeRj07NjknojLtHuhA79ec9Xn6UUd1RehS%2F8%3D

construction and bridge closure), • Rijkswaterstaat (National Road Authority) road work datasets • Waze Trusted Messages	

SCOREwater

SCOREwater focuses on enhancing the resilience of cities against climate change and urbanisation by enabling a water smart society that fulfils the Sustainable Development Goals 3, 6, 11, 12 and 13 and secures future ecosystem services.

SCOREwater develops and tests three large-scale demonstrations for collecting, computing and presenting various data tailored to the needs of their stakeholders. In Barcelona the project initiated a new domain “sewage sociology” mining biomarkers of community-wide lifestyle habits from sewage. In Amersfoort it developed new water monitoring techniques and data-adaptive storm water treatment and it applies to water resource protection and legal compliance for construction projects within the Göteborg-case. The project aims to enhance resilience against flooding by sensing and hydrological modelling coupled to urban water engineering. It identifies best practices for developing and using the digital services, thus addressing water stakeholders beyond the project partners. The project will also develop technologies to increase public engagement in water management. Moreover, SCOREwater will deliver an innovation ecosystem driven by the financial savings in both maintenance and operation of water systems that are offered using the SCOREwater digital services, providing new business opportunities for water and ICT SMEs.

The three use cases are detailed below:

Amersfoort: Flooding

SCOREwater in Amersfoort will focus on improving the detection of flash floods while reducing environmental impacts through:

- Prediction models and early warning systems for flash floods;
- decision-tool (case-based reasoning) for reducing environmental impact considering risks, economic, operational and environmental information.

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Barcelona: Sewage

SCOREwater in Barcelona will focus on reducing wastewater management problems with the vision of improving public health:

- Predicting sewer clogging
- User behavior profiling and analysis;
- Correlate behavior with water quality measurements, and subsequent actions to mitigate health risks and hazardous events.

Göteborg: Industrial

SCOREwater in Goteborg will focus on managing water pollution in the industrial sector by:

- The prediction of water pollution based on the combination of meteorological data and water quality sensors;
- Predictive maintenance of local water treatment equipment.

Standards	**Specs**	**Reference Implementations**
• NGSI-LD	• UWWTDxx • WFD • Smart Data Models	[Score Water Platform] [Score Water Portal]
MIMs	**Scope**	**Maturity**
• MIM1 • MIM2	• Water management	• TRL7
Data Sets	The ScoreWater Portal was developed by Civity and is called “DataPlatform”. This software is based on CKAN.	
• Soil Moisture Levels • Water Levels • Water Quality • Flooding Risk Maps • Data sets are collected for three different pilots, Amersfoort, Barcelona and Göteberg and may depend on the local		

use cases. However, all sensor data was collected with similar or the same sensor devices and are accessible through the ScoreWater platform.	

Farm2Fork

Developed within the LokalnoGOR project[14], Farm2Fork application initially aimed to connect the city of Kranj as partner, schools and kindergartens to farmers, which has been now extended to the retail market providing a B2B setting between producer and customers. The aim is to provide a short food supply chain that can only have one intermediary. In doing so, the project supports local self sustainability for food from early 2020 by providing a backend / DevOps / frontend solution. Farm2Fork uses TMForum API's for communication between front- and backend based on REST. The TMForum payment API is being used, while missing prepayment, and PayPal included.

The application works mostly with small producers, so very little data is available or being collected. Mostly Excel sheets with price lists are provided, where farmers have direct access to, via admin module or can get support by the project team. Modules translate the format of input data (by the farmers) into the project's own data format to be implemented in the platform. The application is built with Python and C++ scripts, uses regGIS and AWS server components for content broker and as data storage. Generated data can be exported as .csv from Wordpress. Identified priority data sets are data sets on product and process information of local products, available as open source.

There is a unified taxonomy for products registry of local products project by the Chamber of Commerce and the approach is already interesting to large producers as well. However, the lack of data as well as the need for manual interventions can be challenging for future scaling.

[14] LokalnoGOR: https://www.kranj.si/lokalno-gor

DATA SPACE FOR
SMART AND SUSTAINABLE
CITIES AND COMMUNITIES

Standards	**Specs**	**Reference Implementation**
• regGIS • REST	• Python • C++ • Mobile apps regnity • Microservices (self dev) • AWS • TM Forum • Excel	• DIH Agrifood Cooperation Platform
MIMs	**Scope**	**Maturity**
• MIM 3 • MIM 4	• Food • Green Deal	• TRL 8
Data Sets	https://itc-cluster.com/dih-agrifood/	
• Pricelists (Excel) • Product export from Wordpress (CSV) • Unified Taxonomy of local products, created by the Slovenian Chamber of Commerce	WOO	

2.3 Workshop Results

The workshop at the third stakeholder forum on April 12th, 2023 started off with a presentation about past work and current progress related to WP4, followed by an interactive part with the stakeholders. The aim of this exercise was to identify priority data sets other than those in the shortlist. This part was organised in two 35-minutes breakout sessions, using Miro Boards to share experiences and opinions on priority data sets, missing data and relevant use cases. Participants were asked to give detailed information and to share links. Each of the main data space domains were provided as potential use case subjects: *Health, Agriculture,* *Energy, Mobility, Public Administration, Green Deal, Skills, Financial, Manufacturing, Tourism.*

The focus of use cases / datasets were clearly on Energy, Mobility, Public Administration, Green Deal, Health which have been discussed within the group. After returning, both breakout room organisers presented a summary of the respective workshops.

While the EC decision defines priority datasets by topic, the research conducted in the scope of this deliverable made it clear that it is often ambiguous for local Cities and Communities which are the contributing parts of each of these priority datasets, and especially who governs them. In many cases, cities and communities need to rely on regional or national agencies and institutions to compile such a dataset, and depending on the local context, this may incur difficulties in terms of granularity, quality, accessibility and even availability of the dataset on a supra-local level.

Therefore, most cities and communities maintain a local version of each of these priority datasets, which can be laboursome. As stated in the introduction, there is a clear trend for cities and communities to focus on datasets pertaining to mobility, energy, health and the green deal. To illustrate, we highlight the results gathered from the Stakeholder Forum during which public servants working with data were asked to define their priority datasets within their city, community or project (Fig.2):

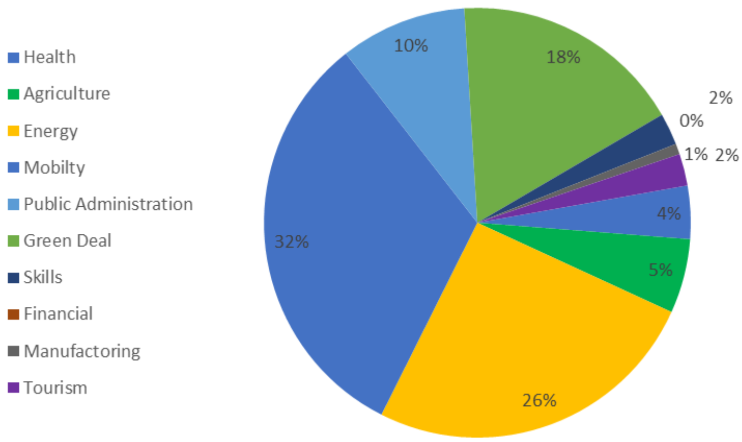


Figure 2. Dataset domain distribution, as identified at the Stakeholder Forum Workshop (April 2023)

The distribution of priority datasets indicated by the Stakeholder Forum clearly indicates the gaps between the different domains.

3. Key Findings

Based on the above we conclude the following key findings that will help us in following steps to shape the blueprint for DS4SSCC.

3.1 Priority datasets and gaps

Although most of the priority datasets derived from interview results and the workshops are relatable to datasets and domains as defined by the European Commission, we were able to detect the following priority data sets, existing gaps - as for instance, data that has not been tagged as priority data set by the EC, in bold. While the European Decision on Priority Datasets focusses on making public data available free of charge, we can clearly identify that some of the use cases we have researched have a need for privately-owned datasets to be available as well:

Detected priority data sets	**Related Dataset (as defined by EC)**	**Domain**
Floating car data		Mobility
Planning data (road closure)		Planning
Energy data	Energy resources	Earth Observation and Environment
Building registry	Buildings	Geospatial
3D City Model	Buildings	Geospatial
Weather data	Weather alerts	Meteorological
Water Quality	Water quality	Water
Soil Humidity	Soil	Soil
Vehicle / pedestrian count		Mobility
Water levels	Water levels	Water
Opening hours		Individual / Commercial
Housing Quality		Planning
Land Use	Land Use	Land Use

Product Descriptions		Individual / Commercial

Detected gaps of priority datasets, that have not been listed as priority dataset by the European Commission, include:

- Floating car data
- Planning data (road closure)
- Vehicle / pedestrian count
- Opening hours
- Housing quality
- Product descriptions

Most of these are mainly publicly owned, but floating car data, opening hours and product descriptions are typically private.

3.2 Technical overlaps and specifications

The in-depth analysis of these different cases has contributed to a thorough understanding of the real-world ICT architectures being used in different city or community settings. Some new technologies, specifications and standards were identified and have been added to the **Catalog of Specifications (D3.1)**. In general, we can confirm that the Building Blocks identified are indeed the most important ones being used in cities.

There are some clear overlaps in terms of requirements of the local authorities, but there are many different technologies being used to underpin them. In this section, we will go through some of the most relevant overlaps. We can identify three large categories of technologies that are often referred to: Geographic tools, 3D city models and data management tools. Within each of these categories there are many alternative technical implementations. For more information on each of these please refer to the Catalog of Specifications.

Geographic Tools

The GIS and geographic tooling is the most pervasive technology that is being used in all of the discussed use cases. However, there are many different ways this is implemented:

- Esri ArcGIS: ArcGIS is a comprehensive suite of GIS software developed by Esri. It provides a wide range of tools for data management, spatial analysis, mapping, and visualisation. Most cities and communities use ArcGIS for their GIS infrastructure and spatial data management.

- Open-source GIS: Open-source GIS technologies like QGIS (Quantum GIS) and GRASS GIS are popular choices for cities due to their flexibility, cost-effectiveness, and active user communities. These platforms offer similar functionalities to proprietary GIS software and can be customised to meet specific city requirements.

- Web-based GIS: Web-based GIS platforms allow cities to share geospatial data and applications with the public and internal stakeholders through the internet. Examples include ArcGIS Online, Mapbox, and Google Maps API. These platforms enable interactive mapping, data visualisation, and analysis accessible through web browsers.

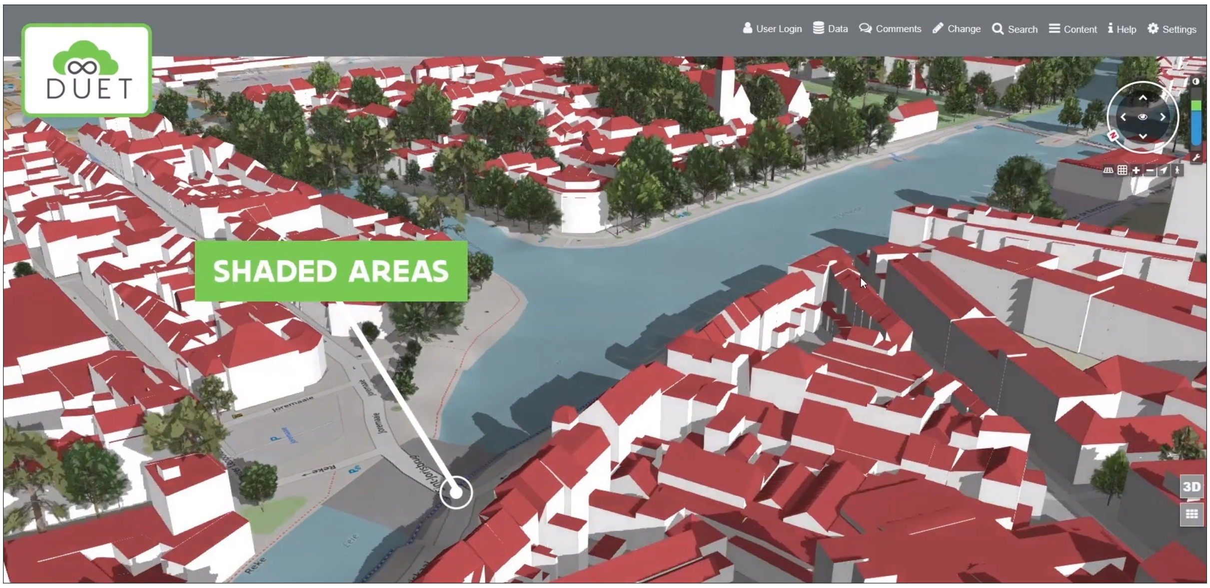
- Remote Sensing: Cities utilise remote sensing technologies such as satellite imagery, aerial photography, and LiDAR (Light Detection and Ranging) data to gather detailed spatial information. Remote sensing data is used for urban planning, land use management, environmental monitoring, and disaster response.

- GPS and GNSS: Global Positioning System (GPS) and Global Navigation Satellite System (GNSS) technologies are crucial for data collection and asset tracking in cities. GPS/GNSS receivers are used to capture accurate geographic coordinates of points, lines, and polygons, supporting field data collection and navigation. The dominance of GPS over Galileo SAR services in software remains a fact, as none of the use cases analysed is using the latter.

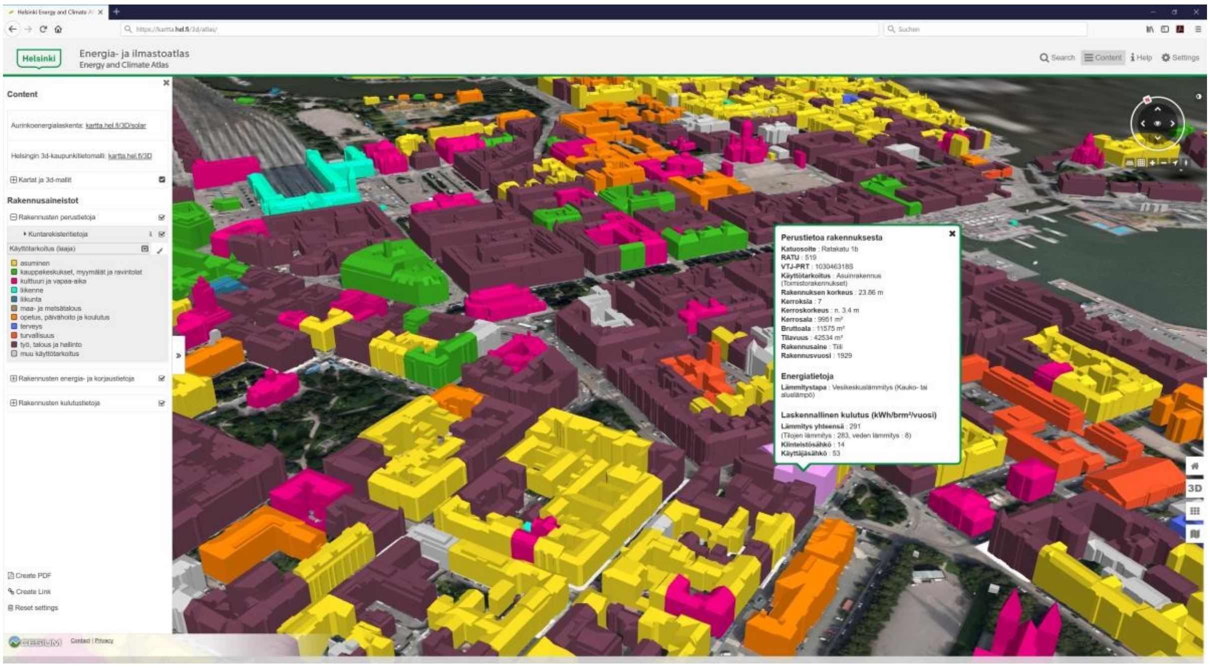
3D Modelling Tools

Local Digital Twins provide a new way to underpin city management. Some cities are already experimenting with these technologies, which often includes a 3D visualisation of the city. To present 3D models of cities, several technologies and formats are utilised.

For instance:



The [DUET project](#) created Digital Twins in Ghent, Belgium and Pilsen Czechia, mainly focussing (but not limited to) mobility challenges



The [Helsinki Climate Atlas](#) focuses on energy use and Climate Impact.

The City of Rotterdam is investing heavily in a [cross-domain digital twin](), which will be deeply embedded in the City's ICT architecture

Argaleo, a company based in 's-Hertogenbosch, the Netherlands, is creating [Local Digital Twin solutions]() for many domains, including urban planning, mobility, security, and more

Each of these solutions will, in some way or another, include a visual 3D representation of the city.

We identified 2 commonly used technologies for visualising 3D city models within the use cases that were researched:

- CityGML: CityGML is an open data model and XML-based format specifically designed for representing and exchanging 3D city models. It provides a standardised way to describe the geometry, semantics, and appearance of urban features such as buildings, roads, terrain, vegetation, and more. CityGML enables the creation of detailed, multi-scale 3D models of cities and supports interoperability between different software applications.

- glTF (GL Transmission Format): glTF is an open standard file format designed for efficient transmission and loading of 3D models in real-time applications. It is specifically optimised for web and mobile platforms and provides support for geometry, materials, textures, animations, and other visual attributes. glTF is widely used for presenting 3D city models on the web and in augmented reality (AR) and virtual reality (VR) applications.

These technologies can be used in conjunction with other tools and software to create interactive and immersive experiences of 3D city models. Here are a few additional technologies and techniques commonly used for presenting 3D city models:

- 3D Modelling Software: Software applications like SketchUp, Autodesk 3ds Max, Blender, and Trimble CityEngine are commonly used for creating and editing 3D models of cities. These tools provide a range of modelling and texturing capabilities to build detailed representations of urban environments.

- Visualisation Engines: Game engines and visualisation platforms such as Unity, Unreal Engine, and CesiumJS are used to render and display 3D city models. These engines provide real-time rendering, lighting, and interactive capabilities, allowing users to explore and interact with the virtual city models.

- Virtual Reality (VR) and Augmented Reality (AR): VR and AR technologies enhance the visualisation of 3D city models by providing immersive experiences. Virtual reality headsets like Oculus Rift, HTC Vive, or AR-enabled devices like smartphones and tablets enable users to view and navigate through realistic virtual city environments. An example of how VR can be employed by cities can be found in UDI's Digital City Program

- Web-based Platforms: Web-based platforms like CesiumJS, Three.js, and Babylon.js provide frameworks and APIs for rendering and interacting with 3D city models directly in web browsers. These platforms leverage WebGL and other web technologies to deliver 3D visualisation and interactivity without the need for additional plugins or software installations.

- Point Cloud Data: 3D laser scanning or LiDAR technology is used to capture large-scale point cloud data of cities. Point clouds represent the surface of buildings and other urban objects with dense sets of 3D coordinates. Software applications like Autodesk ReCap, Bentley Pointools, and CloudCompare are used to process and visualise point cloud data, enabling realistic representations of cities.

These technologies, including CityGML and glTF, offer various options for presenting and interacting with 3D models of cities, enabling urban planners, architects, and the general public to explore and analyse urban environments in a visually immersive manner.

Sensor Data Management

A common need found within those cases working with real-time and/or sensor data is the collection, distribution and contextualisation of this data. For this purpose, a "context broker" can be used, such as the Orion Context Broker[15], or alternatively, a "message queue" with publish-subscribe functionalities. Furthermore, standards and specifications are required for the transmission and publication of sensor data (streams). Some examples:

- LDES (Linked Data Event Streams): LDES is a W3C specification that enables the publication, distribution, and consumption of linked data streams. It provides a standardised way to represent and transmit real-time event data as linked data. LDES leverages existing web technologies such as HTTP, JSON-LD, and Linked Data Platform (LDP) to facilitate the exchange of

[15] https://github.com/FIWARE/context.Orion-LD

sensor data.

- NGSI-LD (Next Generation Service Interface for Linked Data): NGSI-LD is an open standard developed by ETSI (European Telecommunications Standards Institute) for managing and exchanging data in a context-aware system. It is particularly well-suited for the Internet of Things (IoT) and smart city applications. NGSI-LD allows for the representation of sensor data as linked data, providing a standardised format for describing entities, attributes, and relationships in a semantically meaningful way.

- MQTT (Message Queuing Telemetry Transport): MQTT is a lightweight publish-subscribe messaging protocol that is widely used for IoT applications. It enables efficient and reliable communication between sensors and the applications that consume their data. MQTT supports a publish-subscribe model where sensors publish data to a broker, and subscribers receive the data by subscribing to specific topics.

- Apache Kafka: Apache Kafka is a distributed streaming platform that is often used for real-time data processing and event streaming. It provides a highly scalable and fault-tolerant infrastructure for handling large volumes of data. Kafka allows for the efficient ingestion, storage, and distribution of sensor data, making it suitable for scenarios where high throughput and low latency are required.

- AMQP (Advanced Message Queuing Protocol): AMQP is an open standard messaging protocol that supports reliable and interoperable messaging between applications and systems. It provides features such as message queuing, routing, and security. AMQP can be used to distribute sensor data in a decoupled and scalable manner, enabling efficient communication between sensors and data consumers.

- CoAP (Constrained Application Protocol): CoAP is a lightweight protocol designed for resource-constrained devices and networks, such as those found in IoT deployments. It follows a client-server model and supports request-response interactions. CoAP can be used to distribute sensor data over constrained networks, providing a scalable and energy-efficient solution.

- RESTful APIs (Representational State Transfer): RESTful APIs are a common approach for distributing data over the web. They use standard HTTP methods such as GET, POST, PUT, and DELETE to interact with resources. RESTful APIs can be utilized to expose sensor data as web services, allowing data consumers to retrieve and manipulate sensor information using standard HTTP protocols.

3.3 Common challenges

Setting up a data space in cities and communities can be a daunting task. Partly due to the diversity of data that is relevant within cities and communities, as has been shown in section 2.3: Workshop Results, but also due to a number of legal and practical constraints. Through the evaluation of the use cases, we were able to identify some recurring issues:

- **Procurement**

European and member state procurement laws and regulations are designed to allow a free market and to make sure that any provider with a qualitative product may have access to government funds[16]. However, specifically in an ICT context, this often leads to a fragmented ICT landscape within local and regional governments. At any point in time, when a tender is sent out, different providers may change their pricing strategy in order to gain the contract, forcing the procurer to integrate new software. This leads to large integration costs, and an ever evolving ICT landscape. Therefore, ICT solution vendors will naturally try to “lock-in” customers by differentiating their solution based on the way they handle data, or specific processes or domains they support. It is not rare within ICT procurement for the argument of “sole supplier” to be used.
Nevertheless, both solution providers and procurers agree that standardisation may help to reduce integration costs and level the playing field for solution providers. Many initiatives in this sense have already been launched and implemented, of which *Interoperable Europe* and the introduction of the *Minimum Interoperability Mechanisms* are some of the most obvious. These initiatives often identify the need to enforce interoperability through the use of procurement clauses.

[16] EU initiative *Big Buyers Working Together:* https://public-buyers-community.ec.europa.eu/about/big-buyers-working-together

Procurement clauses:

➔ Sharing and Re-use Standard clauses by the Open Source Observation (OSOR)

This is a set of standard procurement clauses which can be used when procuring reusable software. These clauses have been produced in the scope of ISA Action 4.2.5. “Sharing and re-use Strategy”. The aim of this ISA action is to develop a holistic approach to sharing and reuse across border and sectors with a view to helping public administrations all over Europe to share and reuse solutions related to public services delivery in an efficient and effective way.

➔ Amsterdam’s procurement clauses for AI: Standard Clauses For Procurement Of Trustworthy Algorithmic Systems

These are “standard” clauses that can be applied when procuring AI tools. There is a wide ranging discussion on how and when AI can be used in an ethical way in general, but also specifically within governments. There are a number of initiatives tackling this, such as Living-in.eu’s work on MIM5, championed by the city of Amsterdam. One of Amsterdam’s solutions in this field is the creation of these clauses, which focus on transparency and explainability.

➔ The Flemish Sample Clauses for Open Data, and their Standards Registry.

A recurring issue is that ICT vendors keep data locked in their systems. This can be a practical or a strategic decision on their part, but in any case, procurers should be aware that if they require continuous access to the data underpinning solutions, this needs to be made explicit in procurement contracts. This is especially (but not only) the case when the data should be published as open data. It is for this reason that the Flemish regional government has produced these standard clauses for open data to be used in procurements in Flanders.

- **Data quality**

The lack of high-quality data was mentioned by most of our interviewees. For instance, in the case of the Helsinki Energy Atlas machine-readable data was not available at first and had to be created manually in a pre-step. Furthermore, various significant variables were not available. The quality of existing data was too poor to show the renovation history of the buildings. For the IDEA project in Amsterdam, the issue of data quality of reported road and bridge closures and hence trusting its sources was the reason to kick off the project overall.

- **Level of granularity**

Often the rather coarse level of granularity of existing datasets led to limitations and challenges when developing use cases. For instance with the Helsinki Energy Atlas, the coarse level of district heating leads to data averaging, which can result in biassed outcomes. Furthermore, energy data was available aggregated per building due to GDPR constraints (as mentioned below).

- **Limitations / Challenges for data sharing**

Accessibility and sharing of data has been found to be highly challenging. For instance, in the case of accessing energy data (Helsinki Energy Atlas): Even though the owner of the energy data was the city-owned energy company, it was difficult for project stakeholders to gain access to it to develop the Energy Atlas.

- **GDPR and legal based challenges**

GDPR regulations, especially when including energy data as for instance in the case of Helsinki Energy Atlas, lead to challenges: data was available aggregated per building and only with owners' permits.

3.4 Minimum Interoperability Mechanisms in DS4SSCC use cases

Minimum interoperability mechanisms (MIMs) can facilitate the creation of data spaces because they define the mechanisms through which minimal interoperability can be achieved across local authorities, with sometimes far different ICT architectures. Through the evaluation of the use cases, we have been able to identify some concrete mechanisms already in place. This section details these mechanisms for the most relevant MIMs for data spaces for cities and communities, namely MIM1 and MIM2.

Recently, the MIM specification (version 5.5) has undergone some changes to reflect the new “y.MIM” standard which specifies the substituting components of each of the MIMs. These components can summarily be described as:

- **Objective**: the interoperability issue(s) this MIM is trying to solve, going from providing context information in IoT settings to authentication of users.
- **Capabilities**: the intended capabilities of any solution which adheres to the MIMs specification.

- **Requirements**: a more detailed description of how these capabilities can be realised technically.
- **Mechanism**: a description of the different mechanisms which fulfil these requirements.
- **Specifications**: an overview of the specifications used within each of these mechanisms
- **Interoperability guidance**: a number of solutions to allow interoperability between different mechanisms adhering to the same MIM
- **Conformance and compliance testing**: A description of how adherence to the MIM specification can be achieved.

The y.MIM specification is currently undergoing a standardisation track within the ITU.

3.4.1 Relevant MIMs for the Use Cases

Each of the selected use cases pertains to multiple MIMs, as indicated in section 2.2: Workshop results. In this section however, we discuss the most relevant MIM that impacts each of them. This allows us to draw some conclusions about which mechanisms are being used in real-world settings implementing these MIMs. This will in turn feed back into the further development of the MIMs. The table below gives an overview of which MIM has been identified to be most paramount for each of the use cases.

Flemish Smart Data Space (Flanders)	MIM1: Context MIM2: Data Models
Climate Atlas (Helsinki)	MIM2: Data Models MIM7: Places MIM8: Indicators MIM9: Analytics
Intelligent Data Exchange Alliance (Amsterdam)	MIM1: Context MIM2: Data Models MIM7: Places MIM8: Indicators
Urban Development Initiative (Eindhoven and Helmond)	MIM1: Context MIM2: Data Models MIM7: Places MIM8: Indicators

Score Water (Barcelona, Amersfoort, Göteborg)	MIM1: Context MIM2: Data Models
Farm2Fork (Kranj)	MIM3: Contracts MIM4: Trust

By far the most common MIMs in this overview are MIM1 and MIM2. We therefore focus on each of these and define the specific mechanisms used in those use cases to realise them.

MIM1

Of special interest to the creation of local data spaces is how context information is exchanged between different IoT infrastructures. We identify two different mechanisms among the use cases that are both very different, but essentially attempt to enable the same capabilities. Therefore it is logical that they should somehow allow "minimum interoperability". We will drill down on how this can be achieved, first, by examining, in detail, how each approach (or "mechanism") fulfils MIM1's requirements, and how these differences can be addressed in order to establish a data space between them. This is important because a local data space will always consist of different actors (data providers) which may very well be operating very different systems, especially

- **Flemish Data Space**

The Flemish Smart Data Space (VSDS) aims to support multiple data space initiatives within Flanders, by providing a number of technical building blocks, convening partners, using a similar and well-documented approach. We will use this use case to gain more insight in MIM1:

MIM1 Requirements	MIM1 Mechanisms
R1: A uniform interface should be used; the context management API	The Smart Data Space has multiple pilots running right now, but uses a common architecture for all of them. This architecture is based on providing Linked Data Event Stream (LDES) for each of the data providers, within and across domains, thus realising a common uniform interface. Event streams cannot be strictly defined as an "API" but do provide all the required

MIM1 Requirements	MIM1 Mechanisms
	functionalities to be considered as one in this context as R1 only refers to "read" methods.
R2: Information from all sources should use the same concepts, so called data information models	An event stream typically records occurrences related to a specific sensor, which can be related to any semantic concept or "Class". The Flemish government has put a lot of effort in co-creating the OSLO vocabularies, and aims to mainly use these as information models for any stream within the VSDS. OSLO vocabularies are based on the ISA^2 Core Vocabularies, and are carefully constructed to always refer to the most prevalent ontologies within the domain. There is no restriction however to point to information models available outside of the Flemish context, and indeed, sometimes [Smart Data Models]() are referenced.
R3: The uniform interface should support retrieval of latest data	The VSDS architecture is based on streams that are paginated. This means that any data consumer will have to "follow" the stream to the last entry in order to find the most actual occurrence or measurement. This process can be sped up by providing a pointer to the last "page" in the stream description.
R4: The uniform interface should support retrieval of historical data	This requirement is where event streams really excel. They inherently record occurrences over time without dropping or archiving any of the previous ones.
R5: The uniform interface should support geospatial querying	Event streams can be organised to be subsequent not in terms of "time" but in terms of geometry as well. There is an LDES server implementation which allows the publication of streams organised geographically, using the concept of "slippy maps". However, as this is not the primary goal of the VSDS they are currently not implementing this.

MIM1 Requirements	MIM1 Mechanisms
	In order to query geographically over a time-based LDES event stream, the client will need to populate a database (which can be either a triple store or a geographic database such as PostGIS) with the events it wishes to query and apply a GeoSPARQL or other geospatial query.
R6: The uniform interface should support subscription to changes	This can be achieved through a simple polling mechanism. The last "page" of an event stream gets populated with new occurrences until the "pagelimit" is reached. When this occurs, the HTTP Cache-Header: is set to "immutable", which implies the next page is available. The link to this page can be found in the stream.
R7: Relevant data sources to any required context (at least location and time period) should be discoverable and retrievable according to their context	Currently, the VSDS is not keeping an index of different contexts. It simply lists the different data producers (sensors or otherwise) as individual streams. In order to allow the retrieval of a data source specific to a context, the client should evaluate each of these streams client-side. In order to truly allow programmatic discovery of new data sources related to any context, this list should be structured as an index, through a broker or otherwise through a data catalogue (such as DCAT)
R8: Specific subsets of data relevant to the context should be retrievable from within larger data sets and with default limits and page sizes	This requirement is inherently fulfilled due to the pagination-based approach of Linked Data Event Streams.

- **SCORE Water**

MIM1 Requirements	MIM1 Mechanisms
R1: A uniform interface should be used; the context management API	The SCORE Water project uses the Orion Context Broker to publish most of its

MIM1 Requirements	MIM1 Mechanisms
	sensor readings. Thus, this requirement is satisfied by using the NGSI-LD API.
R2: Information from all sources should use the same concepts, so called data information models	This is provided through the common NGSI-LD information model, which is the meta model on which the API is based. The (NGSI-LD) world consists of Entities that can have Properties, Relationships etc.
R3: The uniform interface should support retrieval of latest data	THE NGSI-LD specification supports retrieval of the latest data by simply querying the pertaining entity using a HTTP GET call (GET /ngsi-ld/v1/entities/<entity>)
R4: The uniform interface should support retrieval of historical data	NGSI-LD supports the querying of historic data, provided it is being stored on the server. To this end, again, a simple GET request can be sent to the entity being observed, and a parameter ("LastN") can be set to list the latest N observations.
R5: The uniform interface should support geospatial querying	The NGSI-LD specification allows geospatial querying by providing the "georel" attribute, which can restrict results to a geographic area.
R6: The uniform interface should support subscription to changes	It is possible to subscribe to changes on an NGSI-LD compatible context broker, simply by "POSTing" a subscription object. This object can specify exactly when the client will be notified and extensive filtering is available. In each subscription object and endpoint should be specified, which will receive a POST request from the broker, as soon as the requirements for notification are met.
R7: Relevant data sources to any required context (at least location and time period) should be discoverable and retrievable according to their context	A context broker supporting NGSI-LD will maintain a list of entities. These can be retrieved based on their types and attributes, such as their geographic location.
R8: Specific subsets of data relevant to the context should be retrievable from within larger data sets and with default limits and page sizes	NGSI-LD in itself is agnostic to pagination.

MIM2

The objective of MIM2 is to support cities and communities to use consistent and machine-readable definitions of all the entities about which data is being captured in a data ecosystem, so that data about any entity can be combined with other data referring to that entity in the confidence that they refer to the same thing.

We will compare how each of the use cases under scrutiny realise this objective. Because each of the use cases use a plethora of different data models, an exhaustive analysis of each of these would take us too far. Instead, this analysis focuses on the most relevant dataset in each of the three cases and summarises how these do or do not fulfil the requirements of MIM2

- Helsinki Energy & Climate Atlas

In section 2.2, the main datasets (and therefore their models) have been identified for each of the use cases. For the Helsinki Energy & Climate Atlas, these are:

- ➔ 3D City Model (CityGML)
- ➔ Building registry (heating mode, building materials, contained square metres, number of building stories)
- ➔ Energy data (district heating, electricity, water consumption, energy efficiency level)

CityGML is a pervasive standard in many Local Digital Twin projects. Whereas building and energy data often differs more based on local utility providers and contexts, we will currently focus on CityGML.

MIM2 Requirements	MIM2 Mechanism
R1. As far as possible, data models should be taken from a list of standard specifications. Use common concepts and vocabularies.	In the case of CityGML this is obviously the case. CityGML is one of the most prevalent standards to be used when visualising cities and is well [defined by the OGC]().
R2. All key entities in any data set should be formally defined in a machine-readable way.	CityGML is serialised as XML and thus fulfils this requirement.
R3. Data models should contain as much information as possible regarding their context	CityGML, as opposed to other 3D modelling standards such as KML, offers a

	rich set of semantic properties related to urban context.
R4: Data models should be in a format consistent with MIM1	Each feature within CityGML can optionally contain a bitemporal timestamp, which makes it easy to model changes over time. It is inherently geographic in nature so it also allows geographic positioning. The standard includes a “Dynamizer” module, which makes it easy to connect to IoT components, particularly to those within the OGC family (supporting SOSA/SSN, the SensorThings API, etc)
R5: Data models should be clearly defined using a consistent process to enable ease of transformation between the different sets of standard data models	CityGML is governed as an open standard by the OGC and is extensively documented, and so are its different versions. Transitioning between version is possible, and links with other data models are maximally made where relevant (for instance, to the ISO 191xx family)
R6: Translation engines should be developed/identified to enable data models from different standards to be aligned	This is clearly the case within the Helsinki Energy and Climate Atlas, since different datasets pertaining to energy have been aligned with the CityGML features. The features themselves have been enriched by importing properties from City-governed datasets which detail building materials etc…

- **Amsterdam Intelligent Data Exchange Alliance (IDEA)**

In section 2.2, the main datasets (and therefore their models) have been identified for each of the use cases. For the Amsterdam Intelligent Data Exchange Alliance, these are:

➔ BeMobile Floating Car data,

➔ Amsterdam / The Hague City CouncilPlanning data (Official data on road construction and bridge closure),

➔ Rijkswaterstaat (National Road Authority) road work datasets

➔ Waze Trusted Messages

The most interesting data model to zoom in on in this case is DATEX II. Datex II is a standard that is very actively used with the ITS ecosystem and has especially gained traction with the introduction of NAPCORE, which aims to harmonise mobility platforms across Europe.

MIM2 Requirements	MIM2 Mechanism
R1. As far as possible, data models should be taken from a list of standard specifications. Use common concepts and vocabularies.	DATEX II is a well known standard, governed by the CEN Technical Committee 278 and widely used throughout Europe by traffic and mobility operators.
R2. All key entities in any data set should be formally defined in a machine-readable way.	DATEX II is originally based on XML but can also be serialised as JSON.
R3. Data models should contain as much information as possible regarding their context	DATEX II is a large multi-part standard containing lots of semantic information about many different traffic and mobility phenomena. Furthermore, multiple efforts have been made to either map the standard to a fully linked data version, or to include linked data references within the existing specification.
R4: Data models should be in a format consistent with MIM1	Datex II supports both time-based and location-based reference of measurements, for instance within the "MeasuredData" class, and can this be applied within an IoT setting.
R5: Data models should be clearly defined using a consistent process to enable ease of transformation between the different sets of standard data models	The governance of DATEX II is being carried out within CEN, and therefore is well defined, and versioning is well supported.
R6: Translation engines should be developed/identified to enable data models from different standards to be aligned	As to be expected in a rather mature domain such as mobility, many alignment initiatives have been undertaken to align DATEXII with various other data models and standards (notably TMC: Traffic Message Channel or SIRI: Service interface for real-time information relating to public transport operations)

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4 DS4SSCC Data Cooperation Canvas: the Use Cases perspective

As introduced in section 1.1, the DS4SSCC blueprint defines the guidelines and mechanisms required for the upcoming deployment of the data space. The blueprint is being defined by different pieces across several work packages in the project (WP2, WP3, WP4). In order to align and consolidate all these pieces in a common tool for the data space creators,an instrument called **Data Cooperation Canvas** has been conceived by the WP2 to support them, in collaboration with WP3 and WP4, detailed in deliverable D2.2: Multi-stakeholder governance scheme. The WP2 is more focused on filling the Canvas regarding the Governance and Business Models, while WP3 and WP4 are filling the Technical aspects, which included the Data & Data Sources (mostly coming from the provided input by the use cases about their datasets), Interoperability (which mechanisms they are using or plan to use), Technical Concepts/models and Technical infrastructure, both more on the side of WP3.

. Below is a summary of the aspects to take into account in the Canvas. Each component of the canvas is further elaborated below the overview.

Data & Data Sources	
Supply Side	**Demand Side**
• Provide metadata • Document access type (API) • Detail data quality attributes • Detail SLA levels • Provide contact details	• Find potential data source • Access third party API • Assess data quality attributes • Decide required SLA specs • Negotiate or define smart contracts
Interoperability	
Supply Side	**Demand Side**
• Analyse state of the art in terms of semantics (LOV, Smart Data Models, …) • Apply the most common	• Assess if the semantics of the data are properly understood • Assess if the provided data models and ontologies can

ontologies for the data domain • Decide on applicable / feasible level of verbosity • Provide links to other relevant ontologies	sufficiently be mapped to the (internal) target system • Where necessary, identify the required MIM2 PPI's (Pivotal Points of Interoperability, for instance, GeoJSON) and interoperability mechanisms (wrappers, mappers, convertors)
Technical Concepts / Models	**Technical Infrastructure**
• Decide on trust levels and set up Trusted Exchange / Marketplace model accordingly • Decide on necessary Usage Control systems • Select an Identity Provider • Set up metering	• Define scalability requirements • Define durability requirements *For cloud-based infrastructures:* • Define data transferability requirements • Check GDPR compatibility • Check pricing structure

Data and Data Sources

In setting up a local data space, the first question one should ask is: What data is required to operationalise it? What are the data sources used? Who manages the data and how is it governed? This may differ depending on the local context and governmental setting. National regulations may have far reaching impacts on how data spaces can be organised, but also sector-specific regulations may be in place. As such, many cases local authorities will depend on regional or national governments for a number of data sources, but they will certainly also need to manage some datasets themselves. Moreover, most certainly, authorities will need to depend on 3rd parties such as utility companies and private companies to complete the landscape. Once this landscape is plotted, several steps will need to be taken both on the supply and the demand side:

- **Supply side:**
    - ➔ Provide metadata
    - ➔ Document access type (API)
    - ➔ Detail data quality attributes
    - ➔ Detail SLA levels
    - ➔ Provide contact details

- **Demand side:**
  - ➔ Find potential data source
  - ➔ Access third party API
  - ➔ Assess data quality attributes
  - ➔ Decide required SLA specs
  - ➔ Negotiate or define smart contracts

Semantics and Definitions

- **Supply side:**
  - ➔ Analyse state of the art in terms of semantics (LOV, Smart Data Models, …)
  - ➔ Apply the most common ontologies for the data domain
  - ➔ Decide on applicable / feasible level of verbosity
  - ➔ Provide links to other relevant ontologies

- **Demand side:**
  - ➔ Assess if the semantics of the data are properly understood
  - ➔ Assess if the provided data models and ontologies can sufficiently be mapped to the (internal) target system
  - ➔ Where necessary, identify the required MIM2 PPI's and interoperability mechanisms (wrappers, mappers, convertors)

Technical Concepts / Models

- Decide on trust levels and set up Trusted Exchange / Marketplace model accordingly
- Decide on necessary Usage Control systems
- Select an Identity Provider
- Set up metering

Technical Infrastructure

- Define scalability requirements
- Define durability requirements

For cloud-based infrastructures:

- Define data transferability requirements
- Check GDPR compatibility
- Check pricing structure

Some of the use cases will be selected to fill their Data Cooperation Canvas. They will provide them an holistic overview of what to address in all aspects to set up the data space. This tool can be complemented with the CookBook to be provided in D3.2 with the particular recipes for these use cases to follow on technical deployment.

4.3 Design Architecture & Implementation

The final step in realising the local data space is to design the architecture, implement the required systems and organise the operational side by setting up contracts, SLA's, organisational changes, etc. These are extensive operations and require careful planning, execution and continuous evaluation.

This task is further detailed in WP3, more specifically in D3.2: Technical Architecture.

5 Conclusions and next steps

5.1 Conclusions

In this deliverable, we presented the outcome of our in-depth study on priority datasets and related use cases. Based on a large selection of use cases relevant to the DS4SSCC, we prioritised and shortlisted finally a set of 7 use cases we then further conducted interviews on, exploring overlaps in technological approaches and datasets that have been used. Results have shown that while most datasets are relatable to datasets and domains as defined by the European Commission, there are existing gaps for both public (as covered by the EC) and private sector (as covered in upcoming Data Act[17]) data in the current official dataset environment that need to be taken into account.

The in-depth analysis of these different use cases has contributed further to a thorough understanding of the real-world ICT architectures being used in different City or Community settings. Outcome shows that there are clear overlaps in terms

[17] Data Act: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1113

of requirements of the local authorities, but there are many different technologies being used to underpin them that have been presented in this work.

Together with results of work conducted in other WPs (D2.2,D3.1, D3.2), these results will lead to the development of a blueprint and Data Cooperation Canvas as outlined in this deliverable, supporting stakeholders setting up a dataspace for smart and sustainable cities and communities.

5.2 Next Steps

Findings of this deliverable will support WP3 to customise the high level reference architecture to some representative use cases of data spaces (D3.2). These use cases will be the perfect validation framework for the proposed architecture and recipes (CookBook). Therefore we will select and invite at least three of our use cases for further elaboration. Based on our findings, Minimum Interoperability Mechanisms (MIMs) will be updated and an action plan developed. The developed blueprint will be then taken into action by the application to pilot projects that will be gathered in an open call process as part of DS4SSCC-Deployment project.

6 Annexes

6.1 Annex 1: Use Case list

Strategic Field of Data Spaces	Use Case	Related Project	geographic Scale	# of MIMs	MIMs	Tech	# of Techs	Total
Energy	Web based information platform for energy management: The platform is a cloud -based service which collects data from the buildings and the District Heating (DH) substations. The data is then used for governing the space heating demand-supply in a more efficient way, and to visualize the buildings energy performance.	Ruggedised	Umea, SWE (building level)	3	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM9 – Analytics ;	9	4	16
Public administration	Sensors to measure filling of waste containers implemented	Ruggedised	Rotterdam, NL	2	OASC MIM1 – Context ; OASC MIM2 – Data Modules;	8	3	13
Health	Noise and air pollution monitoring for more efficient mobility and healthy cities	GreenMov	Region Murcia, ESP ; Nice, FRA	3	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places;	8	4	15
Urban Planning	Developing a Digital Twin to simulate urban (re-)development projects	Slim Ruimtelijk Plannen	Ghent	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM5 – Transparency ; OASC MIM7 – Places;	7	2	13
Mobility	Intermodality between bikes and trains: bikes availability at train stations spots	GreenMov	Flanders	4	OASC MIM1 – Context ; OASC MIM3 – Contracts; OASC MIM4 – Trust OASC MIM7 – Places;	9	3	16
Public administration	Keep sidewalks bin-free: The objective of the challenge was to predict waste collection time thanks to AI, and alert building caretakers via text messaging of exact collection times in order to reduce the occupation of public areas.	Data City Lab	Paris, FRA	3	OASC MIM2 – Data Modules; OASC MIM5 – Transparency ; OASC MIM4 – Trust ;	7	3	13

Urban Planning	Driving urban planning through citizen's voice: The solution consists of an interface that enables the user to monitor opinions expressed by citizens on all feedback channels, including social networks (Facebook, Twi er), DansMaRue and other sources. The main dashboard presents the aggregated citizens' opinion expressed on sourced networks, classified into categories of urban management (such as security, education, public spaces, environment etc.) and specifying if this opinion is positive, neutral or negative. In addition, any user can drill down to actual trends and keywords people use and create alerts on specific categories and/or topics.	Data City Lab	Paris, FRA	6	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts; OASC MIM4 – Trust ; OASC MIM5 – Transparency ; OASC MIM7 – Places;	7	3	16
Tourism	Analysing travel patterns on tourist buses: The objective of the challenge was to help RATP Dev, operator of transportation systems, to understand customers' usage of its bus fleets by analysing specific bus routes and ticket sales to optimise the routes of the Open Tour travelling throughout Paris.	Data City Lab	Paris, FRA	5	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts; ; OASC MIM5 – Transparency ; OASC MIM7 – Places;	8	2	15
Energy	Renewable energy on a district scale	Data City Lab	Paris, FRA	3	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM9 – Analytics ;	7	3	13
Green Deal	GoalGreen App	Replicate	Florence, IT	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	9	3	16
Mobility	Lisbon: micro mobility, road management		Lisbon, POR	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	9	4	17

Cross	Barcelona: Digital Democracy and Data Commons.; Citizen Science Data Governance (noise level, pollution) Amsterdam: Amsterdam Digital Register	DECODE	Barcelona, ESP ; Amsterdam, NED	3	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM4 – Trust	7	5	15
Mobility	MaaS Madrid		Madrid, ESP	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	9	3	16
Mobility	Vlaanderen	KLIP	Flanders	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust			4
Public administration	Thames Valley Berkshire Live Lab - Road maintainance: GPC will use a combination of anonymised crowd movement data from O2 Motion, road usage information from Siemens, and analysis from 3D cameras mounted on bin lorries to map the most heavily used local routes with the worst road surface quality. This will help local authorities prioritise improvements such as fixing potholes.	Thames Valley Berkshire Live Lab	Reading, UK	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM4 – Trust; OASC MIM5 – Transparency	6	3	13
Mobility	Lisbon / Vodaphone		Lisbon, Por	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	8	2	14
Mobility	Ghent	TMaaS	Ghent, BEL	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	9	3	16

Health	Thames Valley Berkshire Live Lab - Air Quality: We've introduced software company GPC Systems to combine anonymised, aggregated O2 Motion movement data with findings from Siemens air quality monitors to measure air quality and public exposure to harmful pollutants. This provides valuable insight into how many people are affected, for how long, and on what types of journeys. The project will then look at encouraging healthier and more sustainable ways of getting around	Thames Valley Berkshire Live Lab	Reading, UK	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	7	3	14
Mobility	Flanders Smart Data Space Data Integration for Smart Mobility Flanders Water Dataspace	DCAT AP-VL	Flanders	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	9	4	17
Green Deal	SUPERvisory control system for plant-wide OPTImization of wastewater treatment plant operation - SUPEROPTI		Slovenia	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts; OASC MIM7 – Places;	9	3	16
Energy	Optimization based control of P2G converter connected to hydro power plant		Slovenia	3	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts;	8	2	13
Environment	Pamenti waterworks to monitor water consumption in real time, monitoring garbage production in real time			3	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts;	8	2	13

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Environment	The Smarter AoE project focuses on the Amazon of Europe (AoE) area around the Mura-Drava-Danube biosphere reserve, and extends through Austria, Slovenia, Croatia, Hungary and Serbia. The main goal of the project is to establish an international ecosystem of tourism SMEs in the area (and the pilot areas in Montenegro, Bulgaria, and Romania. It aims to boost social, digital and innovation through collaboration, capacity-building and digital transformation.		AUT, SLO, CRO, HUN, SER, MON, BUL, ROM	4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts; OASC MIM7 – Places	7	3	14
Environment	Waste management and waste prevention program: The main objective of the project is to implement a comprehensive set of complementary technical, digital, environmental, social, and circular solutions to realize the full potential of the program, achieve maximum material self-sufficiency, and increase the circular return in the waste and resource sector.	LIFE program		4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM3 – Contracts; OASC MIM7 – Places	7	3	14
Mobility	myAthensPass - parking app			4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM7 – Places; OASC MIM4 – Trust	9	3	16
Public administration	Novoville app - Novoville is a Civic Engagement Platform that transforms the way citizens access local services			4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM4 – Trust; OASC MIM6 – Security	9	3	16
Public administration	Athens Coordination Center for Migrant & Refugee issues (ACCMR)			4	OASC MIM1 – Context ; OASC MIM2 – Data Modules; OASC MIM4 – Trust; OASC MIM6 – Security	9	2	15
Energy	Energy and Climate Atlas		Helsinki, FIN	4	MIM1, MIM2, MIM4, MIM7	9	3	16
Mobility	Real time traffic of the city		Madrid	4	MIM1, MIM2, MIM4, MIM7	8	2	14
Mobility	MobilityLab EMTMadrid		Madrid	4	MIM1, MIM2, MIM4, MIM7	8	1	13

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Mobility	Explore.Porto: a tool to assist citizens in their mobility within the city of Porto and also to provide Tourists with quick and easy access to touristic information and route planning. This tool uses several components such as Digitransit and OpenTripPlanner, and depends on data gathered from multiple sources within (and outside) the municipality (e.g. e-scooter, bus and metro data).		Porto	2	MIM2, MIM7	9	1	12
Public administration	Cartao Porto: a physical and digital card to facilitate the life and interaction with the city services for the citizen of Porto. It provides several services and allows access for digital offering such as commercial vouchers, city information and environmental warnings. It uses a Web Application and Databases to manage data but is also connected to a Data Platform providing Business Intelligence Services;		Porto	1	MIM4	9	1	11
Green Deal	TOUREST will support the development and proliferation of sustainable tourism policies & practices to increase water efficiency in ADRION coastal areas, seeking to: a) minimise the negative impacts of tourism activities on natural heritage, and b) protect increasingly scarce water resources. These focal interventions points will directly contribute to the implementation of the 4th EUSAIR pillar.		Adrian	0				0
Agriculture	Grapes			0				0
Financial	Build location strategies and streamline your operations with Belmap, the 3D digital twin of the built environment		Belgium	2	MIM4, MIM7	9	1	12
Energy	Build location strategies and streamline your operations with Belmap, the 3D digital twin of the built environment			2	MIM4, MIM7	9	1	12
Urban Planning	Build location strategies and streamline your operations with Belmap, the 3D digital twin of the built environment			2	MIM4, MIM7	9	1	12

Mobility	Smart Mobility & Predictive traffic management:We are working on Smart Mobility & predictive traffic management, the link to this project: .			3	MIM1, MIM2, MIM5	9	3	15
Urban Planning	Smart Urban Planning, with tools like Digital Twinning & VR and also an Integrated Impact Assessment Model (IIAM) in cooperation with the UDI (Urban Development Initiative)			5	MIM1, MIM2, MIM5, MIM4, MIM7	9	3	17
Energy	Energie Transition in cooperation with the UD			5	MIM1, MIM2, MIM5, MIM4, MIM7	9	3	17
Health	Harvesting and sharing data or air quality and meteorological conditions			4	MIM1, MIM2, MIM4, MIM7	8	2	14
Energy	harvesting and sharing data on energy consumption		Maia (PT)	4	MIM1, MIM2, MIM4, MIM7	8	2	14
Health	Emission factor (and other historical series)		Maia (PT)	4	MIM1, MIM2, MIM4, MIM7	8	2	14
Mobility	parking status			4	MIM1, MIM2, MIM4, MIM7	8	2	14
Mobility	traffic conditions			4	MIM1, MIM2, MIM4, MIM7	8	2	14
Health	ESG data ecosystem for accurate calculations including scope3 (),		Vastuu	4	MIM1, MIM2, MIM4, MIM7	9	2	15
Urban Planning	circulating data in the construction and real estate industries			4	MIM1, MIM2, MIM4, MIM7	9	2	15
Public administration	personal data operating helping citizen engagement, literacy and openness ()			2	MIM4, MIM6	9	1	12
Mobility	Smart intersection use case where we monitor traffic intersections in urban areas for improving the traffic flow and also to improve the citizens' safety:			4	MIM1, MIM2, MIM4, MIM7	9	4	17
Mobility	Smart mobility: use case where we monitor the traffic infrastructure, make predictions and provide support for decision making : -			4	MIM1, MIM2, MIM4, MIM7	9	4	17

Public administration	Smart Parks: use case where we help cities to manage more efficiently their park infrastructure:			3	MIM1, MIM2, MIM7	9	2	14
Public administration	The Turbinator – smart sensor for predictive water maintenance: It can be used for early warning of pollutants or for predictive maintenance of a city's pipeline network for waste- and stormwater. It is based on image processing and edge AI to predict turbidity and water level. The data collected can be used for preventive maintenance of a city or municipality pipeline network for waste- and stormwater. The technical solution of the Turbinator – combining a camera, a focused light beam and image analysis for measuring turbidity – is patent approved in the US, EU and Sweden			2	MIM1, MIM2	9	2	13
Health	SCOREwater (H2020 Innovation Project) focuses on enhancing the resilience of cities against climate change and urbanization by enabling a water smart society that fulfils the Sustainable Development Goals 3, 6, 11, 12 and 13 and secures future ecosystem services. SCOREwater develops and tests three large-scale demonstrations cases for collecting, computing and presenting various data tailored to needs of our stakeholders. In Barcelona we initiate a new domain “sewage sociology” mining biomarkers of community-wide lifestyle habits from sewage. In Amersfoort we develop new water monitoring techniques and data-adaptive storm water treatment and apply to water resource protection and legal compliance for construction projects within the Göteborg-case.			4	MIM1, MIM2, MIM5, MIM7	8	6	18
Mobility	Project and mobile application on sustainable mobility		Kalmar	7	MIM1, MIM2, MIM3, MIM4, MIM7	8	2	17
Urban Planning	Regional policy development for spatial planning in Kalmar county		Kalmar	1	MIM7	6	1	8
Mobility	Regional ticketing information and application -			1	MIM7	9	1	11

Public administration	SPOTTED Eu project on satellite data analysis and tools for Urban Green infrastructure management -			3	MIM1, MIM2, MIM7	8	3	14
Health	Smart water management for data driven water treatment and buffering Partners: water board			3	MIM1, MIM2, MIM7	9	2	14
Mobility	Schwung: predictive traffic management mobile app data collection linked to traffic light operation Partners: Vialis (commercial solution) and civilian participants			4	MIM1, MIM2, MIM4, MI6, MIM7	9	3	16
Smart Retail	Smart retail connecting farmers and other local food producers with retail customers in smart city/society	Lokalno GOR	Slovenia	3	MIM1, MIM2, MIM3	5	3	11
Smart Mobility	Smart mobility supporting several use-cases in the smart city: smart parking, multi-modal mobility, route optimization, control room	iPOT	Maribor/Slovenia	4	MIM1, MIM2, MIM3, MIM7	8	4	16
Mobility	IDEA predictive mobility based on floating car data	IDEA project	Netherlands	4	MIM1, MIM2, MIM4, MI6, MIM7	8	3	16

○ 6.2 Annex 2: Priority Datasets from Workshops

Health	**Agriculture**	**Energy**
Sewer pollutant information	Weather Stations	User provided energy signature
Meteorological Data	Ground Humidity Levels	Aggregated energy use by providers
	Forestry data provided by drones	Potential green energy supply
		solar and wind information

		Energy consumption in schools
		Energy data on building level
		EV e-ferry, bus, bike charging stations
		building solar energy potential
		building automation data
		energy certificates
		Calculated energy consumption
		PED planning
		Heat sensors

Mobility	**Public Administration**	**Green deal**
Manual vehicle counting	Urban planning licensing	Water level measurements
ANPR camera	Building (BIM) data	Pollutant information
Parking spaces power consumption	3D City model	Water quality
Public transport time schedules	Visitor counters	Air quality

Traffic data	Swim water temperature	Weather station data
Self provided data from students	Building renovation potential	
Railway data		Tree registry
Data from carpooling companies		
NEC mobility data kit		
Mobile devices entering or leaving the city		
Waze and GPS data		
Induction loop data		
Biking pathways		

○ 6.3 Annex 3: Interview question template

Introduction project/ aim of interviews:
Brief background of the interview participant:

- Affiliation:
- Position:
- Years of experience:

Questions	Notes
Could you tell us about the initiation of project XXX . What's the backstory, what was the need?	

What technical standards and specifications do you consider the most important when it comes to data sharing?	
What type of data do you use/ how do you extract value from it in these use-cases? (format, aggregation, re-use, etc)	
What domains and related data sets are prioritized?	
What would your organisation identify as priority data sets on the local, regional, national and EU-level identified, so far?	
Have you experienced any challenges in accessing / importing the required data in your systems	
Which technologies, platforms, or notable ICT systems have you used in the project?	
What are specific Data space requirements relevant to your use case?	
Relevant Building blocks?	