Data policy models
in European smart cities

Experiences, opportunities and challenges in data policies in Europe

Bamberg, 15th November 2021

Commissioned by:

City of Bamberg, Smart City Stadt Bamberg, Maximiliansplatz 3, 96047 Bamberg

www.smartcity.bamberg.de

Reference persons:

Sascha Götz, Hilke Allerheiligen

Authors of the report:

Coordinator:

Dr. Sofia Pagliarin, Smart cities and sustainable communities, Vital Cities and Citizens, Department of Public Administration and Sociology, Erasmus University Rotterdam (the Netherlands)

Scientific Collaborators:

BA. Hannes Glückert

BA. Jon Meyer

BA. Patrick Vizitiu

Prof. Dr. Daniela Nicklas, Chair for Informatics, Mobile software systems, University of Bamberg, Germany and Smart City Research Lab (SCRL) of the University of Bamberg

Prof. Dr. Dominik Hermann, Chair for Privacy and Security in Information Systems Group, University of Bamberg, Germany

Attribution of authorship:

Dr. Sofia Pagliarin has structured, drafted, written and revised the main text of the report (including the Glossary) and of the texts for the cities of Barcelona and Zurich.

BA. Hannes Glückert has drafted the texts (city profile and Appendix text) of the cities of Hamburg and Stuttgart. BA. Jon Meyer has drafted the texts (city profile and Appendix text) of the cities of Vienna and Stuttgart. BA. Patrick Vizitiu has drafted the texts (city profile and Appendix text) of the city of Helsinki.

Prof. Dr. Daniela Nicklas and Prof. Dr. Dominik Hermann have written Chapter 1 (guiding questions) and performed the final editing for the remaining sections of the German version of the report.

All team members have been involved, to different degrees and also by means of https://www.deepl.com/translator (free version), to the translation of the English text into German.

Table of Contents

This page is intentionally left blank.

1. Guiding questions for the development of a data policy

In this first section, we present some central guiding questions that could play a role in the development of a data policy in the city of Bamberg:

What data can a data policy deal with?

- Personal and personally identifiable data
  - Personal data for citizen services (such as identity and address);
  - Personal data; here, personal individual information can be included in the data collection (population statistics, movement data, capacity utilisation of buses).
- Digital twin of the city
  - *Static*: geodata (maps, photos, plans), infrastructure (bus stops, electricity connections, range of WLAN access points, timetables, smart city infrastructure: information on available systems and the types of data collected in each case);
  - *Real-time data*: Sensor data (e.g. environmental parameters such as water and air quality, traffic lights, traffic counters, current position of buses, availability of parking spaces and car-sharing vehicles, water levels); if collected, these data can be related to a specific person;
- Transparent democratic processes: data and information from municipal processes (minutes of meetings, motions, budget ...) can be made publicly available.

What measures are taken to protect personal data?

- Basic technical and organisational mechanisms of data protection
  - Principle of data economy, avoidance of collection of personal components, pseudonymisation and, if possible, anonymisation as early as possible.
- The data policies considered do not specify detailed measures.
- Recommendation: Commitment to voluntary data collection
  - Avoid linking service use to data collection.
  - Example: Enable scooter use without creating movement profiles.

To what extent do data policies address the conflict between transparency of public data and protection of critical data?

- Data protection usually comes first.
- Private-law protection interests (competitive advantages) must be suitably overcome in order to achieve transparency (see also next question).
- Transparency levels *information asymmetry*; this can be a disadvantage for people or market participants who lose their information advantage as a result.
- Recommendation: *human-centred data use* as a requirement; weighing process before processing and provision: who are stakeholders, who benefits, who could be harmed, what could misuse scenarios look like? These questions can be addresed through risk management.

What contribution can the data policies make on the creation of value through "big data", for example through own business models or by supporting start-ups with public data that can be used to develop marketable products?

- Several manifestations:
  a) Buying data for money;
  b) Trade data for other data;
  c) Publish data with restricted access (identity of users known);
  d) Publish data freely accessible ("open data", users remain anonymous).

- Conflicting interests: Economic interests emerge in the operation of infrastructure by private companies that can conflict with the public interest of data use. To address this, a data policy could stipulate that contracts are only concluded with providers who make the city's data available to them and who collect and process this data in compliance with the data policy.
- Recommendation: A data policy should aim to point (d) above and, to a limited extent, also to point (c), as barriers to entry are reduced. This promotes the participation of citizens, which can lead to favourable and practicable solutions for practical problems.

2. The relevance to develop a data policy

Just as a car needs fuel or electricity to function, nowadays our societies need **data**[1] to be able to properly work. For instance, to go to school or to get an electricity contract for our homes, we need to give personal information about our name, address and mobile phone number. Public administrations need to collect and have access to data about their citizens, institutions, associations and private companies, for instance for the civil registry, to issue building permits, licenses and subsidies. Similarly, we also provide our data to private companies when we want to open a bank account or subscribe a plan in a gym.

However, a key characteristic of today "fuel" is that data come in digital form. For instance, we "feed" with our personal information the social media where we post our pictures and messages, or the online shops where we purchase goods and services.

Although we can voluntarily provide our personal data when filling in forms to enrol in schools, or to become a new client of a bank or to buy something online, nowadays most data are collected constantly and in an automatic form. The collected data are stored in enormous registries (called "databases") containing hundreds of millions of entries (**big data**). Our societies need enormous amounts of 'fuel' to function properly.

However, we are usually not aware of this constant data collection, nor of which data are collected or for which purposes, and by whom. For instance, we are usually trackable through the GPS of our smartphones and this presupposes that multiple satellites constantly exchange information to infrastructures (e.g. antennas) and data centres located in our cities. But we do not know which data the satellites "read" in our smartphones, when they are collected, where they are stored and how they are used. Digital data can also be collected through physical sensors or cameras in cities (**smart urban technologies**). Sensors and masts can be placed in the urban environment, for instance at crossroads or specific points along roads and highways, for monitoring traffic and air pollution. Digital CCTV cameras and 'webcams' can also be located in squares or pedestrian roads, recording and zooming to people's movements and faces.

The collection of these data is not a problem per sé, but for a city/public administration a central question is what to do with this new "fuel". Which data should be collected about citizens? How can citizens recognise the 'things' where data are generated, e.g. a sensor or a mast, and be informed about which data are collected and why? And what happens to these data? Where are these data stored, how are they used, and by whom, and can they be sold?

Answering to these questions is particularly important for cities that want to successfully become "smart". Although there are several definitions of what a **smart city** is, in this report we define a city to be smart when **information and communication technologies** (ICTs) are purposefully used to improve the **quality of life** of its citizens and the efficiency and inclusiveness of service provision and redistribution.

---

[1] Words marked in bold are included in the Glossary at the end of the Report.

To achieve these aims, a city needs to use data about its citizens and environment. Therefore, a smart city needs to develop a **data policy** concerning the collection, management and use (and by whom) of the data being collected about its citizens, organisations and private companies and about everything that happens within its city boundaries. A smart city is truly 'smart' when it has democratic control on the digital data collected about its citizens and environment. Data have become a new **public good** that democratically elected city administrators have to decide about.

This report presents some key findings of a comparison among the data policies implemented in a selected pool of European smart cities: Stuttgart (DE), Hamburg (DE), Vienna (AT), Zurich (CH), Helsinki (FI) and Barcelona (ES). The report is exploratory and has no ambition to be exhaustive. Rather, it provides concrete examples and identifies some good practices that can potentially inspire the data policy for the City of Bamberg. Interviews have been performed with the reference person(s) in charge of data policies to identify experiences, opportunities and challenges in developing and implementing a data policy for smart cities.

3. Data policies in smart cities

In this section, a "city profile" is presented for each of the selected cities. A short introductory paragraph provides key information on the experience of each city as a "smart city" and its timeframe, including the smart city vision identified by each city. In the city profiles, the main features characterising data policies are presented, together with examples of projects where big data have been used. The presentation of these projects has both the aim to show the diversity of the implemented projects, and also to provide an idea of the wide range of possibilities offered by the democratic use of citizen data in cities to improve government functioning and public service provision. Sometimes, similar projects are found in different cities. In some city profiles, quotes from the interviews are also reported.[2]

An important element of the city profiles are the key characteristics that we considered relevant to serve as possible guidelines to implement smart city and data policies in Bamberg. When writing the city profiles, we focussed on the potential lessons to be learned from other smart city experiences about how to develop data policies and a smart city strategy.

With the aim to facilitate readers in accessing the information contained in the city profiles, we used a simple visualisation through boxed frames that include short texts. We also used icons as a graphical element to communicate information of each of the selected cities in an immediate way. Across the city profiles, the icons for the "Smart city vision", "Data" and "Recommendations" boxed frames are all the same. Different icons have been used for the boxed frames referring to the projects.

Together, the smart city vision, the features of data polices and the key characteristics of the data strategy are used to identify different models of data policies for each city.

In the following pages, the selected cities are not presented in alphabetical order. Rather, we present the examined cities in a sort of progressive development of data policies and smart city strategy. In our analysis, the city of Stuttgart (DE) is in the first stage of data policies (i.e. setting open data infrastructures, smart city strategies, pilot projects), followed by the cities of Hamburg (DE), Vienna (AT) and Zurich (CH), which are in an intermediate stage (i.e. pilot projects, consolidation of the IT-infrastructure). We consider the cities of Helsinki (FI) and Barcelona (ES) to be in a more advanced stage, as they provide a more comprehensive smart city vision and heavily focus on citizen participation in developing a data policy.

---

[2] Additional and more detailed information on each of the city is provided at the end of the Report in the Appendix.

Of course, this does not mean that one city is "better than" another; simply, they are at a different stage of planning and implementation of their data policies and smart city strategies, according to the contextual economic, political, social and cultural specificities of each individual city.
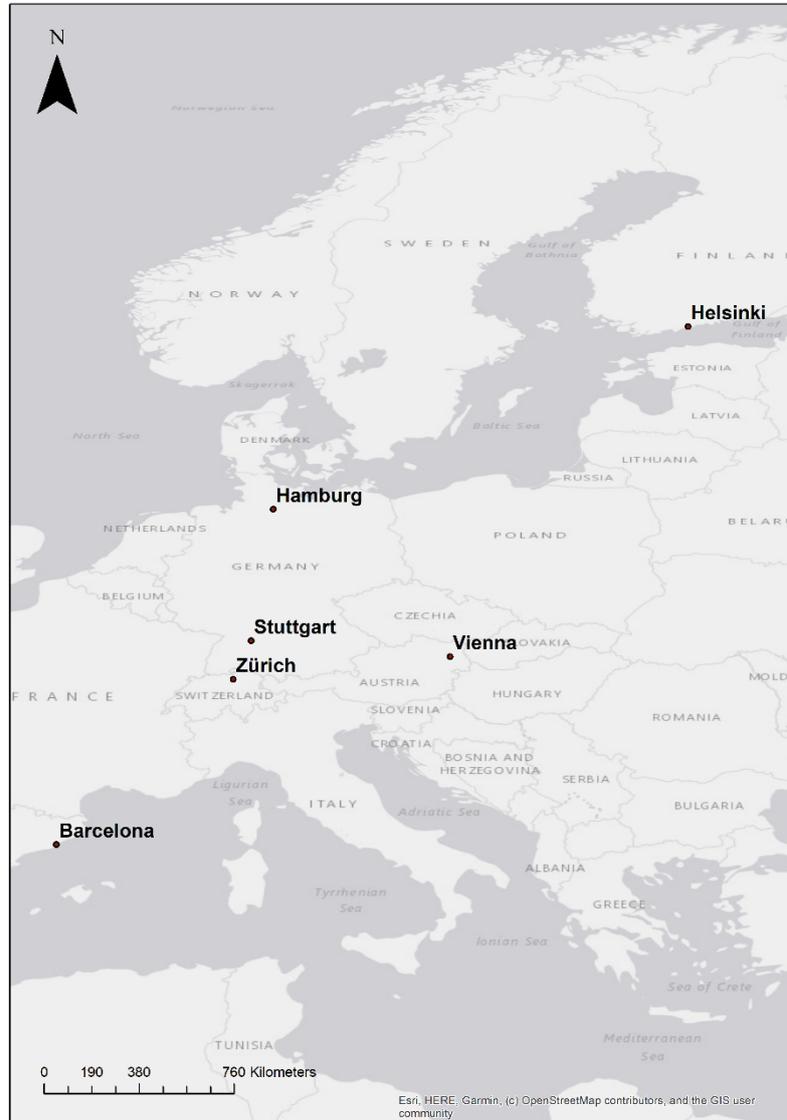
Map of the selected cities. Elaborated on Esri ArcMap Version 10.7 from "Natural Earth cultural vectors" https://www.naturalearthdata.com/downloads/10m-cultural-vectors/

3.1 Stuttgart, Germany

The City of Stuttgart has only recently started its own process to becoming a smart city. While individual smart city projects exist (https://www.stuttgart.de/service/digitalisierung/smart-city.php), there is not yet a comprehensive smart city strategy or an open data strategy. However, the city has an e-government strategy (2019) with a corresponding department that addresses the digitalisation of the administration. The Smart City department and team is foreseen to be located in the Economic Development Department.

Smart-City-Vision:

Sustainable and efficient design of the city of the future through intelligent networking of municipal infrastructures.

Data:

- Sharing of geodata across city departments
- An urban data platform for internal and external data exchange is being developed
- A digital or data strategy has not been developed yet
- An open data policy has not been developed yet (including the available geodata)
- There is still a general lack of awareness of the potential of data as an asset within the city administration
- Data protection, privacy and security are a priority

Key characteristics:

- Data-driven (pilot) projects are being devised and implemented as a foundation for stimulating the digital transformation of the public administration
- A pragmatic approach in developing (pilot) data-driven projects is preferred
- The City of Stuttgart is currently involved in the drafting of a framework strategy
- Permanent structures for exchange across public departments and private stakeholders (network for smart city cooperation) should be established in the future

"Together with the e-government department, we are making a proof of concept or a prototype, so to speak, a small amount, 50 data sets. (…) We are simply making these available now as open data, then we will go to the City Council together with the e-government team and present this open geodata to obtain legitimation of open data and proceed further."

Interview, Geodaten Stuttgart, November 2021

Project: Street panorama images of Stuttgart

The panoramic images obtained by the City Surveyor's Office from three tours of Stuttgart's 1800 km long road network were taken with enormous attention to data protection. All images are pixelated and filmed from a height of two metres. For capacity reasons, the data is stored in the provider's cloud, which also handles all data protection issues. Citizen participation only takes place in the form of informing the population about the activities through the media. Publication as open data is still difficult to reconcile with data protection requirements and the distribution model of the private company involved in the collection of the data.

Interview, Geodaten Stuttgart, November 2021

3.2 Hamburg, Germany

The Free and Hanseatic City of Hamburg operates its data governance under the umbrella of the Digital Strategy of 2020. The aim of this strategy is to find a balance between data use and data protection. The Hamburg 2020 Digital Strategy does not include concrete guidelines to do that, but the City of Hamburg adopted a practice-oriented, stakeholder-based approach where data management and use will be developed by the City council in cooperation with both public and private partners.

Smart-City-Vision:

Exploiting the transformation potential of digitalisation for the best possible quality of life and comprehensive social participation.

Data:

- Open data by default
- Data are accessible through the " transparency portal"(https://transparenz.hamburg.de/), on the meta-data catalogue of various federal states (https://metaver.de) or the German-wide data portal (https://govdata.de)
- The "transparency portal" is supported by the Urban Data Platform (UDP_HH), a state enterprise
- Data are legally protected through the "Hamburg Transparency Act"
- Data protection and information security are priority areas

Data policies have to be developed through individual, concrete pilot projects. Pilot projects lasts from 3 to 5 months and then they are evaluated. When these projects are successful, a blueprint is developed to be implemented in other contexts and city-wide. In this way, we have different projects that gradually build up Hamburg's data policy, integrating the regulations of the federal government.

Elaborated from Interview 1, Smart City Hamburg, October 2021

Project: Automatic traffic volume recording (aVME)

In the past, traffic monitoring was done manually once a year. Now real-time data are obtained with thermal imaging cameras - from all streets of Hamburg every five minutes, 365 days a year. These data are valuable for urban planning and traffic control. The images are analysed directly in the camera devices, and the data is then transferred to a Microsoft cloud via an interface specially set up by the experts at UDP_HH. Other interested actors, like private companies, also contribute to analyse the collected data. For citizens, the city's geoportal is the "window onto the data".

Elaborated from Interview 2, Smart City Hamburg, October 2021

Key characteristics:

- No comprehensive smart city strategy or data policy
- Practice-oriented approach to develop data-driven projects
- Long-term cooperation with public and private actors is preferred, using existing networks like the Association of Cities or the Metropolitan region
- Experiences from "smart cities" pioneers are considered
- Technical solutions are developed in the public sector to avoid dependency with external providers
- Building up technical know-how on new digital tools in the public administration is a priority

3.3 Vienna, Austria

The Vienna Smart City strategy is embedded in a broader strategic plan to reach sustainability goals ("Smart City sustainable development strategy 2050"). An important part within this framework is the Vienna Digital Agenda, which aims at the long-term governance of the digital transformation of the city. In the Vienna Smart City strategy, the optimal usage of new technologies is combined with extensive citizen-participation and the establishment of a modern digital infrastructure, where digital security and privacy are priority areas. The Digital Agenda also serves as a guideline for many specialised sub-strategies, like "Data Excellence" or "IoT (Internet of Things) -Strategies" that tackle the concrete challenges in everyday life, from the handling of Open Government Data (OGD) to the optimal steering of traffic via sensors.

Smart city vision:
A high quality of life for all Viennese citizens with the greatest possible resources through comprehensive social and technical innovations.

Vienna Rahmenstrategie

Data:
- Open data by default since 2011:
  The municipality provides data, documents and services classified as public in a machine-readable and freely accessible way.
- Data interoperability
- "Levels of Openness": maintaining a balance between data availability and limiting access to them for non-regional stakeholders

Project: Vienna Provides Space

A comprehensive mapping of the city through combination of GPS (geographical positioning system) and high-definition cameras mounted on cars. The product is a very high-quality and geo-located panorama imagery of the city. The data is anonymized and stored on secure, city-owned servers. These data are used for:

- Improved planning for public events (street festivals, flea markets)
- Faster processing of permits for public spaces, ranging from the opening of cafés to construction work
- Digital planning inspections

Data Excellence
A smart open administration is characterised by the following 3 pillars of data excellence:

- Pillar 1, Data Governance: Rules, organisation and processes are harmonised within the whole administration
- Pillar 2, Data Quality Management: Data are managed as a high-quality asset
- Pillar 3, Enterprise Data Management: Innovative ways are fostered to use data as assets

Key characteristics:
- Centralisation of data to facilitate access to the same database from multiple departments (overcome "data silos")
- Visions and comprehensive strategies are important to stimulate interest and set goals (desirability), but they also have to be linked to sufficiently concrete goals to be translated into (pilot) projects to implement (feasibility)
- Distinction between "nice-to-have" and "must have": which projects are necessary and which can be put off for a while?
- Create incentives and regulatory framework to promote and facilitate stakeholder participation

3.4 Zurich, Switzerland

In the City of Zurich, since the mid-2000s the Information Technology (IT) infrastructure is centralised into 2 main IT-centres (*Rechenzentren*, RZ). Cloud services, in combination with high attention to (personal) data protection and security, have been central to develop a data policy. Since 2016, the Smart City Zurich strategy has been issued; key areas are, for instance, digitalisation of public administration services and easy access for citizens and companies to public administration ("e-government"). The Smart City Zurich Team has been created in 2018 and it is cooperating across other public department and proposing pilot projects.

Smart city vision:
Connecting people, organisations or infrastructures to create social, ecological or economic added value.

"As a smart city, our approach is to make small scale projects, relatively fast to try to find out about what works and how the lessons about what works can be implemented in different contexts."

Interview, Zurich, October 2021

Project: Digital transparency in the public space

"Hundreds of sensors are already present in the city of Zurich. In this pilot project, we marked some sensors (around 30) with pictograms and QR codes to inform people that a sensor was there. The QR code could be scanned, and the citizens were redirected to the website where the data are stored. This pilot project included infrared or weight sensors to register pedestrians or bike traffic, so no personal data was collected. We cooperated with the departments of environment and statistics, and we had an external designer for the pictograms, about which we got feedback by asking 15 random people on the street".

Interview, Zurich
Digitale Transparenz im öffentlichen Raum,
https://www.stadt-zuerich.ch/prd/de/index/stadtentwicklung/smart-city/transparenz.html (Accessed October7, 2021)

Data:
- Open data by default
- Data interoperability
- Data are managed by the statistics department of the City of Zurich to make them open
- Open source code of implemented projects
- Switzerland-wide open data platform https://opendata.swiss
- High attention to (personal) data protection and security

Key characteristics:
- Data already available (e.g. environmental sensors, traffic data) are used for pilot projects
- Small team(s) to manage different (pilot) projects in the smart city
- Freedom to distribute budget to different projects
- Cooperation with different departments in public administration and private actors
- Integrate innovation in public administration can require more work and time from the side of civil servants
- Concerns about data security, protection and privacy should not hamper the implementation of data policies and innovative tools in smart cities
- Costs for the management and maintenance of open data should be considered in advance

3.5 Helsinki, Finland

The City of Helsinki approved its digitalisation programme in March 2019. Key characteristics of Helsinki's approach are putting people at the centre when developing data policies: data are to be used collectively across government, citizens and private companies. Data protection and security are key priorities in the digitalisation programme of Helsinki. The City of Helsinki foresee to become a fully functional digital city by 2025. To ensure the successful implementation of their data policy strategy, in August 2018 the City of Helsinki appointed its first Chief Digital Officer.

Smart city vision:
Making Helsinki the most functional city and its data the most usable and used city data in the world, in order to improve residents' quality of life.

Data:
- Move towards complete open data
- Using data collectively with residents, universities and communities for research and service creation
- Virtual 3D-representation and virtual access to services of the City of Helsinki
- Residents can limit and grant personal data usage according to MyData principles (www.mydata.org)
- Ethical use and full transparency of data use

Initiative: Proactive and Preventive Health Care

"We have been analysing our health care data using 300 medically approved criteria and from the data we have been trying to identify care gaps – the individual with the highest risks of getting sick – and proactively contact those. So, let's say you have a high blood pressure. We can call you in and make sure you have the right medication to avoid a heart attack or a stroke".

Interview, Helsinki, November 2021

"I believe that this human-centric use of data is increasingly important… I think we should find our European way of respecting human rights and being transparent and trustworthy. That is so important."

Interview, Helsinki, November 2021

Key characteristics:
- Human-centric approach to data-use: What benefits do we want to offer to serve people?
- Cross-divisional working groups to monitor the implementation of the data strategy
- Identification of service gaps for residents that use of data would fill
- Proactive and preventive use of data to serve people's individual needs at just the right time
- Recruitment of data scientist and collaborate with external data experts
- Development of the City's Artificial Intelligence and robotization capabilities, and use continuously updated data to improve services and decision-making
- Creation of an ambitious Digitalization Program and a leading head of digitalization position, such as a Chief Digital Officer (CDO) of the city
- When collecting and using data, complying with personal data usage regulations

3.6 Barcelona, Spain

Embracing the smart city agenda since 2011, the new political administration elected in 2015 radically changed the framing and the goals of Barcelona as a "digital city". From a technology-oriented and business-led smart city agenda, the City of Barcelona has been at the forefront of smart city initiatives focussing on social inclusion and empowerment. Collected data about citizens are considered a public or common good, as a new urban infrastructure, like roads or bridges. **Digital rights** are considered as a type of human rights, to be hence protected and used to create public value to satisfy the needs of citizens (i.e. development of digital democratic policies).

Smart city vision:
Barcelona digital city is characterised by 3 pillars: digital transformation of the city government, digital empowerment of citizens and digital innovation through public-private cooperation.

Data:
- Open data by default
- Citizen data as a prime asset (*City Data Commons*)
- Data interoperability
- Open source code, open software
- Data to be used to improve government (transparency, efficiency, accountability), satisfy citizens' needs (e.g. housing, unemployment, health, energy and mobility)
- Data managed by the Municipal Data Office (OMD)

Key characteristics:
Data policies in the City of Barcelona comply with the characteristics indicated in the Manifesto in favour of technological sovereignty and digital rights for cities (https://www.barcelona.cat/digitalstandards/manifesto/0.2/):

1. Public administrations in cities have full control, property and autonomy of their Information and Communications Technologies (ICTs) (***technological sovereignty** and data sovereignty*)
2. Citizen data are a public good to be protected (*digital rights for citizens*)
3. Data and documents have to be open (open city data), interoperable and accessible, including free software and open source codes (***open standards***)
4. Technologies are developed collaboratively through free software and open source codes
5. Open City Data are used by citizens and industry in cooperation in an ethical, transparent, accessible and sustainable manner
6. The above points will create transparency and auditability, security and privacy both within and across public authorities and through collaborations with the private sector.

Project: Open Budget

To achieve government transparency and accountability, citizens and anybody interested can view how public budget has been spent in Barcelona. The Open Budget tool allows viewing online where public money goes, from broad categories to detailed items of expenses. Data can be downloaded in open formats and is available in Catalan, Spanish and English.

https://ajuntament.barcelona.cat/estrategiaifinances/pressupostobert/en/ (Accessed 6 November 2021)

"We wanted to move away from a top-down, technology-driven approach of the smart city to a bottom-up citizen-framed vision. (...) We started with the real problems that cities have, in the case of Barcelona is affordable housing (...), of course healthcare, sustainable mobility and the energy transition, how to fight climate change and how to make our cities greener and more sustainable, creating more green spaces and a more participatory democracy."

Francesca Bria, City Digital Innovation Officer (CDO) Barcelona
Video: https://www.youtube.com/watch?v=0uUcjYOrGXw, (Accessed 10 November 2021)

4. Conclusions

From our analysis of the examined cities presented in the previous section, it is possible to appreciate that developing a smart city strategy and a data policy is a process. Becoming a smart city takes time and effort. In our analysis, we identified different ways, or "models", through which the examined cites are currently implementing their data policy and smart city strategy.

The city of Stuttgart is moving the first steps to define itself as a "smart city". The cities that are in an intermediate and more advanced stage (Hamburg, Zurich, Vienna, Helsinki and Barcelona) have already developed a smart city strategy, a data policy and an IT infrastructure that can support their transformation into smart cities. However, even among these cities, differences can be found.

The city of Hamburg has already a well developed IT infrastructure (Urban Data Platform, UDP_HH and Urban Data Hub, UD-HUB), but the value of citizen data as a resource and common good is not yet clear for the city administration. There are still several administrative barriers that limit the publication of citizen and government data as open data, hence decreasing the potential to create public value from the implemented data policy. Overall, the Hamburg smart city strategy and data policy appear to be predominantly technology-led and business-oriented, where pilot projects are developed in cooperation with private actors following a pragmatic approach.

The cases of Vienna and Zurich are similar to the Hamburg case, but their vision as smart cities is clearly related to a sustainability framework and smart urban technologies should also be used to increase citizen participation. The cities of Vienna and Zurich are currently engaging in the implementation of several pilot projects to find out what works (or not) ("experimentation" or "trial-and-error" phase) and how to implement successful projects city-wide (*scaling-up*).

A specificity of the City of Zurich is its IT-infrastructure: it has been completely restructured and renovated since the mid-2000s, offering an efficient, up-to-date and secure IT-infrastructure to plan and implement data-driven policies in the city. Additionally, as compared to the city of Stuttgart, the Zurich Smart City Team is not part of the Economic development department, but of the Spatial Planning department, thus differently characterising the role, scope and values of the Smart City Team.

The cities of Helsinki and Barcelona are, in our point of view, more advanced in their smart city strategy and data policy. This is due to two main reasons. First, in both cases, data are clearly and explicitly recognised as a key asset for the economic, political and social development of the city. Second, data are considered as a public good owned by the citizens. The status of data as common good owned by the collectively is put at the centre of Helsinki and Barcelona's data policies.

The consideration of data as a public good and whose ownership is held by citizens radically changes the way through which data policies and smart city strategies are planned and implemented. Even if data are open by default, interoperable, and open source software and coding are available in the other examined cities as well, what makes the cities of Helsinki and Barcelona different is how data are considered and used: the use of citizen data has to produce a public value for the collectively. Not only there is a strong emphasis on citizen participation, but also on social inclusion: digital technologies have to empower citizens to exercising their civil, social and political rights. For instance, training programs are set up to teach different age groups and genders how to use new technologies and how to more easily access the public services they are entitled to. In this way, the city administration becomes the custodian of citizens data. Digital data are a new type of human rights that public actors have to protect and secure.

Data security, privacy and protection are priorities that are common to all the examined cities. Another element characterising all the examined cities is the implementation of pilot projects to test data-driven policy ideas on a small-scale (i.e. different locations in the city on a small sample of the data that are already available) and for a short period of time (2-5 months). These pilot projects,

which can also run in parallel, are set up ("experimentation phase") in different domains (e.g. transport, environment, energy) and then evaluated ("evaluation phase"). The goal is to find out what works and then implement city-wide only the successful projects ("scaling up").

The planning, implementation and evaluation of pilot projects requires cooperation across departments within the public administration, in particular concerning data sharing. To stimulate cooperation, the identification of common goals, but also the individual benefits for each department ensuring from the cooperation, is key. However, our analysis also showed that the usual, non-digital procedures within the public administration need to change. The planning and implementation of pilot projects already need a digital transformation of the government. The public administration needs to make room for innovation, for instance by following AGILE working procedures or leaner processes.

Another key challenge that emerged in our analysis is a deficit of adequately skilled personnel to stimulate the increasing digitalisation of city administrations. City administrations have to re-train their staff to improve their digital skills (*Digitalisierungskompetenz*), gradually renew their working personnel and expand their IT-department with staff characterised by highly specialised and technical profiles.

We want to conclude by noting that, from our analysis, the term "smart city" seems to be already outdated and critically looked upon. The term "smart" or "intelligent cities" can suggest that some cities are qualitatively different and "better" than "non-smart" ones. Rather, many of the examined cities present themselves as "digital cities". Hence, it seems that the gradual digitalisation of public administration is the new primary goal for European cities in the next future.

In developing its data policy, the City of Bamberg should hence concentrate its efforts on the following main questions:

1. How does the IT infrastructure of the City of Bamberg need to change to support the digital transformation of the city administration?
2. How can the City of Bamberg improve the digital skills of its employees (*Digitalisierungskompetenz*) and support the cooperation within and across public departments and private actors for data sharing?
3. Which pilot projects using citizen data can be easily implemented by the City of Bamberg to increase the quality of its public services and promote social inclusion?
4. Which data of the City of Bamberg can be made open more easily and connected to Bavaria- and Germany-wide repositories?
5. Which steps are necessary to ensure data protection, privacy and security to make data "open by default" and interoperable?

5. Glossary

Data and big data: Data are information collected and organised in a structured way. For instance, a form we fill in to register in a municipality as a new resident, in a school as a new student or at a doctor's as a new patient are all forms of data: they require us to fill in information in a structured way, indicating e.g. our name, address, age, gender. In contemporary societies, we can also fill in information as data online, for instance through online forms or by filling in our personal information in smartphone apps.

Data are 'big' when information is collected in a structured way continuously and through computer-based automatic procedures. This means that, in a short time, hundreds of thousands or millions of data points can be collected about people (e.g. cars, GPS-locations, posts in social media) or the environment (e.g. air particles to monitor air pollution collected Germany-wide). As the volume of this data is enormous, they are generally referred to as 'big'. For more information about big data, see (Kitchin, 2014; Yeung, 2018).

Data management: Data management refers to which data (about citizens, organisations and enterprises) are collected and how, why and by whom these data are used, stored and/or sold.

Data policy: As it is defined in this report, a data policy is how public administrations intend to regulate data as a public good. Public administration are called to decide about which digital data about their citizens, organisations and enterprises are to be collected and how, why and by whom these data shall be used, stored and/or sold. This data management requires that public administration cooperate with private actors (governance agreements). Data policies are also connected to a specific vision of a smart city. Data policies are also called City Data Policy (CDP) or Smart City Data Policy (SCDP). Once a data policy is defined, a public administration will then be able to develop and implement a concrete data strategy.

Digital rights: Digital rights correspond to the capacity of individuals to decide about how and to what extent the personal information collected about them in digital form is to be used, stored and managed, and even deleted forever. Personal data in digital form are owned by the individuals who provided them. Public institutions have the duty to protect the digital rights of citizens and sanction their violation.

Information and communication technologies (ICTs), Information Technologies or Information infrastructures (IT): Information and communication technologies or Information Technologies is an umbrella term used to refer to the integrated use of hardware (e.g. cables, computers, servers, printers, mobile phones, antennas, sensors, WiFi routers, satellites) and software (e.g. software applications "apps", user interfaces, coding software) to enable the digital transmission of data across nodes in networks. An example of ICT is the Internet: it is the integration of hardware (cables, routers, servers) and software (internet protocols, browsers, search engines) to allow the transmission (communication) of data within a network. Networks can be local ("intranets") or connected globally ("internet"). ICTs have increasingly developed thanks to key innovations like the telephone, the radio, computers, satellites and the advancements in micro-electronics, especially since the 1970s (Castells 1996/2010, chapter 1).

Open data: Open data are data that are made publicly available by a public administration or institution. For data to be 'open', data have to be findable, accessible, interoperable, reliable and (re)usable by any citizen or organisation that want to. This is of course not easy to do, because it means that data have to be prepared beforehand for end users by specialised staff. For instance, data have to be 'polished' (organised in an understandable tabular form), made available in an **interoperable** format (e.g. Comma Separated File .csv; Open Office .odt) and also sources have to be found (e.g. by providing 'metadata'). An example of open data is the databases provided by the Eurostat: https://ec.europa.eu/eurostat , the Statistical Office of the European Commission.

However, some data cannot be 'open', like personal information about citizens' address or phone number. Further information about open data are available at the Open Knowledge Foundation https://okfn.org/.

Open data are usually considered to be an asset for smart cities because the opportunities for their use multiply. For instance, computer programmers or students can access them to make a new software application for smartphones (usually called as 'app') for city residents or inhabitants in a certain neighbourhood, or be used in artificial intelligence (AI). Therefore, education programs and initiatives like hackathons to teach (young) citizens about coding and programming are considered to be key in making the most out of open data in the future. See e.g. Barlow and Lévy-Bencheton (2018), chapter 2.

Open standard: There are several definitions of what an "open standard" means (see https://en.wikipedia.org/wiki/Open_standard). In a nutshell, a standard is a clearly defined set of characteristics ("specification") of a product or a service. A standard is "open" when it is publicly available and accessible. While a standard is defined by an owner or creator (an individual, institution or collectively), an open standard is non-commercial. In certain domains, "open" also means that the product or service is not only freely available, but also modifiable, to improve the product or service, but also to create new products and services.

Public good: A public good is an element that is non-excludable *and* non-rivalrous. A good is non-excludable when its consumption does not imply a payment (the good is freely accessible). A good is non-rivalrous when the consumption of the good by an individual does not decrease the ability of another individual to do the same. Public goods are both non-excludable and non-rivalrous. Examples of public goods are air or water. However, ways to equitably distribute public goods still need to be found to mitigate the negative effects of non-excludability and non-rivalry (e.g. overconsumption by groups of people).

Quality of life (and urban quality of life): Quality of life can be defined as the standards of living of people regarding material living conditions, access to public services, education and health, as well as other set of indicators, including some related to sustainability. More information can be found at the Eurostat website on the quality of life of Europeans: https://ec.europa.eu/eurostat/cache/infographs/qol/index_en.html

Smart city: A city is 'smart' when digital and information and communication technologies are integrated into the urban environment and in the management of the city to achieve a more efficient and inclusive service provision and redistribution.

Smart city policy: Smart city policies are specific public policies implemented in cities by using digital and information and communication technologies. Examples of technologies implemented in smart cities are:

- the installation of sensors for monitoring traffic and air pollution;
- the implementation of e-cards for integrated mobility (bikes, bus, tram, trains) in cities;
- digital monitoring of water systems or gas pipelines (smart grids);
- app-based health services.

Smart city vision: Smart cities are defined by the implementation of technologies in the urban environment and in city administration to improve the efficiency of public service provision. As the implementation of smart city policies depends on the decision of democratically elected city councils, these actors are called to identify and clearly communicate which technologies they want to implement, how and why. This corresponds to the vision that public actors have about how a smart city should look like. A smart city vision also calls into question the role of the public administration and of citizens in smart cities (i.e what does it mean for a city administration to be 'smart'? what does is mean for citizens to be 'smart'?) (Lim et al., 2019).

Smart urban technologies: They are physical supports, like sensors, cameras and e-cards, that collect data. If interconnected, they are a type of digital infrastructure that is commonly referred to as 'internet of things' (IoT).

Technological sovereignty: It is the capacity of individuals, groups or institutions to develop their own technologies and decide about which technologies are to be used for which purposes, and which characteristics these technologies have to have. Technological sovereignty has the goal to empower individuals, groups, institutions and organisations and make less dependent from the commercial power of technological companies.

This page is intentionally left blank.

6.   Academic references

Barlow M & Lévy-Bencheton C (2018) Smart Cities, Smart Future. John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119516224.ch1

Castells M (1996/2010) The Rise of the Network Society. 2nd ed. Oxford: Wiley-Blackwell.

Kitchin R (2014) The real-time city? Big data and smart urbanism. GeoJournal 79(1): 1–14. https://www.jstor.org/stable/24432611

Kitchin R (2014) Big Data, new epistemologies and paradigm shifts. Big Data Soc. 1, 2053951714528481. https://doi.org/10.1177/2053951714528481

Lim Y, Edelenbos J & Gianoli A (2019) Identifying the results of smart city development: Findings from systematic literature review. Cities 95, 102397. https://doi.org/10.1016/j.cities.2019.102397

Lynch CR (2020) Contesting Digital Futures: Urban Politics, Alternative Economies, and the Movement for Technological Sovereignty in Barcelona. Antipode 52(3): 660–680. DOI: https://doi.org/10.1111/anti.12522

Ostrom E (2010) Beyond Markets and States: Polycentric Governance of Complex Economic Systems. American Economic Review 100(3): 641–672. DOI: 10.1257/aer.100.3.641

Yeung K (2018) Algorithmic regulation: A critical interrogation. Regul. Gov. 12, 505–523. https://doi.org/10.1111/rego.12158

7. Reports and other resources

Bertelsmann Stiftung (2020) Umfrage in deutschen Kommunen im Bezug auf der Thematik "Open Data", "Wegweiser Kommunen". Available at: https://www.wegweiser-kommune.de/ (Accessed October 2021).

Bundesministerium für Ernährung und Landwirtschaft (n.d.) Open Data Land Projekt. Available at: https://opendataland.de/ (Accessed October 2021).

Deloitte (2020) Study on public sector data strategies, policies and governance Data analytics for Member States and Citizens. Annexes. D01. The Lisbon Council. Think tank for the 21st century. Available at: https://joinup.ec.europa.eu/sites/default/files/custom-page/attachment/2020-06/DIGIT%20-%20D01%20-%20Study%20on%20public%20sector%20data%20strategies%2C%20policies%20and%20governance%20v3annexes.pdf (Accessed October 7, 2021)

Kitchin R (2016) Getting smarter about smart cities: Improving data privacy and data security. Dublin: Data Protection Unit, Department of the Taoiseach. Available at: http://mural.maynoothuniversity.ie/7242/1/Smart (Accessed October 7, 2021)

McKinsey Global Institute (MGI), (2018) Smart cities: Digital solutions for a more livable future. McKinsey&Company. Available at: http://ceros.mckinsey.com/smart-cities-ex2-v1-online-1-1 (Accessed October 11, 2021).

OECD (Organisation of Economic Co-operation and Development) (2019) Data in the Digital Age. OECD Going Digital Policy Note. OECD, Paris. Available at: https://www.oecd.org/going-digital/data-in-the-digital-age.pdf (Accessed November 6, 2021)

Osimo D, Mureddu F, Peristeras V, et al. (2020) Data Strategies, Policies and Agenda. In: CEUR Workshop Proceedings, Linköping University, Sweden, 2020, pp. 11–27. http://ceur-ws.org/Vol-2797/. EGOV-CeDEM-ePart 2020. Available at: http://ceur-ws.org/Vol-2797/paper1.pdf (Accessed November 6, 2021)

8. Appendix

In the Appendix, more information is presented on the cities we examined about the development of smart city and data policies. In writing the Appendix, we tried to show the stages through which each of the examined smart cities have developed. Additionally, other relevant quotes from the interviews or from the documents are reported, as well as other projects in digital policies. To highlight yet another aspect of diversity across the selected cities, we also included the main logos and images elaborated by each city to communicate their smart city strategy and data policy.

In the Appendix, the selected cities are presented following alphabetical order.

Barcelona (Spain)
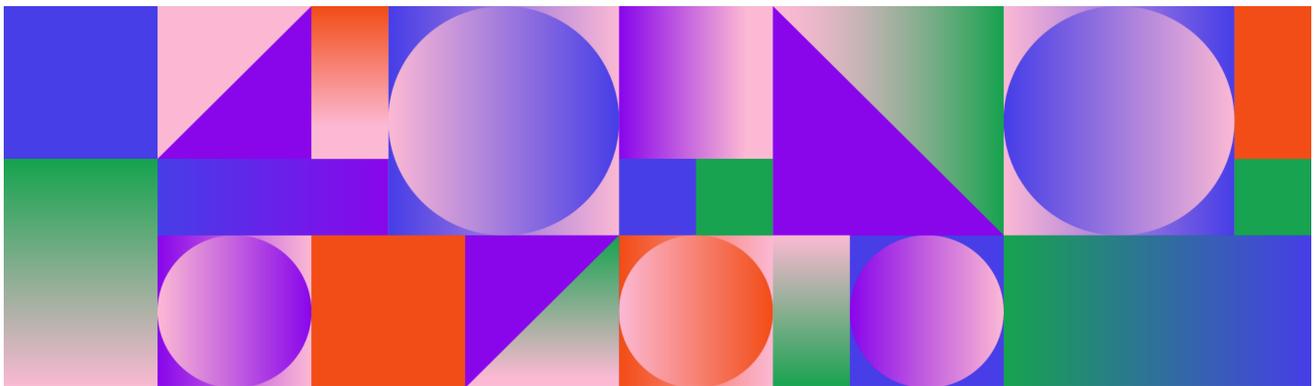
Barcelona Digital City / *Barcelona Ciutat Digital* https://ajuntament.barcelona.cat/digital/en
(Accessed 7 November 2021).

The City of Barcelona has been promoting a smart city agenda since 2011, but the political change occurred in 2015 has dramatically re-oriented the key characteristics and goals of the implementation of smart urban technologies in Barcelona. In the new smart city policy vision of the City of Barcelona, data collected on city residents are considered a prime asset in knowledge societies. As the increasing digitalisation of society implies that our digital footprint is becoming larger and larger, data are a key resource that needs to be managed and used in a democratic, open, transparent and regulated way.

Smart urban technologies have to provide social value for its residents and in a non-commercial way, in line with the Manifesto in favour of technological sovereignty and digital rights for cities (https://www.barcelona.cat/digitalstandards/manifesto/0.2/). Barcelona has also been one of the founders, together with New York (USA) and Amsterdam (NL), of the alliance to protect the digital rights of individuals on a global scale: the Cities Coalition for Digital Rights (https://citiesfordigitalrights.org/declaration). Key goals of the Cities Coalition for Digital Rights are providing equal and universal access to the Internet and promote computer literacy, while ensuring privacy, data protection and security. In public administration, this translates into a "better government" characterised by transparency and accountability: government data are open by default and should be non-discriminatory. This means that algorithms using these data are critically looked upon.

In terms of infrastructures, the Barcelona Digital City program is based on a Municipal Data Office (OMD, *Oficina Municipal de Dades*), headed by the Chief Data Officer (CDO), who closely cooperates with the Data Protection Officer (DPO). The OMD represents a transition from a more

traditional statistics office and view on data to a transversal office centred on the approach of data as a common good.

The Municipality of Barcelona has implemented a number of data-based projects to improve the provision of public services (from housing, to education, to mobility) and achieve social inclusion and empowerment; see https://ajuntament.barcelona.cat/digital/en/projectes (Accessed 6 November 2021). Participatory democracy is one of the main ways through which social inclusion is achieved.

Project: City Operating System (City OS)

A new generation of intranet in public administration has been developed in the City of Barcelona and it is called "City OS". It is a digital infrastructure based on open-code big data technology to optimise internal processes to offer better public services to citizens. It is also connected to the Municipal Management Urban Dashboard, which is an application available to city council employees showing a real-time visualisation of city data and supervised by the Municipal Manager's Office.

Another key project is about digital identity, allowing citizens to authenticate in a digitally secure area to be digitally identified and access public services.

https://ajuntament.barcelona.cat/digital/en/digital-empowerment/digital-inclusion/digital-education-and-digital-social-inclusion and https://ajuntament.barcelona.cat/digital/en/digital-empowerment/digital-education-and-training/steam (Accessed 6 November 2021)

Project: Decidim Barcelona

"Decidim Barcelona" is a digital and democratic platform for citizen participation, where citizens can participate in public debates by commenting upon existing proposals and make new proposals. Projects include the design of green areas and the formulation of strategic plans.

https://www.decidim.barcelona/ (Accessed November 6, 2021)

Projects: Fighting the digital divide and gender disparities in science and technology

Digital policies developed by the City of Barcelona are strongly characterised by ab emphasis on social inclusion. Training and educational programs have been set up for children and young people (up to 17 years old) and people over the age of 55 to promote education in digital technologies. Furthermore, together with the employment agency of the City of Barcelona (*Barcelona Activa*) specific programs have been set up to foster science and technology vocations from pre-school to secondary school, especially targeting women, by offering tools and resources to both teaching staff and families.

https://ajuntament.barcelona.cat/digital/en/digital-empowerment/digital-inclusion/digital-education-and-digital-social-inclusion and https://ajuntament.barcelona.cat/digital/en/digital-empowerment/digital-education-and-training/steam (Accessed 6 November 2021)

Hamburg (Germany)

Several milestones can be identified in the last decade on Hamburg's path to becoming a smart city. The "Transparency Act" issued in 2013 defined the publication of municipal data as open data, which is carried out via a city-owned "transparency portal". Hamburg's digitalisation really took off in 2015 when the city government, the Senate, adopted its first digital strategy, called "Digital City Strategy - Opportunities for Economic Power, Communication and Public Services". A key area was the further expansion of the open data available on the transparency portal.

In 2017, the data infrastructure, called the Urban Data Platform (UDP_HH), was established and integrates various databases in cooperation with the Urban Data Hub (UD-HUB) as the developer. This was followed in 2018 by the establishment of an Office for IT and Digitalisation (ITD) at the highest level of the city state: in the Senate Chancellery of the First Mayor. To reinforce the Hamburg digital and IT infrastructure, a Chief Digital Officer (CDO) was appointed.

In a decentralised manner, different departments developed digital strategies for their respective areas with the help of the ITD. A digital strategy portfolio allows each of the departments to compare the status of their projects and the ITD to gain an overview of the city's digitalisation efforts.

In 2020, a new digital strategy for Hamburg was approved, which includes the new data-driven projects and identifies areas of cooperation across departments by following common guidelines. The area of data and data policy is mentioned as one of these strategic future fields of development of Hamburg as a smart city. While data governance is the gradual regulation of urban data use, the UDP_HH is the technological backbone of the city in terms of data.

It is important to add that Hamburg, as a city state that combines municipal and state tasks in one territorial authority, enjoys a privilege in German federalism. It can be argued that implementing changes (also in terms of law and regulations) to achieve smart city policies through cooperation across departments is easier in Hamburg as compared to the other 13 German states that have much larger territories (*Flächenländer*).

Freie und Hansestadt Hamburg Senatskanzlei (2021). Digitale Stadt. IT und Digitalisierung. https://www.hamburg.de/senatskanzlei/it-und-digitalisierung/ Accessed 9 November 2021.

The central mission of data governance in Hamburg

"How can people be involved? Keywords are data sovereignty, dealing responsibly with people's data. This applies to the employees of the administration, but also to civil society and also to the private sector, which exchanges data in cooperation with the city."

Interview 1, Hamburg, October 2021

The challenges of data policies in Hamburg

"If we now say we are doing data governance for Hamburg, there are very few who shout 'hurray'.

"When you say 'Give me the data, I'd like to make it available to the public', the first question that comes is 'Why?'"

Interviews 1 & 2, Smart City Hamburg, October 2021

Hamburg's Urban Data Platform (UDP_HH) & Urban Data Hub (UD-HUB)

As a "system of systems", the heart of urban data use in Hamburg is the Urban Data Platform (UDP_HH). Using an analogy, the Urban Data Platform of the city of Hamburg is like Twitter or Facebook: it is a system of interfaces (called APIs, Application Programming Interfaces] with which the UDP_HH, like Facebook or Twitter, extract information about users and citizens.

The UDP_HH was established in 2017 and relies on open source technology. The UDP_HH staff contributes to the platform development with their own ideas and experience, and by proposing projects. The UDP_HH staff usually acts as "partners for the technical implementation, enabling and organisation of the data infrastructure" (Interview 1).

The Urban Data Hub (UD-HUB) is the IT-infrastructure supporting the technical aspects of the UDP_HH. The staff of the UD-HUB designs and controls the UDP_HH and its development. The UD-HUB is managed by the Hamburg State Office for Geoinformation and Surveying (LGV) and, as a organisational unit, is a "mesh of APIs and datasets that is then made available to citizens and the public". (Interview 2)

In the Hamburg's digital strategy, the UD-HUB is described as the "focal point for urban data use" (p. 31), while the UDP_HH is described as a "technological 'data hub'" (p. 29).

Interviews 1 & 2, Smart City Hamburg, October 2021

Cloud services in Hamburg

"I don't think it is necessary to generate yet another Cloud service that would go on top of the already existing specialised systems that we already have. Everyone must be aware that it is more important to combine things than to add something new."

Interviews 2, Smart City Hamburg,
October 2021

Helsinki (Finland)

Helsinki ranks second in world-wide Smart City Index. Available at:
https://www.hel.fi/uutiset/en/kaupunginkanslia/helsinki-ranks-second-in-worldwide-smart-city-index
(accessed 10 November 2021).

Through the analysis of the digitalization strategy of the City of Helsinki, we were able to identify four *goals* that the creation and implementation of data policies should promote:

1. Data should be used to create a city that proactively responds to resident's service needs on their terms
2. Expand and speed up the utilization of knowledge through data to make data-driven decisions
3. Optimize the city's use of resources automatically through data, artificial intelligence and robotics
4. Collaborative work with residents, communities, universities and companies to improve and develop city services.

In order to facilitate the implementation of these four goals, the city of Helsinki has outlined five *"initial measures"* that will be gradually brought underway:

1. The establishment of data and analytics platforms to collect, visualize, and analyse data
2. Creating cross-divisional working groups, monitoring the implementation of the data strategy
3. Creating a consent management system for residents to transparently monitor data use
4. Facilitating the data use by the city without violating ethical principles
5. The establishment of a data and analytics team, which can collaborate with external consultants.

While the collection and use of personal data for the creation and implementation of data policies is essential on the path to city digitalization, one of the most important factors to be overcome is an ethical one. All initiatives brought underway by the city of Helsinki that involve the use of personal data must always align with data protection regulations. Therefore, the city of Helsinki has promoted the use of data in accordance with MyData principles (https://mydata.org/about/), which offers citizens full control over the use of their personnel data.

Building a trustworthy relationship between the city and its residents based on full transparency is the second fundamental building block for Helsinki, with the first being the data policy goals and initiatives outlined above.

"One of the most important development areas in our Digitalisation Programme is improving the data and AI capabilities. Our Data Strategy sets important ground rules for the utilisation of data. The world's most usable city data makes for a great change: a city, which anticipates the need for services, on the people's terms. In the future, we can use data to anticipate the people's and companies' different needs for data and services and, for instance, in the promotion of health and well-being, prevention will play an increasingly important role."

Data produced by Helsinki is world's most usable and used city data by 2025
https://www.hel.fi/uutiset/en/kaupunginkanslia/data-produced-by-helsinki-is-worlds-most-usable-and-used-city-data-by-2025

Project: Digital Twin

"Helsinki has been transformed into a comprehensive 3D model that will be further refined into a digital twin. This will help the City develop and model ideas that would be difficult to test in the real world. (…) City and traffic planning, as well as construction decisions, can be visualised and tested using a virtual city model. (…) Tourists can visit, experience and shop in a virtual Helsinki."

Helsinki Digitalization Program

Helsinki's 3D city models,
https://www.hel.fi/helsinki/en/administration/information/general/3d/3d (Accessed November 10, 2021)
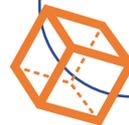
Stuttgart (Germany)

Smart City Stuttgart,
https://www.stuttgart.de/service/digitalisierung/smart-city.php
(Accessed November 11, 2021)

The strategy of the City of Stuttgart to stimulate the digital transformation of the public administration ("e-government") is called "DigitalMoveS" and was adopted in 2019. The city administration has taken on the role of an "engine" for the city's digital development. The DigitalMoveS strategy sets the three pillars on which a more comprehensive smart city strategy for Stuttgart should be based on:

1. People: Administrative and public services have to be oriented to satisfying people's needs;
2. Processes: existing procedures and operations in public administration have to be gradually digitalised;

3. IT-infrastructure: the IT infrastructure forms the basis for implementing the two pillars above.

Regarding Pillar 1: People, key areas where data-driven policies have been implemented are the city-wide mobility data management for the monitoring of air pollution, traffic monitoring and water drainage control. These are also key areas connected to the more comprehensive topic of sustainability. Furthermore, the city administration of Stuttgart has made efforts to stimulate the participation of citizens by consulting the participation advisory board. Participation has taken place through an online platform accessible at the city's homepage – to collect ideas, recommendations and critiques from citizens. Regarding Pillar 2: Processes, an urban data hub for geodata has been established.

The City of Stuttgart sets 2025 as the timeframe within which to implement its strategic plan as a smart city. This transformation is also supported by changes in the legal framework, in particular the implementation of the federal Online Access Act (OZG) by 2022. The City of Stuttgart also relies on the cooperation and partnership with other municipalities, for instance thanks to the German Association of Cities, as well as with the state of Baden-Württemberg.

"It is not the people who serve the technology, but the technology that serves the people (p.9).

e-Government Strategy Stuttgart

The lack of awareness of data as a key resource for city administrations

"[W]hat would be helpful is if this awareness of the value of data were to increase a bit more. [...] [T]he municipalities are far from being aware of how valuable the data actually is, or only at half the level. [...] [I]ntrinsically, it is not yet really ingrained in us, in the city administrations, not just in Stuttgart probably, but in general, that this is actually an incredible, valuable data stock and that we have to build on it, because it is the basis for decision-making."

Interview, Geodaten Stuttgart, November 2021

The challenges of Open Data in Stuttgart

"Unfortunately, there is no 'top down' open data strategy in Stuttgart. This has come up again and again in politics, but (…) and as a personal opinion, but which is also shared by many others in the department, (…) I think it is a bit of a shame. [because] We would like to offer a bit more open data, but sometimes we would need a mandate to do so, because it simply costs time and money and is difficult without a mandate. At the same time, the internal pressure [to make data more open] has not yet been that great."

Interview, Geodaten Stuttgart, November 2021

Vienna (Austria)

Stadt Wien (2021): Smart City Vision. https://digitales.wien.gv.at/digitale-agenda/ .
Accessed 07.11.2021

The development of a smart city strategy for the city of Vienna started in 2011 with mostly energy technology related projects towards a transformation of the city into a more sustainable urban living space. The Vienna smart city strategy was the result of a cooperation between experts from politics, public administration, science, government and civil society. The first smart city strategy for Vienna was issued in 2014 and has been updated in 2019. A key characteristic of the 2014 and 2019 smart city strategies for Vienna was the establishment of a direct link between digitalization and the United Nations (UN) Sustainable Development Goals (SDGs, https://sdgs.un.org/goals). The Municipality of Vienna foresees to successfully complete the transformation to a smart city by 2050.

Within the Vienna smart city policy, a central role is assigned to the Digital Agenda, which is connected to concrete projects. We found the "Data Interoperability" and the "Internet of Things (IoT) strategy" particularly interesting, and more information on them can be found below.

Data Interoperability and Combination

Every city generates a massive amount of data in a diverse landscape of municipal departments, research projects or in cooperation with private actors. An often overlooked aspect is the need to find an efficient way to combine these data to analyse. The City of Vienna is addressing this issue in a 10-year timeframe by finding out good ways to big data generated by sensors and increasingly connected in networks (Internet of Things, IoT).

Internet of Things (IoT)

•   The city of Vienna aims at establishing and expanding a network of interconnected data infrastructure (IoT).

•   The ideas and suggestions for IoT in the Vienna city administration come from the citizens. Citizens are called to actively help shape their city by using the participation program of the city of Vienna.

https://www.partizipation.wien.at/de/consultation/diskussion-zu-internet-things
Accessed November 2021

Zurich (Switzerland)

In our examination of the experience of the City of Zurich, we could identify three main phases for the development and implementation of data policies.

First phase. A necessary condition for the development and implementation of data policies is an up-to-date IT-infrastructure. In the mid-2000s, the City of Zurich heavily invested in the re-organisation and upgrading of its IT-infrastructure. Within the framework of a comprehensive strategic plan called "Führungsmodell Stadtrat Zürich", the 2006 "IT Strategie" for the City of Zurich aimed at reducing costs for staff, hardware and software through three main strategies:

- centralise over 80 IT offices into 2 main IT-centres ("Rechenzentren" (RZ) or "Organisation und Informatik Zentrum", OIZs) according to the principle of "Georedundanz";
- standardise the hardware (e.g. monitors, printers) and software (apps) used in the OIZs and in the public administration offices of the City of Zurich;
- implement SAP and organise training on the new IT-tools for civil servants (*Digitalisierungskompetenzen*).

Second phase. Once the IT-infrastructure has been renewed, reorganised and updated, in 2016 the City of Zurich proposed a new IT-strategy ("IT-Strategien 2016"). Key areas of the 2016 IT-strategy are: (personal) data protection and security; digitalisation of public administration services; easy access for citizens and companies to access administrative services and fulfil administrative duties online ("e-government"; e.g. "Mein Konto" for citizens; "Digitaler Posteingang") and the development of a digital twin ("Digitale Zwilling"). In the City of Zurich, government data are "open by default". This means that, if there are no reasons against it (e.g. privacy concerns), the data are provided in an **interoperable** format (e.g. in csv) and uploaded online in a Switzerland-wide repository (https://opendata.swiss).

The Smart City team of the Stadt Zürich is part of the urban planning department of the city (*Stadtentwicklung Zürich*). The Smart City team mainly act as a node: on the one hand, they communicate across the other departments in public administration that implement smart technologies in the city; on the other hand, they propose their own smart city projects, like digital transparency and participatory budget.

"Because we are the department of urban planning, we actually do not have that many *Hoheitsgebiet*, areas where we are the deciding department, because we are a department that work across the other departments, as compared for instance to the environment and health department. We are a cross-sectional department, so we need other people in other departments to do our work, so we are prone to work in network and cooperate."

Interview, Smart City Zurich, October 2021

"Smart city policies very much distributed in different departments. (...) Smart City Team is a sort of node where all different departments, like energy, come together. (...) Our primary role is communication, we communicate with other departments about the smart city projects that are implemented, and then we have our own projects. We have this dual role."

Interview, Smart City Zurich, October 2021

Project: Participatory budget

"On an online platform, people posted their ideas. We got 160 different ideas in different neighbourhoods, like neighbourhood parties or tree planting. It is participatory because we asked people what they want, and now people can vote on 136 of them. We will then distribute the money – roughly 500'000 CHF - to the projects that get the most votes so people will implement the projects themselves."

Interview, Smart City Zurich, October 2021

9. List of examined documents

Below, the main documents used in our analysis of each of the selected cities are listed.

Barcelona

Bria F and Bain M (v0.2) Manifesto in favour of technological sovereignty and digital rights for cities :: Ethical Digital Standards (v0.2). Available at: https://www.barcelona.cat/digitalstandards/manifesto/0.2/ (Accessed 6 November 2021).

Municipality of Barcelona (2021) Barcelona Digital City / Barcelona Ciutat Digital. Accessible at: https://ajuntament.barcelona.cat/digital/en (Accessed 7 November 2021).

Municipality of Barcelona (2021) Barcelona Digital City. Projects. Accessible at https://ajuntament.barcelona.cat/digital/en/projectes (accessed 6 November 2021).

Municipality of Barcelona (2017) Barcelona Digital City. Frequently asked questions (FAQs). Available at: https://ajuntament.barcelona.cat/digital/en/about-us/faqs (Accessed 6 November 2021).

Institut Municipal d'Informàtica (IMI) (2017) Pla digital de l'Ajuntament de Barcelona. Mesura de govern per a la digitalització oberta: programari lliure i desenvolupament àgil de serveis a l'administració pública. Tecnologia i Innovació Digital, Comissió d'Economia i Hisenda (Consell Municipal de Barcelona), Àrea de Treball, Economia i Planificació Estratègica. Available at: https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/106226 (Accessed 1 October 2021).

Institut Municipal d'Informàtica (2016) *Mesura de govern: Transició cap a la Sobirania Tecnològica. Pla 'Barcelona Ciutat Digital'*. Octubre 2016. Ajuntament de Barcelona. Available at: https://ajuntament.barcelona.cat/digital/sites/default/files/pla_ciutat_digital_mdgovern.pdf (Accessed 1 October 2021).

TX Group - Switzerland (2019) Turning Barcelona into a Smart City - Francesca Bria (City of Barcelona). Zurich. Available at: https://www.youtube.com/watch?v=0uUcjYOrGXw (Accessed 11 November 2021).

Hamburg

City of Hamburg (n.d.) Digitalstrategie. Available at: https://www.hamburg.de/contentblob/13508768/703cff94b7cc86a2a12815e52835accf/data/download-digitalstrategie-2020.pdf (Accessed October 2021)

City of Hamburg (2015) First declaration of intent. Available at: https://www.hamburg.de/contentblob/9260384/ed1cb41d024dbef3f62bd9cd834ca838/data/strategie-deutsch.pdf (Accessed October 2021)

Helsinki

City of Helsinki (2020). Smart city strategy. Available at: https://www.hel.fi/uutiset/en/kaupunginkanslia/data-produced-by-helsinki-is-worlds-most-usable-and-used-city-data-by-2025 (Accessed 11 November 2021)

City of Helsinki (n.d) Data strategy. Available at: https://digi.hel.fi/english/helsinki-city-data-strategy/ (Accessed 11 November 2021)

City of Helsinki (n.d.), With digitalization we can make Helsinki the most functional city in the world. Available at: https://digi.hel.fi/english/ (Accessed 11 November 2021)

Stuttgart

City of Stuttgart (n.d.) E-Government-Strategy. Available at: https://www.stuttgart.de/medien/ibs/FR_ES_Broschuere_Digital-MoveS_Endf.pdf (Accessed October 2021)

Vienna

Stadt Wien (2019): Smart City Wien Rahmenstrategie 2019-2050. Die Wiener Strategie für eine nachhaltige Entwicklung (2019). Available at: http://media.obvsg.at/AC15555000-2001

Stadt Wien (2019): Digitale Agenda Wien. Wien wird Digitalisierungshauptstadt. Available at: https://digitales.wien.gv.at/wp-content/uploads/sites/47/2019/09/20190830_DigitaleAgendaWien_2025.pdf

Stadt Wien (2018): IoT-Strategie. Digitale Agenda der Stadt Wien. Available at: https://digitales.wien.gv.at/wp-content/uploads/sites/47/2019/11/iot-strategiev101290318.pdf

Stadt Wien (2019): Data Excellence-Strategie. Digitale Agenda der Stadt Wien. Available at: https://digitales.wien.gv.at/data-excellence/

Zurich

Stadt Zürich (2021) Strategie-Schwerpunkt «Digitale Stadt». Available at: https://www.stadt-zuerich.ch/fd/de/index/informatik/strategien-und-ssp/strategieschwerpunkte-2018.html (Accessed 7 October 2021)

Stadt Zürich (2018) Strategy Smart City Zurich. Available at: https://www.stadt-zuerich.ch/portal/de/index/politik_u_recht/stadtrat/weitere-politikfelder/smartcity/english/strategie.html (Accessed 7 October 2021)

Stadt Zürich (2016) IT-Strategie 2016 - Stadt Zürich. Available at: https://www.stadt-zuerich.ch/fd/de/index/informatik/strategien-und-ssp/it-strategie.html (Accessed 7 October 2021)

Stadt Zürich (2006) IT-Strategie 2006 - Stadt Zürich. Available at: https://www.stadt-zuerich.ch/fd/de/index/informatik/strategien-und-ssp/IT_Strategie_2006.html (Accessed 7 October 2021)