interreg-central.eu/projects/enclod/

@EnCLOD Project

Interreg CENTRAL EUROPE

Co-funded by the European Union

EnCLOD

POLICY BRIEF #1

Open data for data-driven territorial governance

EVIDENCE-BASED RECOMMENDATIONS FOR LOCAL AND REGIONAL AUTHORITIES



VICENZA | OLOMOUC | DEBRECEN | ŽILINA | NOVA GORICA

EXECUTIVE SUMMARY



This policy brief was developed within the framework of the Interreg-funded EnCLOD project, which aims to strengthen the governance capacity of five Central European public authorities by promoting Open Data (OD) and Internet of Things (IoT) sensor networks. Within this context, five pilot areas, namely Vicenza (Italy), Olomouc (Czechia), Debrecen (Hungary), Žilina (Slovakia), and Nova Gorica (Slovenia), were selected to address specific challenges in mobility, environment, and climate change. To achieve this, each region developed a local Action Plan to leverage OD and IoT solutions for smarter territorial governance and city-region planning.

Drawing from the implementation and key findings of these five pilot actions and project activities, such as hackathons and capacity-building initiatives conducted across Central Europe between 2024 and 2026, a comprehensive set of guidelines for OD and IoT usage in local governance was drafted. These guidelines were further validated and refined through the expertise of the EnCLOD partners.[1]

This policy brief translates those guidelines into evidence-based recommendations designed for local and regional policymakers, technicians, urban planners, and governance experts. Ultimately, the goal of these operational recommendations is to encourage them to benefit from Open Data for local governance, as the effective adoption of Open Data and IoT by local administrations delivers substantial benefits, boosting evidence-based decision-making, enhancing transparency and community engagement, and favouring cross-sector innovation and operational efficiency.

Despite these clear advantages, the use of Open Data in public governance remains limited by several persistent barriers, such as a lack of awareness, technical skill gaps, low cross-agency collaboration, and financial/operational constraints. To overcome these obstacles, this policy brief proposes seven core recommendations for boosting data-driven territorial governance at the local and regional levels:

- Define and plan a dedicated open data strategy;
- Design sensor networks holistically;
- Procure urban data services;
- Ensure data quality, standardisation, and accessibility;
- Enhance the technical expertise of local and regional administrators;
- Boost cross-sector and cross-agency cooperation;
- Raise public awareness and foster stakeholder engagement.

1 The EnCLOD Consortium is composed of: Province of Vicenza; Iuav University of Venice; DKV Debrecen Exclusive Public Transport Company LTD; CITIQ; Palacký University Olomouc (Department of Geoinformatics); CityOne; Urban Municipality of Nova Gorica; University of Ljubljana (Faculty of Architecture); University of Žilina, ALDA+.

Interreg CENTRAL EUROPE

Co-funded by the European Union

EnCLOD

TABLE OF CONTENTS

Glossary

State of the art

Key recommendations for local governance to benefit from Open Data

A. Define and plan a dedicated open data strategy

B. Design sensor networks holistically

C. Procure urban data services

D. Ensure data quality, standardisation, and accessibility

E. Enhance the technical expertise of local and regional administrators

F. Boost cross-sector and cross-agency cooperation

G. Raise awareness and stakeholder engagement

The experience of the EnCLOD project

Conclusions

Resources

Disclaimer

This publication has been developed within the EnCLOD project, supported by the Interreg CENTRAL EUROPE Programme with co-financing from the European Union. Its content is the sole responsibility of the authors and the project partnership and does not necessarily reflect the views or positions of the Interreg CENTRAL EUROPE Programme, its programme bodies or the European Union. Neither the programme authorities nor the European Union can be held responsible for any use that may be made of the information contained herein.

GLOSSARY

Open Data (OD) refers to datasets made freely available to the public without restrictive licenses. It enables transparency, innovation, and collaboration.

Internet of Things (IoT) refers to devices with embedded sensors, processing ability, software and other technologies that allow them to connect and exchange data with other devices and systems over the internet or other communications networks. These devices are also known as “smart”.

City digital twin: a dynamic virtual model of a real urban area that integrates spatial data, real-time data from IoT sensors and advanced simulation, used for infrastructure management, analysis of phenomena and development planning.

Digital urban planning: a set of digital services for urban planning that combines open data, dynamic IoT data, machine learning and artificial intelligence to support green transition investment planning and the assessment of socioeconomic impacts within a functional urban area.

Microzones: virtualised territorial units for independent strategic planning using static and dynamic open data. They are the reference framework against which all datasets are recalculated, compared and, where the data is sensitive, aggregated.

Geofencing: zone-based traffic monitoring achieved by covering the entry and exit points of a microzone, either physically with detectors or by calculation from the adjacent profiles of main roads on the zone boundary, to estimate, e.g. traffic load and parking demand; only aggregated counts are used, with no tracking of individual vehicles.



STATE OF THE ART:

In the digital era, data serves as the foundational raw material for territorial governance, driving both economic growth and public innovation. However, despite the growing availability of technological tools and data sources, public authorities often face a lack of capacities, methodologies, and practical experience needed for their systematic use. Also, they often struggle to leverage data effectively within their governance and decision-making processes. At the same time, there is a significant unexplored potential in involving civil society, academia, and the private sector, which possess valuable expertise and innovative capabilities that can contribute to solving public challenges.
In this context, maximising the potential of innovative concepts like Open Data (OD), the Internet of Things (IoT) sensor networks, micro-zoning, and digital urban planning is crucial. Together, they form a vital asset to sustain multi-level territorial governance, foster civil society involvement, and stimulate public-private collaboration.

At the European Level, the Open Data Directive (Directive (EU) 2019/1024) encourages EU Member States to make as much publicly accessible information as possible available for reuse. In particular, the core principle of the directive is to promote the reuse of information that is already being collected for government purposes, thus generating additional value once it is reused for different purposes. Moreover, the directive establishes minimum standards to harmonise national rules and practices, reduce barriers to reuse and facilitate innovation through public sector data reuse.

Despite this framework, public authorities frequently fail to fully exploit these resources. A widespread lack of structured data collection, systematisation, and processing often leads to policy inefficiencies, ultimately hindering the achievement of critical environmental, societal, and mobility goals.

To ensure effective open data publication and reuse, governance must be established at both national and subnational levels. Consequently, the adoption of tailored open data measures at the local and regional level is essential. National governments should support this process by creating an enabling environment for subnational entities and providing the necessary technical, financial, and advisory support to local and regional administrations.

Against this background, it emerged that local and regional administrators – especially policymakers, technicians, urban planners, and governance experts - should understand several crucial aspects of using open data to improve urban governance, enhance planning, and engage the public effectively. The following paragraph provides an overview of the key benefits for local and regional authorities in using Open Data.[2]

[2] Additional information is available on the EnCLOD Deliverable "D3.3.1: EnCLOD guidelines on effective Open Data usage for territorial governance"

Benefits of using Open Data in local and regional governance:

- **Evidence-Based Territorial Governance:** Open Data strengthens data-driven decision-making by informing policies in key areas such as traffic management, environmental monitoring, and urban planning. By providing insights into both real-time and historical patterns, it optimises mobility, infrastructure, public services, zoning, and climate change adaptation strategies. Furthermore, Digital Urban Planning - supported by open static and dynamic IoT sensor data - offers a pathway to evidence-based, cross-sectoral decision-making and to the creation of a digital twin of the territory.
- **Transparency & Community Engagement:** Open Data ensures that public datasets are accessible, allowing citizens to monitor government projects and decision-making. By leveraging participatory digital tools, administrations can boost civic engagement, ultimately fostering greater trust between citizens and local authorities. Furthermore, it enables crowdsourcing mechanisms to tackle complex urban challenges.
- **Collaboration & Innovation:** The availability of high-quality, interoperable datasets boosts innovation across both the public and private sectors. Access to OD supports startups and businesses in developing innovative services (e.g., mobility apps).
- **Economic Development, Efficiency & Cost Savings:** Open Data creates greater efficiency in processes and delivery of public services and can contribute to the development of innovative services and the creation of new business models. Moreover, it can help organisations make more informed decisions and better use existing resources.

Key applications of Open Data in urban planning



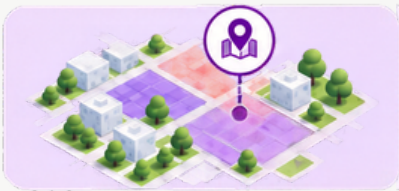
Traffic management and safety

Track congestion, optimise road networks, manage parking policies, and improve pedestrian safety at crosswalks.



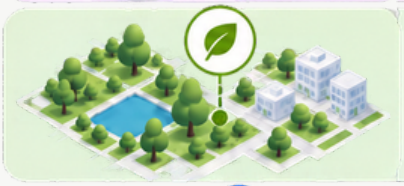
Public transportation and sustainable mobility

Use real-time traffic, public transport schedules, and infrastructure data to improve efficiency, sustainability, accessibility, and predictive apps.



Land use and zoning

Analyse spatial and demographic data to design smarter, evidence-based zoning rules that reflect city growth and community needs.



Environmental monitoring and climate resilience

Use air quality, noise, green spaces, and climate data to build resilient cities, reduce heat islands, and guide ecological investment.



Governance and operational efficiency

Combine IoT data and open platforms to monitor infrastructure, optimise resources, reduce costs, and support targeted decisions.

Key recommendations for local governance to benefit from Open Data

A. Define and plan a dedicated open data strategy

The effective design and implementation of an Open Data strategy often face critical obstacles, particularly regarding institutional barriers, shifting political priorities, and resource constraints. Furthermore, integrating new IoT systems with existing urban infrastructure can be technically complex and costly, requiring careful planning and seamless coordination among different stakeholders.

To overcome these challenges, local and regional authorities should adopt the following strategic actions:

- **Establish Clear Data Governance:** Adopt a formal governance framework that treats IoT sensor outputs as a public good and defines clear responsibilities for data ownership, operation, quality assurance, and publication. Also, assigning clear institutional leadership by designating an "institutional champion"—such as a specific department or chief data officer—is essential to coordinate across municipal agendas, maintain political visibility, and ensure long-term continuity.
- **Develop a Strategic Orientation**. Anchor the Open Data initiative within existing policy processes and align it with regional and national digital strategies (such as digital twin programs, national Open Data portals, or Green Deal investment frameworks). Aligning applications with local priorities secures political leverage, opens co-funding opportunities, and builds a robust framework for sustainable urban governance.
- **Leverage Green Transition Investments**: Connect sensor deployment directly to green transition funding. Because sustainability projects inherently require data, deploying holistic sensor networks within these larger frameworks allows municipalities to accelerate smart-city investments while delivering new digital tools at a lower cost.
- **Conduct an Infrastructure Gap Analysis**: Perform a comprehensive match-mapping of existing data sources, technologies, and infrastructure. This identifies which datasets can be opened immediately using current assets and defines precisely where new hardware deployment is required. Also define data storage and technical/software requirements for publishing the Open Data.
- **Strengthen Data Interoperability**: Develop frameworks and adopt open standards to ensure the seamless integration and sharing of datasets across municipal departments and external stakeholders, overcoming administrative silos.

Roadmap for Implementing Open Data and IoT in Territorial Governance

1 Identify a policy entry point

Start with a strong local need, such as traffic or climate data.



2 Map data and gaps

Review existing datasets, systems, and missing infrastructure.



3 Map the territory

Use microzoning to build a spatial reference model.



4 Define data governance

Clarify ownership, roles, licences, and sustainability.



5 Procure smartly

Bundle hardware with data services and open standards.



6 Publish promptly

Release early data through portals and dashboards.



7 Engage stakeholders

Involve citizens and local actors through real use cases.



8 Measure and iterate

Track KPIs and refine the strategy over time.



B. Design sensor networks holistically

Before deploying any hardware, it is crucial to design sensor networks holistically. The following are the key recommendations to implement this holistic approach:

- **Divide the territory into microzones** aligned with existing statistical or census units to create a logical reference model for the entire city[3], then prioritise deployment by policy relevance and available budget.
- **Combine traffic and environmental monitoring** within the same spatial framework to maximise cross-sectoral value from a single infrastructure investment.
- **Use simple, documented placement principles for traffic sensing:** use geofencing to cover all the microzones; for climate sensing, use appropriate height and pick the place with minimal obstructions - and publish all sensor locations transparently via a public map to support replication.
- **Plan for the full sensor lifecycle:** include contingency locations, maintenance budgets, provisions for relocation when roads are reconstructed, and protection of hardware during winter maintenance operations.
- **Complement the sensor network with structured manual surveys:** when needed, collect relevant evidence manually.

C. Procure urban data services

Effective procurement is a crucial phase for implementing Open Data territorial governance. The following are the key procurement recommendations for urban data services:

- **Use procurement as a data governance instrument**: Include binding Open Data requirements in procurement specifications and contracts. Requirements should cover, at minimum, open formats, API access, metadata, open licences, and data quality monitoring. Where possible, promote collaboration in hackathons and for community engagement.
- **Procure a data service alongside hardware**: The Data-as-a-Service model shifts the focus from ownership of equipment to the continuity and quality of data services, reducing the technical burden on municipalities. The contract should clearly define the supplier's responsibilities, including: deployment and operation of IoT sensors; publication of data on the municipal open data portal and the national catalogue; provision of data through publicly accessible dashboards; access to live sensor data for third parties throughout the service period; active participation in city hackathons, including data support and mentoring.
- **Define specific and verifiable technical requirements**: Require a central database with documented REST APIs following a recognised specification such as OpenAPI; tools for temporal and spatial aggregation; export to common geospatial formats; a device registry compatible with the regional digital technical map a device registry compatible with the regional digital technical map (in Czechia, the DTM, a region-level digital register of technical infrastructure) or an equivalent national infrastructure register; tracking of replacements, repairs and maintenance; device-status monitoring and notifications in case of failures; a help desk for data users; a short annual report on the quantitative and qualitative performance of the system.

[3] NB: Microzones are not always the same as statistical or census units, but can be upgraded based on many local factors.

- **Link time series to logical data elements:** This is essential for ensuring continuity of long-term monitoring. A traffic profile or climate monitoring point should be defined as a logical set of sensors, so that the failure or replacement of an individual device does not interrupt the time series. Otherwise, long-term datasets can easily become fragmented and unusable.
- **Specify dashboard and acceptance requirements in the contract:** The procurement specification should define general requirements for the presentation, accessibility, interoperability and usability of the platform.
- **Separate handover from verification:** Set two contractual dates: I) the date for handover and activation of the complete network and its dashboards; and II) a verification period (e.g., of 14 calendar days) during which the municipality checks compliance with the specification and the supplier is contractually required to cooperate with the verification process and address any identified non-conformities.



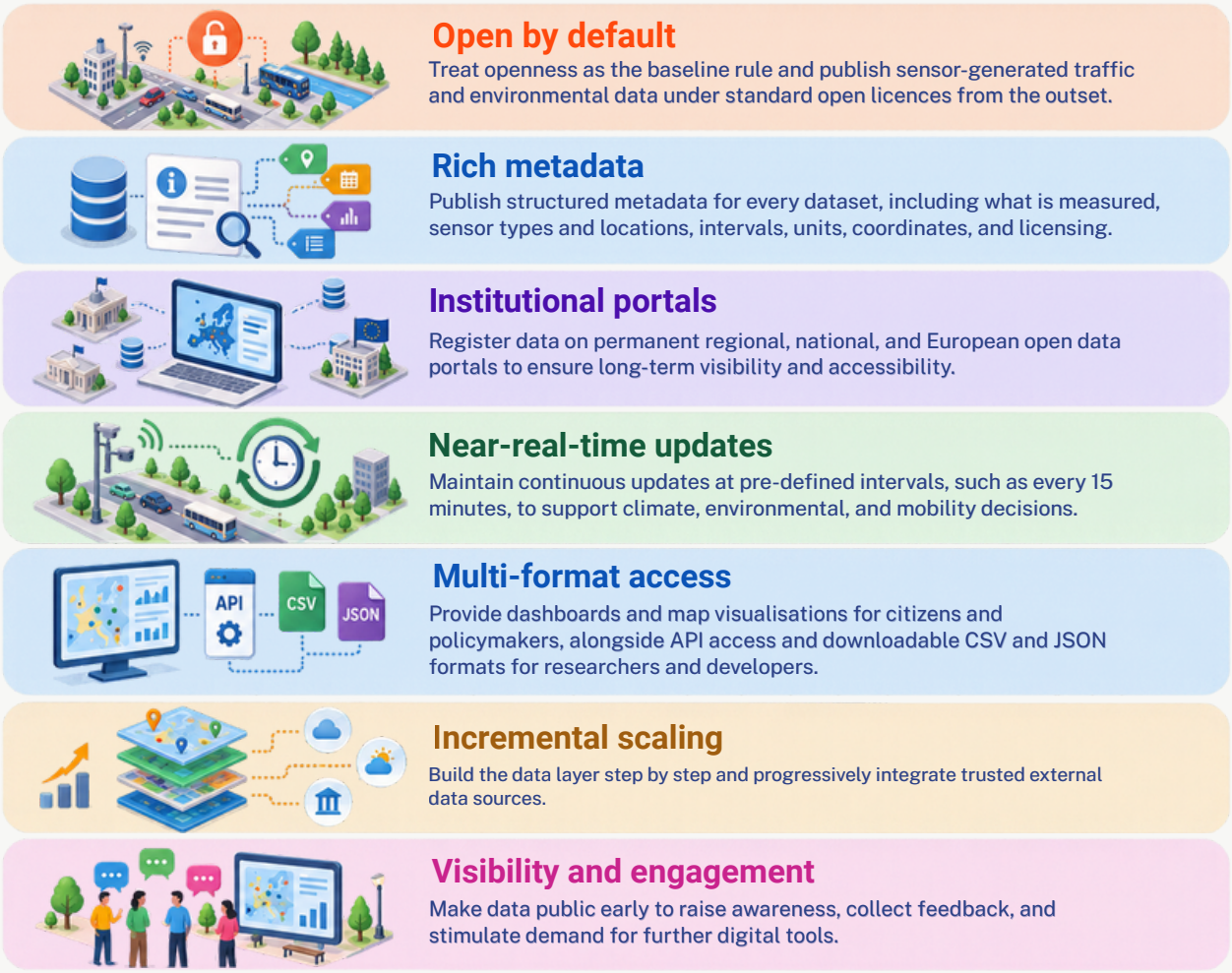
D. Ensure data quality, standardisation, and accessibility

Ensuring the quality and accessibility of open IoT data remains a significant hurdle. Poor data quality can lead to ineffective decision-making and undermine public trust in digital infrastructure. Similarly, inconsistent formats and incomplete datasets jeopardise the adoption of data-driven governance. To unlock this potential, public authorities should focus on the following key actions:

- **Enforce Rigorous Collection and Processing Standards:** Establish high technical standards for data collection and processing, while defining clear legal and technical terms for third-party access.
- **Protect Privacy by Design**: Where sensors may capture personal data (e.g., camera-based traffic counters), process data on the device where possible, publish only aggregated and anonymised counts, and document GDPR compliance, including a data protection impact assessment where required.
- **Deploy a Quality Monitoring System:** Set up an automated system to validate and improve data quality, ensuring accuracy, consistency, and reliability. Consider the system's requirements and costs.
- **Design a Sustainable Publication Model:** Plan the data-sharing infrastructure from the very beginning. Launch a user-friendly Open Data Platform equipped with robust APIs and standard formats for ensuring accessibility.
- **Develop Interactive Dashboards:** Create interactive dashboards for real-time data visualisation. Prioritise high-impact public areas such as traffic flow, air quality, environmental metrics, and aggregated water and energy consumption.

Guidelines for Open Data publication

To maximise the impact of data deployment, regions and municipalities should consider the following key guidelines on Open Data publication:



E. Enhance the technical expertise of local and regional administrators

Investing in municipal staff capacity is a fundamental prerequisite for sustainable open data governance. Currently, a widespread gap in technical expertise among local and regional administrators acts as a major barrier to upscaling data-driven decision-making and executing long-term Open Data strategies. Therefore, the following are the key recommendations for enhancing the technical expertise of local and regional administrators:

- **Implement Structured Capacity Building:** Organise targeted training programs for public representatives. These should cover the fundamentals of Open Data management, IoT integration, and evidence-based decision-making, alongside hands-on technical training with modern data analysis and visualisation tools.
- **Facilitate Cross-Border Peer Exchange:** Complement formal staff training with cross-national knowledge exchanges. Support the exchange with other stakeholders to discuss approaches, methodologies, and solutions tested in other European cities.
- **Forge Strategic Academic Partnerships:** Actively involve local university faculties as long-term training partners. Leveraging their technical expertise ensures that public administrations stay aligned with the latest technological and analytical advancements.

F. Boost cross-sector and cross-agency cooperation

European civil society and the private sector are digitising far more rapidly than the public sector. Businesses and civic organisations have embraced Open Data, the Internet of Things, and Digital Twins as indispensable tools for growth. However, because these stakeholders are rarely integrated into municipal problem-solving frameworks, their collective expertise remains an underutilised asset for the community.

To bridge this gap and harness this potential, public authorities should:

- **Cultivate Multi-Stakeholder Ecosystems:** Facilitate structured collaborations among local governments, tech companies, academia, and NGOs to drive innovation and support OD strategy implementation (e.g., through strategic partnerships).
- **Expand Partnership:** Partner with neighbouring cities and wider metropolitan areas to exchange practical knowledge and co-develop transferable digital solutions. Aligning the open data agenda on a regional scale ensures greater data consistency and maximises territorial impact.



G. Raise awareness and stakeholder engagement

A widespread lack of awareness regarding the relevance of Open Data among citizens represents a significant barrier. While engaging the community and local stakeholders in the planning and implementation of IoT projects is crucial, it remains difficult if the tangible benefits of these technologies are not clearly understood.

To bridge this gap and foster civic participation, local authorities should:

- **Involve Civil Society Directly:** Actively engage the community in data initiatives to raise awareness and rebuild trust in public administration. This can be achieved by organising public outreach events and collaborative initiatives—such as hackathons and innovation challenges—focused on the utilisation of Open Data at the city level (e.g., on concrete themes like smart mobility, climate resilience, and digital urban planning).
- **Deploy Interactive Civic Tools:** Develop user-friendly tools for citizen consultation and interaction. Providing public dashboards that display localised, real-time open IoT data allows citizens to visually connect data infrastructure with their daily lives.
- **Establish Feedback Mechanisms:** Design structured citizen feedback channels (such as surveys and online participatory platforms) to monitor engagement levels. Wherever feasible, these inputs should be formally incorporated into urban planning and decision-making processes.

The EnCLOD Hackathons as participatory and innovation-driven tools

The EnCLOD project organised **5 hackathons in 5 different countries** as a participatory and innovation-driven tool to enhance public participation in open data and **bridge the gap between data availability and its practical application in public governance.**

The events brought together **representatives of public administration, academia, private companies and civil society** to co-design innovative tools that improve territorial governance using open data datasets, including data from the EnCLOD sensor network.

The hackathons demonstrated **an impact in fostering innovation, promoting the use of open data and strengthening cross-sector collaboration**, showing how these initiatives can transform available datasets into practical, innovative and actionable solutions for urban governance, sustainability and digital transformation.

5
Hackathons

5
Countries

Public administration, academia, private sector and civil society

Examples of winning solutions

Smarter mobility
A real-time dashboard to optimise traffic flows and reduce congestion.

Cleaner and greener cities
A tool combining air quality data and green infrastructure to support healthier urban planning.

More inclusive governance
A citizen-facing platform to visualise local data and support community decision-making.

THE EXPERIENCE OF THE ENCLOD PROJECT IN PROMOTING THE USE OF OD AND IOT TO IMPROVE TERRITORIAL GOVERNANCE

The EnCLOD project (Interreg-funded project) aims at strengthening the governance capacity of 5 local public authorities in Central Europe by promoting the use of Open Data and the Internet of Things sensor networks. In the context of this project, five pilot areas addressed a specific challenge related to mobility/transport, environment, or climate change policy area through the development of 5 local Action Plans for the effective usage of Open Data and IoT opportunities for territorial governance and city-region planning. The following case study box provides an overview of the five EnCLOD Pilot Actions and the solution/tool that was successfully developed for improving territorial governance.

VICENZA (IT)

Using Open Data to optimise winter road salting

The Province of Vicenza lacked a comprehensive system to monitor road and weather conditions. Four weather stations were installed to collect continuous data on temperature, humidity, rain and snowfall, helping road managers to plan salt-spreading operations more efficiently, reduce costs and mantain road safety.



Open Data dataset
Open data map – Provincia di Vicenza

Read more
Pilot Action Vicenza

NOVA GORICA (SI)

Leveraging Open Data to improve traffic management and air quality

The municipality lacked an integrated tool linking traffic patterns with urban air quality. A network of 24 traffic sensors and 7 air-quality sensors, complemented by a reference station, generates continuous open datasets to support evidence-based policies on mobility and air-quality protection.



Open Data datasets
Xirix (air quality) | Telraam (traffic)

Telraam traffic dataset article

Telraam traffic open dataset

Read more
Pilot Action Nova Gorica

ŽILINA (SK)

Using Open Data to improve road safety policies

The city lacked a reliable, data-driven approach to traffic safety decision-making. An Urban Living Lab with over 100 sensors provides near-real-time insights to identify high-risk locations and support evidence-based safety interventions for vulnerable road users.



Open Data datasets
Traffic safety index | Crosswalks registry | Microzones Zilina

Crosswalk Inspector

RIZICON

Read more
Pilot Action Žilina

OLOMOUC (CZ)

Open Data for climate change adaptation measures against heat islands

The city lacked reliable local data to link parking regulation, traffic flows and climate adaptation. An integrated sensor network monitors traffic intensity, parking occupancy, air and surface temperature. The data are processed into dashboards and open data outputs, and support a pathway towards a city-wide digital twin for climate-sensitive governance.



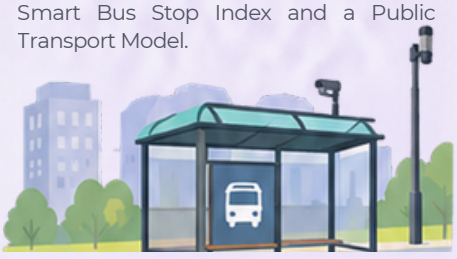
Open Data datasets
Heat islands tool | Other dashboards

Read more
Pilot Action Olomouc

DEBRECEN (HU)

Sustainable mobility for a fast-developing city

The pilot combined real-time IoT monitoring, open data governance and cross-sector collaboration to support smarter and more sustainable public transport and city traffic management. A network of 42 traffic sensors generates near real-time data used in Mobility Decision Support Platform, including a Smart Bus Stop Index and a Public Transport Model.



Open Data datasets
Microzoning dashboard | Other datasets

Read more
Pilot Action Debrecen

CONCLUSIONS

In conclusion, Open Data is an increasingly diffused but largely untapped digital tool which enables more informed decision-making in many governance sectors, brings economic benefits, drives innovation and enhances citizens' empowerment and participation.

This policy brief aims to collect a set of evidence-based and operational recommendations for boosting the use of data-driven territorial governance at the local and regional level. The key recommendations include the definition and planning of a dedicated open data strategy; designing sensor networks holistically; procuring urban data services; ensuring data quality, standardisation, and accessibility; enhancing the technical expertise of local and regional administrators; boosting cross-sector and cross-agency cooperation; raising public awareness and fostering stakeholder engagement.
Adopting a data-driven approach at the local and regional governance level recognises the transformative potential of Open Data to address complex urban challenges, foster innovation, and enhance citizen engagement.



RESOURCES

- *D3.3.1: EnCLOD guidelines on effective Open Data usage for territorial governance*
- *Open Data Maturity Report 2025*
- *Open Data Directive (Directive (EU) 2019/1024)*
- *Commission Implementing Regulation (EU) 2023/138*
- *The importance of open data in the mobility sector: Enabling smarter and more efficient transport systems*
- *EnCLOD website*
- *D1.4.1 EnCLOD project, 5 Action Plans for Open Data and IoT usage for territorial governance in project Pilot Areas*
- *The benefits and value of open data*

interreg-central.eu/projects/enclod/

@EnCLOD Project

FROM OPEN DATA TO BETTER TERRITORIAL DECISIONS.

EnCLOD strengthens the capacity of public authorities to use Open Data and IoT for smarter, more transparent and collaborative territorial governance.



Interreg CENTRAL EUROPE

Co-funded by the European Union

EnCLOD