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Regional and local data-driven innovation through collective intelligence and sandboxing

Sandboxing

How to use it to strengthen your local data ecosystem

Joint Research Centre

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Executive Summary

This report is a practical **guide for cities and regions** to experiment with innovative solutions for data management and sharing through a sandboxing approach. It is targeted at public administrators aiming to develop and improve data ecosystems in their local contexts.

Policy context

Making Europe fit for the Digital Age has been and still is among the key priorities of the European Commission. To this purpose, the Commission leads a wide range of digital transformation initiatives, including the ISA² Programme and the more recent Digital Europe Programme, to support the development of digital solutions that enable public administrations, businesses and citizens in Europe to benefit from interoperable cross-border and cross-sector public services.

Within ISA², the ELISE Action offers a package of legal, policy, organisational, semantic and technical interoperability solutions to facilitate especially those services that involve location information.

Data ecosystems and stakeholder interactions

A **data ecosystem is defined as a complex socio-technical system of people, organisations, technology, policies and data** in a specific area or domain that interact with one another and their surrounding environment for a specific purpose. It **combines multiple varying interrelationships between several actors within a given infrastructure** that contribute to the creation of resources or management of their access. Stakeholders are connected based on a set of interest or business models, and their coordination is essential to enable the exchange of data. **Collaboration and connection between stakeholders in different fields of expertise and knowledge is necessary** for a data ecosystem to develop. The same holds for the need to ensure a commitment to produce or to extract value among the stakeholders involved.

Although both the amount of data is growing and the consumers and producers of the data are increasing, the **use of data is restricted due to several challenges**. The underuse of data is linked to management, social and institutional challenges as well as the technological infrastructure. However, it is found that more often it is the interaction and collaboration among different actors (such as government authorities, industry players, service delivery providers, intermediaries) that restricts the use and uptake of available data. The main factors include a **lack of knowledge about the actual benefits of sharing data, lack of governance frameworks to facilitate data sharing and lack of data culture or capacity**.

A necessity for the development of data ecosystems is to **map and define the actors that collaborate in the data ecosystem**, including data stewards, contributors, intermediaries, data creators and beneficiaries. Several tools and methods exist to map actors' role and ecosystem dynamics. These allows for a better understanding of the formal value exchanges and soft value exchanges. Furthermore, it also helps to better **identify potential opportunities to both expand and develop the data ecosystem**.

Benefits of sandboxing

The **use of sandboxes can help overcome challenges** for the sharing of data and collaboration between existing actors, such as for addressing potential distrust in sharing data. Sandboxing refers in this report to virtual environments to safely experiment with innovative solutions. It allows for an agile and inclusive approach to foster hands-on experience for testing new applications or new organisational or regulatory approaches.

The present report differentiates between two types of sandboxing: technical and organisational sandboxing. While technical sandboxing covers the process of safely and quickly developing and testing new applications before scaling them, operational sandboxing refers to the identification of ways to develop and test solutions to non-technical barriers such as incentives and partnerships to acquire private sector data. Overall, sandboxing can **help demonstrate the real value of data ecosystems, by allowing stakeholders to test organisational improvements or more technical solutions**. For instance, sandboxing can positively influence the work of the administration by enhancing evidence for policymaking, fostering collaboration potential and improving skills of local administrators. Further to this, it can facilitate ecosystem-wide benefits by improving collaboration between external data providers and a public administration, enhancing awareness and understanding of the data ecosystem and improving the understanding of the Minimum Interoperability Mechanisms.

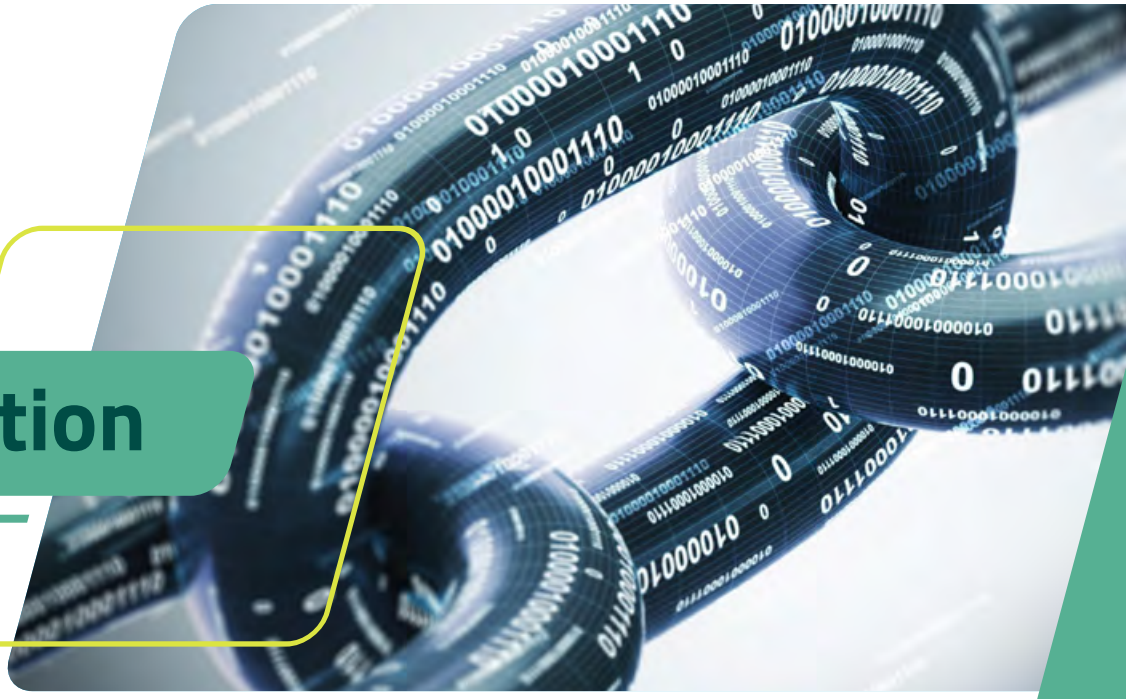
Sandboxing needs to be **tailored to the local context** and to address some preparatory questions, taking the different level of maturity for cooperating in data sharing into consideration. Among others, cities need to reflect on the initial challenges and on existing examples from other cities facing similar challenges. **A self-assessment is considered as an essential step** before setting up a sandbox. It considers different elements of the data ecosystem – both technical and non-technical – and serves to help the city define what can and what cannot be done in a specific ecosystem. A self-assessment can rely on interviews with stakeholders and help understand the sandboxing needs with regards to strategies, skills, infrastructure and data.

Setting up organisational and technical sandboxes

When it comes to **setting up an organisational sandbox**, a step-by-step approach is outlined. This builds on the need to understand the local data ecosystem and the different roles with regards to the collection, management and use of data. It equally entails the **identification of a value proposition for each actor** to incentivise them to get involved and take active part in the ecosystem. In addition, a **governance structure with mechanisms** for discussion, planning and resource allocation as well as **terms and conditions** for the access to and use of data should also be envisaged. It is recommended to agree upfront on ground rules concerning liabilities, intellectual property, privacy and personal data protection. The overall objective should be to create a **culture of cooperation** among the participating stakeholders. Achieving this requires that one offers frequent opportunities for interaction that result in win-win results.

The **launch of a technical sandbox** requires that the concerned parties reflect initially on the role of sandboxing, how the Minimal Interoperability Mechanisms can help, who should host the sandbox and how the sandbox will be used (i.e. for a specific use or as ongoing resource). Building once again upon a step-by-step approach, the first actions are to **encourage the development of new applications and to address organisational concerns** restricting the use of data. The use of technical sandboxing can help to outline the value of potential applications by providing quick and relatively cheap proof of concepts to be further developed. Overcoming this can be supported by **relying on tried and tested examples of good practices** that can be adopted by any technical sandbox. For example, containers (such as Docker containers) can help create a virtualisation environment for running an application. Stakeholder involvement is key to ensure that the application being developed is **targeting concrete user needs and meets requirements of users**. It is overall recommended to involve users at each iteration of the application. A decision is also needed for the hosting, and whether this should be offered within the organisation or from a partner organisation or a cloud provider. In each case the requirements need to be clearly defined and the process needs to be well managed to facilitate a delivery that meets the expectations. It is considered useful to set up a **sandboxing facility** – either as part of a data space or data sharing ecosystem – offering a service for existing and potential stakeholders.

1.0 Introduction



Data sharing plays a fundamental role in strengthening the European economy. It can take place in different ways, from simply making data available online (e.g. "open data") to establishing collaborations between public and/or private actors in order to create value.

The use and reuse of data have great potential at **local and regional levels**, as this allows informing and improving a wide range of public services that citizens utilise in their everyday lives. **Accordingly, different European cities** have been investing in data ecosystems – i.e. a structural solution for an effective sharing of data among key stakeholders, namely public actors, private actors and/or citizens. However, these stakeholders have to deal with organisational and/or technical barriers hampering the development of such ecosystems, and, more extensively, the growth of the entire data economy.

Therefore, the need to find effective and sustainable approaches for the use and reuse of data is becoming ever more urgent, and innovative practices of data sharing can constitute a relevant solution. Local and regional administrations, just like other private stakeholders, may leverage on **testing of technical or organisational mechanisms** before adopting – and investing in – such solutions.

In this context, this Playbook aims to be a **practical guide** to adopt innovative solutions for data sharing at the sub-national level by leveraging on the sandboxing approach. It is conceived as a practical orientation for a wide range of public administrators who are eager to develop, or improve, data ecosystems in their local contexts.

With the term "sandboxing" we mean a space for experimenting with alternative organisational approaches and/or technical tools aimed to facilitate data-driven innovation and the evolution of data ecosystems at the local or regional levels (sections 2, 3, 4 and 5). **The use of such sandboxes** described in this Playbook derives from a direct hands-on experience in different European cities, which included the analysis of the main barriers hampering the development of data ecosystems and the implementation of four sandbox experiments to test potential solutions. In this light, the Playbook provides an evidence-based guidance on opportunities deriving from sandboxing for local ecosystems, both with regard to organisational (section 5) and technical (section 6) improvements.

EU agenda for the data economy

Making Europe fit for the Digital Age is among the top key priorities of the European Commission for the period 2019–2024. This means that the Commission has been implementing a set of actions focused on making digital transformation work for people, public sectors and businesses.

In this context, the European Data Strategy aims to make the EU a leader in a data-driven society by creating a single market for data. It proposes the construction of an EU data framework that enables the sharing of data both from business-to-business (B2B) and from government-to-citizens (G2C).

In particular, the ISA² Programme has specifically supported the development of digital solutions set to help public administrations, businesses and citizens exploiting the benefits from interoperable cross-border and cross-sector public services.

Among the main actions of this Programme, the ELISE Action addresses interoperability solutions for digital public services using information from location.

Figure 1: How to use this Playbook

How to use this Playbook

If you want to know what a "data ecosystem" is you can read the Playbook from the beginning
> Go to section 2 <

If you already know what a "data ecosystem" is, you can start by exploring "What is sandboxing"
> Go to section 3 <

You can learn why and when sandboxing can be used...
> Go to section 4 <

In particular, you may want to explore:
How to set up an organisational sandbox
> Go to section 5 <

In particular, you may want to explore:
How to set up a technical sandbox
> Go to section 6 <

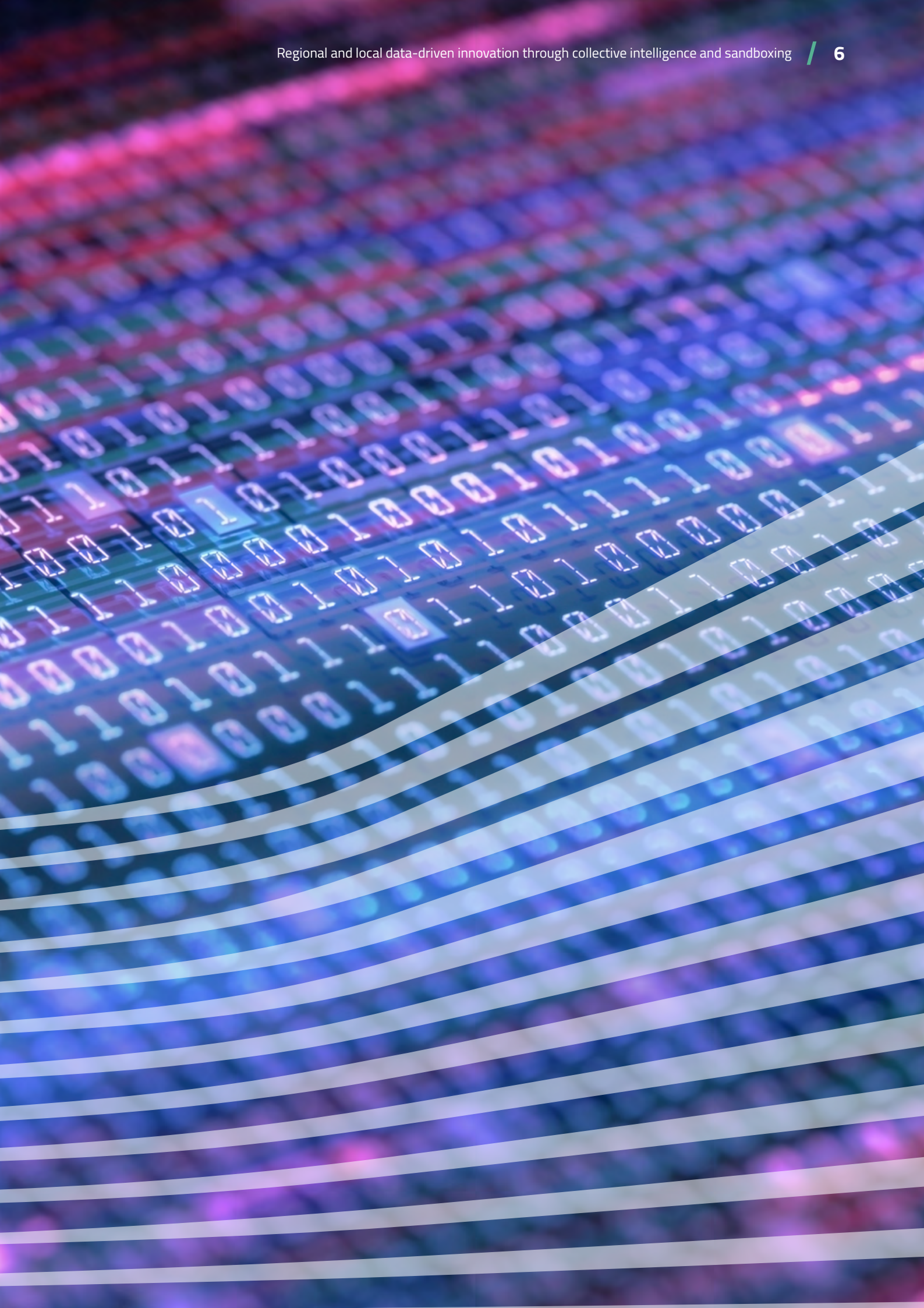
You may also want to know

How to make your sandbox sustainable and replicable
> Go to section 7 <

Finally, do not hesitate to find out how you can receive support for your sandbox
> Go to section 8 <

2.0

What is a data ecosystem and why is it important?



2.0

What is a data ecosystem and why is it important?

The term "ecosystem" has been used in numerous contexts, ranging from biology to business. In a similar way, it has been adapted for the new data economy. The ecosystem metaphor is appropriate when it concerns **multiple and varying interrelationships between many actors within a given infrastructure that contribute to the creation of resources or management of their access** (e.g., data, business, services or software). Ideally, all the actors should be committed to producing value for, or extracting value from, the ecosystem. Being a part of an ecosystem demands collaboration and connection between different actors in different fields of expertise and knowledge[1]. Actors' relationships range from a relatively simple supply-demand chain to a more complex network of multilateral relationships. In this context, **the use of sandboxing may overcome some challenges existing** between actors, as for instance the potential distrust in sharing data. The use of protected environments as sandboxes can be considered a useful mechanism to further develop and expand existing ecosystems.

In a data ecosystem, **each actor is connected to other actors by a set of interests or business models**. The ecosystem organisational structure entails the way in which actors are connected and the properties of their relationships. The box below provides a definition of data ecosystem that can be used by cities.

Box 1: Definition of data ecosystem: coordination, incentives and rules

A data ecosystem is a complex socio-technical system of people, organisations, technology, policies and data in a specific area or domain that interact with one another and their surrounding environment for a specific purpose. This might be under **coordination mechanisms** that facilitate collaboration, such as monetary and non-monetary incentives, working groups, and quasi-regulatory trust-based principles and **rules**. Such ecosystems **evolve and adapt** through a cycle of data creation and sharing, data analytics, and value creation in the form of new products, services, or knowledge, which, when used, produce new data feeding back into the ecosystem.

Source: elaborated by the authors building on Martin et al. (2021)[2]

1 - Oliveira, M., Barros Lima, G. & Farias Lóscio, B. (2019). Investigations into Data Ecosystems: a systematic mapping study. Knowledge and Information System, 61: 589–630.
2 - Martin S., Gautier, P., Turki, S., Kotsev, A. (2021). Establishment of Sustainable Data ecosystems. Recommendations for the evolution of spatial data infrastructures, EUR 30626 EN, Publications Office of the European Union, Luxembourg.
3 - Appio, F.P., Lima, M., Paroutis, S. (2019). Understanding Smart Cities: innovation eco- systems, technological advancements, and societal challenges. Technol. Forecast. Soc. Change 142, 1–14.
4 - Micheli, M., Ponti, M., Craglia, M., & Berti Suman, A. (2020). Emerging models of data governance in the age of datafication. Big Data & Society, 7(2.
5 - Please see https://www.klimafonds.gv.at/themen/mobilitaetswende/serviceseiten/zem/smile-smart-mobility-info-ticketing-system-leading-the-way-for-effective-e-mobility-services

The sub-national territorial level (regional and local) provides a fruitful environment for developing data ecosystems, which can then be scaled and spread across different cities and regions with similar characteristics. Already several studies have shown how data can generate benefits in regional and local settings.[3,4] The establishment of well-functioning local data ecosystems is not only expected to foster economic growth, but also to **support the public sector's mission and the promotion of a fairer data economy**.

However, while the amount of data, as well as the consumers and producers of **these data, are growing at fast pace, there is a significant portion of data that is underused or not used at all**. To understand the reasons behind such underuse of data it is important to consider management, social and institutional challenges related to data innovation. While the technological infrastructure is an important component of a data ecosystems, it is more often the interaction and collaboration between the different actors (e.g., government authorities, industry players, service delivery providers, intermediaries) that hinder the use of available data.

For instance, many public and private organisations are still **hesitant to share their data**. The case of business-to-government (B2G) data sharing is particularly relevant, but it is not the only obstacle behind data sharing to improve local public policies. The main factors include: (i) lack of knowledge about the actual benefits of inter-organisational data sharing, (ii) lack of governance frameworks, which explains private companies' reluctance to share their data with public sector organisations, and (iii) lack of data culture or capacity, especially among public sector organisations. Overcoming these obstacles may create the conditions for different actors to increase trust with each other, share data and generate public value, as shown in the Box above.

The following sections describe the main roles of a data ecosystem and provide a useful tool to map such systems, which is an important preparatory activity in the context of sandboxing.

The European research project SMILE[5] developed a platform in Vienna that brought together several Austrian mobility partners and operators, from public transport companies to bike and car-sharing providers, taxis and parking garages. Combined datasets of different mobility stakeholders were used to show diverse options of multimodality, with the later referring to the integrated use of a range of different forms of transport. The app indicated different options for the routing. The implementation of the project required complex negotiations and the creation of a Private Public Partnership (PPP), with the objective to foster sustainable public services by optimising intermodal route planning.

Box 2: Example of B2G data sharing

2.1 The key roles in the data ecosystem

Data ecosystems include several actors that play different, sometimes partially overlapping, roles. Each actor is connected to multiple other actors by a set of interests or business models. The coordination of the actors and the relational processes are strategic to enable the exchange of data. Actors' relationships range from a relatively **simple supply-demand chain to a more complex network of multilateral relationships**. The ecosystem organisational structure entails the way actors are connected and the properties of their relationships.

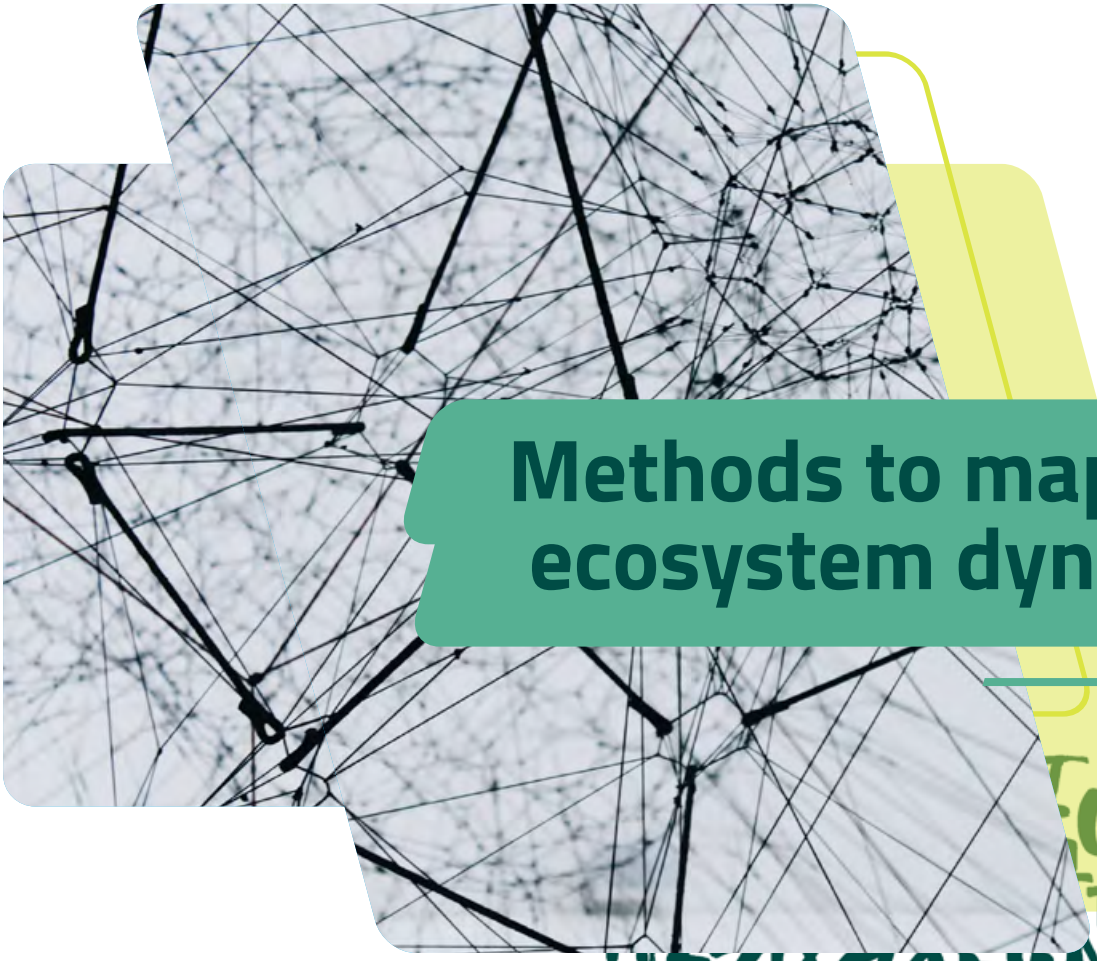
It is important to **map and define all the actors that collaborate in the data ecosystem**. Table 1 below presents the key roles that are common to every ecosystem. The list should be considered only as a starting point, as every ecosystem is different and may have different roles.

Roles

Table1: Key roles in a data ecosystem

Data stewards	Persons within the organisation responsible for collecting, managing or ensuring access to a dataset.
Contributors	People or organisations who contribute to or help curate a dataset; they may do so knowingly, using tools and frameworks provided by a data steward, or unknowingly through their use of a service.
Intermediaries	Trusted independent organisations located between data providers and users, responsible for accessing and managing data.
Data creators	Analysts who use data to create information, in the form of products and services, analyses and insights, or stories and visualisations. They can be part of the organisation or external researchers.
Beneficiaries	People/citizens or organisations that benefit from the data ecosystem because it enables them to make better decisions informed by using products and services, along with their own experience and understanding.

2.2



Methods to map data ecosystem dynamics

Why mapping data ecosystems?

A data ecosystem map can be used to:

- **Collaborate directly with other stakeholders for organisational/ecosystem change**
- **Explore new sources of data to improve internal operations**
- **Exploit existing data flows to drive new services or improve existing services**
- **Inform a project to build a data-enabled service**
- **Identify where changes are needed, and what effects they might have**

Box 3: Why mapping of data ecosystems?

Once the data ecosystem's actors and their roles are mapped and defined, there are some **useful methods to map the ecosystem dynamics**. This helps to highlight the interactions between actors and resources of each data ecosystem. For instance, the tool proposed by the Open Data Institute (ODI)[6] illustrates in a visual and intuitive way how data is being accessed, used and shared by a variety of organisations. An example of this tool is provided at the end of this section. Another example is a business canvas for data tailored for local data ecosystems at the city and regional levels by the Joint Research Centre.[7]

6 - https://theodi.org/article/data-ecosystem-mapping-tool/
7 - Please see https://publications.jrc.ec.europa.eu/repository/handle/JRC1241488

Representing ecosystems in detailed maps can be particularly useful when contexts are complex, not well understood or not yet fully developed. The maps provide an overview of the following three elements:

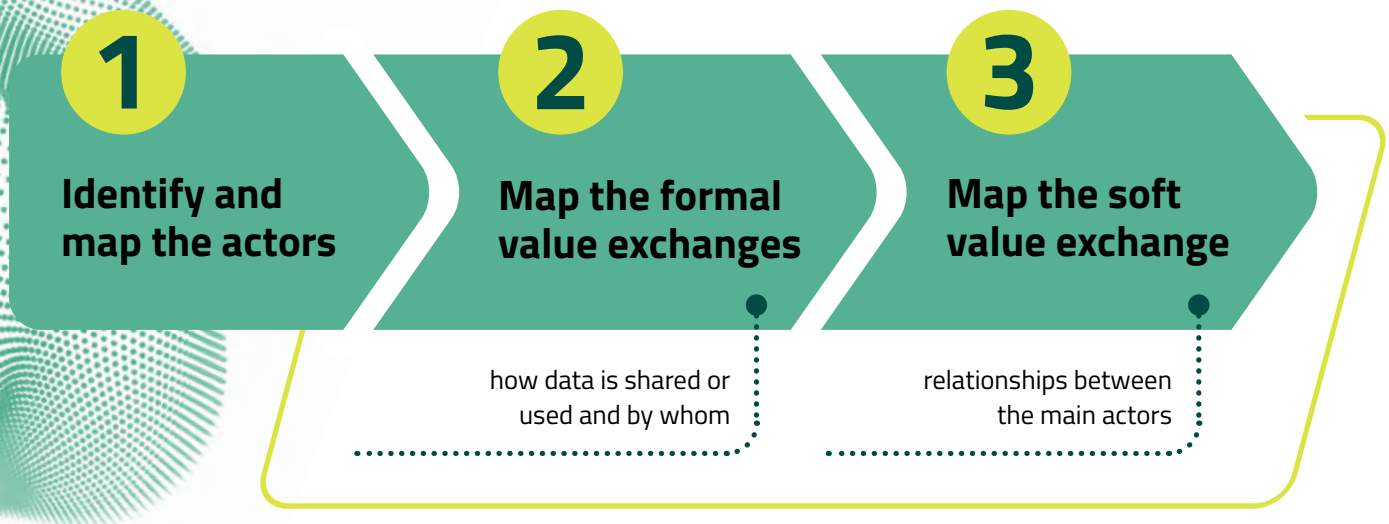
1) the **data assets** that are being accessed, used, and shared;

2) the **people and organisations** involved in either creating outputs using data, or benefiting from its use;

3) the **relationships and roles** that these actors have within the ecosystem.

This methodology consists of three steps, which are explained below.

Figure 2: Key steps for mapping a data ecosystem



Source: ODI, Data ecosystem mapping tool.

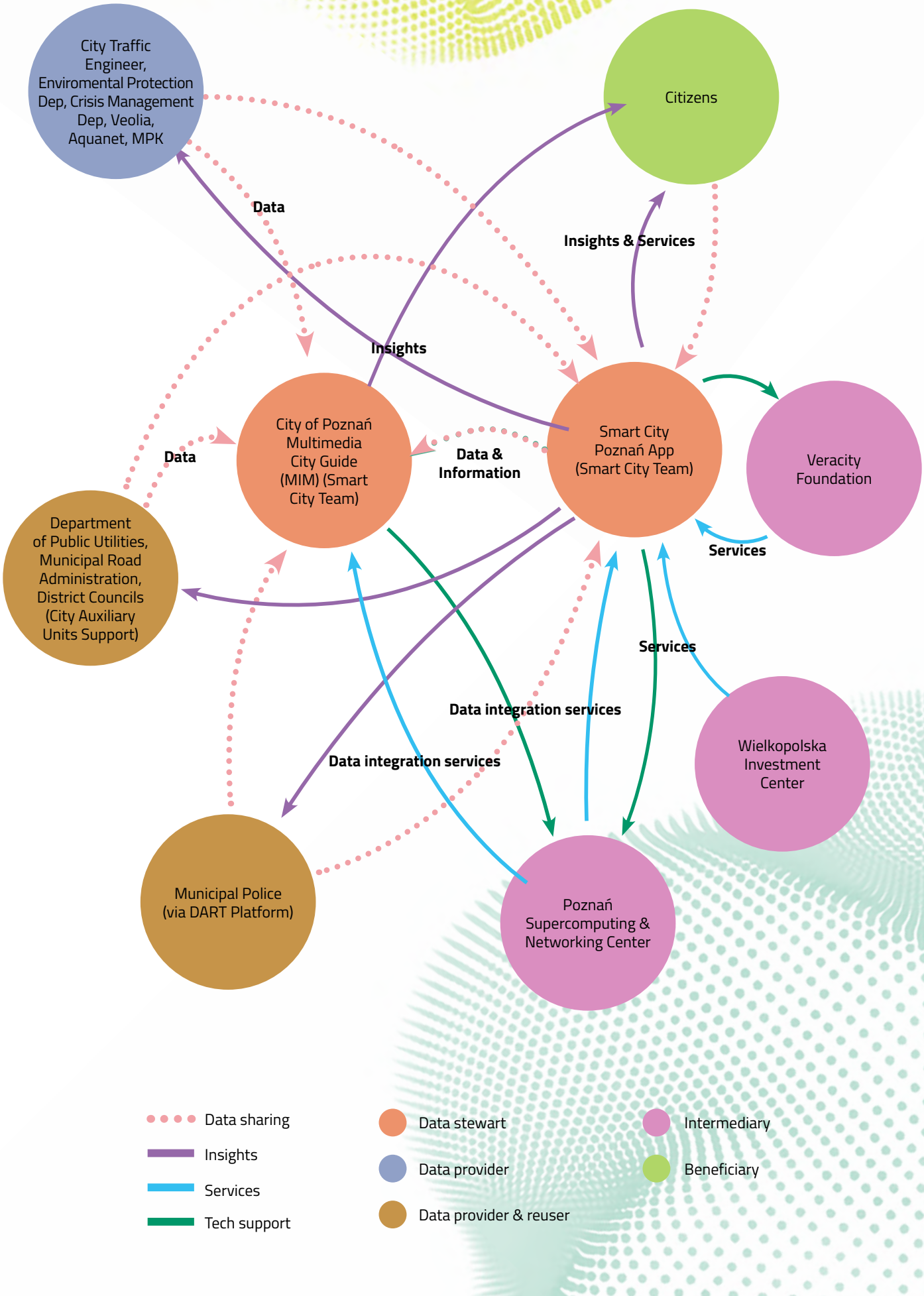
Formal value exchanges are the exchange of data (shared or used) between different actors in the ecosystem. **Soft value exchanges** are all the relationships between actors that do not entail an exchange of data, which may include technical or financial support, advice from external experts, and the insights gained from the analysis of data.

It is important that the steps are followed as described in order to produce a realistic graphic representation of the data ecosystem. An accurate representation can **help to understand and explain to stakeholders how the data ecosystem works** and how it could develop further. For the graphical representation of the ecosystem, online tools, such as Kumu,[8] can help to understand and engage complex systems more effectively. The example below is a representation of the data ecosystem of the Smart City Poznan (SCP) mobile application which was developed to support engagement and interaction between residents and the city administration.

Once the data ecosystem is mapped with all its actors and relationships, it is easier to **identify potential opportunities to expand and develop the ecosystem further**. In this context, cities may strategically consider the use of sandboxing. This approach is extremely useful to overcome some challenges, especially when it comes to data sharing.

8 - Please see https://www.kumu.io

Figure 3: Smart City Poznan data ecosystem



3.0

What is sandboxing and how can it help?

3.0

What is sandboxing and how can it help?

Given its agility and inclusiveness, sandboxing could **foster hands-on experience in the development** of, for example, personal data spaces, predictive analytics (i.e. the analysis of data through modelling and machine learning to predict future scenarios) or in the **set-up of new governance models** in regional and local data ecosystems.

Box 4: Definition of sandboxing

The term **"sandboxing" refers in this playbook to testing solutions in a safe environment**. Sandboxes are virtual operating environments where it is possible to experiment with the application of innovative solutions aimed at enabling more efficient and effective delivery of public services through data sharing.

Sandboxing experiments can be **technical** - referred to testing new applications before operationalising them - or **non-technical** - referred to testing new organisational or regulatory[9] approaches to overcome barriers and challenges.

9 - The European Council recognises regulatory sandboxes as "concrete frameworks which, by providing a structured context for experimentation, enable where appropriate in a real-world environment the testing of innovative technologies, products, services or approaches [...] for a limited time and in a limited part of a sector or area under regulatory supervision ensuring that appropriate safeguards are in place". Cfr. Council of the European Union (2020). Regulatory sandboxes and experimentation clauses as tools for better regulation: Council adopts conclusions. Press release, 16 November. Available at: https://www.consilium.europa.eu/en/press/press-releases/2020/11/16/regulatory-sandboxes-and-experimentation-clauses-as-tools-for-better-regulation-council-adopts-conclusions/

3.1

Type of sandboxes

Within the scope of the definition provided above, experience in different European cities has demonstrated that it is helpful to **differentiate between two types of sandboxing**: technical and organisational.

It should be noted that this differentiation is not mutually exclusive. In a single local context, both technical and organisational challenges may emerge for actors operating in a data ecosystem. Therefore, a public administration may need to experiment both on the technical and on the organisational side.

However, the key distinguishing elements of the two sandboxing types are described below.

Technical sandboxing

Technical sandboxing refers to the process of quickly and safely developing and testing new applications before operationalising them. Traditionally, new applications are developed and tested in an isolated technical environment before incorporating them into the operating environment. This can be an effective mechanism to:

I. develop a new application and check if it delivers what is required;

II. check if an existing application works in a new environment;

III. compare various applications for the delivery of a certain set of requirements and evaluate which performs best.

A sandbox can be used for testing an application in an environment that is as near as possible to the operating environment, although isolated from it. Only once the application has been thoroughly tested, is it introduced into the operating environment.

Organisational sandboxing

While the sandbox is primarily understood as a technical environment, **organisational sandboxing** refers to the identification of ways to develop and test solutions to those non-technical barriers in the same way as technical sandboxing is used to address technical barriers. This can happen, for example, through the evaluation and application of best practices and policies for Business-to-Government (B2G) data sharing, such as incentives, contracts, and partnerships to acquire private sector data.

It should be highlighted that some aspects of organisational sandboxing can be addressed through technical sandboxing by:

I. providing an **inexpensive and low risk way** of demonstrating the value of joining the data ecosystem;

II. demonstrating **how the process can deal with legitimate concerns**, such as the secure handling of personal or business-sensitive data in the ecosystem;

III. providing an **easy first step to collaboration**.

3.2 Objectives, outputs and challenges of sandboxing

Which are the objectives of the experiment? What solutions/outputs should be tested for the ecosystem? Which are the specific challenges to be considered in each local context for the implementation of a sandbox? For a sandbox to be successful, it needs to deal with these three key questions.

Four sandboxing experiences held in four different European cities – Poznan, Milan, Barcelona and Helsinki – offer a glimpse of what can be included in these questions.

Table 2: Sandboxing experiences in four European cities

	Objective	Outputs	Challenges
POZNAN	Improve management of micro-mobility and implementation of Mobility-as-a-Service (MaaS)	The main output of the sandbox is a dashboard illustrating the location and status of the e-scooters of a private company (en route, broken, parked, etc.)	Accessing data from the e-scooter company took more than expected (3 months) Technical knowledge of the administration on how to run a sandbox can improve
BARCELONA	Develop an automated process to enable the integration and analysis of data, including (i) information on the buildings from the land registry and (ii) geospatial data to locate and visualize buildings on a map.	A spatial database combining data collected from the land registry with geospatial information. This database allows spatial analysis of the data and visual representations.	Poor quality of land registry data Limited internal technical knowledge of the administration on how to run a sandbox
MILAN	Develop practical incentives and organisational arrangements to make other parties (public or private actors) to join the ecosystem and contribute to its development	Revised contracts and terms of services for new data providers and users; Development of a new description of the ecosystem to aid awareness-raising; A guidance document on possible ways to expand the ecosystem, with the potential support of MIMs	Limited availability of the key department's personnel Limited opportunity to involve third parties beyond the local administration
HELSINKI	Understand how different approaches to sandboxing could be used to further develop the Minimum Interoperability Mechanisms and achieve their objectives	Summary document on alternative approaches for data management linked to MIM2 MIM1 and MIM4	Limited opportunity to leverage on similar sandbox experiences, as the city started from a very advanced experience with sandboxes, tailored to the specific city context

3.3 What are the benefits of sandboxing?

Sandboxing can demonstrate **the real value of data ecosystems**. Stakeholders can experience the benefits of data sharing, by testing organisational improvements and/or more technical experiments, depending on the exact focus of the sandbox. This emerged clearly from the four sandboxes shown above.

Accordingly, **different kinds of benefits can be expected**. They may positively affect the work of the administration (public administration benefits) as well as all the overall ecosystem (ecosystem-wide benefits), as explained below.

Public administration benefits

1) A sandbox **can enhance evidence for policymaking** at the disposal of local administrations as well as the capacity of administrators to interpret such evidence

2) A sandbox can **improve cooperation potential** among different departments of a local administration by showing more efficient ways to share and interpret data from different sources

3) A sandbox can **improve the skills of local administrators** in using and managing data

Insights from the sandbox in Barcelona

With regard to the improved cooperation potential, the experience in the city of Barcelona shows that, once the data were integrated into one database, the work of different departments and organisations was facilitated. As confirmed by public administrators who took part in the sandbox, this was due to the fact that more integrated data enabled them to better understand and access each other's data through visualisation.

Ecosystem-wide benefits

1) A sandbox can improve **cooperation between a public administration** and **external data providers within the ecosystem**

2) A sandbox can **enhance the awareness and understanding** of the ecosystem for all the actors involved

3) A sandbox can **improve understanding of MIMs**[10] – Minimum Interoperability Mechanisms – and contribute to their development

Insights from the sandboxes in Poznan and Milan

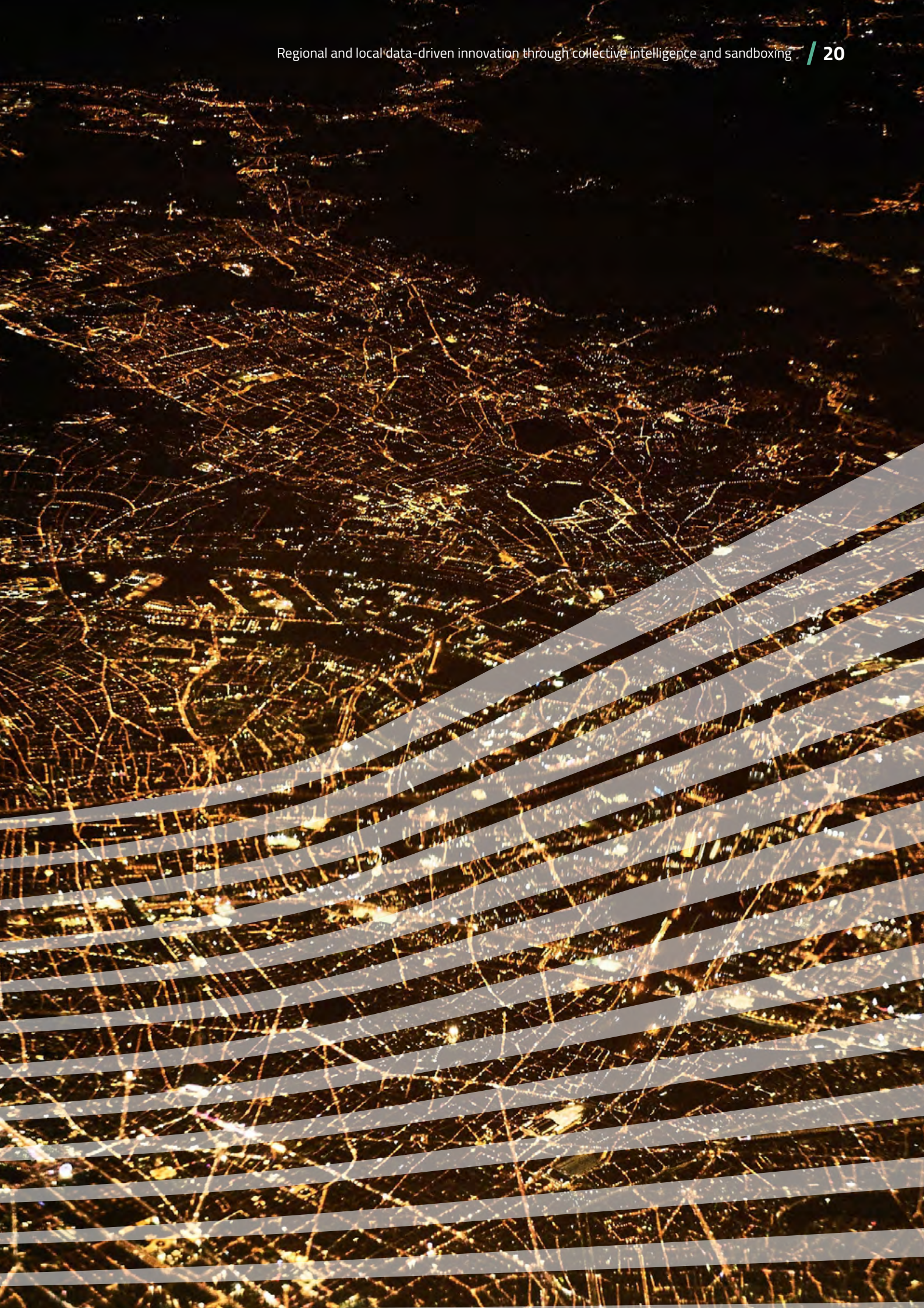
In the cities of Poznan and Milan, the sandboxing exercises allowed the respective teams in charge of the ecosystems to develop practical terms and conditions for the cooperation with private sector companies. As highlighted by administrators who took part in the sandbox, this allowed them to evaluate how to include new data providers or data users within the data ecosystem.

Moreover, in Milan, guidance on MIMs helped the department in charge of the ecosystem to better benchmark its needs. As confirmed by administrators who took part in the sandbox, this allowed them to evaluate how to use MIMs for the development of the ecosystem.

10 - See section 7 for an explanation of the role of the MIMs

4.0

Why and when to use sandboxing in cities



4.1 When is sandboxing needed at city-level?

Sandboxing can be a good approach for developing a "play environment", a facilitator for trying things out for building or expanding a local or regional data ecosystem. Sandboxing can be implemented for different reasons, depending on the context and the city's objectives. However, the solutions are different for everyone, so the **sandboxing exercise should be tailored to local contexts**. For instance, some cities may not be at the level of maturity of culture for cooperation needed in sharing data. Trying to impose good practices from different projects may be useful, but some cities may not have reached this level yet. Given the difference in digital culture within city administrations, and their restricted capacities to deploy complex digital solutions, offering **different possibilities for short- and long-term sandbox implementations** foster an easier transition to digital tools.

Therefore, there are some **preparatory questions** to ask which may help in deciding whether a sandboxing is needed and what type of solutions can be implemented in a given data ecosystem.

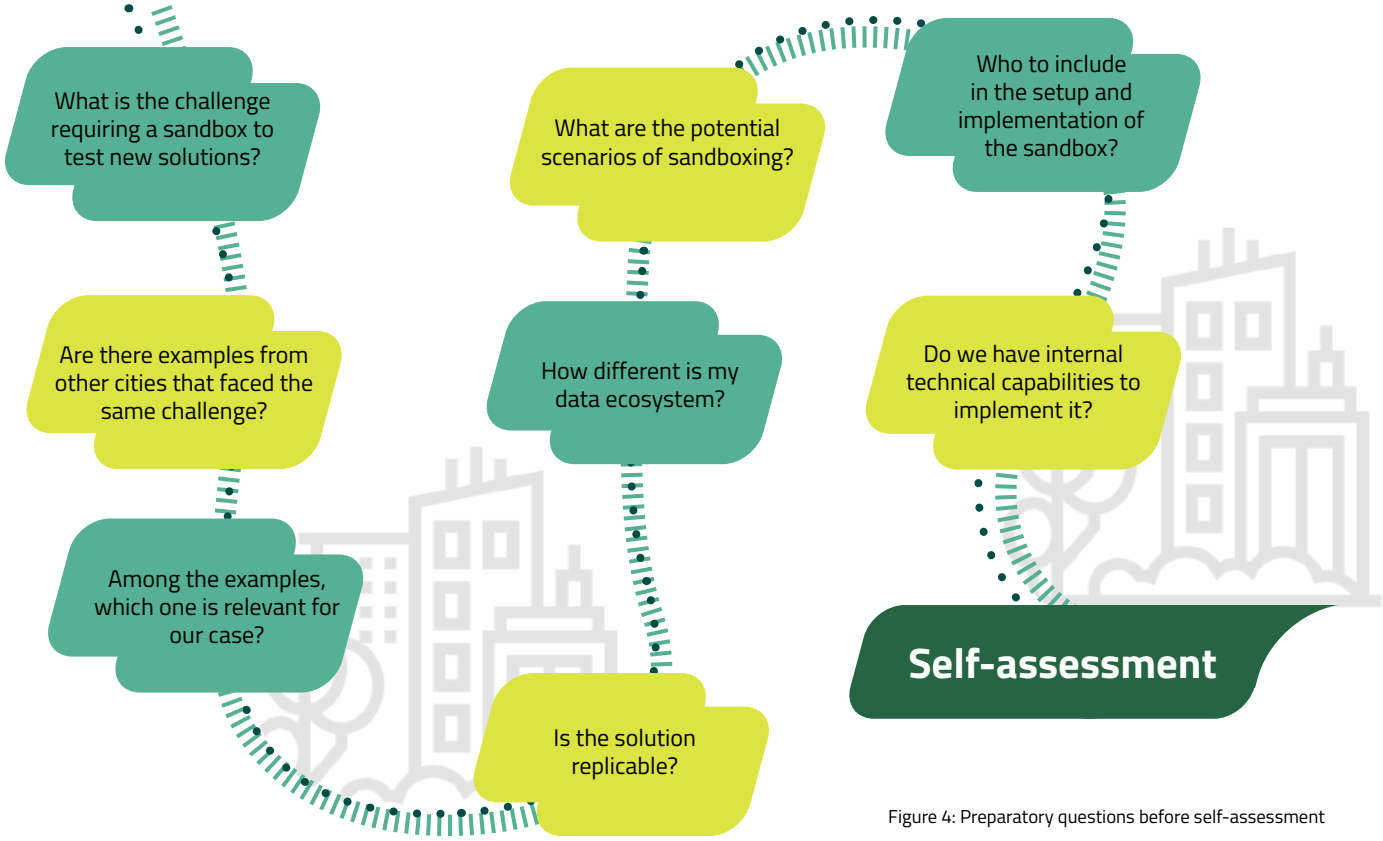


Figure 4: Preparatory questions before self-assessment

The last point of the Figure above, the **self-assessment**, is the last preparatory step before defining the type of sandboxing and beginning with the implementation.

4.2

Self-assessment of maturity and sandboxing needs

The self-assessment of the **ecosystem's maturity and the specific sandboxing needs** is the essential step before setting up a sandbox. This is not a benchmarking exercise to assess whether a city is lagging compared to others. Instead, it **helps organisations to define what can or cannot be done in a specific ecosystem**.

The assessment should always consider the different elements of a data ecosystem, and not merely the technological aspects. Therefore, the assessment should not focus only on data maturity. There are several maturity assessments models available[11] which do not consider that it is the whole ecosystem that should be considered – from strategic alignment between data and policy objectives, to analytics and data itself, to data infrastructure, and to people and skills. These four elements for the self-assessment are summarised in the righthand figure.

To assess each of the aspects above, as well as to fully understand the sandboxing needs, a number of **interviews with stakeholders involved in the ecosystem** (e.g., city council officials, solution providers, publicly owned companies) should be carried out. Below is a list of **potential profiles** to be interviewed, which could change depending on the specificities of the city:

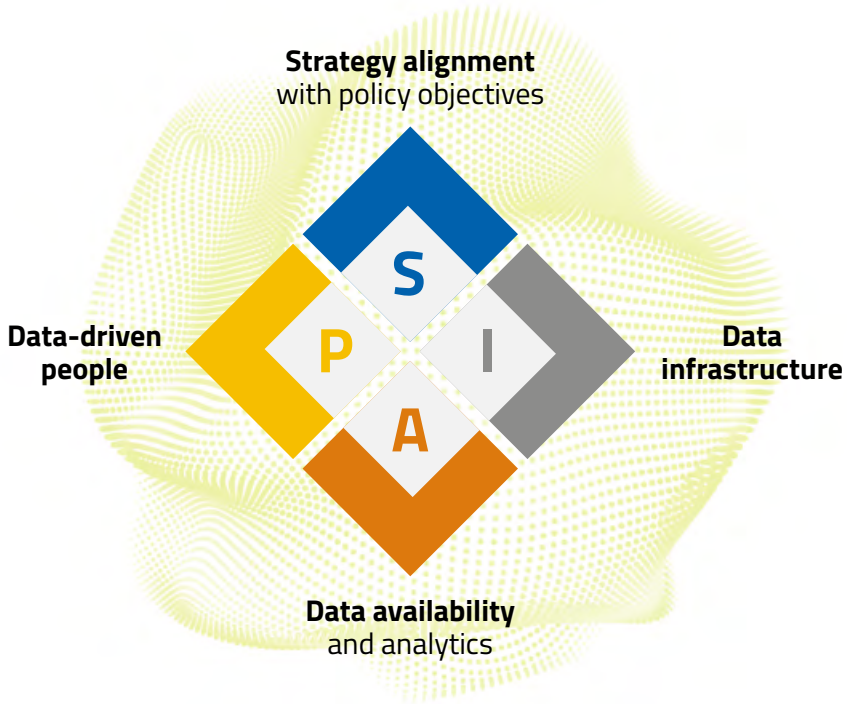


Figure 5: Elements for the self-assessment

- **Head of smart city unit** – to gather an overview of the data ecosystems and the integration with the other policy units of the city council.
- **Head(s) of policy department(s)** – to understand whether there are specific challenges in relation to data where a sandboxing approach could be useful.
- **Head of IT department** – to gather specific information on the data infrastructure developed by the city council.
- **External actors (e.g., private companies, universities, NGOs)** – to explore the possibility of expanding the data ecosystem through B2G data sharing.

Once the self-assessment on the level of maturity and the sandboxing needs is completed, the city will **decide whether to proceed with implementing a sandbox (organisational or technical)**. The following sections will provide guidance on how to set up both types of sandboxes.

11 - For instance: https://www.bcg.com/publications/2019/rough-road-to-data-maturity.

5.0

How to set up an organisational sandbox

5.0

How to set up an organisational sandbox

The preceding section offers background guidance for when a sandboxing is needed and how the initial assessments should be carried out. The following section offers **concrete guidance for cities on how to set up an organisational sandbox and the recommended steps to pursue**.

An organisational sandbox can have **multiple formats, while the objectives** pursued can also be many. This implies that the guidance provided below should be considered as a discussion starting point, providing overall guidance instructions, with the need to tailor and adapt them to local realities and needs.

5.1 Do-not-forget list

Once it has been clarified in the local ecosystem that organisational sandboxing can benefit and provide added value, the launch of the organisational sandboxing journey triggers a set of **initial questions** to be addressed. These include:

- Which **stakeholders to involve**, how to engage the key ecosystem players and how to ensure ownership?
- How to build the **value proposition**? How to provide incentives to share data?
- What are the key **governance mechanisms** and terms and conditions to rely on?

Building on the sandboxing experiences from four different European cities – Poznan, Milan, Barcelona and Helsinki – a set of **key guiding principles** can be sketched out, as shown in the figure below, addressing components such as the local ecosystem, value proposition and agreements.

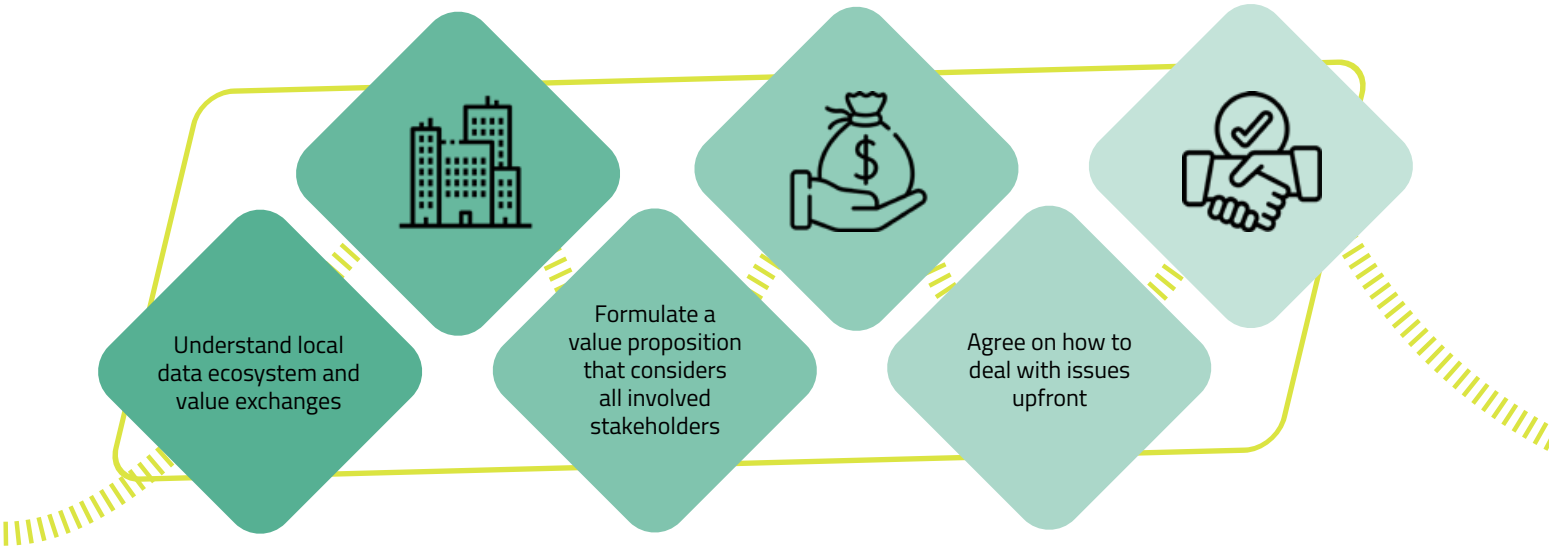


Figure 6: Organisational sandboxes – guiding principles

A key driver for the implementation of an organisational sandbox is that the **local data ecosystem is mapped** in order to understand not only the key stakeholders, but also their roles. The mapping further sheds light on present value exchanges and barriers as well as incentives. Similarly, when formulating a value proposition, one needs to account for the involved stakeholders; they should see their needs reflected in an encompassing value proposition. By value proposition we refer to how the sandboxing activity benefits participating stakeholders, which can provide a reason why a given actor would be prepared to get involved or to share data. Equally necessary is an initial effort to align ways to respond to certain issues among the concerned parties.

A **step-by-step approach** on how to set up an organisational sandbox is provided in the figure below:

Figure 7: Organisational sandboxing – step-by-step approach

Each step involves a range of activities to be carried out and requires concrete decisions on who undertakes the initial assessment and mapping, how often actors meet to discuss, and who is responsible to conduct each step. Such steps and decisions are to be tailored to the organisational sandbox and the tested solutions and organisational barriers addressed. The activities linked to each of the steps are further outlined in the table overleaf.

Insights

How to achieve replicability for organisational sandboxes

Solutions related to the development of technical guidance on how to develop terms of services to facilitate the involvement of external stakeholders (e.g. private companies or municipally owned companies which may want to share data) can be useful for other cities facing similar issues, if shared.

Box 5: Insights on how to achieve replicability for organisational sandboxes

Table 3: Organisational sandboxing – activities in focus per step

1. Map the local data ecosystem	Map the local data ecosystem and stakeholders	Map "soft" and "formal" value exchanges	Map the data ecosystem architecture	Identify and deal with key barriers and incentives	
2. Understand the different roles	Understand the different roles, incl. contributors, beneficiaries and data creators, and skills needs	Identify who collects, manages and ensures access to data	Map the organisations and people who contribute to or help curate datasets	Identify the beneficiaries benefitting from the data, i.e. for better decision-making	Understand who uses the data to create information, i.e. in the form of products and services
3. Identify the value proposition for each actor	Understand the value proposition for the concerned actors	Address the needs identified, to help incentivise the sharing of data	Make sure the value proposition accounts for all stakeholder types involved		
4. Involve stakeholders	Involve key stakeholders, e.g. from city administration, private sector and societal stakeholders	Set up a stakeholder group to oversee the process and manage the ecosystem	Involve actors from different domains to design and manage the ecosystem		
5. Develop good governance	Discuss the organisational issues (i.e. coordination, incentives)	Plan improvements and identify resources together	Develop practical terms and conditions for data sharing	Commission and undertake ecosystem mapping	Identify barriers and missing links in the ecosystem; link them to policy goals of the city
6. Put in place terms and conditions	Co-creation conditions, incl. operational rules and principles for actors to generate value from network	Set up an open and transparent management of the data ecosystem	Identify and deal with issues of liabilities, intellectual property, privacy and personal data protection	Clarify financial and non-financial incentives to address issues of reciprocity, fairness and equity	Address technical inter-operability issues

5.2

Key challenges and how to overcome them

There are several challenges to prepare for when embarking on a journey to set up and implement an organisational sandbox. In the following, we have outlined some of the **main challenges and the related recommendations on how to overcome them**.

Getting all stakeholders to work together in an open and transparent manner:
Developing good governance is sometimes difficult to implement, also due to various interests. The overall objective should be to create a culture of cooperation that considers the local context. Such culture could first and foremost be created by pursuing an open and transparent management of the ecosystem. This can be complemented by repeatedly providing meaningful opportunities for interaction that result in win-win results for the ecosystem parties involved. Ground rules – for instance on liabilities, intellectual property, privacy and personal data protection – should be agreed upfront, as part of the procurement or initiation process, because these become much more difficult to implement later.

Lack of infrastructure and technical expertise:
Expertise in understanding and interpreting data could be tackled through training and awareness raising activities. Concretely, a data provider or intermediary could be brought in and asked to train or explain the data to the users and the results of the sandbox.

Overcoming missing linkages and exchanges in the ecosystem:
Sandboxes can benefit from the involvement of multiple stakeholders in the ecosystem, and from a participatory process in their design and implementation. In this way one facilitates interaction among the involved stakeholders and ensures that a larger set of needs are accounted for. Sometimes, this depends on the willingness of the host organisation to open up the process to external stakeholders.

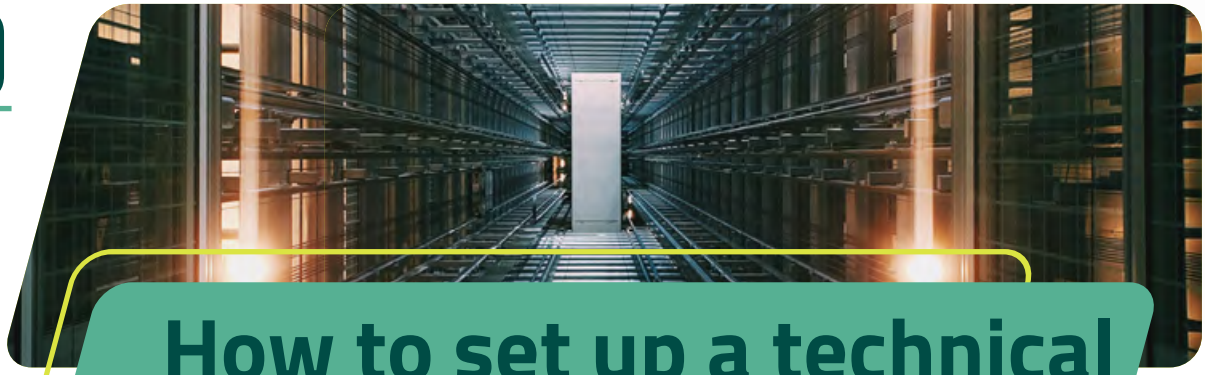
Convincing stakeholders to share data:
Emphasise the need to demonstrate public and business benefits and have a robust business model when trying to get external agents on board. In order to generate a commitment to share data, it is important to closely align the activities for opening up data with both how it is to be used by the local ecosystem stakeholders and how it will contribute to the delivery of services at the local level.

Low resources and resource constraints:
It is important to identify the skills and capabilities as well as resources available at the city-level prior to the initiation of the sandboxing process. In the case of small to medium sized cities lacking resources, initiatives at regional and national or pan-European levels (see section 8) could act as a lever to support data-sharing and data platform development.

6.0

How to set up a technical sandbox

6.0 How to set up a technical sandbox



Technical sandboxing has a well-established role in supporting good information and communication technology (ICT) management. However, there are **specific requirements** when sandboxing within a local data ecosystem where you will need to combine data from different sources in order to deliver added insights and new products and services.

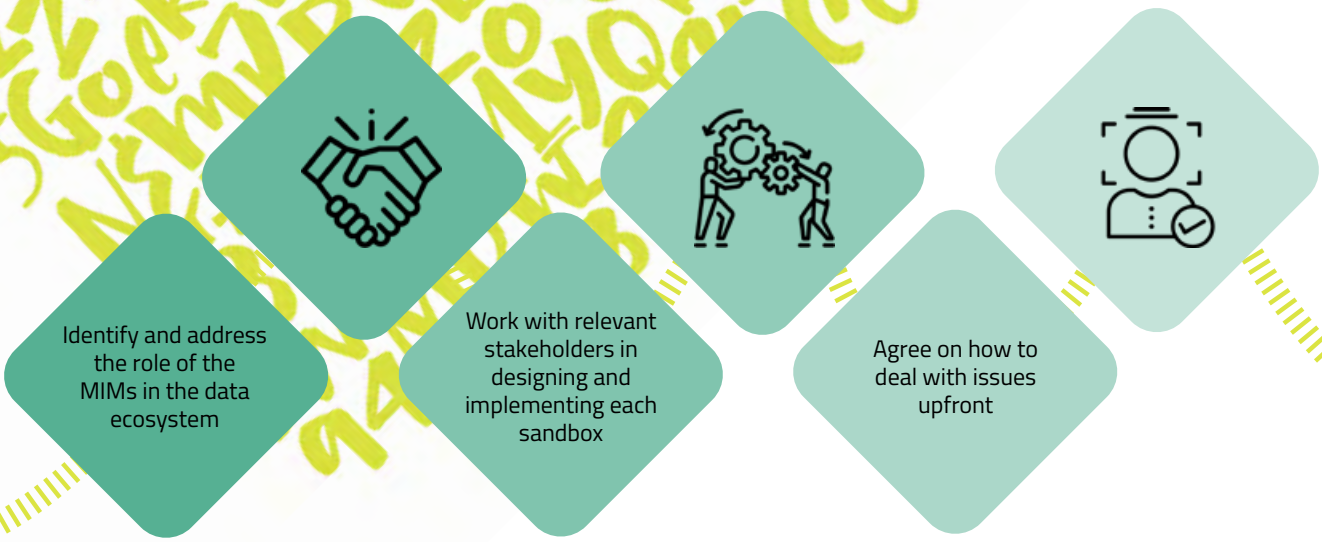
Here the **sandboxing can be used to develop and test applications in a data ecosystem** before operationalising them.

Or **to address concerns raised by stakeholders** during organisational sandboxing in order to help them commit to joining the ecosystem.

6.1 Do-not-forget list

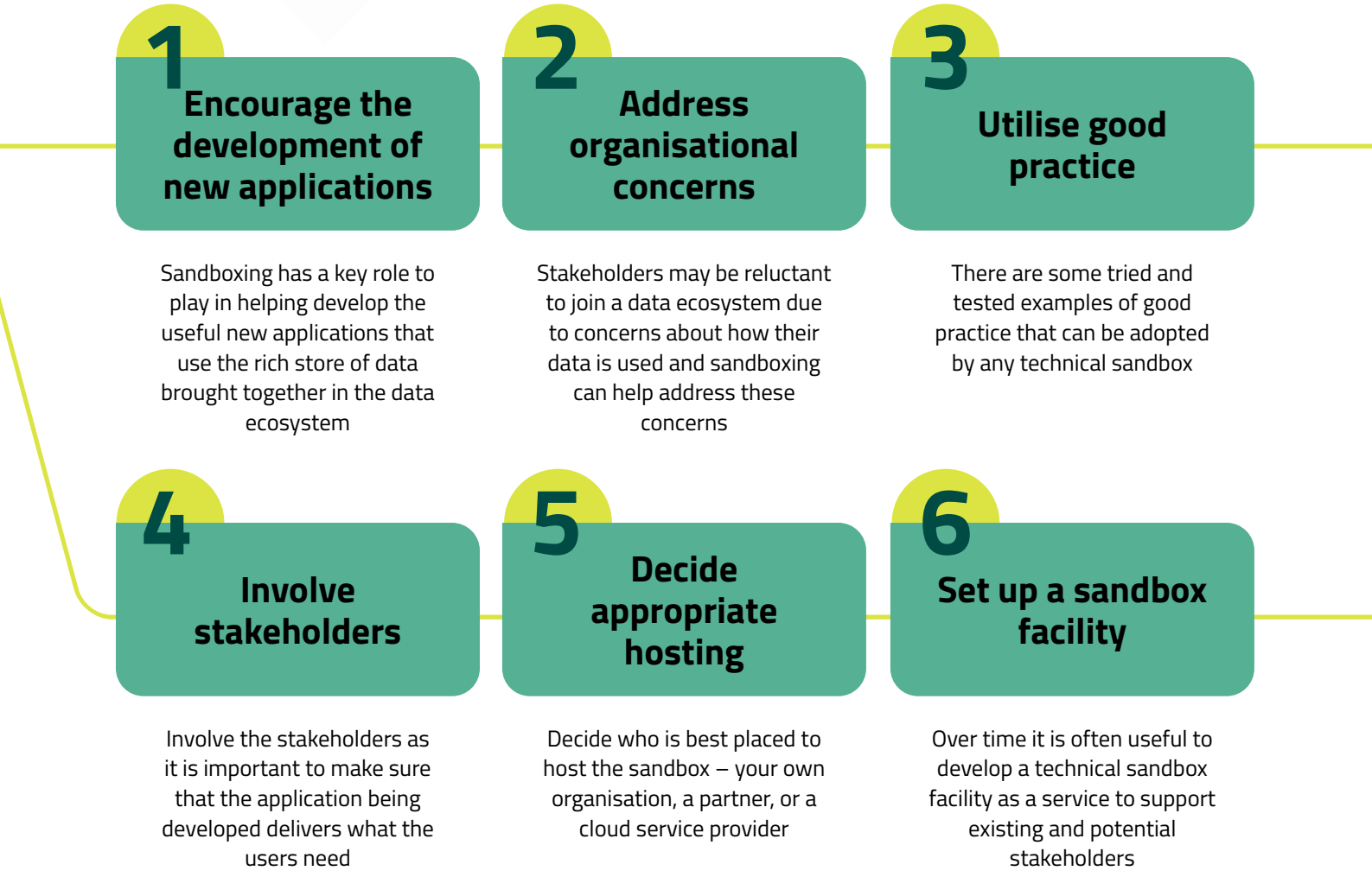
- As with organisational sandboxing, the launch of the technical sandboxing journey triggers a set of **initial questions** to address. These include:
- What is the role of the sandbox? Is it:
    - **developing and testing new applications**; or
    - **supporting organisational sandboxing**
- How can the **Minimal Interoperability Mechanisms** (MIMs) help? (See section 7)
- Who should **host the sandbox**?
- Is the sandbox only for a **specific use** or should it provide an **ongoing resource** to the data ecosystem?
- As with organisational sandboxing, a set of **key guiding principles** can be sketched out from the experience of the sandboxing in Poznan, Milan, Barcelona and Helsinki as shown in the figure overleaf.

Figure 8: Technical sandboxes – guiding principles



A **set of steps to follow** when planning or setting up a technical sandbox is provided below.

Figure 9: Technical sandboxing – step-by-step approach



Each step involves a range of activities to be carried out, and decisions should be made about the best way to handle each of them. The activities linked to each of the steps are further outlined in the table below.

1. Encourage the development of new applications	When setting up a local data ecosystem, the challenge is that the data will come from many different organisations and may be in different formats with different levels of accuracy and reliability	This makes it difficult to develop new applications and thus the danger is that the data ecosystem is poorly used	The use of technical sandboxing can help to show the value of potential applications by enabling quick and affordable proof-of-concepts to be developed	Justifiable worries of stakeholders about how their data might be misused within the data ecosystem can also be addressed by sandboxing	It can also address the lack of consistency of data formats and provide robust ways of developing and testing applications before they are ported to the operating environment
2. Address organisational concerns	When simply addressing stakeholder concerns a simple "proof of concept" might be enough	In this case, a basic sandboxing environment might be sufficient, with no need to replicate the operating environment	However, it is important to determine stakeholder concerns in detail to make sure that the sandbox provides a convincing result	In some cases, this might mean that the operating environment may need to be replicated in part or as a whole	
3. Utilise good practice	It is helpful to use containers, such as Docker containers, in your sandbox. These create a virtualisation environment for running an application: code, runtime, system tools, system libraries and settings	Containers isolate software from its environment and ensure that it works uniformly both at the development stage and when it is incorporated into the operating environment	Another way to reduce risk is to split complex applications into smaller modules/ microservices	These microservices can be loosely coupled and deployed independently and, because of their small size, have minimal impact on the operating environment	In any case, it is good to start with a Minimum Viable Product type application and then add in further capabilities step by step
4. Involve stakeholders	It is important to ensure that the application being tested meets the requirements of the users	There is a temptation to take a set of requirements and then build an application that meets those requirements	The danger is that the technical staff developing the application may not fully understand the business requirements	The value of sandboxing is that it is a staged process and enables the results to be demonstrated to users at every point	It is therefore good practice to involve users at each iteration of the application, to ensure that changes can be made where needed
5. Decide appropriate hosting	If you feel confident that the technical infrastructure and the expertise is available within your organisation, then it may well make sense to set it up within your organisation	However, you also have the option of using the help of a partner organisation or of working with a cloud provider to use their andboxing environments	In every case, it is important that you set the requirements and manage the process, to make sure that it delivers the outcomes you require and to continue to build your expertise	A good place to start is to make use of the European Commission's Big Data Test Infrastructure (BDTI) mentioned in section 8	This will enable you to gain experience with technical sandboxing without needing any investment and benefitting from the support of this dedicated organisation
6. Set up a sandbox facility	It is useful to provide a technical sandbox facility as part of any data space or data sharing ecosystem as a service for existing and potential stakeholders	This would make it easy for them to develop and test the new applications and services that could come from access to the many new data sets and data streams available in the data ecosystem	By making this easy, it will be much more likely that the stakeholders will use the data ecosystem to develop many new and useful applications	However, it is best to start by setting up one-off sandboxes to tackle specific issues	In this way you can build up a good understanding about the requirements for sandboxing in your specific data ecosystem before investing in something which may not provide what is needed

Table 4: Technical sandboxing – activities in focus per step

Insights

Box 6: Insights on how to achieve replicability for organisational sandboxes

How to achieve replicability for organisational sandboxes

As far as possible, incorporate from the outset the use of open-source technologies and open standards for the solution components. This aids their replicability potential, so that sandboxes set up to develop and test one application can be easily made suitable to develop and test others.

6.2 Key challenges and how to overcome them

Checking the suitability of the data you plan to use

- **Making sure the sandbox is fit for purpose:** For the sandbox to perform effectively it important that there is no unnecessary complexity so that it is quick and easy to set up and to start producing results. However, it is also important that all key issues can be properly tested and therefore that every facility is included. It is therefore vital to determine all the issues that need to be tested before designing and setting up the sandbox.
- **Making sure that the new applications can be implemented in the operating environment:** It is important that the applications that are developed and tested in the sandbox perform appropriately once they are placed in the operating environment and do not cause problems there. It is therefore important that the sandboxing environment replicates the operating environment.
- This can either be done in an **isolated environment** which replicates as far as possible the operating environment or by using a DevOps approach (See the box below.)

Box 7: DevOps and sandboxing

DevOps is a process that allows new applications to be developed and tested safely in the existing operating environment. The development and operation teams work hand in hand, allowing fast, efficient, reliable software delivery. The process of building, testing and deploying the new application is a continuous one.

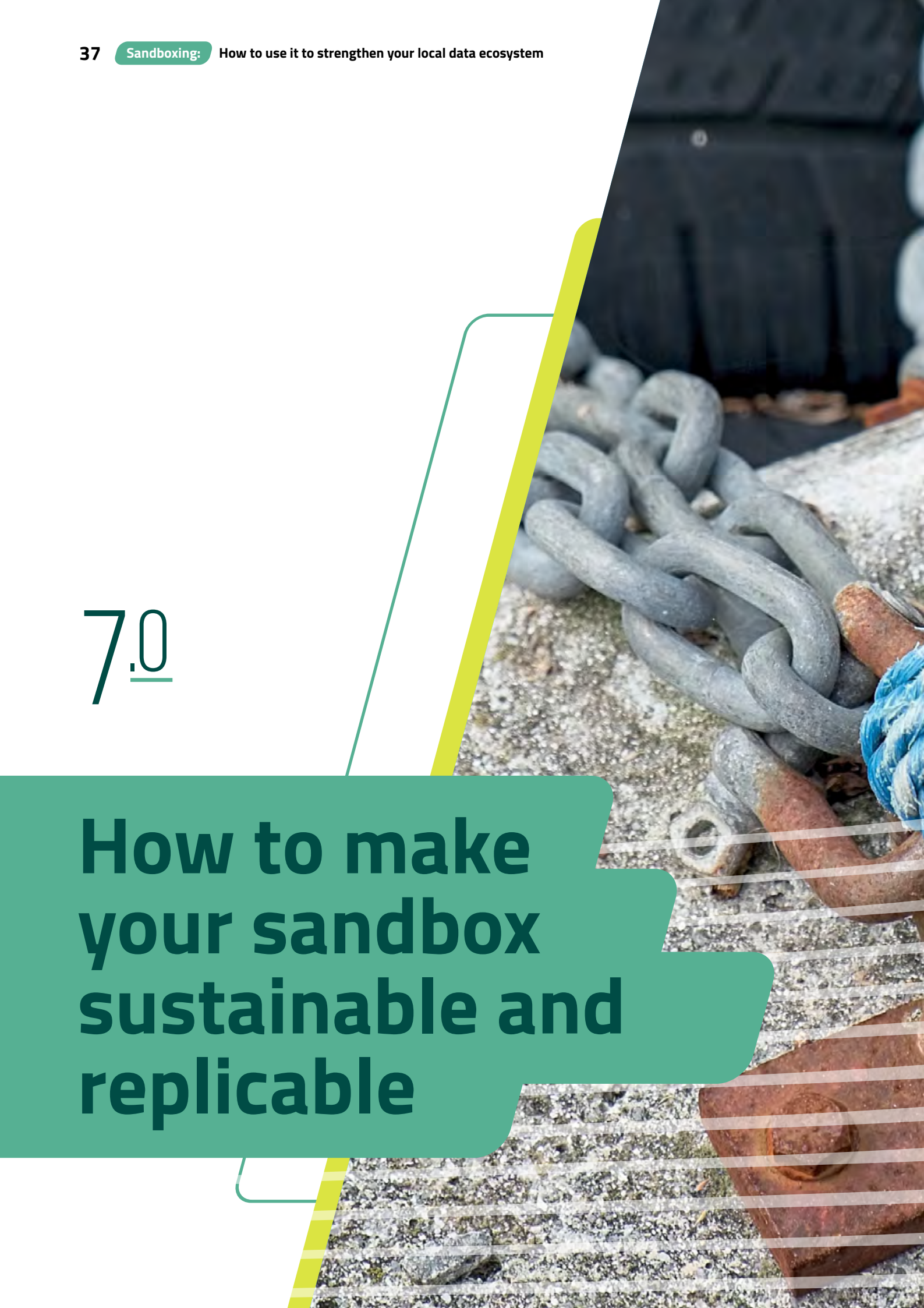
A minimal viable product (MVP) is first developed and put in the shared repository to be integrated into the production environment. Continuous versioning ensures that multiple versions of the code are available where needed, to enable immediate fall-backs to previous versions, should any problems be detected.

Changes to the source code in the shared repository are made several times a day, allowing rapid feedback so that any defect can be identified and corrected as soon as possible. A continuous integration service automatically builds and runs unit tests using automated tools on all new code changes to immediately surface any errors.

The tests are carried out using monitoring tools that continuously analyse resources and their metrics such as CPU, Host, Memory, Storage, and the network as a whole, to enable developers to immediately understand the performance and availability of their application, detect any errors, and correct them immediately.

This process enables changes such as the inclusion of new features, configuration management and bug fixing to be put into the operational system immediately. Any errors in the production code, can be quickly fixed, thus allowing the application to be developed and deployed rapidly and reliably with minimum overhead.

Of course, for the initial MVP and for other major changes, developers will run local unit tests on their code as an extra verification layer before integrating it into the production environment, but due to the use of microservices and containers, this can be done quickly and effectively, thus avoiding the use of traditional sandboxes.



7.0

How to make your sandbox sustainable and replicable

7.0

Sandboxing and Minimal Interoperability Mechanisms

7.1 Introduction

When setting up a local data ecosystem to support and manage data sharing between a range of different organisations there are several key capabilities needed to enable the development of useful and dependable applications.

Minimal Interoperability Mechanisms (MIMs) describe the minimum but sufficient set of these capabilities to enable the data ecosystem to be useful and effective. MIMs also indicate technical specifications that would enable those capabilities to be met.

As a result, most data ecosystems will include **at least the set of capabilities** described by the MIMs, whether or not they follow the specific technical specifications covered.

When setting up a technical sandbox it is therefore important to consider which of these **key sets of capabilities** need to be reflected in the sandbox in order to properly carry out the development and testing process.

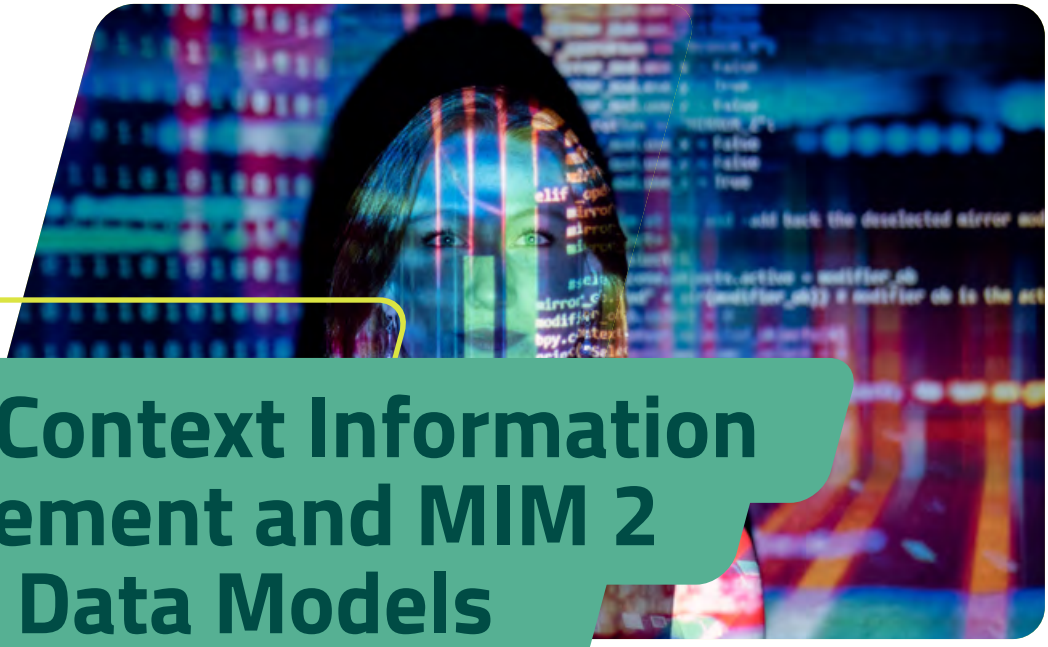
Here are some of the **most important capabilities** needed:

Finding and using data	A consistent catalogue system is needed that describes what each data set is about, its accuracy and reliability, and the conditions under which that data is made available by the owner
Managing context	Data owners will want to access other data that provides useful information about the context of their own data set in a way that will allow the relevant parts of the data in the two data sets to be automatically linked
Data models	All datasets being combined need to use consistent and machine-readable definitions of key terms or data models
Personal data	The data ecosystem needs to enable individuals to grant permission regarding who has access to their data, so that they always remain in control
Security	A framework for governance, risk management and control in the area of data security is needed, along with a baseline of security measures addressing the identified risks
Geospatial	Spatial (and spatio-temporal) data must be interoperable among stakeholders, whether it is static data concerning assets such as streetlights, buildings, and streets or spatio-temporal data from sensors

Table 5: Overview of important capabilities

These capabilities, along with others, are addressed by the set of ten MIMs in various stages of development by the Open and Agile Smart Cities https://mims.oascities.org/. Four of these are of most relevance to sandboxing in a local data ecosystem.

7.2



MIM 1 Context Information Management and MIM 2 Shared Data Models

These two MIMs work closely together.

The technical specifications in MIM 1 point to the **European Telecommunications Standards Institute (ETSI) Next Generation Service Interface-Linked Data (NGSI-LD) standard** as a tried and tested way to meet the capabilities described. This requires **Context Information to be structured around entities that have properties and relationships to other entities**. NGSI-LD then describes the application programming interfaces (APIs) needed to link the context data appropriately with the original database.

MIM 2 deals with the requirement that for the data to be MIM 1 compliant, all the data need to use consistent data models. The technical specifications point to several catalogues of data models that could be used to do this. In particular, MIM2 points to the **Smart Data Models initiative** https://smartdatamodels.org/ where data models are defined according to certain rules in an open and transparent way, based on specific use cases. This has resulted in an ever-growing catalogue of data models that have proven relevance to common use cases and ensures that applications that use those data models are interoperable.

When developing new applications using several different data sets or data streams originating from different stakeholders, it is **necessary to ensure that they all use a consistent set of data models and are NGSI compliant**. One way to do this in a sandbox is to have a set of components taking the data in, converting it to make it comply with the NGSI-LD ETSI standard and then delivering it into the context broker[12]. In the process, standard data models from the Smart Data Models initiative would be used.

Box 8: MIMs 1 and 2 example – the Poznan sandbox

In Poznan, the sandbox was used to develop an application as a proof of concept. The aim was to provide an easy first step to get one micro-mobility provider working in the city on board. The function of the sandbox was to provide a demonstration of how data could be received from the micro-mobility provider and be visualised. It this way it would help make the case for the city to implement a fully functioning system to help it plan and manage a system of dedicated zones from where the e-scooters could be picked-up and dropped-off.

12 - Context Broker is an API that can integrate data from multiple systems, creating a holistic view of information

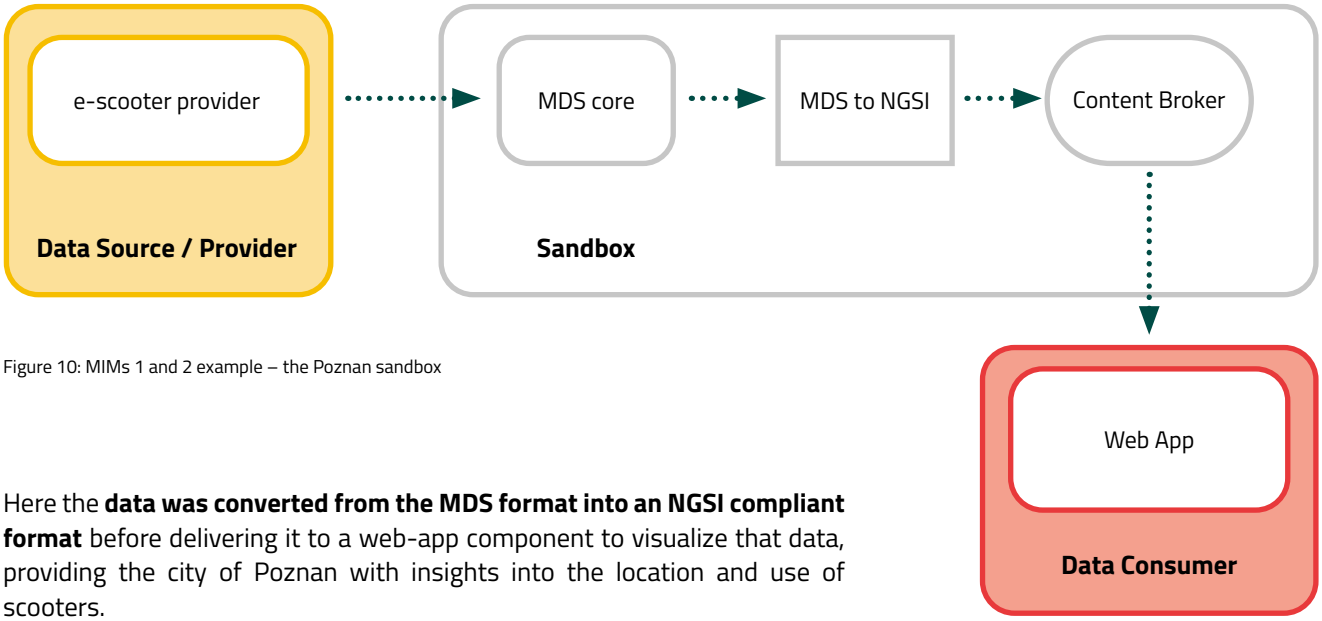


Figure 10: MIMs 1 and 2 example – the Poznan sandbox

Here the **data was converted from the MDS format into an NGSI compliant format** before delivering it to a web-app component to visualize that data, providing the city of Poznan with insights into the location and use of scooters.

7.3 MIM 3 Ecosystem transaction management

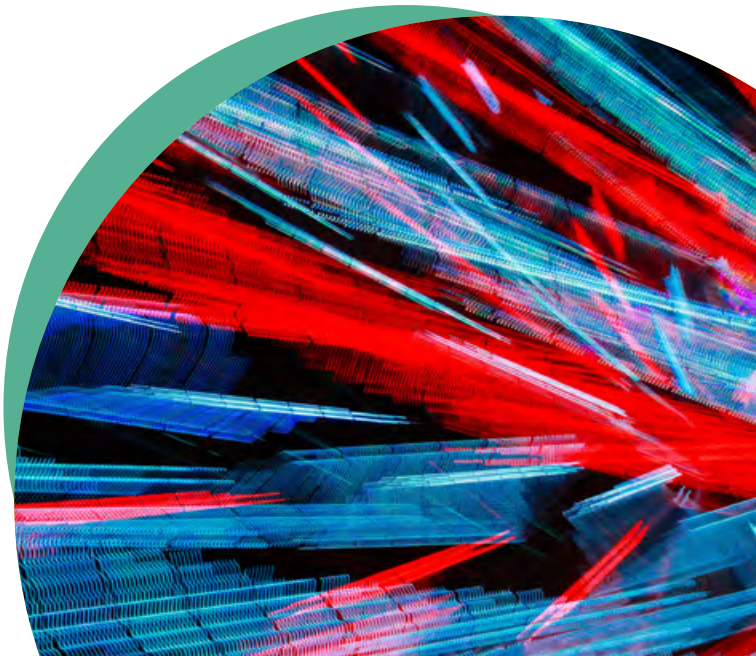
MIM 3 is relevant when new applications are being developed and tested in a sandbox using data taken from a complex data ecosystem.

MIM 3 provides the **management layer within that ecosystem which allows stakeholders to:**

- provide data along with relevant information about its **content and quality** and any terms and conditions for use;
- provide data processing services along with relevant **information and terms and conditions** for using the services;
- find and access the data and data processing services and other services they may need and to be able to gain **relevant insights into what those data streams/ data processing services/data applications consist of** and how valuable they can be.

There are various ways to realise such **Ecosystem Transaction Management**. MIM 3 points to a standardised way of doing so provided by TM Forum, which has created an application programming interface (API) suite of specifications for digital marketplaces, called the Business API Ecosystem.

A sandbox being used to develop and test applications that are intended to **take data from a data ecosystem needs to ensure that it includes and uses the APIs** needed to find and access the data that will be needed.



7.4 MIM 7 Places

The discovery, querying, retrieval, visualisation, and editing of geospatial information based on location and temporal criteria can be achieved through **open standard formats, protocols and preferably through the use of standardised API interfaces**. MIM 7 Points to a relevant set of standards to do this developed by the Open Geospatial Consortium and endorsed by the European INSPIRE initiative. Integrating context information with geospatial information can be enabled by the context management API and geospatial management API through common data information models defined in the MIM 2 data models.

Box 9: MIM 7 example – the Barcelona sandbox

The sandboxing in Barcelona focused on developing and testing an **automated process to improve the city's housing data ecosystem** to support management of data for public housing stock.

Specifically, the work involved:

- **Enriching data**, combining data from the land registry (Services of Cadastral Cartography by the General Directorate for Cadastre) with geospatial data from other internal systems and third-party data from external sources, enhancing the informative value contained in the data.
- **Integrating and managing data**, facilitating easier and more accessible data input/output (IO) operations, such as retrieving, writing and updating the information in order to access (and also modify) data faster and more effectively.

The figure below is a **graphical representation** of the Barcelona sandbox.

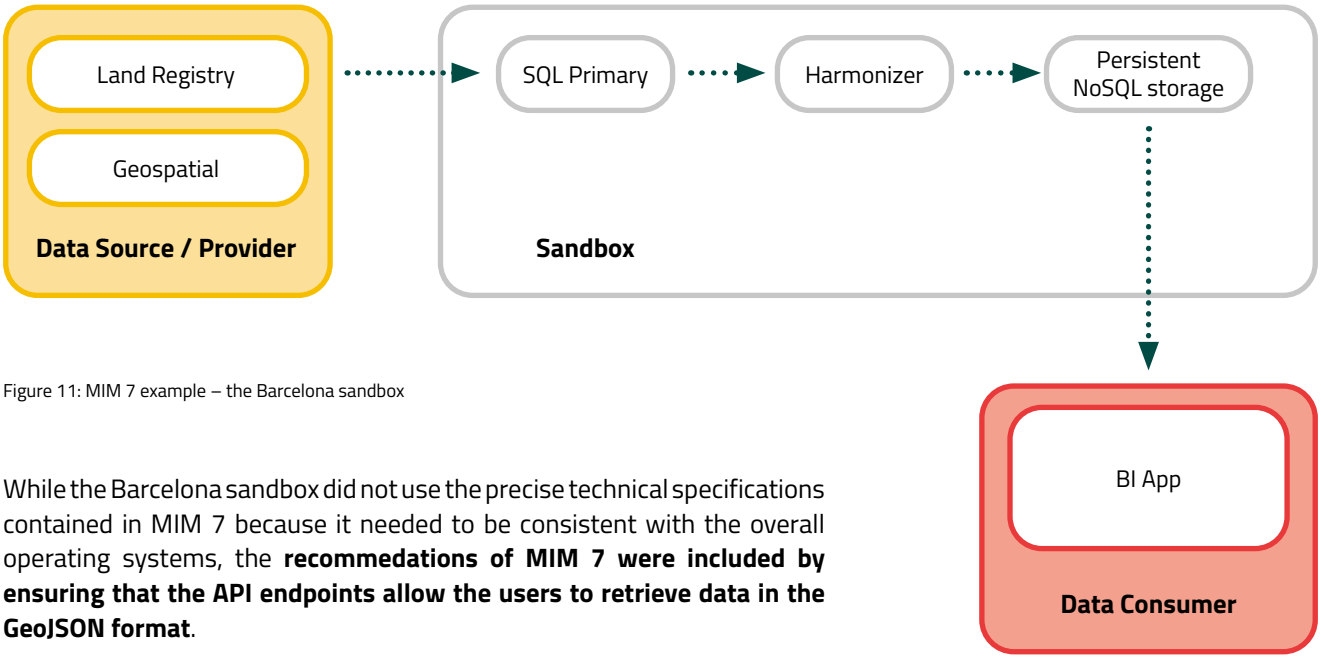
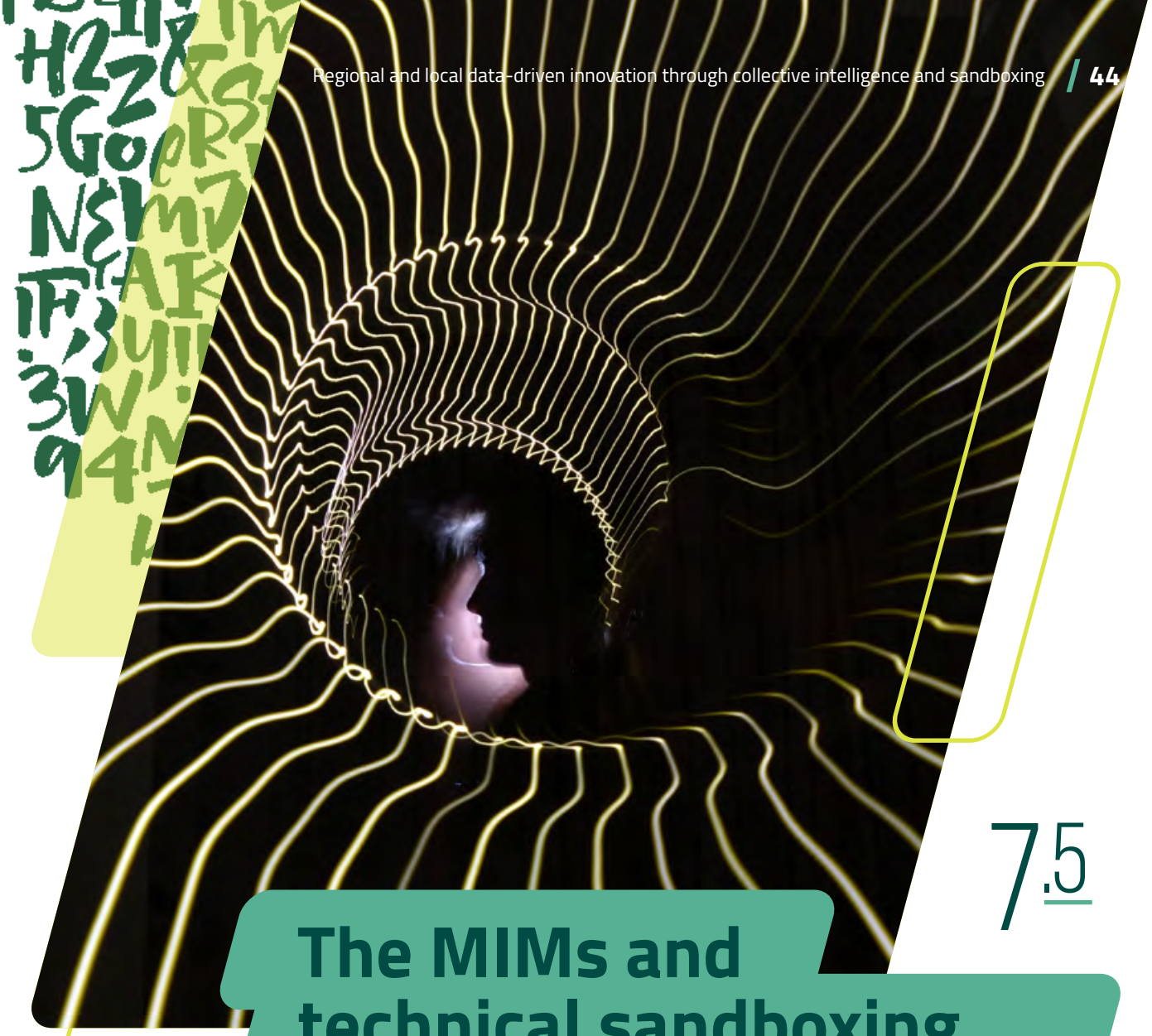


Figure 11: MIM 7 example – the Barcelona sandbox

While the Barcelona sandbox did not use the precise technical specifications contained in MIM 7 because it needed to be consistent with the overall operating systems, the **recommedations of MIM 7 were included by ensuring that the API endpoints allow the users to retrieve data in the GeoJSON format**.



7.5

The MIMs and technical sandboxing

Just as the MIMs provide a set of minimal but sufficient capabilities within a local data ecosystem or data space, they are also **important for technical sandboxing linked to such data ecosystems**.

MIMs 1, 2 and 7 are important in ensuring that the **data sets and data streams in the data ecosystem can be combined easily and effectively**. MIM 3 ensures that relevant data can be found, assessed for use, and accessed from the data ecosystem.

Other MIMs such as MIM 4 Personal Data Management, and MIM 6 security may also be relevant, for instance, in **demonstrating to stakeholders that the data they share within the data ecosystem will be managed effectively**.

When developing and testing applications that will be fully implemented, it is **important to comply with the technical specifications that are used within the operational environment of the data ecosystem**. However, when simply aiming to address concerns identified during the organisational sandboxing exercise, it will then often be sufficient to simply use the basic specifications covered within the MIM documentation.

Almost every technical sandbox used in such a data ecosystem will therefore need to employ one or more of these MIMs in its design.

8.0

Where to go for support

8.0

Where to go for support

The JRC serves as a **source of practical information on data sharing**. It is worth browsing the JRC Science Hub https://joint-research-centre.ec.europa.eu/index_en where many of your questions can be answered. The JRC Data Catalogue https://data.jrc.ec.europa.eu is a useful collection of sources of open data that can be used for sandboxing purposes.

A good first step to gain experience with the technical issues of sandboxing is to use the **European Commission's Big Data Test Infrastructure (BDTI)**, which was set up to help public administrations be more efficient using big data. The BDTI provides a set of services that can help you explore and experiment with various data sources, software and methodologies relevant to a local data ecosystem.

It will allow you, as a public administration, to:

- **Experiment with data analytics tools:** By testing and playing around with data analytics tools without wasting time on installation and settings, setups and configurations.
- **Collect insights:** By exploring data and collecting useful insights that might challenge and redirect public sector priorities and activities.
- **Experiment with data analytics tools:** Through using the free-to-use pilot facilities.

In short, the BDTI can provide you with the **necessary technical documentation and support services** to test and prototype analytics and Big Data solutions before deploying them in your own production environment.

As a clear focus for support of sandboxing activities related to local data sharing ecosystems, a good place to start is the **Living-in.EU initiative** https://living-in.eu. It is at the point of having its capacity expanded by the implementation of a secretariat and a data space.

The Living-in.EU **networks** are also an excellent resource to turn to. They can help with peer-to-peer networking, as well as providing advice and practical information.

- **Eurocities:** https://eurocities.eu
- **Open and Agile Smart Cities (OASC):** https://oascities.org
- **European Network of Living Labs (ENoLL):** https://enoll.org

- **Council of European Municipalities and Regions (CEMR):** https://www.ccre.org
- **European Regions Research and Innovation Network (ERRIN):** https://errin.eu
- **European Committee of the Regions (COR):** https://cor.europa.eu/en Specfically its network of Regional Hubs https://cor.europa.eu/en/our-work/Pages/network-of-regional-hubs.aspx that are focused on providing advice and help on legal issues, for instance on the General Data Protection Regulation (GDPR) can all be of help.

If you want to find companies that offer services to cities and communities, including sandboxes, the **LI.EU supporters list** (https://living-in.eu/supporters) can provide you with a good start.

In general, **Living-in.EU** provides a set of working groups, online resources and events for those who want to work with sandboxes, and they are aligned with such key initiatives as:

- **Mission on Climate-Neutral and Smart Cities:** https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en
- **100 Intelligent Cities Challenge:** https://www.intelligentcitieschallenge.eu
- **New European Bauhaus:** https://europa.eu/new-european-bauhaus/index_en and
- **The Smart Cities Marketplace:** https://smart-cities-marketplace.ec.europa.eu

All of which offer concrete support for setting up sandboxes.

Much of all of this is just starting up, but in particular, the 100 Intelligent Cities Challenge mentor programme and the Net Zero Cities mission platform https://netzerocities.eu/ offer concrete starting points.

In addition, the European Digital Innovation Hubs https://digital-strategy.ec.europa.eu/en/activities/edihs – especially those targeting public administrations – are also envisaged to be supportive of sandboxing, for instance, by providing testing facilities and transfer of knowledge.

9.0 Concluding remarks

In summary, the creation of sandboxes to address technical and organisational aspects of city ecosystems requires a tailoring to the local context. Assessing the local ecosystem's maturity and the specific sandboxing needs are essential steps before setting up a sandbox, helping organisations to define what can and what cannot be done in specific ecosystem.

- For any organisational sandbox, it is required to:
- Understand the local data ecosystem, the different roles and value exchanges as well as to formulate a value proposition that covers all concerned stakeholders

Ensure involvement of stakeholders, provide governance mechanisms and put in place terms and conditions allowing for co-creation

In addition, a technical sandbox requires:

- Identifying and addressing the role of the MIMs in the data ecosystem
- Have an agreement upfront on what needs to be developed and tested and involve relevant stakeholders in designing and implementing the sandbox

Utilise good practices, address organisational concerns and decide who is best placed to host the sandbox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The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies.

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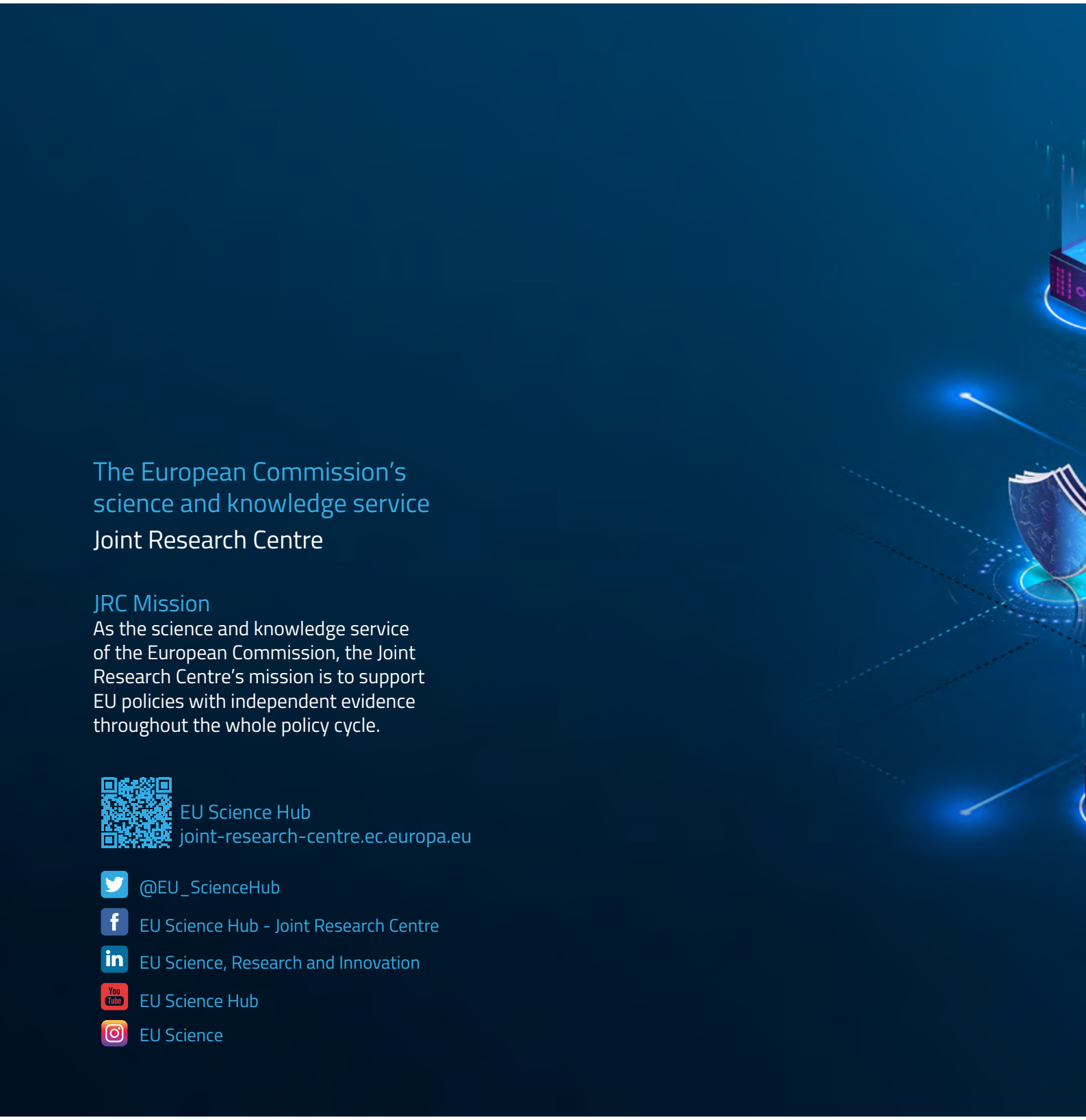
Sandboxing

How to use it to strengthen your local data ecosystem



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