UNIVERSITY OF LIVERPOOL | Heseltine Institute for Public Policy, Practice and Place

A Good Practices Reference Guide

Prepared for: **Heseltine Institute for Public Policy, Practice and Place,** the **Geographic Data Science Lab, University of Liverpool** and **Liverpool City Region Combined Authority**

Briefing Notes on the Key Case Studies profiled

Building Data Ecosystems to unlock the value of Urban (Big) Data: A Good Practices Reference Guide

Alanus von Radecki, Nikolay Tcholtchev, Philipp Lämmel, and Gretel Schaj (BABLE UG, Fraunhofer FOKUS, Germany)

BRIEFING NOTES

The purpose of the Good Practices Reference Guide is to profile recently completed and ongoing good practices in the building of Smart Cities and data ecosystems in so-called 'Lighthouse Cities' which might prove instructive for municipal leaders and stakeholders in Liverpool City Region (LCR), as they too work to build the city region's digital and data infrastructures and capabilities. The Guide has been prepared at the behest of the Heseltine Institute for Public Policy, Practice and Place at the University of Liverpool and the Liverpool City Region Combined Authority (LCRCA) by international experts Alanus von Radecki, Nikolay Tcholtchev, Philipp Lämmel, and Gretel Schaj, based at BABLE UG/Fraunhofer FOKUS in Germany.

A wide range of good practices are profiled in the Guide. Given the importance of some particular cities/projects, deep dive briefing notes for key exemplars have been compiled to compliment the Guide. These will be made available on the Heseltine Institute website: **www.liverpool.ac.uk/heseltine-institute/reports/**[1] (BABLE, 2019).

Key Case Studies Profiled in the Guide

Name	Location	Solution
1. Open Source Database	Vienna, Austria	The Use Case provided a technical ICT framework for monitoring the project data, a testbed for wider use in the city of Vienna, and a framework for ICT applications.
2. Big Data Visualisation	Cologne, Germany	The Urban Cockpit Solution provides a fast and easy overview of the current situation in the city concerning traffic, energy and environment. The tool is publicly available online for the citizens.
3. Sharing Cities Urban Sharing Platform	Milan, Italy	The Sharing Cities Urban Sharing Platform (USP) is a logical collection of technical components, capabilities and processes which provides information from a wide variety of devices and sensors to improve use of city resources and inform better choices.
4. Smart City Data Platform	Eindhoven, Netherlands	The living lab in Strijp-S is connected via this platform. The platform is designed to be open and transparent without compromising privacy or security and while respecting data ownership. Integration can occur in matters of minutes and the platform is set up to be limitlessly scalable.
5. Big Data Integration Solution	Barcelona, Spain	This semantic model reflects and connects three domains of interest: mobility, energy, and integrated infrastructures. Users can browse and query the ontology. The goal is to provide a solution that is easier to evolve, maintain, and export to new cities with different data and use patterns.
6. Data-Enabled Innovation Challenges	Manchester, United Kingdom	The innovation challenges run twice a year from 2018-2020. The process will adapt and learn. The first challenge focused upon the exemplar apps and encouraged participants to identify ways to improve these ideas.
7. X-Road Data Exchange Platform	Estonia	X-Road connects all e-governance applications in Estonia. It is a secure internet-based data exchange layer that enables the state's different information systems to communicate and exchange data.
8. Citizen Science & IoT Data Governance	Barcelona, Spain	This uses the DECODE wallet to connect to the SmartCitizen infrastructure and link the sensors with their accounts. Using the wallet, the users can select from a range of data sharing policies from predefined groups that have been previously discussed and agreed within their communities.
9. Dublinked Data Portal	Dublin Region, Ireland	Development and permanent update of an Open Data repository on Greater Dublin's urban provisions and built environment. Dublinked collects, curates, standardises, and shares data with the wider public on local services and provisions such as energy, environment, waste collection, water, traffic, and planning.

1 As part of the BABLE's Use Case database, there is also the opportunity to contact the Use Case's owner, who participated in implementing and managing the project implementation.

CASE STUDY 1

VIENNA (OPEN SOURCE DATABASE)

Location: Vienna, Austria

Scale: City level

Challenge/Goal

Data management is one of the major challenges facing the city. The Use Case provided a technical ICT framework for monitoring the project data, a testbed for wider use in the city of Vienna, and a framework for ICT applications.

Solution

The process included:

1. Intensive international peer-to-peer exchange with other cities in Europe and abroad on possible ICT/database solutions
2. On-site visits abroad
3. Decision making on the usage of FIWARE framework
4. Elaboration of tailored solutions
5. Testing of tailored solutions and feedback from users
6. Communication within the city administration
7. Gamification
8. Rollout.

Citizen Participation

In the context of ICT solutions, the term 'citizens' applies first and foremost to the users of and the staff working with the databases. The database was promoted within an ICT Challenge (with some 6,000 participants), where two groups of amateur ICT specialists developed two apps in a hackathon on the foundations of the database. The general public was invited to attend a thematic district walk where the usage of urban data was showcased. Information on the FIWARE database was included in all general project information and promotion.

Service Provider

MA 01 (Municipal Department), AIT (Austrian Institute of Technology)

End User

AIT (for Smarter Together), MA 01 (for all city uses)

Financial details

Initial Investment:	EUR €50,000–250,000
Type of Investment:	Non-municipal public funding 100%
Funding Details:	EU Horizon 2020
Return on Investment Period:	<5 years
Revenue Streams:	Project monitoring, urban data management, project marketing

Project timeline

Planning Time:	0.5–1 years
Implementation Time:	0.5–1 years

Benefits

- Increased data transparency
- Improved personnel efficiency
- Enhanced data security

Insights gained during the implementation

Supporting Factors

Open source enables the city to consider the usage of this solution within a long-term process open to innovation and new solutions.

Lessons Learned

- Early inclusion of the city administration and staff is essential
- Regular inclusion of the hierarchy is necessary
- Showcase development within the project is key to credibility and to launch a process as well as openness (mindset)
- Gamification is a perfect add-on, showing the possibilities that offer an open source solution.

Advice for Replication

Involvement of employees is highly advantageous.

Results

Impact

- Enabled project data monitoring
- Innovation drive for additional projects.

Next Steps

The relevant municipal departments are included and researching possibilities of a step-by-step roll-out.

CASE STUDY 2

COLOGNE (BIG DATA VISUALISATION)

Location: Cologne, Germany

Scale: City level

Challenge/Goal

Owing to the huge amount of data generated in the city, there is a great scope to process and analyse this information. Analysing the current data and predicting future trends could help in well-informed decision making on several different levels. A user-friendly way of visualising the open data is also needed to promote extensive use of data.

Solution

The Urban Cockpit Solution was chosen from the Urban Institute to manage big data from the city of Cologne. The tool provides a fast and easy overview of the current situation in the city concerning traffic, energy and environment. The tool is publicly available online for the citizens to see and use.
On the left side, the 'pulse' of the city can be seen. This is a grouping of many indicators and is updated every few seconds. What the indictors show can be adapted for every city and for every user group, such as citizens or control centre staff. The indicators are adjusted during the project according to data availability. The better the values or KPIs of the cities, the better the indicators are (as shown by how green the values are). Worsening values will turn yellow or red, and the pulse will rise to indicate that the city is in a stressed state. This can happen for example when the environmental data is very bad, when there are too many traffic jams in the city, or when the percentage of renewable energy production is too low. On the right side of the Cockpit, there is more detailed information about various different aspects of the city's current condition. This may include the number of free parking spaces, number of cars shared, current use of public transport, and so on. All data from the platform is processed in real-time to generate value added data. The data is stored to provide data analytics. KPIs are used to visually indicate the current condition of the city (e.g. very high pollution, very low renewable share, shown as Red Alerts). The Urban Traffic and Urban Environment feed into the Urban Cockpit.

Citizen Participation

Public meetings with tenants were held to inform people. The Urban Institute showed the dashboards and asked for feedback.

Service Providers

Cambio Cologne, KVB

End User

Commuters and residents in Mülheim (Cologne's neighbourhood)

Financial details

Type of investment: Non-municipal public funding and municipal funds

Project timeline

Planning Time:	0.5–1 years
Implementation Time:	<0.5 years

Benefits

Main benefits

- Improved data accessibility
- Increased data transparency
- Encouraging digital entrepreneurship

Additional Benefits

- Enabling new business opportunities
- Promoting sustainable behaviour
- Facilitating citizen engagement
- Creating new jobs.

Insights gained during the implementation

Supporting Factors

1. Cologne has an open data platform which collects data from various sources and feeds the data into the Urban Cockpit
2. Funding from the EU Horizon 2020 project.

Lessons Learned

- Collection and integration of data from different sources was quite a challenge. A special interface was created to enable this integration
- The validity of data being added to the platform needs to be checked to safeguard the quality of the platform. Authenticating the collected data is very challenging and verification takes time
- It is also important to decide what data is needed for display on the Cockpit, as different stakeholders would wish to prioritise different datasets
- Collecting data for free is challenging, as companies can now sell the information instead of providing it for free. There is not enough incentive for them to provide data to the platform.

Advice for Replication

It would be advisable to inform companies in advance about the Urban Cockpit Solution to convince them to obtain and provide the data, so the city knows how much data they would be able to showcase on the platform.

Results

Impact

The Urban Cockpit works well in combination with the other smart solutions. One example is the smart solution 'mobility hub', where many different means of transport are accessible from one spot. At a mobility hub the user can choose between bikes/e-bikes, shared cars/e-cars, and buses. They can also park their car and use the charging stations for loading their e-cars/e-bikes. All the relevant data for a mobility hub can be represented in the Urban Cockpit, to gain a quick and easy overview of the current or historical usage of the mobility hubs.

Next Steps

The solution can be easily replicated in other European cities, as it is independent of implemented measures and their domains.

CASE STUDY 3

MILAN (SHARING CITIES URBAN SHARING PLATFORM)

Location: Milan, Italy

Scale: District level

Challenge/Goal

Smart Cities need to collate information from a wide variety of devices and sensors in order to be able to store and process the data and present information to the city managers, suppliers and citizens (residents, businesses and visitors) to support better use of city resources and inform better choices. The Sharing Cities Urban Sharing Platform is a logical collection of technical components, capabilities and processes which provide this information. In particular, the Milan USP aims to give value to local existing infrastructures and investments planned in the short, medium and long term, and to enable their evolution and enhancement so that improvements can be continuous and sustainable over time.

Solution

The Urban Sharing Platform fosters integrated sharing of Smart City information, thus enabling digital interoperability between different stakeholders. In particular, the Urban Sharing Platform supports the collection, elaboration and analysis of data provided by various sensors, to benefit city managers and citizens.

The Milan USP is based on the following solutions and principles:

- The Monet EMS solution, by Siemens IT
- The Interoperability Platform of the Municipality of Milan.

The USP can provide the following key functions:

- Support real-time data collection from different sources, e.g. sensors and devices such as electric vehicles and bikes, smart lamp-posts, and energy efficient buildings
- Provide guidelines and tools for interoperability both at technical and process level
- Provide IT components for data storage and business intelligence
- Support seamless integration of third-party open data and APIs
- Support engagement by enabling the development of dashboards and applications for end-users (e.g. citizens and city managers) to exploit data collected through the USP
- Support proper governance processes.

Citizen Participation

Hosting engagement activities at various times of day was key. Beyond that, partners were encouraged to adhere to specific demographic profiling. The locations were easily approachable and remote engagement tools supported further participation.

Service Provider

Cefriel, Comune di Milano, Siemens

End User

Citizens, city managers

Financial details

Type of Investment: Non-municipal public funding 70%; private sector investment 30%

Project timeline

Planning Time:	0.5–1 years
Implementation Time:	2–5 years

Benefits

Main benefits

- Enhanced data collection
- Improved data accessibility.

Insights gained during the implementation

Supporting Factors

- Each Lighthouse City of Sharing Cities has significant existing capabilities which can inform the design of the USP and provide valuable skills, experience, blueprints and resources, which can then be shared with other cities
- In recent years, Milan's partners have invested in a set of solutions that constitute the foundation of Milan USP supporting urban smart digital interventions, such as the Interoperability Platform of the Municipality of Milan, the E015 Digital Ecosystem, and the Monet SEMS
- The shared reference architecture extends the strengths and capabilities of each of the cities, 'vertically' increasing each city's capability, and being 'horizontally' shared between the cities, followers, and scale-up cities
- Sharing is also enabled by providing an interoperable digital platform based on open standards.
- Utilisation of Enterprise Architecture and API economy best practices helps to align city needs with services and technology
- Provision of a standardised governance structure helps to ensure alignment between the cities.

Lessons Learned

During project implementation the project managers encountered data privacy issues, and have worked on to address the balance between data sharing and personal information protection, in accordance with new GDPR.

Advice for Replication

According to Milan's experience, it is important to have:

- A positive regulatory framework open to innovation
- Local active policies on project's topics
- High quality consortium
- Variety of partners involved (public bodies, NGOs, research and academia, companies, SMEs)
- Contact with cities which have already implemented similar measures, as mentors for sharing procedures
- A cross-department approach to implementation.

Results

Impact

The result is an evolving, integrated, modular, open digital ecosystem, inclusive and shared and already operating to support the implementation of local project interventions. The Milan USP enables interoperability between different entities through common guidelines, technologies, and standards, thus fostering participation of stakeholders from both the private and the public sector. Special focus is placed upon federated governance processes involving particular departments of the city administration, and upon adoption and replication of the proposed model by other cities. The goal is to extend and expand their existing strengths and capabilities over time, and to increase sustainability far beyond the duration of the Sharing Cities project.

Next Steps

The project is still ongoing. One of the project goals is the scale-up and replication in other areas of the city and in other cities.

CASE STUDY 4

EINDHOVEN (SMART CITY DATA PLATFORM IN STRIJP-S)

Location: Eindhoven, Netherlands

Scale: City level

Challenge/Goal

To make the Smart Region of Strijp-S even smarter, this Use Case addresses some of the important questions in Smart City real-time data integration. How can all sensors and actors in the urban environment be connected, when it is still unknown which sensors and actors need to be connected? Can sound and visual information be used to control the street lights? Can connecting sensors increase quality of life, safety and the environment? Can system integration times be reduced? Can open data and open algorithms be provided without concessions to privacy or security?

Solution

The living lab in Strijp-S Eindhoven is connected via this platform. The platform is designed to be open and transparent, without compromising privacy or security and while respecting data ownership. Integration can be done in matters of minutes, and the platform is set up to be limitlessly scalable. Each data, sensor or actor/owner decides on the terms and conditions of data availability. The initial phase was used as proof of concept for system integration, neighbourhood watch, traffic control, smart-parking, and entertainment.The platform is self-supporting and does not require additional infrastructure. The current cloud solution is capable of serving multiple cities. All available real-time data can be shared via the data platform if the data owner decides this is applicable for the data. The level of interest of citizens and sensor suppliers was a positive surprise.

Technical specifications of the system:

- Ready to work with FIWARE
- JSON/REST APIs
- Open source building blocks
- Technical support available within 24 hours
- Uptime is currently 100% and is 99.9% guaranteed.

Service Provider

Omines (for now). An NGO is preferred to maintain the system.

End User

Eindhoven Strijp-S civilians, police, neighbourhood watch, traffic control, event organisers

Financial details

Initial Investment: <50,000
Purpose: The costs were used for platform development.
Type of Investment: Non-municipal public funding 100%
Funding Details: Public/private tender within EU Horizon 2020 project

Return on Investment Period: <5 years
Revenue Streams: Currently everything is free. It is possible for a data-supplier to request payment for the data. The NGO will request a small percentage as commission.

Benefits

Main benefits

- Improved data accessibility
- Facilitating citizen engagement

Supporting Factors

- This data platform ensures full independence from bureaucracy, politics, vendor-locks and financial issues. Data ownership and responsibility remains with the sensor owner.
- Each owner can decide under what terms and conditions the data is made available.

Lessons Learned

A greater scale is required for the project to become useful for more civilians. Other municipalities and governments are invited to contact the project managers to join the enterprise and take it to the next level.

Insights gained during the implementation

Advice for Replication

- Keep it simple
- Do not try to transfer ownership or responsibility if not mandatory
- Respect each parties' interests
- Be independent from government and business
- Be open and transparent without unnecessary complication.

Results

Impact

Splitting the data layer and governance layer has been very useful. Every sensor-supplier involved is sharing his or her data because they can maintain their own terms and conditions on the data.

Next Steps

- A 'proof of concept' is currently running in Eindhoven, and is scaling up in industry zones and other municipalities
- Platform development is already funded. Additional requirements will depend on future Use Cases. The intent is to make the platform free and available for use by all.

CASE STUDY 5

BARCELONA (BIG DATA INTEGRATION SOLUTION)

Location: Barcelona, Spain

Scale: City level

Challenge/Goal

Cities and their citizens are producers of large amounts of diverse data. Diversity of many data sources is in fact one of the biggest issues in big data processing. Semantic data integration offers unique advantages as opposed to more traditional approaches, such as ETL (Extract, Transfer, Load), which create bottlenecks for data access and don't scale as well as technologies which consume data directly without moving it around.Under the GrowSmarter project, Barcelona's big data integration solution aims to develop a semantic model that reflects and connects three domains of interest: mobility, energy, and integrated infrastructures. Users can browse and query the ontology. The goal is to provide a solution that is easier to evolve, maintain, and export to new cities with different data and use patterns.

Solution

This solution consists of three components:

- **City ontology, together with a browse and query tool**: The city ontology reflects the meaning (i.e. semantics) of all the urban concepts (entities and relationships) that describe the domains of interest and the connections between them. The browser and query tool allow keyword-based search of concepts, navigation starting from these anchor concepts, and the construction of queries graphically.
- **Semi-automatic mapping tool**: This tool aligns the semantic model and the specific model of the city data platform, and will be available via the web. Multiple users can participate collaboratively to produce valid alignments.
- **Semantic access layer (SAL)**:
  - SAL functions as an access point for applications that pose semantic queries to access the data on the city platform. Applications accessing data from different cities can work without modification if a SAL exists for those cities which maps between the city ontology and the actual city schema. SAL acts on behalf of the applications (with their security and privacy credentials defined by Cellnex) to fetch the required data via a REST API and compute the query results for the most common query operations (such as 'join'). It requires the mapping tool to know which resources in the city platform scheme correspond to the semantic concepts contained in a query.
  - Data integration solutions traditionally imply a data warehouse approach. While this is based on well-established and efficient technology as well as solid formal foundations, several characteristics of data in urban environments are a misfit for this type of data integration. Firstly, data and schemas evolve; secondly, data is incomplete and no assumptions should be made about non-existent data; thirdly, there are an increasing number of data sources of heterogeneous nature and formats that need to be integrated in an efficient and (as much as possible) automated way; fourthly, data is usually available for consulting, but cannot be moved around and stored at the target.
  - These are scenarios where semantic technologies excel. They are a natural fit for the Open World paradigm, but they also evolve gracefully and foster semiautomatic mapping techniques for massive data population and access.
- One advantage is that new data can be integrated faster, new semantic relationships can be inferred, and users can query the data without having to learn a query language or understand the entire data model at any time.

Insights gained during the implementation

Supporting Factors

Without many sources of data and/or applications that will use it, it is difficult to make the case for a semantic technology solution, despite its many great advantages. Success factors include: cooperation of domain specialists (energy, mobility); quantity and quality of integrated data; available data access technology, which affects how quickly and efficiently a query can be run, such as REST API vs. SPARQL.

Lessons Learned

API changes and unavailability of data have been the challenges. Due to there being less available data than originally envisaged, the approach is harder to test in real scenarios.

Advice for Replication

Other cities can replicate this solution by:

- Adopting this semantic model. The browse-and-query tool is geared toward domain specialists, but does not require one to either learn a query language or to understand the whole model at a time.
- Implementing a semantic access layer that uses this mapping tool to translate from semantic concepts to actual data. This implies the creation of a data schema for the new city (in .owl format) and the implementation of the desired query features in case the city platform does not accept queries via – for instance – an SQL access point. A domain specialist should be available to validate the correct mapping recommendations on behalf of applications.
- One potential problem is that new applications may require answering queries over entities that were not modelled or involve relationships that were not contemplated by the current measures. This requires that a domain specialist and a semantic technology specialist work together to extend the ontology with the missing concepts. The advantage is that the model is flexible and naturally extensible.
- A more complex is that some new types of applications are radically different from the ones that guided the ontology design (although within the same domain of discourse), in which case it may be more efficient to redesign the ontology. The browse-and-query tool, as well as the mapping tool, can remain largely unchanged.

Results

Impact

- Environmental benefits: Integration of data from different domains via a model that explicitly formalises the relationships between concepts enables global and comprehensive analysis. This makes it possible to account for long-range effects between aspects that may otherwise

seem unrelated, making for better planning, optimisation, and decision making in all respects related to the urban environment

- Socio-economic benefits:
  - Application writers can develop services using a large range of already unified data
- The service using semantic rather than direct data access could work as-is for every city that adopts the semantic city model and develops a semantic access layer to city data

o Such a framework could result in economic benefits to service developers (and providers), make data access more egalitarian, and create jobs. From a social standpoint, the approach could be extended to integrate data extracted from semi-structured or unstructured data, such as text posted by citizens and concerning citizens' needs

- The urban semantic model is a transversal solution that can affect all the other measures proposed in GrowSmarter, and has both economic and social (indirect) impact by enabling the query and analysis of integrated city data (as explained in 'Benefits')
- This use case is focusing on Barcelona data, and there is possible deployment of at least one of these measures in Cologne. The idea is that follower cities could leverage Barcelona data integration, access, and query tools to access their city data, if this is recorded in digital form and available on a city platform

Next steps

The long-term impact is that application developers who want to build services in these cities can do so with little initial effort and no redesign, as long as the city platform API doesn't change and they use query functionality that is implemented as part of SAL. This solution promotes equal access to non-private data, and therefore fosters sustainable and equitable economic development.

CASE STUDY 6

GREATER MANCHESTER (DATA-ENABLED INNOVATION CHALLENGES

Location: Manchester, United Kingdom

Scale: City level

Challenge/Goal

The data-enabled innovation challenges are about getting a wider group to engage with the data curation service and data visualisation platform, and encouraging this group to make use of these tools and data. The goal is to encourage data-enabled solutions, i.e. solutions which make use of the data available by organising events such as hackathons. The best solutions proposed during the hackathon will receive €5,000 funding.

Solution

A grassroots approach was adopted to identify citizen challenges, giving participants a guideline on which challenges they could possibly solve using the data. To demonstrate the sort of innovation of interest, three exemplar apps were created. These were simple concepts that used data, systems and ideas from the Triangulum Project and aligned with the themes of mobility and energy. The innovation challenges will run twice per year from 2018-2020. The process will adapt and learn. The first challenge will focus upon the exemplar apps and encourage participants to identify ways to improve these ideas.

Citizen Participation

Active participation: press releases, social media, hackathons, grassroots approach to identify challenges.

Implementers

Clicks & Links, University of Manchester (UoM), Manchester Metropolitan University (MMU), Siemens

Service Provider

Clicks & Links, University of Manchester (UoM), Manchester Metropolitan University (MMU), Siemens, Manchester City Council (MCC)

End User

Municipality (the hackathon is aimed at improving liveability using open data), participants

Financial details

Initial Investment: £50,000–250,000
Purpose: prize money, equipment (including VR studio).
Type of Investment: Non-municipal public funding 100%
Revenue Streams: improving life quality of citizens, added value by enhancing data.

Project timeline

Planning Time:	0.5–1 years
Implementation Time:	<0.5 years

Benefits

Main benefits

- Encouraging digital entrepreneurship
- Facilitating citizen engagement

Additional Benefits

- Creating new jobs
- Enabling new business opportunities.

Insights gained during the implementation

Supporting Factors

- Supporting infrastructure: Data curation service, data visualisation platform
- Social: Number of established technical groups, e.g. Manchester Digital, which facilitate communication with possible participants.

Lessons Learned

- The main challenge is public procurement challenges (it is going through the municipality), and IP-related challenges
- Hackathons are too often focused on technology, people, and data, and forget about citizen issues. It is important to identify the right challenges to work on
- Participants should be guided by defining challenges and providing examples
- Advertise to the right audience to target the right participants.

Advice for Replication

- Necessary projects: data curation service and data visualisation platform
- Possible customers: anyone with data and challenges
- Possible financing options: any partner that may get (financial) benefits out of the results.

CASE STUDY 7

ESTONIA (X-ROAD, DATA EXCHANGE PLATFORM OF ESTONIA)

Location: Estonia

Scale: National

Solution

X-Road is a data exchange platform that connects all e-governance applications. Moreover, X-Road is a secure internet-based data exchange layer that enables counties' different information systems to communicate and exchange data with each other.
X-Road serves as platform for application development by which any institution can relatively easily extend their physical services into an electronic environment. For example, if an institution or even a private company wishes to develop an online application, it can apply to join the X-Road and thereby automatically gain access to any of the following services: client authentication (either by ID card, mobile ID, or the internet banks' authentication systems), authorisation, registry services, query design services to various state-managed data depositories and registries, data entry, secure data exchange, logging, query tracking, visualisation environment, and central and local monitoring (Vassil, 2016). Another important feature of X-Road is its decentralised nature. X-Road is a platform and environment for efficient data exchange, but it has no monopoly over individual data repositories belonging to institutions that join the X-Road. Moreover, by its very design, X-Road requires every joining institution to share their data with others if required and necessary.
Because the data sharing enables development of more convenient services than those institutions would be able to generate single-handedly, this system implicitly incentivises the reuse of the data.

Service Provider

Cybernetica maintains the software, and also provides technical implementation services and e-government interoperability implementation consulting .

End User

Citizens, civil servants, private sector

Financial details

Revenue Streams: Assuming that a query conducted between individuals (e.g. citizens and public officials) saved 15 minutes of the citizen's time (very conservative measure), in 2014 a total of 2.8 million hours or 3,225 years of time were saved – human-to-human queries were approximately 113 million that year.

Project timeline

Planning Time:	0.5–1 year
Implementation Time:	Ongoing

Insights gained during the implementation

Supporting Factors

Naturally, this open design is accompanied by rigid security measures, including authentication, multilevel authorisation, high-level log processing and monitoring, and encrypted and time-stamped data traffic – the basic functionalities that are covered within the very structure of X-Road.
Use of open sources enabled co-development with the private sector, putting in place a common architecture based on open standards and truly open source IT projects, such as actual e-services and information systems.

Results

Impact

- The total number of services[1] grew from around 40 in 2003 to more than 1,600 in 2015. On average, uptake grew by around 121 services per year
- Only around 10 institutions offered their services to X-Road in 2003; however, the number grew quickly to almost 900 by 2014. The number of institutions includes both public institutions at the central and local government level, and private companies. The share of public institutions was about 71% in 2014
- In 2003, only 18 databases were connected to the X-Road. In 2014, this number rose to 213 data repositories connected to X-Road
- The number of end users grew from around 30,000 in 2003 to just over 2 million in 2014.

1 Services include both the actual end-products that citizens can use and also those services that, for example, public servants use in their day-to-day work.

CASE STUDY 8

BARCELONA (CITIZEN SCIENCE AND IOT DATA GOVERNANCE PILOT)

Location: Barcelona

Scale: City level

Challenge/Goal

To test the concept of granular data sharing permissions – data entitlements – at different levels (individual, community and public) with privacy-enhancing technologies (PETs) and IoT devices. The aim is to crowdsource data, and to that end, awareness must be raised among interested communities in order to work with them to define policies for the use of crowdsourced aggregated data. The secondary objective of the pilot is to test privacy-enhancing technology (PET) with low-risk personal data in order to consider its later expansion to more sensitive domains, such as healthcare and others. The Citizen Science and IoT Data Governance pilot is carried out in collaboration with the SmartCitizen IoT platform and Ideas For Change, which were the main promoters of the CAPS project Making Sense EU.

They have two main motivations to participate in the project:

- The first is concern about the **privacy risk** expressed by user communities when publicly sharing data from IoT devices streaming from within their private homes. The users would like to experiment with advanced forms of data sharing beyond an 'all or nothing' publishing scheme
- Secondly, these groups of users would like to use devices **to gather even riskier personal data sources** such as health data, for which they need a platform flexible enough to allow for sharing usable data while allowing users to keep control. The IT lead at SmartCitizen will be in charge of adopting the DECODE connector and technology built by the consortium. Users from the existing community from the previous EU project will participate in the workshops to define and provide feedback about the UX as well as the pilot itself.

Solution

The DECODE wallet will be used to connect to the SmartCitizen infrastructure and link the sensors provided by SmartCitizen to their users with their DECODE accounts. The wallet provides access to encryption schemes facilitated by the custom DECODE-developed, easy to use, cryptographic virtual machine and scripting language Zenroom. Using the wallet, users will be able to select from a range of appropriate and diverse data-sharing policies from predefined groups which have been previously discussed and agreed with their communities Once the users have decided which of the policies they wish to apply to the stream of data coming from the device or devices within their homes, they will be able to create an encrypted stream of data from the device which only the designated recipient will be able to decrypt The users will then be able to use their DECODE wallet in order to prove their memberships of their chosen groups, and so obtain access to the personalised views of the different datasets generated and shared according to different rules in the BCNNow tool.

Citizen Participation

The Citizen Science Data Governance pilot will join existing communities who have been involved in previous initiatives, such as Making Sense EU (an H2020 project) and TRIEM. The connection of these communities is an opportunity to merge a group of citizens previously involved with IoT devices and decided-upon data control and governance.

The activities planned include:

- Introductory workshops and awareness activities
- Debates and co-creation activities around personal data, data sharing and privacy
- Technology onboarding activities
- Data gathering campaigns, awareness raising and action planning

Implementers

SmartCitizen IoT platform, Ideas For Change, BCCNow platform, Municipality of Barcelona

End User

Communities who have been involved in previous initiatives, such as Making Sense EU (an H2020 project) and TRIEM.

CASE STUDY 9

(DUBLINKED DATA PORTAL)

Location: Dublin Region

Scale: Regional level

Challenge / Goal

In recent years, many cities have been launching open data initiatives – online platforms where urban data is made available and can be freely accessed by everybody. A key challenge here is to turn raw data (such as planning application data, transport movements, water flows) into useful applications that improve efficiency, quality and transparency of urban services. In the past, city governments were not very good at this; data management and innovation are not their core business. So why not engage with citizens, universities and companies that are? With this in mind, the city of Dublin set up Dublinked. Through the Dublinked initiative, the city opens up data about public provisions, promoting data-driven innovation and encouraging new collaborations between city departments, IT companies, and research institutes. The aim is to design better services, solve a variety of urban challenges, and – importantly – create new businesses along the way.

Solution

Dublinked was launched in 2011 with the ambition to nurture a full-fledged 'IT-digital innovation ecosystem' in the city, drawing on the presence of many global companies and entrepreneurs. At the core of Dublinked is the development and permanent update of an open data repository on Greater Dublin's urban provisions and built environment. Dublinked collects, curates, standardises and shares data with the wider public on local services and provisions such as energy, environment, waste collection, water, traffic, and planning, among others. This data is then openly released through an internet-accessible platform. Dublinked has two key additional ambitions. Firstly, it established a so-called 'research zone': a specific area in the platform with licensed and more technically complex datasets (e.g. real-time streams of traffic, energy or water flows). The data provided in this area offers more scope for innovation and commercial opportunities, but requires additional curation and calibration. Secondly, Dublinked is not only about the technical platform (software) and the data. Dublinked's proponents regularly host diffusion and networking events for potential data users and providers, as an integral part of the strategy. They do so in order to (i) raise awareness, (ii) get feedback from the data-users (e.g. which data they want to see and in which formats), and importantly, (iii) to facilitate the development of new networks of innovators, communities and R&D projects around the data and the city's challenges. Dublinked events and workshops provide good opportunities to informally raise awareness for new relevant urban issues while brokering new partnerships.

Implementers

Local authorities of the Dublin region, National University of Ireland Maynooth (NUIM), IBM

Service Provider

Dublin City Council, NUIM, IBM

End User

General public, researchers, private and public institutions

Financial details

Initial Investment: EUR €50,000–250,000

Benefits

Main benefits

- Encouraging digital entrepreneurship
- Enabling new business opportunities
- Promoting sustainable regeneration in urban areas
- Improved data accessibility
- Increased data transparency.

Insights gained during the implementation

Supporting Factors

- First, the push from IBM and other lead firms interested in open data was important to ignite the initiative, showing the relevance of the data and the opportunity for the city. The requirements of such companies helped to set priorities on the most 'valuable' types of data to collect and release. However, Dublinked's proponents also recognised that too much private involvement could result in rent-seeking and unfair advantages vis-à-vis other (smaller) players. It was therefore decided to make the data available on a neutral platform, thus combining the best of two worlds: private push and equitable access
- Second, the kick-off and early implementation of Dublinked largely benefited from the leadership of the City Manager and his senior staff
- Third, the University (NUIM) played a key role, acting as a neutral independent party between the public and private sector, contributing to solve many of the issues and challenges faced during the start-up process
- Fourth, developing the initiative on the metro level (Dublin region) was a strong plus. The metropolitan scale assisted with data collection at the relevant level for the users, and enabled start-up with a large and more consistent amount of data. Moreover, it facilitated learning from the more advanced open data initiative of Fingal council
- Fifth, the project benefited from the Studio as the anchor unit within DCC, and as the connection with other partners and organisations outside DCC
- Sixth, the launch and early implementation of Dublinked benefited from smart prioritisation. It commenced with the collection and release of less complex datasets with limited privacy issues, almost exclusively from the public sector and technically easy to handle.

Lessons Learned

- In order to support new digital-related businesses and innovation, open data initiatives should move beyond building a datastore and invest resources to involve end users in the processes, namely through multiple events, 'hack-days', and other community building initiatives
- There are advantages to involving private companies in the design and piloting of open data initiatives in cities, as they can bring relevant expertise, resources and signal the most valuable datasets (as illustrated with IBM). However, local authorities should make sure to avoid privilege treatment and ensure that data can be accessed on a neutral and equitable basis, namely in order to reach a broader number of innovators in the city
- Open data is not a quick win which easily leads to digital innovation and new business creation in the city; the

approach may take time to prove its value and permeate mindsets (within and outside city councils), and will require combinations of public and private resources before alternative revenue streams can be harnessed from the services provided
- Releasing city data requires cultural change and movement outside the comfort zone of the city administration; there is substantial uncertainty about it and the risk of failure. In this sense, it requires strong political support and high-level commitment (e.g. of the city manager), social innovation, and the establishment of agile units that can foster change in the organisation, encourage new routines, and challenge vested interests, such as that of data owners. In many cases, the real challenge is to communicate the vision so that there is clear understanding around the added value that good data management and data sharing practices can bring
- Even though more complex data streams can have higher commercial value and interest for entrepreneurs, open data initiatives can benefit from starting with 'easier' datasets in order to prove themselves. Moreover, having data at the relevant level (often metropolitan) calls for partnerships across city and national administration.

Advice for Replication

The context of Dublin – e.g. the presence of a dynamic ecosystem of IT companies and strong leadership – largely facilitated the emergence of Dublinked, and is rather city-specific. However, on a more concrete level there are at least three important takeaway lessons that can be generalised and applied to other cities:

1. Firstly, business and innovation-driven open data initiatives should move beyond building a datastore and proactively involve end users (and potential entrepreneurs) in a process of co-production through community building initiatives and other events such as hackathons, challenges, and competitions
2. Secondly, as previously mentioned, releasing city data requires cultural change and movement outside the comfort zone of city administrations. There is significant discomfort around this and the perceived risk of failure. Therefore, strong political commitment (especially from city managers), social innovation, and the establishment of agile units to foster change in the organisation are all required to encourage new routines and challenge vested interests, particularly those of data owners
3. Thirdly, there are and will always be important issues around privacy and data protection that will need to be addressed. Moreover, open data challenges traditional models of public procurement. This can be complex to navigate for public administrations where co-creation and ongoing maintenance of software and data are required. New regulations may be needed to better embed open data routines in the local administration and society.