
How does Open Data influence Urban Resilience?

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Abstract

In the last years, the role of data has been increasingly bigger in different parts of our lives. Big data, open data, smart cities, data science are concepts that are now present in our daily lives, changing the way we travel (through the use of different mobility apps), the way we shop (using our record to suggest products and services) and can even change the way we vote (as seen in cases as the Cambridge Analytica). Open Data can also change the way societies face challenges and risks such as climate change, pandemics and crime, among others.

The present work aims to contribute to the innovation studies regarding the relation between open data and resilience, particularly by a better understanding of the innovation ecosystem role. Moreover, this dissertation, proposes a framework that establishes the relevant dimensions on the innovation ecosystem for the impact of open data on urban resilience.

Adopting a qualitative methodology, this work applies a survey to 10 European cities to assess the impact of open data in urban resilience and conducts of six interviews with experienced informants in the open data and urban resilience dynamics. These interviews were conducted to informants both from cities and from international organizations.

Regarding the influence of open data in urban resilience, it is clear a moderate to strong positive relation, even though there are also “dark sides” on the use of open data. This consideration led to the discussion of the role of the different features of the innovation ecosystem, arguing the relevance of not only the agents and their relations but also of resources, decision-making and adequate framework and regulations.

Resumo

Nos últimos anos, tem sido crescente o papel dos dados em diferentes partes das nossas vidas. *Big data*, dados abertos, cidades inteligentes e a ciência dos dados são conceitos que estão agora presentes em nosso dia a dia, mudando a forma como viajamos (por meio do uso de diferentes aplicativos de mobilidade), a forma como fazemos compras (usando o nosso histórico para sugerir produtos e serviços) e podendo mudar até a forma como votamos (como no caso da Cambridge Analytica). Os dados abertos, em particular, têm também a capacidade de mudar a forma como as sociedades enfrentam desafios e riscos, como as mudanças climáticas, pandemias, ou crimes, entre outros.

O presente trabalho pretende contribuir para os estudos de inovação no que diz respeito à relação entre dados abertos e resiliência, nomeadamente através de uma melhor compreensão do papel do ecossistema de inovação. Além disso, esta dissertação propõe uma *framework* que estabelece as dimensões do ecossistema de inovação mais relevantes para o impacto dos dados abertos na resiliência urbana.

Adotando uma metodologia qualitativa, este trabalho aplica um inquérito a 10 cidades europeias para avaliar o impacto dos dados abertos na resiliência urbana e realiza seis entrevistas com informadores experientes em dados abertos e na dinâmica da resiliência urbana. Essas entrevistas foram efetuadas com informadores de cidades e organizações internacionais.

No que diz respeito à influência dos dados abertos na resiliência urbana, é evidente uma relação positiva e moderada a forte, apesar de também existirem lados sombrios no uso de dados abertos. Esta consideração conduziu à discussão do papel das diferentes características do ecossistema de inovação, argumentando a relevância não só dos agentes e das suas relações, mas também dos recursos, da tomada de decisão e do enquadramento e regulamentação adequados.

Keywords

Open Data, Urban Resilience, innovation ecosystem, cities, risks, decision-making, smart cities, policies, technology, innovation, technological innovation, citizenship, democracy, institutional framework, innovation management.

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1. Introduction

During three industrial revolutions, technology has been a major driver, leading to large changes across economies, societies, and businesses. Industrial and agriculture production rose, in a transition prompt by steam engines. Innovation in business models, such as the assembly line swiftly scaled production. More recently, the digital revolution and computing power and information connected the world and changed what and how we produce, consume, work and live (Perez, 2010). Technology changes how value is created in the economy and the demand for skills, forming a new techno-economic paradigm (Freeman and Perez, 1988). As a fourth industrial revolution unfolds, steered by developments in technologies as artificial intelligence (Fagerberg and Verspagen, 2020), we witness how societies change and the increasing role that data plays in the economy and society (Lammi and Pantzar, 2019)

At the same time the world lives a rapid urbanization. According to the United Nations, globally, more people live in urban areas than in rural areas, with 55 % of the world's population residing in urban areas in 2018. Seventy years ago, in 1950, 30 % of the world's population was urban, and in 30 years, by 2050, 68 % of the world's population is projected to be urban (United Nations et al., 2019). The 2050 projections have been reviewed upwards. Cities are complex ecosystems, where different factors assemble and mix for an output that defines residents' quality of life. These factors, however, change over time and cities must adapt to constant change (Allen, 1997).

Considering these trends, this research aimed to study and explore the relations between open data and urban resilience and how the concepts connect. Open data, i.e. data in an open format that can be freely used, re-used and shared by anyone for any legal purpose (Open Data Institute, 2016) is frequently regarded as an opportunity, while urban resilience, i.e. the ability of an urban system to maintain or rapidly return to desired functions in the face of a disturbance and to quickly transform systems that limit current or future adaptive capacity (Meerow et al, 2016), has been increasingly considered in the public debate as a necessity. Do cities fully capture the value in open data when facing and overcoming disruptions? So, how can open data foster urban resilience? And what roadblocks do cities find doing that? And how can those roadblocks be overcome? What role does the city innovation ecosystem,

namely its actors and their networks play? These interrogations were the starting point of this research, in which only data from public sources or from public funded initiatives was considered.

Open data policies encourage a wider availability and re-use of public sector information for private or commercial purposes, with minimal or no legal, technical, or financial constraints, and which promote the circulation of information not only for economic operators but primarily for the public. These policies can play an important role in promoting social engagement and promoting the development of new services based on novel ways to combine and make use of such information (Open data and the re-use of public sector information, 2019).

Data can support public policies decision-making and new initiatives generation implies innovative methods, establishing a relationship between political science, public choice, mathematic algorithms, and data analysis (Höchtel et al., 2016). This mix brings specific roadblocks that must be addressed and overcome by cities.

Regarding resilience, this is a concept that compresses a wide range of contemporary risks and has become increasingly important to our understanding of contemporary planning policies and practices, as Coaffee (2013) has mentioned. A large part of urban resilience work is around constantly changing topics as if cities were aiming at moving targets, such as migration patterns, employment trends, natural disasters, demographics, climate change, industrial developments, and diseases.

An increased connection between open data and urban resilience needs cities to build robust local infrastructure but also a global data infrastructure (Open Data Institute, 2016). Local readiness to deal with open data is a challenge as it includes several components as physical infrastructure, datasets, training, policies and regulation, privacy protection and organisations and people that collect, maintain and use data, among others. Data privacy and cross references are a growing risk, as seen in situations as the Cambridge Analytica case, which makes people and organizations distrust data and apprehension about opening it.

However, the European Union for instance, encourages Member States to promote the creation of data based on the principle of ‘open by design and by default’. To the European Commission, (Open data and the re-use of public sector information, 2019) Member States “should ensure a consistent level of protection of public interest objectives, such as public

security, including where sensitive critical infrastructure protection related information are concerned”. Member States should also ensure the protection of personal data, including cross references risks: “where information in an individual data set does not present a risk of identifying or singling out a natural person, but when that information is combined with other available information, it could entail such a risk” (Open data and the re-use of public sector information, 2019).

This dissertation starts with an analysis of relevant literature in order to understand what open data is, its benefits and opportunities but also its challenges and risks. We then analysed how the existing literature crosses these notions with the cities as innovation ecosystems and how open data, technology, innovation and urban resilience can mix or relate. From this analysis the two research questions emerged:

- how does open data influence urban resilience?
- what role does the city innovation ecosystem plays in linking open data development and urban resilience?

These research questions were subject to empirical exploration, under light of an original framework that builds on previous work of Schot and Geels (2008) and Granstrand and Holgersson (2020).

Considering the existant literature, this dissertation confirms previous findings but also sheds light on the link and dynamics between open data and urban resilience and what factors can explain a successful relation. To identify and explore such dynamics, this dissertation draws on in-depth and systematic evidence from three European cities, complemented with the viewpoints from three international organizations – Eurocities, United Nations and World Bank and an exploratory survey to ten European cities. To analyse the cities experience regarding open data and characterize the impacts of open data in urban resilience, a set of interviews with key personalities were conducted in order to evaluate how those mechanisms occur. The dissertation concludes by presenting conclusions, and amongst others, identifying success-enabling factors in the use of open data to improve urban resilience and directions for future research.

2. Literature Review

2.1. Open Data

2.1.1. Definition

Currently, there is no single, broadly, accepted definition of open data; as a result, open data and open government data are often conceptually bound with the grand purposes of open government. In fact, this has created a conceptual ambiguity among open data, open government data, and open government. This is further complicated by the loose interpretation of the term 'data' to encompass anything from raw, granular datasets to written reports (Wang and Shepherd, 2020).

Open data is a term applied to the sharing of once closed or only internally accessible government data with the public, subject to limited restrictions on use and reuse (Jansen, Charalabidis and Zuidewijk, 2012). Unlike typical documents distributed via e-government portals, open data provides raw digital data that are collected by the city. These raw (or lightly edited) data are a deliberate choice to move away from packaged information provided to citizens, allowing new uses, analysis and possibilities.

Despite the mentioned inexistence of a single, broadly accepted definition of open data, the Open Knowledge Foundation provides what is essentially a manifesto for Open Data: *"it should be freely available for anyone to use, repurpose and republish as they wish, governed with an open license that explicitly permits these types of activities. Data should be collected close to the originating source and frequently to allow for automated processing, and be free of proprietary formats"* (Open Knowledge Foundation, 2014).

Discoverability and accessibility are prerequisites and without these two attributes government data cannot be regarded as open (Attard et al., 2015).

By being available to anyone, open data can be used by policy-makers, researchers, entrepreneurs, and citizens in ways that have the potential to foster economic progress and stimulate innovation by enhancing entrepreneurial activity for innovative products and services and encouraging positive social change by empowering citizens and promoting inclusion (Neves et al., 2020).

The openness of data, particularly open government data is not only increasingly discussed as an option, but also a choice to public authorities. Around the globe and at all levels, governments are moving toward the provision of open data to citizens, the private sector

and other third parties. This means to make available raw information and datasets controlled by permissible license, which allows a new and different engagement of communities and their agents and empowering innovation ecosystems (Johnson and Robinson, 2014).

Essential attributes of Open Government Data that directly support the delivery of open government and economy are that it is unmediated, granular, structured, machine-readable data (Wang and Shepherd, 2020).

However, other attributes extend the accessibility and usability of the data as an open, non-proprietary format. Metadata and data interchange features improve the discoverability and usability of the data by attaching machine-readable descriptions of the data using programming languages. An initial, foundational development to open data was the eight Sebastopol principles in 2007. These principles (Table 1) provide a roadmap and are the basis of most guidelines for publishing Open Government Data online (Attard et al., 2015):

1. Complete	All public data, which is not subject to privacy, security or privilege limitations, is made available.
2. Primary	Data is granular and made available, as it is available at the source, not aggregated or modified.
3. Timely	Data is made available to the public as soon as possible after the actual data is created, in order to preserve the value of the data.
4. Accessible	Data is made available to all consumers possible, and with no limitations on its use.
5. Machine Processable	Data is published in a structured manner, to allow automated processing.
6.	Non-Discriminatory - data is available for all to use, without requiring any registration.
7. Non-Proprietary	Data is published in a format that is not controlled exclusively by a single entity.

8. License-Free	Other than allowing for reasonable privacy, security and privilege restrictions, data is not subject to any limitations on its use due to copyright, patent, trademark or trade secret regulations.
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Table 1. The 8 Principles of Open Government Data, 2007

Subsequently this list was updated in 2010 to permit commonly held formats in addition to open formats and added the following two items.

(9) Permanence – available in perpetuity.

(10) Usage costs – should be free.

Berners-Lee, founder of the World Wide Web, set out an alternative approach using the simple 5-Star scheme to gauge and advertise the openness of open linked data. The rating is more focused on the technical aspects of open datasets with respect to format, metadata and linked data (Umbrich et al., 2015):

1-Star	available on the web (whatever format) but with an open licence, e.g., PDF.
2-Star	available as structured data, machine-readable, e.g., XLS.
3-Star	available in non-proprietary machine-readable file format, structured format, e.g., CSV.
4-Star	above plus use URIs as its identifiers (see also RDF), to identify things.
5-Star	above plus link data to other people's data to provide context.

Table 2. Five stars of open data, *Five stars of open data* (2010)

The 5-Star scheme holds a few fundamental weaknesses in defining and measuring the openness of government data. It has no references regarding granularity and timeliness whilst including advanced attributes that are beyond the competence of ordinary citizens. However, an important difference between the Sebastopol principles and the 5-Star scheme is that the

latter is more explicit in recognizing different degrees of openness. (Wang and Shepherd, 2020)

Open data is defined, in this study, as a policy that encourages organisations to release objective, factual, and non-person-specific data that are generated or delivered of public services, to anyone, with a possibility of further operation and integration, without any copyright restrictions.

2.1.2 Benefits and Opportunities

One of government administrations roles has been to create statistical information to manage resources and people. Open data can be very useful to cities regarding this objective.

On a smart city context, open data initiatives seek to promote better city governance, enhance transparency, analysis, and planning, reinforce citizen engagement and participation, foster co-creation and collective intelligence, and support innovative products and services, while can be useful in providing solutions to many socio-economic and environmental problems (Neves et al., 2020).

As time goes by, more and more public authorities open their data, leading to the creation of new content or new services that ordinary citizens may find useful but also to the improvement of public services and decision-making. Communities of tech-savvy entrepreneurs respond creating apps. This might foster a culture of transparency, accountability and reuse of public information for social purposes and public interest (e.g. civic hackathons). Civic Hackathons are simultaneously using open data as the platform for new technology developments while also striving to deliver civic engagement outcomes. (Johnson and Robinson, 2014).

A major driver of government provision of open data is the assumption that data, once provided for citizens and private sector use, might not only reduce government costs (improving efficiency) but also to unlock hidden entrepreneurial value, driving software-related economic development (Jansen, Charalabidis and Zuidewijk, 2012).

Collectively, and according to Attard et al. (2015) there are three main reasons or benefits from opening up government data:

1. Transparency – in order to have a well-functioning, democratic society, citizens and other stakeholders need to be able to monitor government initiatives and their legitimacy.

Transparency also means that stakeholders not only can access the data, but they also should have the capacity to use, reuse and distribute it. The success to achieve transparency results in a considerable increase in citizen social influence.

2. Releasing social and commercial value - governments are one of the largest producers and collectors of data in many different domains (Alexopoulos et al., 2014). All data, whether addresses of schools, geospatial data, environmental data, transport and planning data, or budget data, has social and commercial value, and can be used for several different purposes which are different than the ones originally envisaged. By publishing such data, the government encourages stakeholders to innovate upon it, and create new services.

3. Participatory Governance - through the publishing of government data citizens are given the opportunity to actively participate in governance processes, such as decision-taking and policy-making, rather than sporadically voting in an election every number of years. Through open government data initiatives such as portals, stakeholders can also be more informed and be able to make better decisions (Rojas et al., 2014).

But these three main reasons can translate into more benefits. Adapting from Kucera and Chlapek (2014), we can identify the following:

Benefit	Description
Transparent way of informing the general public about infringement of legislation	As many public bodies perform administrative supervision, open data can be a way how a public sector performing such supervision informs general public about actions or subjects that do not comply with legislation.
Improved public relations and attitudes towards government	Public sector can use Open Data to better inform citizens about its decisions and actions. This strengthens trust and understanding between citizens, organisations and public decision-makers.
Increased reputation	By publication of Open Data a public body can present itself as an open and transparent

	institution. This might increase its reputation among citizens and organisations.
Increased transparency	Better availability and accessibility of data about performance of the public sector, e.g., budgetary data, public contracts or money flows.
Improved government services	Better availability of data about government services improves their accessibility and helps citizens and organizations to better utilize them. Open Data can help in identifying of inefficiencies and subsequent improve of the government services provision. This is particularly important to improve cities resilience.
Supporting reuse	Machine readability, availability of metadata and legal openness of data makes data easier to re-use - which helps the development of new applications utilising Open Data, which might be developed by private sector entities. This might also support the improvement of innovation ecosystem.
Better understanding and management of data	The need to catalogue and develop lists of published or maintained dataset might help public sector to better understand what data they have and how to better manage this data.
Stimulate economic growth	Publication of Open Data as resource that can be used by entrepreneurs to develop new or innovative products and services. Public sector might stimulate use of Open Data and as a result it can stimulate innovation and growth as well.

Table 3. Author, based on Kucera and Chlapek (2014)

Verhulst and Young (2017), however, present a different perspective, summarizing the positive impacts into four different groups.

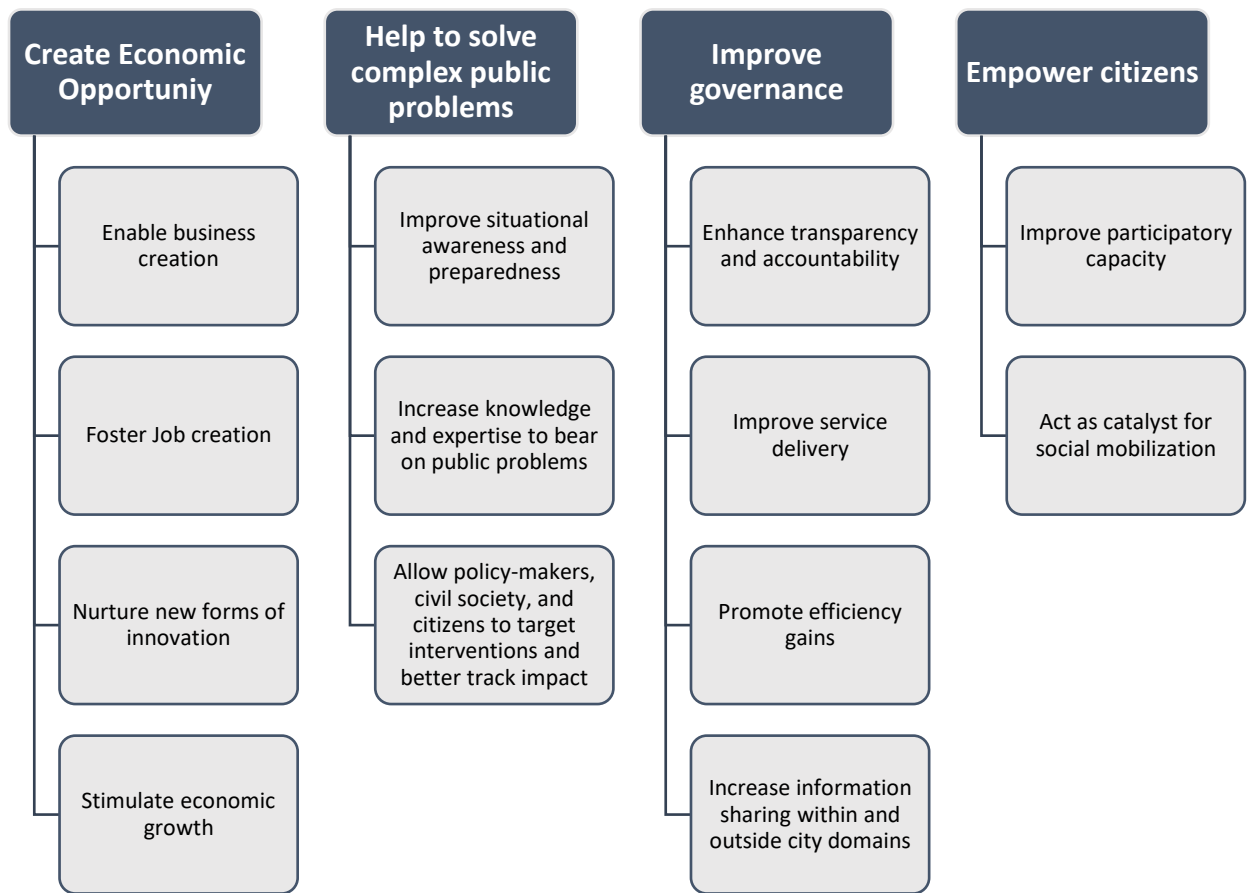


Figure 1. The positive impacts of open data. Author, based on Verhulst and Young (2017)

2.1.3 Challenges and Risks

Publishing open data is a relatively recent development. As a recent and not exhaustively explored option, many cities face significant challenges when it comes to building and executing open data initiatives. This happens because not only cities may find difficulties to push their performance towards the goals, but also in measuring the impact of open data programs and showing and confirming the value provided to the community. Accordingly, public authorities need to try to establish a robust, accurate, and meaningful performance assessment tool or framework for their open data initiatives (Neves et al., 2020).

As open data develops, the quality and extensiveness of datasets accelerate, and cities generate more insightful knowledge concerning the performance measurement and impact of open data. It is also claimed (Neves et al, 2020) that the quality of the open data provided

and its use are the main success factors for open data initiatives. As stated by the World Web Foundation (Montano et al., 2014), “Opening data will not automatically translate to use and cities must look beyond just merely tracking the number of data downloads to determine the impacts of open data”.

Open data is faced with risks and challenges and with opportunities in terms of governance, economic issues, licenses and legal frameworks, data characteristics, metadata, access, and skills. Issues such as the unlawful disclosure of data, the infringement of trade secret protection, violations of privacy and breaches of the security of the infrastructure might have a severe negative impact. Therefore, and taking in consideration the risks related, compliance assessment and the quality control of the data being published should be implemented into the open data publishing. Where the primary data contains sensitive data like personal information, anonymization should be applied (Kucera and Chlapek, 2014).

The challenge of opening up data has two major pillars: infrastructure data and citizen data (Degbelo et al., 2016). Regrettably, most infrastructure data in cities is still difficult or impossible to use, due to several reasons: lack of resources, knowledge, technical skills, vision, etc. The “open data” movement, although gaining traction, has only scratched the surface of “freeing” this type of data (Schaffers et al., 2011). On the other hand, Caragliu et al. (2011) declares that there is a need for cheaper, accessible and better solutions to allow cities and infrastructure developers and maintainers to get their data out and expose it.

To Verhulst and Young (2017), there are five major concerns, which translate to several risks, summarised in the following:

1. Privacy	Privacy concerns consistently rank among the most commonly cited uncertainties over opening up data. It is crucial to public authorities, organisations and citizens to be aware and prevent fraudulent and deceptive practices concerning privacy issues.
2. Data Security	Much government data comprehends sensitive information regarding individuals, industries, or even defence and national security. To open that data often leads to

	realistic and pertinent questions about data security. Cybersecurity remains a challenge across the world. However, even if security concerns are real, they must be balanced with the opportunity cost of not sharing data;
3. Poor decision-making	There is a significant risk in taking decisions based on data if this provides information that is incomplete, faulty or inconsistent. Given the many risks and challenges related to open data projects, it is important to recognize the risks inherent in supporting important decisions on unreliable information. Insights collected or developed from data are only as good—and their effects only as positive—as the quality of the core data.
4. Power asymmetries	Awareness of the existing privileges and authority reinforcement or the digital divide. Digital divide might be defined as the gap that exists between individuals who have access to modern information and communication technology and those who lack this access.
- 5. Open washing	The term “open washing” has become more common in practitioner circles and literature over recent years describing the

	risk that governments may seek to leverage the eagerness for open data to avoid more difficult and potentially transformative openness and transparency efforts. There is also a growing belief that a subset of still largely closed governments is joining open data initiatives fundamentally in order to increase their international reputation. This spin is used to persuade the public that such an organization's products, aims and policies are open data-oriented.
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Table 4. Verhulst and Young (2017)

Adapting and building on from Kucera and Chlapek (2014), we have another perspective on the challenges and risks of open data, as the following:

Risk	Description
Inappropriate Publication of data	Publication of data prohibited by law or infringing personal rights or freedoms.
Trade secret protection infringement	Publication of data that reveals some trade secrets that ought to be protected.
Privacy infringement	Publication of personal data that ought to be protected.
Risk to the security of the infrastructure	Detailed data about infrastructure (e.g. power plants, dams, transmitters) might be misused to cause damage to the infrastructure.

Publication of improper or inaccurate data or information	Publication of data that does not violate legislation but might provide incorrect information, misleading users and organisations and used to cause harm or get competitive advantages.
Absence of data consumers	If the datasets are virtually impossible to locate or if nobody finds it interesting, there will be no consumers and therefore any gain from opening up data.

Table 5. Author, based on Kucera and Chlapek (2014)

There are, however, other challenges or difficulties that do not qualify as a risk but surely as challenges or barriers (Charalabidis et al., 2018; Open State Foundation, 2015):

- **Costs:** The expenditure of building, preserving and refining an open data portal. While private companies can more easily make economic advantages from successful app development, the return must also be clear to public authorities (even if non-monetised).
- **Organizational Changes:** An important effort must be spent engaging the community in order to be aware of the potential to generate impact in citizen's lives from data. These organizational methods and changes will directly affect the success of an open data initiative, as only a committed and driven community will engage in the changes that an open data policy requires.

2.2 Cities as innovation ecosystems

Before proceeding to the analysis of urban resilience, it is useful to present an overview on cities as innovation ecosystems and a few concepts.

System: A general concept of a system defines it as being composed of a set C of Components and a set R of Relations among those components. Systems analysis is essentially the exercise to characterise the Components and Relations, and dynamic systems can be characterised in terms of transformation of inputs into outputs through actions by

agents interacting within an environment (Ackoff, 1971; Carlsson et al, 2002; Ritala and Almpanopoulou, 2017).

Innovation: This has been a dynamic concept with several definitions and connotations (Godin, 2015). Recently it has been seen as an outcome of a process, based on two defining features: a degree of novelty of a transformation and a degree of usefulness or achievement in the application of something new. (Granstrand and Holgersson, 2020).

Innovation creates value by definition, being new to all and useful to some actors, but also tend to destroy value, being harmful to others. (Schumpeter, 1942).

The complementary and substitute effects from innovations, especially economically and technologically ones, typically interact and propagate outside buyer and seller populations on defined markets. This corroborates a systems approach or concept in innovation analysis (Granstrand and Holgersson, 2020).

Innovation system: In innovation studies, the concept of innovation system has been thoroughly debated and used. These systems are often qualified as national innovation system, regional innovation system or sectoral innovation system. The concept, first used in public by Christopher Freeman in an analysis of Japan (Freeman, 1987), soon became a popular among scholars who wanted to get a better understanding on the interaction processes underlying a country's technological and economic development (Lundvall, 1992, Nelson, 1993). It can be syntactically seen (Granstrand and Holgersson, 2020) as a set of components and the causal relations influencing the generation and utilisation of innovations and the innovative performance. However, we suggest interpreting it as “all important economic, social, political, organisational, institutional and other factors that influence the development, diffusion and use of innovations” to use Edquist (2006) definition of an innovation system.

Innovation ecosystem: The ecosystem as a concept has its origins in the science of ecology and it conceptualises the flow of material and energy. Regarding innovation, the concept has only become more popular in the last 15 years, which lead to discussion on its relevance and conceptual rigor. However, there is still an absence of scientific consensus about what innovation ecosystems actually are, despite the concept widespread use and it is also found that “much research uses the concept of innovation ecosystem without explicitly defining it” (Granstrand and Holgersson, 2020).

According to Adner (2006) innovation ecosystem is “the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution”.

On the other hand, Gomes et. al (2018) argue that the innovation ecosystem notion has somehow come as a reaction to the profit and competitive focus that was prevalent in the pre-existing business ecosystem literature, and that the innovation ecosystem concept highlights value creation and collaboration.

In this research, and based on Granstrand and Holgersson (2020), innovation ecosystem is defined as the evolving set of actors, objects and the institutions and relations that are important for the innovative performance of an actor or a population of actors. In this definition, objects include products and services, tangible and intangible resources and other types of systems inputs or outputs. This innovative performance depends on a shared set of technologies, knowledge, or skills, cooperation and competition for the development of new products and services.

In what regards cities as innovation ecosystems, cities have always been related with transformative ideas and social initiatives. In this regard, innovation activities can be defined as products of cities or regions, which are not just mere silos. They are actively working in new ideas, new organisational forms and new enterprises. Furthermore, the access and quality of education, the number and quality of science institutions, services and cultural activities combined with population density and frequency of interactions favours technological and social innovation and fosters free enterprise and creativity (Florida et al., 2017; European Commission, and Joint Commission Resources, I., 2019).

Nevertheless, some cities are able to harness most of their potential and do more with their tangible and intangible resources than others. Cities that succeed in innovating are those where people “are less mechanical units of production and more the creators of wealth”. These cities shift from having a density of resources to a density of networks, and circuits where proximity to resources is substituted by proximity to knowledge (Landry, 2015).

Besides technological progress, cities also support other kinds of innovation, as the referred social innovation. This diversity of innovations is associated with products, processes, marketing and organisational contexts, all relevant in urban areas. Even though large cities (as capitals and metropolitan areas) remain major drivers of innovation and creativity, advantageous conditions might also be found in smaller cities. According to the European

Commission (2019) some concrete methods in which cities, as ecosystems, are encouraging innovation are: entrepreneurial innovation oriented to support small businesses in the creation of new jobs; Social innovation highly focused on meeting social needs by enhancing social interactions and integrating ideas, knowledge and vision of civil society with urban development; Innovation in work systems: including remote working, high mobility of entrepreneurs, co-working spaces, open office areas and other alternative ways to generate income; Culture-led innovation, typically stemming from the creative knowledge of the arts and cultural domains and inspiring many city-relevant sectors and areas, including cultural tourism, consumer electronics and urban regeneration.

In all of these, open data can be a powerful tool to help cities achieving their objectives.

The future of cities, regarding innovation, is strongly linked to enhancing human capital and highlighting territorial identities and it is expected to be more room for networking and dialogue among stakeholders as a way to discover innovation. In a more globalized world, cooperation among cities will allow for a quicker process of knowledge sharing, facilitating rapid advances in innovation. (European Commission, and Joint Commission Resources, I., 2019). Schaffers et al. (2011) also argue that partnerships and clear cooperation strategies among main stakeholders are needed in order to share research and innovation resources.

Kraus et al (2015) reinforce this through the idea of digital infrastructure of modern cities offering a unique opportunity to facilitate entrepreneurship, creativity and innovation in order to drive local economic growth.

The infrastructure of cities (particularly smart cities) can create unique collaborative ecosystems in which citizens, producers, consumers, industries, universities and research centres may develop innovative products, services and solutions. Contrary to traditional marketplaces (where only supply and demand can be found), an innovative ecosystem involves a multitude of actors engaged in public and private consumption, production, education, research, entertainment and professional activities. In places where knowledge creation and knowledge application can be found, articulated by local governance, creativity and innovation lead to more competitive and attractive local environments (Appio et al., 2019).

The innovative “uses ICTs and other means to improve the quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of

present and future generations with respect to economic, social and environmental aspects” (ITU-T, 2016). In this data driven approach to innovation in urban context we found the central role that cities play in our societies efforts towards sustainability.

However, Zhang and Wu (2019) consider the city as an ecosystem and as “an arena of innovation”. From this point of view, the city is similar to an arena where multiple agents act and where “agglomeration is a necessary but not sufficient condition for regional development and innovation”. The city is a space where multiple actors and agencies meet working towards urban development, which in its turn, affects innovation. As an arena, they present the city not as an actor in itself but as a space, bridging differences and with various actors working together to pursue their purposes.

Managing innovation at the level of cities innovation ecosystems becomes a task of managing a portfolio of resources and fostering fruitful interlinkages. Managing a smart city innovation ecosystem requires the supervision of the portfolio of “innovation assets” made up of the different facilities and resources and creating partnerships among actors that govern these assets. It is also relevant to provide open access to resources to users and developers (Schaffers et al., 2011).

Nevertheless, returning to the notion of “arena”, Zhang and Wu (2019) consider that cities, as arenas, are not limited to the factors related to innovation and that the ecosystem may include opposition to innovation or investors not prone to innovation. The understanding of the city as an innovation arena also contrasts from the views that the city fosters innovation because of some attribute of the city itself, for example, that diversity and heterogeneity alone lead to creativity or innovation in broad terms. To this author, “To rethink the connection between cities and innovation, we need to identify the real actors and their actions in the city rather than re-sorting to a general notion of agglomeration, diversity, or relatedness (between economic sectors)”. The formulations of ‘platform policies’ (Asheim et al., 2011) and ‘triple helix clusters’ (Etzkowitz and Leydesdorff, 2000) imply more institutional complexity than has been hinted at as a manifestation of agglomeration.

According to Zhang and Wu (2019), the city is an arena where multiple agencies affect innovation capacities and the concentration of innovations in the city is a consequence of the political economic process of the development of innovation capacities. This is in line with the point of view of Lovering (1999), defending that the intrinsic conditions of

knowledge generation are ‘necessary but not sufficient’ for understanding the relation between the city and innovation.

2.3 Conceptualisation of Resilience

2.3.1 Resilience

In Physics, resilience is defined as the capacity of systems, objects, or individuals to survive disruptions while keeping acceptable levels of functionality and returning to pre-disruption levels of functioning in a timely manner (Sharifi and Yamagata, 2018). The physics definition relies in an equilibrium approach that dominated through last century in other research areas (Gunderson and Holling, 2002). By equilibrium approach is meant that resilience was understood to be as high as the capacity of the system to return to the initial position or state. Nevertheless, this concept was questioned by the appearance of theories that introduced multiple equilibrium and non-equilibrium perspectives to resilience. The etymological roots of resilience stem from the Latin word *resilio*, meaning “to bounce back” (Klein, Nicholls, and Thomalla, 2003). Today, resilience is a notion used in several academic disciplines, such as psychology, ecology and planning. (Fastenrath et al. 2019). Groups with different study and policy agendas provide different explanations of the resilience concept and use it to frame and conceptualise their own research. Some may use resilience in the context of climate change adaptation and mitigation, while others utilise it in the context of human development, disaster risk reduction, and international development (Lu and Stead, 2013).

The concept of resilience has been applied in a wide range of experimental contexts, and it extends from a descriptive term that means how the ecosystem works to an approach or way of thinking. There are different concepts for resilience according to the field (Meerow and Newell, 2016; Brown, 2014). Table 6 below shows the applications, related concepts and core concepts of resilience (Brown, 2014).

Field	Applications	Concepts
International relations	Understanding military and terrorist threats	Security; Critical infrastructure

Social ecological systems	Managing complex systems in times of change; Informing adaptive management strategies	Adaptive cycle; Adaptive capacity; Transformations; Linking social and ecological dimensions of resilience
Disasters and disaster risk reduction	Minimizing risk and support recovery	Vulnerability; Community resilience
Climate change	Adapting to and minimizing impacts of climate change	Adaptation; Adaptive capacity; Climate resilience
Human development	Coping and thriving in times of adversity; Individual responses to crises; Poverty traps	Individual resilience; Human well-being; Capacity
Organizational science and social innovation	Managing change	Social learning
Planning	Urban and Regional Planning	Urban Resilience

Table 6. Brown (2014)

The World Bank, for instance, defined resilience as “the ability of a system, entity, community, or person to adapt to a variety of changing conditions and to withstand shocks while still maintaining its essential functions” (World Bank, 2016). The different uses of the term have led to discussion on how it relates to other key concepts such as sustainability, vulnerability and adaptation (Meerow & Newell, 2016).

2.3.2 Urban Resilience

Regarding cities, this is, urban resilience, there is a multitude of definitions or meanings to resilience, from narrow to broader ones, and reflecting different approaches and perspectives. Generally, it is connected with sustainability and communities' strength against risks and forces that put their structures and citizens in danger.

According to Sharifi and Yamagata (2018), three major approaches to the definition of urban resilience can be found in the literature: engineering resilience, ecological resilience and adaptive resilience.

The first, engineering resilience theories, stresses diminishing vulnerabilities to calamities through reinforcing robustness and resistance of the infrastructures.

Considering this resilience interpretation, disruptions can, largely, be predicted and prevented. To some authors (Ahern, 2011 and Sharifi and Yamagata, 2018), this perspective means that cities and their infrastructures should be fail-safe. If stressors exceed the safety thresholds and the system (or parts of it) experience failure, engineering resilience will enable rapid recovery to pre-disruption conditions (equilibrium). Reliance on engineering methods for building urban resilience may, however, give planners and decision makers a false sense of security.

Secondly, ecological resilience entails a different, because more dynamic and flexible approach that recognises inadequacy of resistance and robustness characteristics for building urban resilience. It promotes safety margins into the design of the systems to absorb initial shocks, retain functionality levels and minimise losses. In this perspective, the equilibrium state is dynamic through time, and even if basic structure and function of the system remains, it may experience transitions to new and different equilibrium states.

The third, the theory of adaptive cycle, was initially developed as explanation to ecosystems dynamics. If extended to the urban environment, and according to Gunderson and Holling (2002), it can be argued that cities and infrastructures (either physical or digital) go through four phases: exploitation, conservation, release and reorganization. Transition from the exploitation to the conservation phase takes place over a considerably long time period during which changes occur slowly and the system is relatively predictable.

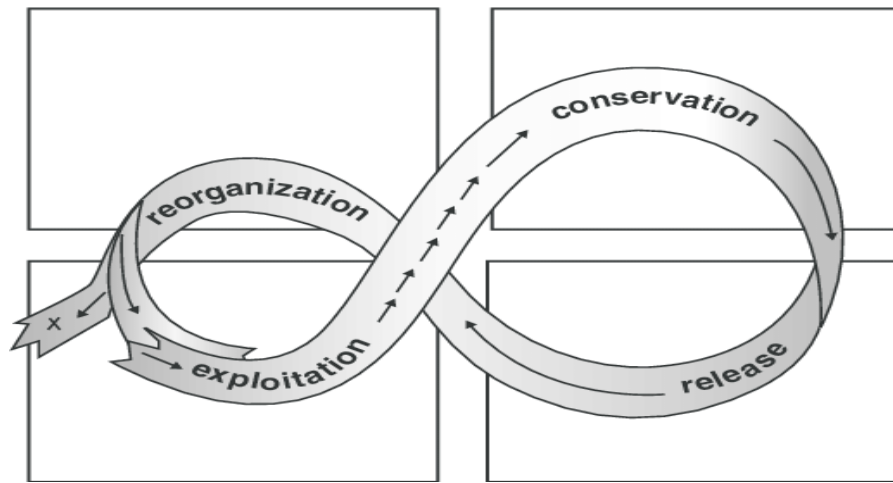


Figure 2. The four phases of the adaptive cycle from resilience, (Gunderson and Holling, 2002)

Highly influenced by the above-mentioned adaptive cycle concept, adaptive resilience conceptualises urban systems as complex and dynamic socio-ecological systems. Adaptive resilience facilitates appropriate interactions between slow and fast variables. This allows the chaotic change, without losing its integrity and functionality. Memory, self-organization and data analysis and management are fundamental to achieve resilience. Overall, adaptive resilience enables building “safe to fail” systems that bounce forward and enhance their performance and adaptive capacity (Ahern 2011).

The adaptive resilience concept recognizes system complexities and dynamics and lends itself to describing and understanding resilience of urban systems as complex and dynamic social-ecological systems. Urban resilience, in a definition rooted in the adaptive resilience concept is “the ability of urban systems to continuously develop short-term coping and long-term adaptation strategies-considering, and in response to constantly changing system dynamics and complexities over a range of spatial and temporal scales – to mitigate hazards, withstand and absorb shocks, rapidly bounce back to baseline functioning, and more effectively adapt to disruptive events by bouncing forward to better system configurations” (Sharifi and Yamagata, 2018).

As described, resilience is as a plural concept that has been interpreted in a variety of ways within and across disciplines. From the literature, is clear that there is not a “one size fits all” resilience concept. However, according to Norris et al. (2018), to build collective resilience,

cities and communities must reduce risks and resource inequities, engage local people in mitigation, create organizational linkages, boost and protect social supports, and plan for not having a plan, which requires flexibility, decision-making skills, and trusted sources of information that function in the face of unknowns.

Other perspective (European Commission, 2017) also refers to the resilience concept in the following terms: “a resilient society is able to cope with and react to shocks or persistent structural changes by either resisting to it (absorptive capacity) or by adopting a degree of flexibility and making small changes to the system (adaptive capacity). At the limit, when disturbances are not manageable anymore, the system needs to engineer bigger changes, which in extreme cases will lead to a transformation (transformative capacity).”

Local Governments for Sustainability (ICLEI) chooses a broader and integrated approach, defining urban resilience as “the ability of cities to anticipate, prevent, absorb and recover from shocks and stresses and to improve essential basic response structures and functions, while integrating the different aspects of urbanization, sustainability, development, and climate change”. Building resilience requires identifying and assessing hazard risks, reducing vulnerability and exposure, and lastly, increasing resistance, adaptive capacity, and emergency preparedness. (ICLEI, 2019).

To Meerow et al (2016), urban resilience refers to the “ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales- to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity”.

In all these definitions, urban resilience is dynamic and offers multiple paths to resilience through transition and transformation. The urban system is conceptualised as complex and adaptive, and it is composed of socio-ecological and socio-technical networks that extend across different temporal and spatial dimensions.

2.4 Resilience-oriented urban planning

When referring to changes and challenges brought by digitalisation, demography, climate or migrations would be an illusion to trust that societies can, in the future, completely eradicate any kind of catastrophes, shocks or structural changes from long term problems. Instead, the uncertainty is likely to be higher (WEF, 2020). The European Commission (2019), also argues for the complexity of the future: “The challenges are complex and interlinked. The

policy response must be bold and comprehensive and seek to maximise benefits for health, quality of life, resilience and competitiveness”. As societies cannot avoid or prevent important changes, it is necessary to learn from those experiences, preparing citizens and organizations to adapt to new circumstances, designing systems that can mitigate damages but also prepare future adversities or to foster resilience. Given the previously mentioned uncertainties and risks cities face - from pandemics to the instability of financial markets - building resilience relies on overall flexibility and adaptability, rather than becoming very adjusted to specific threats (Meerow et al., 2016).

The introduction of the resilience concept in planning has given rise to important transformations in urban disaster risk management. Traditionally, disaster risk management focused on short- and medium-term emergency and mitigation efforts, but the integration of resilience thinking provided a chance to longer approaches, more compatible with phenomena such as climate change (Sellberg et al. 2015).

Resilient cities must be able to cope with sudden stresses caused by natural phenomena (flooding, earthquake, and epidemics), direct anthropogenic hazards (oil spill, radiation, and systems breakdown) or socio-economic crisis (demographic changes, political and social conflict, terrorism, economic crisis). These shocks may affect multiple cities’ systems and services, such as food supply chains, energy grid, mobility systems or health services (ICLEI, 2019).

Altogether, different risks or challenges demand different answers and features. In one hand, in case of abrupt shocks, authorities can use data for rapid alert systems, with several redundancies, for instance. In tackling sudden threats, features as redundancies, flexibility and absorption are critical. In case damage occurs, the design of systems shall permit them to recover rapidly (Kim and Lim, 2016). This means that a critical feature of a resilient city is the speed of action and recovery. It is obviously preferable a quick reestablishment of critical functions following a disturbance than to experience long delays with serious impacts. The speed in which telecommunication and energy systems recover post-disaster, for example, directly affects the degree, breadth, and duration of impacts experienced (Meerow et al, 2016). In the other hand, slow and steady variables that continuously change the system may also cause irreversible transformations and shift the system into completely different status. Under such conditions, only emphasising principles such as robustness and redundancy would not be sufficient and improvements in terms of coping, adaptation and

transformation capacities are needed (Kim and Lim, 2016). Slower challenges might provide data for public policy input and for the development of evidence based public policies increasing cities resilience. According to Sharifi and Yamagata (2018), these slower challenges are hardly recognised by citizens as pressing or vital, eventually affecting urban policy priorities and pushing long-term problems into the future.

Planning resilient cities, in order to achieve positive outcomes in sustainability, cohesion and prosperity depends on: preparation, prevention, protection and transformation policies. “In the context of a stormy future becoming the “new normal”, enhancing resilience might become one of the most important tasks of policy institutions.” (European Commission, 2019).

Visioning and strategy making is one of the most fundamental parts of any planning effort. A move forward from “predict and prevent” approach also require digital innovation and data. Integrating data and intelligence in the development of solutions for resilience is also challenging for local authorities but street connectivity is essential for not only emergency response and safe and timely evacuation following disturbances, but also to assess long-term risks (Sharifi and Yamagata 2018). As the same authors argue, “critical infrastructures such as communication, educational centres, energy and water systems, financial institutions, fire stations, health centres and transportation networks are the backbone of modern cities. To achieve urban resilience is important that principles and characteristics as robustness, diversity, redundancy, flexibility, efficiency, modularity and innovation are incorporated into infrastructure planning”. Resilience oriented management recognises the importance of understanding dynamics and complexities of the system and intends to explain how these dynamics and feedbacks evolve across temporal and spatial dimensions. Resilience can, when adequately assessed, become an important indicator of system vulnerabilities over time (Irwin et al., 2016).

Resilience oriented urban planning should involve as many stakeholders as possible and start as problem definition in the planning process (co-design) (Schauppenlehner-Kloyber and Penker, 2016). Achieving urban resilience requires developing institutional mechanisms that transcend time, space and sectoral boundaries. These mechanisms should be guided by a flexible or adaptive management strategy that facilitates collaboration between different stakeholders and gets them involved in continuous processes and feedbacks loops of learning and adaptation (Crowe et al. 2016).

The devolution of power to local communities, building a culture of collaboration, developing effective communication strategies, appropriate financing of disaster risk management, establishing public-private partnerships and enhancing institutional transparency and accountability are critical for reshuffling adaptive management strategies in urban planning efforts (Sharifi and Yamagata, 2018). Citizens are a major transformation force. Public participation and citizen engagement in mitigation and risk communication efforts is a social learning practice and improves social capital which is widely believed as an essential component of urban resilience (Prior and Eriksen, 2013). The citizens should acknowledge that achieving urban resilience requires individual and communal actions and their digital participation. In this regard, Schilderman and Lyons (2011) stress that participation of people in the planning activities also results in better overall satisfaction with living conditions.

Villagra et al. (2016) also argue a similar idea, by enhancing how successful adaptation and resilience building require direct participation and input from the local community. This author also stresses how achieving this objective is difficult in highly centralised systems that lack integrated management at urban level and how strong local authorities with stable and sustainable budget resources are better capable of enhancing community resilience and responding to disaster risks.

The development and operationalization of resilient solutions is institutionally challenging. Integrating resilience thinking into urban planning provides opportunities to study and understand the interactions between different sectors and understanding the nature and complexity of interlinkages between social, economic and ecological factors. Achieving such integration is essential for better understanding the dynamics of urban systems and their potential future trajectories (Peyroux, 2015). In this regard, digital innovation opens new possibilities in managing uncertainty, keeping services and decision makers not only aware of changes in real time, but also making possible more flexible and adaptable strategies. The possibilities coming from smart systems that learn how to adapt in urban planning and city management, from water and energy to mobility management, from climate to public safety are numerous and with deep effects (ICLEI, 2019).

2.5 Open Data and Resilience relation

In looking for solutions to cities' challenges, it is clear there is a role for technology to play in both better understanding and mitigating shocks and stresses, as new products and services are brought to the market every day. The relatively recent progresses in cloud computing, data, mobile communications and social applications are making a novel set of innovative products and services possible and available. These technologies are re-defining the digital transformation of cities operations and services (100 Resilient Cities, 2019).

This rapid digital transformation and the recent wave of digitalization noticeably influence the lives of most people regardless of their location. Not only is more than half of the global population active on the internet, but “things” too are now becoming connected to the internet. The “Internet of Things” (IoT) let devices, such as appliances and cars to connect to the internet, and generate and store data. As any other development trend, digitalization brings with it both opportunities and challenges for cities (ICLEI 2019).

Digital transformation has a high potential to foster urban planning resilience through data infrastructure and analytical tools. Digital technologies and Information and Communication Technologies (ICT)-based solutions can help in the development of urban infrastructure, and facing challenges, such as waste management, energy efficiency and disaster awareness (ICLEI 2019). Authors as Young and Verhulst (2016) or Neves et al (2020) also claim that and particularly open data initiatives promote better governance, enhance transparency, improve planning and citizen engagement as well as innovative products and services while fostering solutions to socio-economic and environmental problems.

However, cities face complications in taking full advantage of these new opportunities and integrating them into improved resilience. According to 100 Resilient Cities, (2019) cities may face some of these challenges:

- Lack of executive support;
- Inadequate governance models and policies;
- Low levels of community engagement;
- Insufficient business models for procurement and maintenance;
- Uncertainties and issues around architecture, privacy and digital rights.

These challenges limit the benefits cities can grasp from the opportunities offered by data and technology today. In a different perspective, two important steps for cities seeking to leverage the full capabilities of data to support urban resilience are to develop foundational infrastructure and to foster internal and external cultures open to adopting new technologies (100 Resilient Cities, 2019). Van Winden and Carvalho (2017) claim that there is a growing recognition that government data should increasingly become available and easily accessible as through open data format. Many cities implement these strategies to improve transparency and accountability to their constituents, but also to promote local development or to improve the administration performance. Some local governments chose to open data by default, establishing ambitious data policies. Millard (2018) also argues that open data stimulates innovations for government efficiencies. Open data may foster urban innovation because it can be freely used and all sorts of unanticipated ideas and innovations occur (Ahlgren et al., 2016). Nevertheless, despite the potential benefits and growth in the number of open data initiatives, they still represent unfamiliar territory for many cities (Berrone et al., 2016).

Recently, during Covid-19 pandemic, Tokyo (Japan) used open data to improve cities capacity response to this crisis. Tokyo authorities created a one-stop database on the real-time Covid-19 situation including the number of infected people, their status, characteristics (age, gender), number of inquiries to the call centre, number of people using subways, etc (Tokyo Metropolitan Government, 2020). The city also provided the website's source code as open data, so that other institutions or municipalities can use the data and replicate similar webpages. (Tackling Corona Virus: Contributing to a Global Effort, Cities Policy Responses, 2020). All around the world, numerous cities generated internal innovation labs, connecting work on open data with wider themes of data-science, service design, and technology innovation. This integration of openness (open data and open government) into urban development, or "smart city" work, is becoming more common. There is a pattern seen in several cities, where external civic hackers and entrepreneurs were hired by government and given a set of responsibilities that incorporate open data (J.-N. Landry, 2018). This is in line with van Winden and Carvalho (2019) who refers that public procurement for innovation is "not only instrumental to improve public services or address societal challenges, but also as an economic development instrument". Some examples of these are how to diminish air pollution, improving health care accessibility, better mobility, and waste management efficiency, among others. To do so, local procurement budgets became open to new sorts of actors, as start-up companies, with the aim to find and nurture new solutions while at the

same time supporting entrepreneurship and new procurement behaviour. Open data from various sources, government, sensors, citizens and businesses, offer opportunities for advanced analytics and intelligence to detect patterns, generate alerts, visualise information and predict trends. In data-driven decisions, techniques for forecasting and predictive analytics are well established in many domains. The open data urban system demands open innovation and people driven models to be able to turn capabilities offered by data and technologies to services and solutions (Pallot et al., 2011).

The use of open data has impacts in the organization, political and technical variables of smart cities initiatives, allowing developing more adjusted urban services for citizens' real demands and expectations. Nevertheless, so far, the assessment of quality of urban open data is reduced and the operational competences are low. There is also a lack of appropriate frameworks to evaluate the impacts of open data (Neves et al., 2020). Abella et al (2017) argue that open data initiatives success depends on the premise of corresponding the supply with the demand of open data for its effective use. The factors affecting the performance of open data actions depend on the environment and context regarding the existence of specific enabling conditions, which can translate the actions into success or failure, but this topic needs further research. This is in line with previous studies as from Davies and Perini (2016, p. 9), "There are no large-scale, rigorous studies of open data impacts, and most work remains at the level of ad-hoc and isolated case studies". Therefore, the lack of evidence of appropriate frameworks to evaluate the impacts of open data on cities and particularly regarding its resilience emerges from the literature. The fact of open data and resilient cities being relatively recent research also limits the number and quality of frameworks to explore their relation and assessment mechanisms.

We shall, nonetheless, consider that the literature recognises the existence of open data general impacts. On the one hand, and according to Neves et al (2020), the use of open data influences the organisational, political, and technical variables of cities initiatives, granting to develop more adjusted urban services for citizen's real demands and expectations. However, on the other hand, in most circumstances, resilience cannot be observed directly. As argued by Figueiredo et al (2018), "cities that do not face significant shocks and stresses regularly or that respond adequately to minor shocks may not be perceived as resilient, simply because disruptions to the system could not be observed in the first place. Resilience only becomes apparent during a major shock or stress that requires a city to resist, adapt and transform".

2.6 Most relevant dimensions

The literature describes a number of benefits of open data for overall urban development. Some of these potential outcomes are certainly also relevant for urban resilience; yet i) there might be other resilience-related domains to which open data also plays a role, and we need to understand why; and ii) open data might also have unexpected, potentially negative effects in resilience.

It is mention worthy that open data initiatives are simultaneously part of and supported by these innovation ecosystems, i.e. the ecosystem is not something unique at city level, it will assemble and reassemble at open data initiative level, mobilising different agents and resources in different combinations. To the purpose of this research, the innovation ecosystems were assumed as stable in the short-run, even if in the medium-long term they may evolve. This being said, there are four dimensions that emerge as relevant in mediating open data and urban resilience, to explain the relation and important to consider in this research framework of analysis:

- Number and diversity of actors in the ecosystem and their relations

This dimension refers to the social networks, particularly the number and diversity of actors in the ecosystem. Urban actors and municipality partners such as academia, start-ups, incubators, developers, research centres and other actors are important as they are the components of the ecosystem, promoting and supporting open data initiatives. The social networks, this is, the actors and its components translate into richness of opinions and diversity of knowledge and experiences. The number and diversity of actors is relevant to provide expertise, to legitimate socially the socio-technical changes and for a common vision and objectives (Schot and Geels, 2008).

- Resources (Quality of data and its infrastructure, tech skills and other resources)

Resources, tangible and intangible, such as IT infrastructure, funds, facilities, human resources, and of course, data itself, are crucial for the building of the mentioned social networks, but also for the success of open data initiatives and for creating a community supporting the technology change. Granstrand and Holgersson (2020) qualify them as inputs for the innovation ecosystem and countries having open data initiatives that receive both senior-level government backing and sustained resources are much more likely to have a

positive impact (Donker, 2016). To get results, besides infrastructure, the ecosystems need leadership, investment, skills and an adequate framework. But how do those conditions individually influence decision-making is relevant to be explored.

- Ability to mobilise resources and influence decision-making

Initiatives need to be able to overcome roadblocks and mobilize resources and influence municipality decisions to be able to improve resilience. As open data is a relatively recent technological approach, it needs knowledge flows and the mobilisation and alignment of heterogeneous elements (Geels and Deuten, 2006) For instance, leadership is recognized in the literature as crucial to lead to capacity building and to obtain political support for open data, which are important success factors (Craglia et al. 2002). It is important to explore stakeholders' ability to use the available resources in the ecosystem and grasp new ones, as well as how do the stakeholders engage in trying to influence political decision.

- Cultural roadblocks and institutional responsiveness

This dimension condenses the barriers (such as the already mentioned lack of executive support, inadequate governance models and policies, low levels of community engagement among others (Degbelo et al. (2016), Verhulst and Young (2017)) to a more extensive and rewarding use of open data for resilience building, as well as explores existing feedback mechanisms between stakeholders and city decision-makers. A flexible approach and dialoguing city leadership which fosters feedback is crucial for the devolution of power to local communities, building a culture of collaboration or developing effective communication strategies and overcoming roadblocks. A deep understanding of different difficulties and challenges and how can cities discuss strategies and day-to-day difficulties with the ecosystem is crucial to provide insights for a successful open data – resilience relation.

3 Methodology

This research consists in an exploratory study focusing on a better understanding of open data and urban resilience.

During literature review, the methods used to the exploratory research were the analysis of scientific articles, reports, documents or internet-based information. This involved analysing the literature regarding the key concepts, their features and how they relate and on how open data could influence a city's resilience and what role could innovation ecosystems perform on that relation. It is relevant to recall that within this research open data is limited to data from publicly funded bodies or resulting from public initiatives even if it may be used by public or private entities at different administrative levels (e.g., national and local).

After literature review the research focus stabilised on how and why innovation ecosystems agents mediate the relation between open data and resilience, which features may be identified as more relevant and how can these interactions translate into cities that are more resilient.

Hence, for this exploratory research, two research questions emerged:

Research Question 1 (RQ1) - How does open data influence cities resilience?

The research seeks to explore and study the connections or links that exist between open data and resilience, to explore strengths and weaknesses and how resilience objectives are more commonly achieved.

Research Question 2 (RQ2) – What role does the innovation ecosystems plays in linking open data development and urban resilience?

In this question, the importance and the role of the innovation ecosystem and its features will be explored in more detail.

To fulfil the objective of a deeper understanding of open data and urban resilience relations, and answering the research questions we will put to the test and consolidate the four mentioned dimensions on the research framework:

- Number and diversity of actors in the ecosystem and their relations
- Resources (Quality of data and its infrastructure, tech skills and other resources)
- Ability to mobilise resources and influence decision-making

- Cultural roadblocks and institutional responsiveness

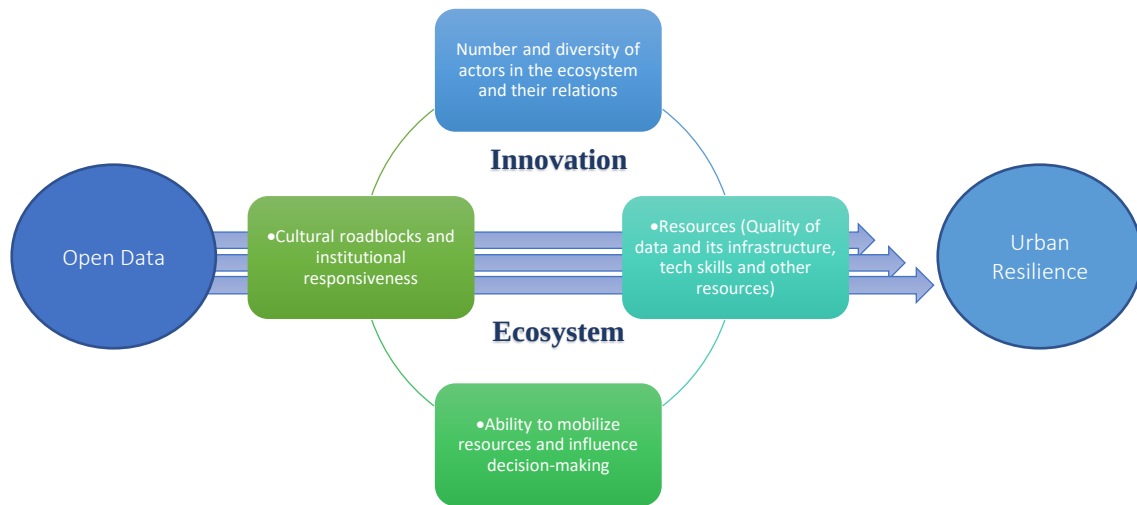


Figure 3. Methodology, Author

To do this, two different methods were applied:

- A short survey. In this survey we had the general objective of answering to RQ1 by gaining insight into the relation between open data and urban resilience and two specific objectives: to assess the most relevant resilience dimensions on the results of present open data initiatives and to assess the potential impact of open data in cities resilience. The survey was designed to assess the contribution of open data to urban resilience in light of the 12 goals of City Resilience Index (ARUP, 2015). The survey (in Appendix 2) was sent to the Eurocities Open Data working group¹, a group of cities within Eurocities dedicated to the open data agenda. Eurocities is an organization who brings together the local governments of over 130 of Europe's largest cities and 40 partner cities, representing 130 million citizens across 35 countries. The survey was sent directly from Eurocities to open data managers in the working group and 10 cities from 8 different countries answered the survey. The countries from which we got answers were France, Germany, Greece, Italy, Netherlands, Portugal, Romania and Sweden. In this survey the analysis was simple as the objective was to have a general idea of the dimensions considered more relevant and the potential of open data.

- A set of six in-depth interviews. These were conducted for a better understanding of the survey exploratory results and particularly to analyse context factors and the innovation ecosystem. The interviews, exploring how and why context factors and the innovation

¹ http://members.eurocities.eu/v2/working_groups/Open-dataandtpl=home

ecosystem might ease or block the open data/urban resilience relation, helped to answer to RQ1 and RQ2, consolidating the framework. The interviews were applied to three international organizations and three European cities, following a semi-structured script (Appendix 1) with the goal of crossing perspectives from a local and a transnational level. This script, with twenty-two questions, was organized in four different parts, aligned with the four dimensions of the research framework.

The interviews with experts from international organisations were conducted to receive a broader input, as they are capable of providing a larger context and a transnational perspective. In three different European cities, the interviews were conducted with relevant open data governance actors with the objective of exploring not only the innovation ecosystem but also the impact *in situ* of open data initiatives. The three cities' interviews were not researched as case studies, instead the interviewees provide insights as experts and experienced informants. The transnational organizations were selected as being transnational organizations with a track record in both resilience and open data and the city informants were selected from a poll of active cities on the open data landscape but in different stages of development in their agendas and the first three to accept to participate. The interviews with transnational organizations were conducted with experts from United Nations Disaster Risk Reduction Europe Office (UNDRR)², Eurocities³ and World Bank⁴. The interviews with city managers were conducted with experienced informants from Porto (Portugal), Milan (Italy) and Thessaloniki (Greece).

The interviews followed semi-structured scripts using open questions according to the topics of interest of the research and key concepts but with a flexible approach to the course of the conversation, trying to ensure that information was collected in as much detail as possible. The interviews were conducted via videoconference through Microsoft Teams, with the duration of approximately one hour and the transcription was manually made by the author from the recordings. The answers were analysed using *Nvivo* software.

The results were used to validate and enhance the four dimensions of the framework as well as to explore new sub-dimensions relevant for the open data – resilience relations and how

² <https://www.undrr.org/>

³ <https://eurocities.eu/>

⁴ <https://www.worldbank.org/>

the open data might translate (or not) into more resilient cities (see figure 3). The interviews also allowed to reveal new dimensions in the relation studied (such as the dark sides of open data).

United Nations Disaster Risk Reduction Europe covers 55 countries in Europe and Central Asia, supporting the development of policies and actions towards a more resilient future. UNDRR assist countries to monitor and track achievements towards implementing the Sendai Framework in risk reduction, support the development of national and local DRR strategies, build greater engagement with the private sector, and provide policy advice, particularly around sustainable finance and climate security. UNDRR launched *Making Cities Resilient 2030*. This is an initiative to support cities in taking action to reduce disaster risk in alignment with the Sendai Framework for Disaster Risk Reduction 2015-2030.

Eurocities is the major network of European cities, a network of 190 cities in 39 countries, representing 130 million people. The organization has a working group on Open Data, in which members exchange experiences and compare examples of city initiatives in the field of open data across the EU.

World Bank is a financial institution that works in the area of development, providing financial support and technical assistance to countries and leveraging on technologies and data to help create sustainable economic growth, and building resilience to shocks and threats that can roll back progress.

The knowledge and track record of these organizations in open data and resilience work as well as their international profile and experience provide a valuable input to better understand the dynamics between the main concepts.

4 Results

4.1 Results Description

As mentioned, the survey (Appendix 2) was applied to 10 cities from Eurocities Open Data working group. From these 10 cities:

- 60% have between 100.000 and 500.000 inhabitants, 20% between 500.000 and 1.000.000 and 10% above 1.000.000 and 10% below 100.000 (figure 4).

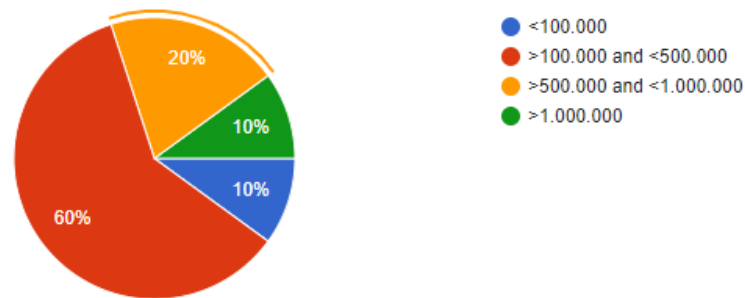


Figure 4. Population from cities considered, Author.

- The large majority, 80% of the cities, have been actively engaged with open data from 5 to 10 years.

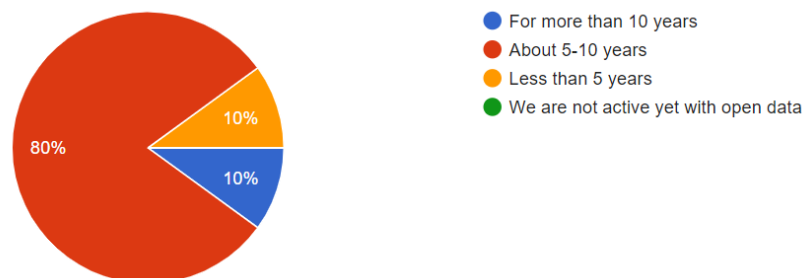


Figure 5. Time of experience engaging with open data, Author.

- Cities consider (see Figure 5) that have achieved most, so far, in two topics:
 - o Transparency and accountability to citizens and other parties
 - o Engaging with citizens and organizations

These results are probably connected to the fact that these are the options whose results are more directly and rapidly achieved by the municipality. In both categories the average answer was of 3.1 (from 1 to 5). On the other side, we found that cities recognize not so good results

in the use of open data for creating new jobs and support data-driven companies. This may be explained by a more indirect relation between opening up data and these objectives.

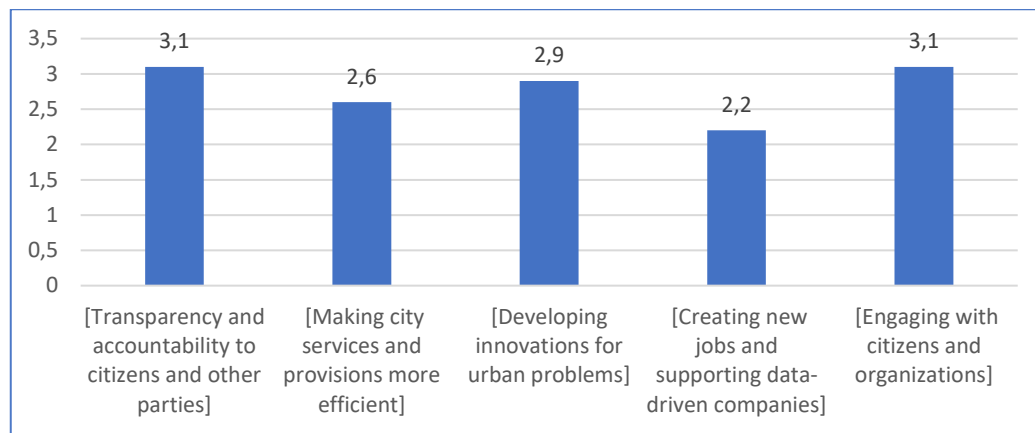


Figure 6. Average considerations on present achievements by cities, Author.

The survey proceeds by measuring the potential of open data initiatives impact in urban resilience with 43 questions on 12 categories (the 12 Resilience Goals) from 1(not relevant or applicable) to 5 (very relevant). The average relation, according to data collected, is positive with a moderate-high connection in all categories. The moderate results may be explained by some doubts about the implementation possibilities or capacities. The goals to which the considered cities believe open data can contribute the most are, according to the survey, “Integrated development planning” (4,2) and “Effective leadership and management” (4,2). The least considered categories for open data impacts are “Effective safeguards to human health and life” (3,2) and “Minimal human vulnerability” (3,2), as in Figure 7.

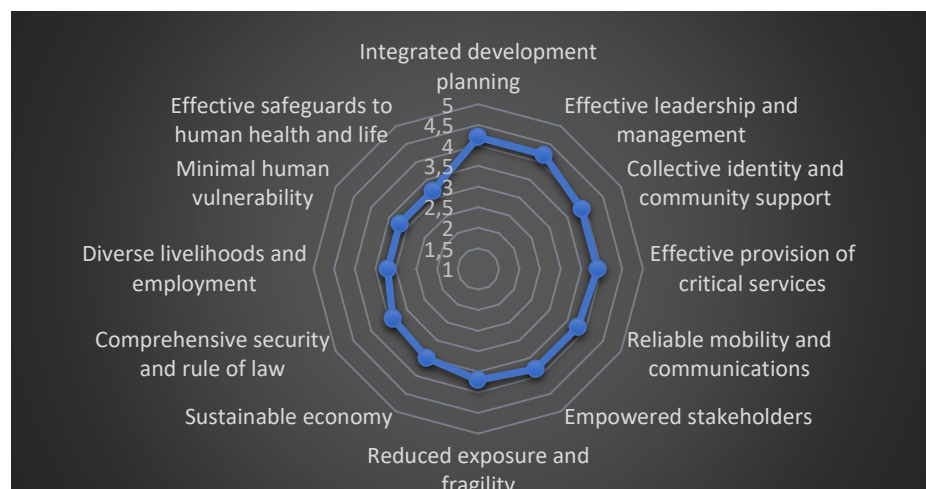


Figure 7. Open data impacts on the 12 goals of resilient cities index, Author.

During the interviews was clear that for all the informants that there **is a strong and positive connection between open data and urban resilience**, and supports the survey findings. The interviewees link it to how cities deal with risks, how to prevent them, but also how to build back better after a shock and develop a more sustainable urban environment. This conclusion is in line with the broader existing literature on the open data impacts on cities as found in Neves et al. (2020).

IO3, as an example, mentioned *“I definitely see a connection between urban resilience and open data. It is very clear from the experience in cities we engage with that resilience building whether it is a thorough work on climate issues or any other risk reduction area of engagement needs to be evidence based and a lot of our engagement with cities is around loss data collection, so loss and damage data.”*

CT3 also argued that the point of having open data for cities is precisely to cope with challenges and that *“I think there is a strong connection between the concepts, as open data clearly promotes resilience.”*

This research also found **the lack of assessing tools for open data impacts on cities to be particularly valid when assessing the impacts of open data in cities resilience**. There is a clear connection between open data and urban resilience, but the lack of frameworks or assessment instruments makes it difficult to measure. The difficulty in assessing resilience exists also, as mentioned in literature, because resilience cannot be observed directly. As argued by (Figueiredo et al., 2018), *“Resilience only becomes apparent during a major shock or stress that requires a city to resist, adapt and transform”*. In this regard it is relevant that the organization in which IO3 works is currently working on diagnosis tools for resilience in a city context, based on data that can help to inform the prioritization of actions and orientations for future planning for resilience, according to IO3.

4.2 Results regarding the framework dimensions

4.2.1 Number and diversity of actors in the ecosystem and their relations

4.2.1.1 The multitude of actors in the ecosystem

Open data and urban resilience strategies need to be co-developed. Many of the institutional partners to local authorities in developing these plans are public entities such as the statistical offices at city level, or the national statistics branches, the utility companies (as water, electricity or gas), universities, research centres, incubators, traffic and mobility authorities and companies, waste companies, regional authorities, port and airport authorities and, in a

different way, European entities. Even though, some have more relevant roles that can be underlined.

According to CT1 *“Academia here is a strong stakeholder because is the one who makes questions and asks for things. The Academia to be more active on this is very important for us”*. There are other entities more focused on resilience that are mentioned particularly by IO3, who mentions *“the crisis management and civil protection services. They have a central role. There is always a big question about information vs evidence but open data comes at the heart of that discussion and how should data inform decisions of emergency management services”*.

But the private sector is also central. The start-ups and scaleups, SMEs, real estate companies, the individual developers, the innovators in general as the main actors that work on these innovation hubs that each city, or at least many of them have all make significant contributions be it by opening up data or working on data to obtain relevant information for evidence-based decision-making. IO3 highlights specifically the vast amount of data in the insurance sector: *“The insurance companies and insurance sector sit on a lot of data that probably should benefit from open source access and inform comprehensive and robust resilience building at a city level, and national level as well.”*

In addition, the commercial and industrial associations and organisations, as mentioned by CT2, which have relevant economic and social data, can be included in the process of opening up data and resilience strategies.

Globally, all the different players, authorities, bodies, entities that are based in a city or in the metropolitan area are mentioned as having to be engaged and consulted to develop together a strategy, as a co-development. To IO1 *“the stakeholders are always the same, are those who are part of the innovation ecosystem of a city or a region as well. You cannot see only the city itself, you have to many times you need to look at the broader perspective to integrate the regional level, the bigger businesses, all the players on the region, like research centers, commercial authorities, the port authority and other public bodies that do not answer directly to the municipality”*.

4.2.1.2 Communities, civic organizations empowerment and citizen engagement

There are important actors beside the more institutional ones, such as individual citizens, grassroots organizations, local communities or minorities representatives. Every actor that connects and works with their own neighbourhood is an important partner to the city. According to IO3 *“As we see at the moment with the pandemic, the most affected are the most vulnerable*

categories of the population, who suffer the most and will take the most to recover from the crisis. Therefore is even more important to include representative groups of all categories”.

Cities have, frequently, specific community groups that are advocates for small urban changes such as better park lanes, new parks, but also other organizations such as the Red Cross societies, neighborhood organizations that are usually interested in crime statistics, police patrolling data, parking enforcement data and other. This kind of willingness to participate and changing little reforms or policies or laws is crucial for urban resilience. According to IO1, *“it is quite important to find ways to empower them, because you are going digital. And maybe they are more the sort of analog meetups. It is useful to have this kind of tech, digitally literate entrepreneurs as part of that. That usually starts just as an website or an app. But it is about having data and informed evidence based conversation about civic advocacy. You need to cross civic engagement and advocacy with evidence from open data.”*

From the series of six interviews stands out the importance of communities and citizens that are committed with their neighbourhoods and cities as a valuable asset to help in the design and implementation of open data agendas and resilience initiatives.

While IO2 chooses to highlight the importance of having innovators in the community that can act as game changers and seeing beyond “the very problem-solution”, IO1 and IO3 emphasize community involvement and empowered communities. IO3 underlines that *“cities build on the local communities by which they are constituted and therefore you need communities and citizens that participate and bring added value”*. The participation of academia as well as empowered grassroots organizations are mentioned as important resources.

To the empowerment of communities and citizen engagement, communication channels are referred as vital. Empowering communities might be an output of open data, as *“open data allows informing and awareness raising as well as increasing understanding and knowledge on risk that will reduce vulnerabilities and increase resilience for communities and individuals”*, IO3 argues. As IO1 also mentioned, the end user of open data, or at least a beneficiary of that data or the decisions taken relying on that open data, would be the citizens, putting them at the beginning and at the end of the process, in a process of co-responsibility.

4.2.1.3 Diversity of agendas and backgrounds and its impact on cooperation, development and learning

People with different mindsets, objectives or perspectives of regarding open data improve cities ability to develop open data projects that might foster resilience. According to CT1, *“If you put all the data just in the hands of the people of mobility, they will just be concerned about the traffic or something that was exactly where the data was coming out. Diversity here is the driver if you want to foster an open data ecosystem.”*

For instance, to solve cities challenges, in hackathons for instance, diversity of backgrounds seems to help teams succeeding. Participants usually come from the university but also come from private companies, the start-ups and the scale-ups in the city. According to CT1, the first team that won a *hackacity* in his city were medical doctors. *“There was one tech guy in the team but the others were medical doctors and they have now a startup and it is interesting to see that we get people from lots of places. I would say these are the type of people more keen to work on these kind of data. The other type are researchers, people that need the data to work on and to put on their research or thesis.”*

Diversity allows that more information is shared among different groups and communities, and therefore helping transparency. IO1 refers *“a number of theories of change”*, such as *“Transparency breeds accountability, participation breeds efficiency, but the more illustrative one is that innovation, new ideas come about when you have people from different communities, from different backgrounds”*.

IO1 reinforces the idea that outside innovators mixing with the existing stakeholders helps to breed new ideas, and that diverse ecosystems are the way to do that: *“diverse communities, and diversity ethnically, economically, age demographic, educational, people that have different experiences and different perspectives are more likely to find these sort of entrepreneurial attitudes mixing with the old school lobbying advocacy groups that never thought about going digital but they care passionately about the history or culture of a particular community and neighborhood. So, maximising a typical stakeholder interaction around common evidence is more likely to generate innovation.”*

In addition, we can draw the conclusion that when cities open their data, they do it in a number of different areas and different policy areas. It is also highlighted the importance of being able to understand what is important to citizens, involving them in the process. Diversity is also important to broaden the scope of open data impacts. Open data can foster resilience in several different areas such as *“social aspects, housing, employment, migrants, but also mobility and traffic but also in economic issues. I think the most important is collaboration with all other*

players that work and live in a city, as researchers, SME, the usual quadruple helix approach”, according to IO2.

For IO1 diversity is *“definitely positive. One person only cannot write the strategy”*. Open data strategies need to be shared and to include as many people as different stakeholders possible. The setting up, by cities, of several discussions, talks with regular citizens, are a huge source of information and knowledge. City government enable the processes, are the actors who organize the network. The public authorities link the actors, making the connections between the stakeholders.

CT3 corroborates this idea, focusing on the importance of a shared and bottom-up strategy: *“Diversity of stakeholders is of the utmost importance. In our resilience strategy, in 2017, that was the first time in the city, the first strategy to be developed and written by the stakeholders. We had 40 stakeholders, more than 2000 citizens and organizations from the civil society that took part in workshops, events, and working groups in order to co-create the strategy”*.

Also, the idea of a bottom-up approach is mentioned as an important achievement and a process that enriches the outcome: *“It was something new. We are updating that strategy and we want to do it again, developing, building up a strategy from the city to the city, not just a document from the mayor. It needs to be like: let’s sit down and discuss the challenges and how are we going to cope with them.”*

The diversity of actors helps to a better awareness of societal challenges, because it means more specific groups of interest will be vocal about their concerns. Being aware and well informed about new trends by listening to advocacy groups helps the city to keep up on different areas. CT3 underlines it in the following: *“And we want to see all the new trends coming. For instance, there was a fair critic to our previous version of the strategy as we did not mention regarding adaptation to climate change. That was not one of the priorities on climate change at that time, but now it is. It is a challenge, especially on planning. So, we have the universities and the advocacy groups that push us to set some new agendas on resilience”*.

Resilience building is regarded as a whole of society and whole of government exercise that *“shall not leave anyone behind and cannot exclude anyone, particularly the most vulnerable groups”* according to IO3. To do that, according to the same interviewee, *“the projects or initiatives to be the most successful and effective, need, whether it is open data or any other data collection process, to involve as many stakeholders as possible, reflecting the ecosystem in which it engages. In this case at urban level it is a system of systems and it should incorporate as much dimensions as possible.”*

4.2.1.4 Cooperation between public and private sectors

Cities need to improve on this cooperation, particularly in working to access private companies' data. According to CT1, cities need more organised and refined data if they want to mobilize new business models. If cities can provide more knowledge about how people live and how the economy is going around this would also benefit businesses and the surge of new business models. CT1 argues that it would be very important to collaborate more with large technological companies: *"we could have data from big companies that could also shape the city and help in new models, help us having a more resilient city. Nevertheless, it is always very difficult because usually when we talk about it the companies are not very keen as they are afraid that someone find something about their business that can cause them problems"*.

4.2.1.5 Formality of partnerships and the balance between flexibility and legitimacy

There is a large set of different kinds of relations between the actors. In different moments and according to different requirements and expectations a wide range of relations occur, such as public private partnerships, bilateral negotiations, public procurement relations, joint research initiatives, open dialogues, public events, citizen participation forums, commercial contracts among others. However, this seems to be a very context specific issue.

Formality, or at least defined roles, common goals and shared and transparent strategies appear to be relevant drivers to achieve results. According to CT1, *"we need to work partnerships in a formal way in order to get to a different level. But if we have a common goal and the right drivers is not difficult to develop those kind of relations"*. This seems to be also an outcome of several years working with open data: *"After working some years with open data, we understand that we need a plan for valuing data, we need an index, something formal and then we can provide open data"*.

According to CT2 most of the time, especially for universities, it is easier to work in a more informal way, while for public administration there is a need to *"go through all the administrative processes that are needed by formal and legal standards. For public administration is not possible to work just on informal terms and that is why we need to find a balance"*. At the same time CT2 recognizes open data that can help to decide in a more flexible and informal approach, but especially, in a more time-efficient manner by reducing administrative burdens but highlights the need for a balance: *"we simultaneously need to legitimate our work but also to be flexible and quick"*. This legitimacy point of view is also mentioned by IO3, for whom political legitimacy of the engagement through formality is a necessary component for a reliable recognition of the

value of open data. In this context, according to IO3, formality does provide *“some form of potential reliability as well as political legitimacy”* and finally, however, informality is also important as provides for a sense of flexibility that allows data sharing and the right type of healthy relationship to secure the data.

IO3 also mentions the potential differences between different geographies, as stakeholders *“might have different approaches in Central Asia context comparing to Portugal, France or Spain. In the sense that culturally speaking, it tends to be different political engagement and oversight of formality of relations as well as access and usability of data.”*

The need for a balanced and context specific approach seems to be widely recognised, with the need of developing a framework, guidelines and well-defined processes but without burdening the city with binding regulations. According to IO2 *“because it requests a lot of time, energy, resources and skills you cannot just leave it freely; you need to, in a way, formalize it. On the other hand, when you talk to some cities, some are also a bit reluctant because of European regulations that bind them and oblige them to open the data because that means a lot of effort and not always that is possible for them”*.

Regarding specifically partnerships with the private sector, IO1 mentions that bilateral meetings between large corporations with the local authorities sometimes occur and companies might even support urban open data strategies but only, *“if they see a benefit to take part, to be involved or to sponsor the collaboration or events with other bodies”*.

CT3 highlights the need to “warm up” these relations over time and differences on how to deal with different actors, highlighting that one size does not fit all regarding formality or informality of the partnerships or relations: *“Some entities or stakeholders we find more difficult to engage with them and for them to participate. They need too much formality in order to discuss and participate. And other stakeholders embrace this kind of initiatives and want to take part and help because they do understand the value of it. It depends on the stakeholders”*.

Nonetheless is also important to highlight that sometimes relations are based on personal connections, particularly among the municipality departments. CT2 highlights the importance of that kind of informal but effective connections: *“There are links between people. We have very close relations even from our past, from university backgrounds and we try to develop them within our roles and job description, our activities, every day as that also helps to develop and implement the city strategies”*.

It stands out the need for cities to be able to keep both formal and informal relations, to understand how each partnership works better and how to get more and better data. It is also mention worthy that stakeholders need to feel part of the movement, as a platform that all can actually use. On the other hand, according to CT3 some formality and top-down approach is sometimes useful when facing fewer collaborative stakeholders: *“formality is particularly important for those who don’t believe in open data, who think that data is more of a secret or something that they do not want to give information about. I guess it is a small power some don’t want to open hand of or their operative framework is not modern and they don’t understand the importance of open data and that is why we need a push from the national or regional authorities.”*

4.2.1.6 The role of international partnerships

International partnerships bring more expertise and the sharing of best practices, as cities have the opportunity to find information and share experiences that might don’t have at national or regional level. Urban leaders or open data and resilience officers share and learn about technical expertise, methodologies and tools, but also learn with other cities mistakes or unsuccessful initiatives. International projects or initiatives also motivate cities to do better, as they become aware of other cities success and can access to some of their know-how and exchange ideas and goals, allowing also important networking and benchmarking among cities.

There is value in international partnerships. Some of the international partnerships even allow the cities to market and feel as leaders in the world stage with innovative information and visualizations. In contrast, institutional partnerships with relevant local and regional players are more result-oriented: *“What ultimately cities want is to have long term relations with research and academia communities and tech business communities to keep advocating for real world use cases and real services locally, biased towards local reality”*, according to IO1. The same informant characterizes some international partnerships as *“a bit of a gimmick”*.

There are several international partnerships (as the 100 Resilient Cities Network, C40, Eurocities, Ellen MacArthur Foundation) that develop resilience and open data frameworks and strategies. According to CT2, the presence in these partnerships has been very useful to learn with other cities but also to share knowledge, particularly during the recent pandemic shock. To the informant: *“Italy was the first one needing to identify strategies and answering to very difficult challenges and a lot of cities were looking at us, speaking with us trying to understand what we were*

doing. Of course, we can exchange knowledge, expertise and competencies; we can develop partnerships for specific projects, we can have sharing all the benefits, it is all very useful.”

IO3 believes that international partnerships are important to maximize and capitalize on the diversity of the more localized and regionalized initiatives and partnerships in place. In his words *“I think there is an aggregate effect that is very useful from open data initiatives. I can take for example the SDGs platform, the platform on monitoring for Sendai framework. We are seeing that it is an extremely tough exercise to access and to collect the right levels of information and data at a very disaggregated and localized level. Yet, I think that it is particularly important to draw those pictures, especially when we are talking about very cross cutting issues such as resilience.”* It is also mentioned that the responsibility of international organizations or initiatives to stimulate these kinds of partnerships to make those platforms and opportunities happen: *“I strongly think that this should be one of the driving principles of international partnerships around open data to engage on those sharing of good practices”.*

4.2.1.7 Institutional and grassroots dimensions

From the set of interviews, there seems to be two types of visions on this subject, one more focused on the institutional dimension and relations, centered on the municipality, academia, enterprises and relevant public authorities in general and another more grassroot-based or bottom-up approach, centered on small and local advocacy groups, neighbourhood organisations and civic engagement initiatives. This enriches the analysis as it makes more clear the eventual need of two different but coordinated approaches to seize the benefits of open data to improve urban resilience.

4.2.1.8 Synthesis regarding the number and diversity of actors in the ecosystem and their relations

Even though all stakeholders are relevant, some that emerge as particularly relevant, such as the academia and entities focused on resilience. The private sector is also crucial, both start-ups and scaleups that might use open data to new business models but also specific sectors such as the insurance sector that stores a huge amount of data. Cities need, although, to improve cooperation to have more access to private companies' important data. Cities can improve how people live and how the economy performs if it has more data, open data, from private companies.

It also stands out the importance of committed communities and citizens as valuable assets to participate in the design and implementation of open data agendas. Additionally, to an

adequate empowerment of these communities and citizens, communication channels are regarded as vital. Citizens have co-responsibility, as they are at the beginning and at the end of the process.

Diversity of mindsets, objectives and goals allow more information to be shared among different groups and communities, and visions to be discussed among stakeholders, strengthening the process. To diverse ecosystems and mixing outside innovators with existing stakeholders also helps to breed new ideas. The variety of stakeholders is important to broaden the scope of areas or sectors in which an open data agenda can reach. It is also important to highlight the relevance of a bottom-up approach as it helps the municipality to be aware and well informed about new trends and challenges by listening to advocacy groups. There needs to be a balance between top down, more institutionalized perspective and the bottom-up approach.

Regarding stakeholders' relations, it is recognized the need for balanced and context specific approaches from the municipality to the ecosystem actors. There cannot be a "one size fits all" approach to these relations, which also need to be nurtured. Nevertheless, it is useful the development of a framework, guidelines and well-defined processes to organize work and establish responsibilities. In the case of international partnerships, these allow policy officers to share and learn about technical expertise, methodologies and tools, but also learn with other cities mistakes or unsuccessful initiatives. These partnerships are also important to maximize and capitalize on the diversity of experiences.

4.2.2 Resources (Quality of data and infrastructure, tech skills, investment and other resources)

4.2.2.1 Quality of Data, its collection and publishing

On the one hand, according to IO2, the European Commission prospective work predicts that by 2025 the amount of data that will be shared, not only by public but also by businesses and citizens, will grow by 5 times. IO2 argues *"that is why European Union is working on regulation as the data governance act, data act and open data directive to make sure we make the most out of data"*. On the other hand, regarding quality of data, it is generally recognised by the interviewees that open data published by cities still has to improve its quality. IO2 argues that data quality is not homogeneous throughout Europe, but cities are trying to improve to a common base level. In general, they provide data that is free, in non-proprietary formats, with information

for context and in workable open formats. Data quality seems to be a more serious issue in developing countries and fast-growing cities. IO1, however underlines that *“there are a lot of examples of rich cities releasing really poor quality data sets”*.

The release of open data is an iterative process. Usually, the chief data officer is under the mayor or the municipal director, but each dataset is usually released by the agency that has the IT infrastructure and databases they are managing.

To improve data quality, cities need to define common guidelines and frequently assess quality of data being released. According to IO1 *“they need to follow some kind of centralized directive but it is dataset by dataset in terms of its publication, its metadata formulation, and that is why it is there such varying quality standards, because you don’t have a centralized data team collecting data on behalf of all the agencies. They do it inhouse themselves and then as an afterthought they are told to release more of it to the public”*.

Both licenses, data format and granularity vary a lot and usually datasets are not connected with other data from different sources providing context, CT3 underlines. This is a signal of poor quality according to the 5 stars of open data. CT2 stresses that quality depends on the topic and on specific datasets: *“I think we have very good quality data for instance in mobility. Data that is open, it can be used, reused, it is free and that we can link with other topics, other fields, other strategies. We are maybe less confident with open data related to green surfaces for instance. We are ok with data from the public green surfaces. Also not so advanced with datasets from private entities. We need to find tools to acquire information and data related to what is public but also to what is private”*.

To IO1, cities *“cannot manage what are not measuring”*, stressing the importance of data availability and quality. In the expert perspective, barriers in the access to quality data are an important restriction to risk management and improved urban resilience: *“if data has barriers to it, if you need permission, if it has a special format, if it is under various “lock and key”, that is a restriction in your capability to manage your own risk, to be informed in a way, to prepare and plan and take action.*

CT1 defends that it is also relevant the amount of data that technological companies gather through citizens computers and smartphones, collecting much more data on the citizens lives than the municipality where they live, work or study does. According to CT1: *“As city leaders we need to give the example but I would like to see joint partnerships from private and public sectors to have open data that could help developing new business models and improving cities resilience”*.

4.2.2.2 Skills as a resource to urban open data initiatives success

IO2 affirms that in the case of cities that do not publish open data it is usually *“a matter of resources and a matter of skills”* as there is a significant cost to develop an open data agenda that impacts cities resilience, particularly in the case of small or medium size cities. It is difficult to attract talent to implement it, particularly in a moment of growing demand for ICT human resources: *“They need to be trained to do this, to store, to manage, to collect, to publish, to understand which processes needs to be put in place, the standards that need to be respected”*. It is acknowledged that the lack of skills, human resources and investment does restrict the success of open data initiatives, but also that cities are improving and have been developing these kind of skills and abilities.

CT2 refers to the cities' investment capacity in digital support and digital tools that can help training human resources to be more prepared as the central resource for the success of open data initiatives.

CT1 mentions that in his city there is a three people team fully dedicated to data itself: *“analysing the data sets, working with the teams that provide the datasets to understand if they are in the city index, available and the owner well identified. But also if the values are in the correct form and being continuously updated. They make all these validations. They manage the data and are also responsible for analyzing data with the team that generates it and to ask if it should be open or not”*. These changes are result of the data valorisation plan that was implemented, a set of principles and guidelines. As soon as the open data is on the platform this team is also responsible to monitor the quality of data. CT1 mentions the increasing difficulty in hiring skilled labour as these professionals are highly requested and the municipality cannot compete with private sector wages. Public sector can't ensure human resources like data scientists or data visualisation engineers and without them cities need to have companies to help them in that task, CT1 adds.

In this regard, IO1 presents a different perspective, a more bottom-up approach as he expresses that skills help but the lack of data and ICT trained people does not have to be a problem as people can train themselves: *“generally speaking, you can make data open, you can enable lower cost, lower complexity ways to analyse it. You don't need to have a PhD in GIS anymore to download a shapefile and figure out in a sort of urban plan you can access in formats to a browser without special software and realize that is something interesting here”*.

IO3 stresses that there is a constant plea for more tech support to municipalities, which, in line with CT1 demonstrate a high demand for skilled labor. It is a recurrent request to increase support to IT capacity of cities to engage. According to IO3, *“municipalities are not necessarily sufficiently equipped or IT trained to engage and do rely on external data managers to proceed and that is an area of capacity that probably need to be strengthened or more robust in terms of resilience building”*.

4.2.2.3 Infrastructure and eco-system regulation

Infrastructure is, according to IO2, the first challenge in order to have data that can be accessed, used, reused, and shared because the mere availability of data does not make any urban environment more resilient *per se*: *“You need to be able to use those data and to create value from it. The cities needs to be able to build develop strong, reliable data infrastructures”*.

IO2 also mention that if cities can build adequate infrastructure and regulation along with the right people then they can succeed. *“The right people in the city government is crucial, the people that are able to build this but also connect it with other topics as the legal aspects, to read the legislation and understand the legal barriers. There are standards to follow, like the Inspire directive (Infrastructure for Spatial Information in the European Community). Cities know the standards and try to respond to that but they not always can fully accomplish”*, IO2.

CT1 argues that without proper infrastructure it is impossible to measure the pulse of the city and believes his city is “at the forefront of the European level” as the city has its own optical fiber network, its own sensors deployed throughout the city, and capillarity. It is possible, according to CT1, to connect all the traffic lights, cameras, public buildings, schools, public services and public transportation. CT1 adds that in his city, *“we have millions of people using different devices using the Wi-Fi that we provide in the city. Therefore, we cover many of these topics in terms of infrastructure, although there is a lot to be done on the platform side on the development of IT, the infrastructure currently is very good”*. This supports the idea that regarding data infrastructure *“the city is very well prepared for the future”* besides the fact that the European Commission agenda to a greener and more digital Europe is ambitious and *“we still have a lot to do to achieve that”*.

To IO1, fast growing and informally planned cities in the emerging world, typically African cities, don't have enough infrastructure as they show a chronic shortage of digital infrastructure and data that they need to improve resilience as well as for general management. To adequately improve resilience the experts believe cities need a history of

land assets, socio-economic activities, the geophysical environment and how it is changing and many cities have a shortage of everything. He underlines that is difficult to have infrastructure in *“places like Dar es Salaam where we know that there are around 1,1 million buildings, we know there is probably around 6 million people, but the official data is 4,6 million. There is a shortage of information on the social economic occupancy of the city. The master plan is very old and outdated”*. The lack of infrastructure undermines the efforts to open data and develop resilience initiatives as many large and capital cities have one (as Dar es Salaam) or none meteorological stations, preventing any effort of water shed management, river management or flood risk assessment. IO1 highlights the weaknesses and the importance of infrastructure that can collect data in disaster preventing issues such as collecting data on river planes, the lack of rainfall gages and stream gages and a chronic short of environmental parameter monitoring, including pollution, heat or traffic. IO1 defends that cities need all that infrastructure: *“I think all of that is part of public good not just to manage the city but also to share with the people who live there because it is part of what they are exposed to. Their pollution, their weather, their changing environmental risk parameters, landslide, earthquake, flood”*.

According to IO1 the *“emerging world”* has a shortage of up-to-date geophysical sensors as well of social economic activities, business, people, houses. The infrastructure, when exists is out of date, inaccurate and incomplete.

In IO3 opinion, there is a *“heavy set of expectations”* on cities to deliver on a variety of different fronts including on data and open data management and therefore most cities can’t provide enough data infrastructure capacity in comparison to what is expected from them. Building on the current pandemic impacts, IO3 argues that *“city level is critical in collecting all the georeferenced data, to manage that data and to inform about the dynamics to very critical policy decision-making on sanitary measures and restrictions and vaccination programs. The level of expectation is such that we can only say that infrastructure is at best limited or insufficient”*.

4.2.2.4 Leadership and investment

Cities need decision makers that understand the necessity of open data, the importance of finding data and opening data to provide information to citizens, making cities more resilient and also strengthening their internal decision-making procedures and need to work with other bodies outside the municipality entities, overcoming cultural roadblocks and getting the private and public sector to work together. IO2 argues that in private companies, data is

used and its value is adequately captured, but data is rarely made available and open. In the expert perspective *“city leaders need to work with private companies so cities can access more data. Nowadays all the data is collected by machines, produced by people and collected by machines, sensors, mobile apps, different companies and all these data are a huge source for city government, for law enforcement, for policy making and city planning”*.

One example of what leadership can bring given by IO2 is about cities public procurement, as there are cities that *“giving the data to public authorities is also a criteria for deciding who wins the bid in several public investments”*, which is promising in areas as mobility and energy, which are crucial for green and digital transitions.

But, if on the one hand, city need leadership to design and implement open data strategies and initiatives, the answers to the survey indicate that open data is also positive to cities *“effective leadership and management”*. The results in this category average 4.2, indicating strong opinions that open data firmly contributes to a successful urban governance.

CT3 mentions that for some cities investment is the most critical resource as the city wants to be more advanced in open data and resilience agendas. This underlines the importance of city leaders with a strong agenda and a clear vision on how open data can help to improve urban resilience. The interviewee argues that the city lacks money to invest, particularly with post pandemic economic crisis to develop adequate infrastructure and invest in human resources skills, but that EU funds are an opportunity city leaders must seize: *“Here in Greece, governance is more centralized, cities don’t collect as many taxes and have short budgets, being largely dependent from the central government. We are looking at other sources as EU funding, through the regional authority. So we need this kind of EU funds and other development programs not for running expenses but for investment in infrastructure”*.

However, not all experts agree. CT1 expresses that in his view, it is not a matter of resources; it is a matter of strategy and empowerment of the people that works on it: *“You don’t need a lot of resources in order to work with open data or to put the data available to the public, is a matter of empowerment and strategy”* even if, according to him, it is difficult to compete for talent with private companies in this area.

4.2.2.5 Synthesis regarding resources

It is generally recognised that the quality of the vast majority of open data presently published still has a large margin to improve, which leads to the importance of cities defining common

guidelines and quality assurance mechanisms for the quality of data released. We shall say, nonetheless, that data quality may significantly vary topic-to-topic and even dataset to dataset. Resources are decisive when it comes to publish quality open data, namely talented ICT human resources, as it is difficult to attract talent in a time of growing demand for these resources, not only in public administration but also in the whole society.

Adequate infrastructure is a first order necessity in order to cities have data that can accessed, used, reused and shared. Cities need infrastructure so they can gather data about land assets, socio-economic activities, geophysical environment and how all these areas evolve over time so they can better plan for resilience. Unfortunately, most cities cannot deliver the level of infrastructure be needed to respond to the expectations.

Leadership is also critical to guarantee that cities have adequate investment, both in infrastructure or human resources or innovative ways of open data related public procurement.

4.2.3 Ability to mobilise resources and influence decision-making

4.2.3.1 Extract knowledge from data and its role in supporting management decisions

“To have data is to have lots of information, but many times it doesn’t provide any value. It is what you extract from it and its quality that it is the key to people to understand the importance of open data.” (CT1).

The quote above points the importance of obtaining value and knowledge from data, which is crucial on decision-making, as extensively mentioned during literature review. The fact that increasingly more decisions need to be taken in short periods of time and that public and political decision is increasingly scrutinised implies a different type of evidence-based decision-making. This happens, for instance, according to CT1 in one of today’s most important societal challenges, climate change: *“In order to cope with climate change and many other aspects of the resilience of cities, we need data in order to figure out if we are in the right path or not. For that purpose, and to measure resilience in a city, to measure how it is coping with climate change or other resilience types, we need to gather more and more data”.*

It is through knowledge, decision-making and resilience initiatives results that is possible to assess the connection between open data and a city’s resilience. Risk assessment and crisis management are examples of areas in which cities are working on objectives and targets that strongly rely on data. CT1 underlines that *“when you are talking about how the city is dealing with*

flood risks or other risks, that is the kind of data you can need to measure and that really influences decision-making”.

The more data can be open sourced to inform and support decision makers on what is the environment in which they are engaging in terms of the impacts of previous disasters to inform future decision-making, the better. IO2 argues that open data needs to be managed and used to “*support resilient sustainable urban development policies*” and IO3 backs this idea, explaining that the need to inform and support is “*why we are working closely with stakeholders who would be owners of data to make sure data is made available, either through open data source or targeted data sharing so that urban resilience can be planned for in as effective ways as possible*”.

IO3 also says that knowledge extracted from open data is “*a critical component to the governance process at local level*” as decisions should be as much as possible evidence based. This unveils also open data as an important tool in giving a sense of accountability to the governance process and decisions being based on sets of publicly accessible information that general public can access as contribution towards greater accountability of governance of cities.

4.2.3.2 The role of stakeholders in decision-making and policy co-design

Previously it was discussed how the diversity and number of stakeholders enriches the process of designing and implementing open data strategies, but stakeholders are also crucial in influencing and improving daily decision-making. The need of a better understanding of the urban fabric and its vulnerabilities it is an opportunity to improve open data use and to strengthen the connection between urban management and open data.

But data is also mentioned as a way to “dig deeper” in the city and understand it more profoundly. *There are different trends that a city can experience, different levels of vulnerability and therefore cities really need to access, understand, and recognize those trends. How do you do it? You do it with data*” (IO2).

We can also conclude that cities are working closer with stakeholders in policymaking, and these seem to be particularly mobilized by social and environmental agendas (CT1). Cities are using municipal councils on different subjects as education, environment or business to have feedback loops with many of the stakeholders, assessing and improving not only the strategies but also their execution. This represents a structured engagement process, and an organized way to stakeholders to be able to give informed and detailed feedback.

As IO1 stresses resilience is a broad concept and involves a lot of stakeholders and *“by and large it does involve stakeholders to be able to empower themselves, to take some action and responsibilities for their own vulnerabilities, their own exposures, their own capacity recover”*. Access to data is therefore key to empowered, autonomous and creative communities as allows cities and stakeholders to be aware of changes and facts they had never realized. This happens because open data *“facilitates discovery, it facilitates co-creation between data sets and stakeholders, it facilitates anticipation from stakeholders that may authorize users they never heard of that have ideas that they never thought of”* highlights IO1. So, cities can develop new and innovative models based on enabling efficient and effective services through co-creation. To IO1 *“there is a certain magic in unlocking these known unknowns with open data”*.

4.2.3.3 Small changes and influencing decision-making

One of the most effective ways to influence decision-making seems to be to show to decision makers how the city can perform better at a lower cost. Decision makers are, according to IO1, particularly interested in initiatives that can save money. One other approach regarded as equally effective in short to medium term is to present easy wins that are politically and socially popular at a low cost. So generally, open data advocacy groups, start up by trying to show where participation and collaboration leads to cost savings and quick wins or popular improvements at a low cost.

IO2 argues that it the focus for influencing decision-making is, usually, on analysing the data in a way that respond also to the political will. According to the interviewee *“Data is very simple but you need be able to analyze them in a way that make evidence for political decision. Even if many times is the way around, decision makers want data that supports their previous decisions”*.

In the long range there are other benefits as creating a culture in which communities and stakeholders' roles are valued differently by being partners in co-creation processes. According to IO1, in the long term, this means that cities might not be completely responsible for the result of the process. Instead, it empowers other people that help creating these services in small, tangible, citizen facing issues as waste collection and management, fixing infrastructure, bike lanes, preventing accidents or gardens maintenance, and other services that are transaction intensive for a city. Small changes that are important to citizens, but cities frequently lack enough resources (people, budget or time) for all the requests. IO3 has a similar perspective, underlining that there is a general overstretch of cities capacity to

do multiple things: *“many of their activities that are expected of them and mobilizing resources is one particularly challenging”*. IO1 argues that releasing open data allows *“other people to take on that role, that consultation design, visioning types of activity and coming back to the city with more specific proposals that have budget and cost estimates that are based on reality, so it makes it more efficient for the city on the long run”*.

This changes, however, as cultural and ecosystem changes can only happen in the long term and cities and decision makers need quick, tangible and easy to communicate wins along the process. These initial small steps happen usually more successfully on local issues, where cities have civic communities already engaging and taking part but without the knowledge given by open data. For instance, in communities particularly concerned about a topic and that already talk and take action it we can expect the results to be better. Be it the environment, waste management and clean-ups, or about mobility, transportation and cycling lanes and safety as mentioned by IO1. Generally, according to the same expert, issues that have a *“vibrant civic discourse and associations, if it has tangible citizen facing assets or service deliveries that the city is in charge of, releasing those datasets has a good return”*. The already existing civic activity fosters a quick engagement the existing stakeholders are able to implement change. CT3 seconds IO1 by stating that a participation inducing approach, communication and citizen science are key points. To the expert *“cities need to engage with stakeholders and civil society in order to do strategic planning and set common goals. (...) It is important to have universities and research centers as well as private companies and to see that the vision is one and you need to find data on that, working together on that from every side, public and private, civil society, everyone”*.

CT2 claims that it is important to have “competitive advantages” both to city decision makers and to stakeholders. These can be revenues, if the stakeholders are private companies, or scientific research and development for universities, or saving money or better services at low cost for the municipality. To the expert this shows that common goals that translate to different benefits to different actors are central, and that *“these advantages are more frequently achieved in recurring civic services, particularly municipal ones, like waste management, transportation or maintenance of infrastructure and green spaces. Services that are close to the citizens’ concerns on a daily basis”*.

4.2.3.4 Synthesis regarding the ability to mobilise resources and influence decision-making

Data is merely information; knowledge needs to be extracted from it. Resilience oriented activities such as risk assessment and crisis management are examples of areas in which cities are working that strongly depend on open data. It is crucial to extract knowledge, as it is vital for decision-making, being a critical component of local governance processes. Open data is a tool for accountability of the governance process and evidence-based decisions.

Some municipalities have structured engagement processes for receiving stakeholders' feedback, assessing and improving open data strategies and initiatives. This improves participation and allows stakeholders to empower themselves and take their own responsibilities for their risks-exposure and vulnerabilities. Access to data can help to empower, autonomous and creative communities, helping cities to co-develop new and innovative models based on new efficient and effective services. Releasing open data allows people to take part on new solutions for city problems. However, these cultural changes typically take time to happen and cities and decision makers usually crave for more quick, tangible and easy to communicate successes.

4.2.4 Cultural Roadblocks and Institutional Responsiveness

4.2.4.1 The roadblocks to a more extensive use of open data for resilience building

Municipalities are complex structures with several departments, units or divisions, with demands in a variety of areas. This reality implies complex challenges of communication inside with the stakeholders but also inside the municipality itself. For instance, those who are actually working with the topic of the city resilience may find difficulties in communicating and sharing a vision and a strategy with those working with open data. IO2 develops this idea: *"Those who are working with data don't necessarily speak with those who work on the field of resilience. They need to be able to talk, to understand each other, to talk the same language, which is not always the case because some people are more technicians and not used to that language. It is a cultural roadblock"*.

Collaboration is, according to the experts interviewed, a major issue. The ecosystem needs collaboration between all actors that work and live in a city, with the quadruple helix approach being referred also by IO2, who argues for the presence of communication silos: *"I work a lot with data scientists, the digital experts in a city and they do all the groundwork but they frequently do not talk to the mobility or the city development or air quality departments. There are communication silos"*.

For CT1 the roadblocks are frequently more serious than communication silos, being a matter of culture and education that the municipality has been trying to improve with innovation days dedicated to data and open data: *“it goes deeper than a silo mentality as the city human resources need to understand that their file or their excel page is something valuable and if made available to their colleagues, to their team or to other department of the city it can help and improve other things like mixing mobility with green areas or pollution”*. Data is frequently neglected as people tend to think it has little value for other departments or entities, and therefore it is never shared and doesn’t become open data.

One other roadblock referred is the risk-adverse mindset, in which a centralised administration approach refuses to release information. This type of roadblock materialises itself in a need of apparent “full control” over the data, and, according to IO1 situations in which decision makers refuse to open data because *““because the data might be slightly wrong” or “we might get sued” or “we don’t have all the information about when it was collected and how it was collected so we don’t want to release any of it”*”. Risk adversity is therefore a cultural barrier to the release and use of open data in general and to improve urban resilience in particular.

A slightly different problem to IO1 is the *“command and control”* perspective when cities don’t want to release open data because are worried of *“loosing authority”* and *“potentially are afraid to be held accountable”*. From these two situations we can understand that there is a lack of confidence and trust in the process from managers in charge of this matters.

IO2, from a cross-European perspective, mentions what can be also categorized as a cultural roadblock: decision-makers thinking that data is *“neither important nor an opportunity”* which leads to the absence of investment in managing and collecting the biggest amount of data possible. Consequently, the lack of political priority to open data and to resilience by the elected decision makers limits the results that cities can obtain. IO2 also reiterates the lack of *“culture of innovation, of working together, of co-creation and co-development, of co-design thinking”* mentioning the case of Eindhoven as a city to which other cities and decision makers could look up to, which is *“always talking about city design, saying that design aspects can really influence all the others aspects of a city also at the policy level to be able to approach all the policy areas. Cities need design thinking methods, being visionary and being innovative”*, IO2 argues.

IO3 believes that the “excessive formality” of data management channels may affect the use of open data sources, mentioning that “the excessive scrutiny of data and also that “to some

extent, concerns over privacy go possibly against open data effectiveness”. Privacy concerns, an issue extensively mentioned in literature wasn’t mentioned as frequently or as strongly as the literature review would suggest, what could indicate that the experts interviewed find the other mentioned roadblocks more critical.

CT2 reiterates the idea of cultural and educational background difficulties: *“Our public servants are not aware as they should for open data potential and urban resilience importance, we don’t have so many young people working in public administration. It is a matter of how people know about all this digital subjects and tools and how they can use it for everyday activities in their job. In this sense is an education and cultural roadblock”*.

CT3 on the one hand, highlights the lack of consistency and coordination between the different stakeholders’ opinions on “what is open, what should be open, and the limits to the openness of data, regarding privacy issues”, shedding light on the importance of coordination and institutional responsiveness by the local authorities.

On the other hand, aligned with the opinion of CT1 reiterates the need to communicate the importance of open data and communicating the data of each organization or department: *“in a networking session with other cities this was also discussed, we don’t know of the existence of some data and then you participate in a summit and you hear about a research or a project and you find new data. Sometimes people have data and don’t communicate and then you find it and you say why? Why didn’t I know this existed?”*.

Finally, reiterates the lack of standardised procedures: *“if you want to set up a set of indicators, you need to know what to collect and then know what to do, what data is to open or not, or to open only part of the dataset because of privacy issues. The lack of this kind of culture and know-how is also a limitation”*. This represents simultaneously lack of knowledge, confidence and open data culture inside the organizations, and is fully in line with the concerns showed by the other interviewees.

When dealing with long term barriers, it stands out the importance of creating an adequate ecosystem, fostering collaboration with citizens, digital citizen participation, being able to understand what is important to the community and to the different stakeholders, but also the need for a strong leadership and coordination in the different areas of the municipality.

CT1 mentions the importance of investing in culture and education, providing competences and skills to people. CT2 goes a bit further mentioning that the Public Administration is still handled in a very traditional way and *“not much open to innovative tools and solutions as open data*.

We need very strong measures to have a turnover in the Public Administration in order to let young people coming in, people that can promote innovation in public servants' everyday activities". This analysis, of a not so innovative culture in public administration can be linked to the idea of some risk adversity and lack of innovative mindset expressed by other interviewees.

Considering the roadblock of lack of dialogue and coordination between the city services, IO2 mentions the example of Ghent city, whose municipality organize a big festival each year, which used to cause severe problems in managing traffic and parking space, but thanks to the use of open data, planning and communication were adequately solved.

To IO1 overcoming these roadblocks takes leadership that *"gets it and generally speaking that has not been the kind of person you hire into city management"*. The informant uses the UK datasets on the bus stops as an illustration: *"The UK released the datasets on the bus stop nationwide, around 50 thousand bus stops, and they were really reluctant to release it because they knew the data wasn't complete, they knew there it would be mistakes, etc. And they were afraid of being embarrassed, afraid of being criticized, maybe afraid of being sued if someone made an app with wrong bus stops"*.

This represents an example of risk adversity mentioned previously. However, local authorities were not anticipating that a lot of open street map community groups would help correct the bus stops location in the data sets of the government for free and much faster than before, according to IO1, that underlines this was a strong example of *"a tangible, citizen facing win"* and also a kind of *"feel good"* media story.

These type of examples, tangible examples, help to build a different culture, overcoming risk adversity and being confident about trying innovative solutions that make local authorities look collaborative and open. Cities need, in IO1 view, to feel the confidence to try these solutions *"in areas as the bus stops, or the river data, or parking, or the touristic information, the crime statistics, and keep promoting it"*.

It is highlighted across the research the importance of recurrent positive feedback and information, the relevance of cities marketing their work to build trust, confidence and an innovation culture inside the ecosystem. IO1 emphasizes *"it is like you have to market the whole thing as a political campaign almost, you need a spin doctor and a digital officer"*.

According to IO2, the cities being involved in international projects, learning from other initiatives, exchanging experiences and knowledge and having the future oriented leaderships (not only elected politicians but in the different municipal departments) helps to overcome

the roadblocks. Taking in consideration the different interviews and problems mentioned, the existence of adequate guidelines (and the mentioned frameworks) is certainly important to improve the ecosystem.

CT3 highlights the importance of the dimension of a city, because *“it is also a matter of resources. To be part of a large international project you need resources, not only to write it internally or externalize the writing but also to implement it”*. Dimension helps in having resources but also in access to European or international networks in which cities can learn and share experiences and setbacks.

4.2.4.2 Citizens’ responsibility and governance responsiveness in open data shift

According to CT1, the institutional responsiveness is related to the data valorisation plan of the city and the diverse city councils previously mentioned. This represents that the framework (of which the plan is an important part) should include the dialogue and feedback strategy through which the city defines the agenda with the stakeholders. CT1 also mentions the importance of making it a clear political priority, preferably making it clear it is an important matter for the Mayor as it makes clear not only internally but also to the other stakeholders that *“this is a very important agenda and that we all have to work together and to build the strategy, to have an the data index from where we can extract value from to support our decisions. We need compromise from the staff. We need to have all the organization involved on the strategy”*. CT2 expresses a similar opinion, as in her city the governance responsiveness is embedded in the collaboration agreements developed with the stakeholders. These agreements provide institutional responsiveness as the stakeholders have a way to provide feedback and communicate directly with the municipality regarding these issues.

IO1 building on his experience and from a grassroots perspective believes that there is a lot to improve in the institutional responsiveness from cities to the actors on the ecosystem. There is an indirect production model for the outcomes and beneficiaries, being difficult for the city to get the credit for what is doing: *“How does the city really get accountable to a person that never heard of, with an idea that never thought of? This is really a difficult concept to design that, in a kind of a legal, formal way”*.

According to IO1, in a sense, open data may redefine how city ecosystems work: cities might become accountable for a much higher quality basic output as a platform, without being

responsible for the final result, *“because citizens and stakeholders will help in the process, and that is at the heart of the shift of open data”*.

To IO3 this seems to be, however, very context specific, with few but sufficient number of institutionalized mechanisms to ensure collaboration and exchange with the right stakeholders. While recognizing there are sufficient mechanisms also supports that this is something that needs to be worked more systematically and actually is part of his work with cities: *“to ensure multi-stakeholder platforms do exist for open data and resilience”*.

4.2.4.3 Synthesis regarding cultural roadblocks and institutional responsiveness

Collaboration is a major issue, as people who working with the topic of resilience may find difficulties in communicating and sharing a vision with those working with data. This can materialise in a silo mentality, or communication silos. In addition, centralised and risk-adverse mindsets may lead to a denial of releasing information, in an apparent “full control” over data. The process of opening up data finds difficulties in situations of lack of confidence and trust, and in the absence of a leadership that fosters a culture of innovation and co-creation.

There are also public administration staff related roadblocks, namely related to cultural and educational background difficulties as public servants frequently are not always aware of the potential of open data or don't want to give hand of the data. A less innovative culture in public administration can be linked to the idea of risk adversity and lack of innovative mindset.

The use of standardise procedures can help to overcome some of these roadblocks as it helps in the definition of what to collect, what to do with data and what data should be open or not. Adequate guidelines and frameworks but also recurrent feedback and information help cities to build trust, confidence and a more innovative culture.

In the future, open data may redefine how city ecosystems work and how the institutional responsiveness works. Cities may become more accountable for an output as a platform and citizens and stakeholders take more responsibilities in their own hands.

4.3 The dark side of open data: the downsides

There are also downsides on opening up data, particularly when the risks associated to open data are not taken in consideration. CT1 highlights in the fact than when managers have a

lot of indicators and data it is more difficult to get knowledge from data and in that situation *“maybe we cannot get the right value out of it because we have too much information but that is a matter of working on data”*.

IO1 identifies a *“a digital divide as open data, depending how it is done, how it is communicated can provide advantage to already privileged groups”* which can potentially add a bias, or at least exacerbate inequality with digitally disadvantaged groups: the elderly, the poor, the poorly educated, the rural. IO1 considers two situations:

- a bias in the datasets by selection. For example, having data from formal neighbourhoods but not from informal neighbourhoods. Releasing that data as open data and helping to get a lot of creativity, services and investment about that data sets. Those areas can get digital service creation around energy efficiency housing, clean neighbourhoods and other services but this will happen only on neighbourhoods where the data was released - the middle class and upper neighbourhoods which creates inequality with poorer/informal neighborhoods.
- Inadequate algorithms. In insurance for catastrophe risk, for example, there can be flood insurance or hurricane insurance for well-engineered, modern, expensive buildings, as algorithms have been trained with data sets from developed cities. But when applied to a fast-growing emerging city the dataset may be inaccurate or inadequate for low income neighbourhoods.

IO2 stresses the importance of data quality, and the lack of it as a risk because the lack of data quality (by being inaccurate, outdated, or not well treated) will make the decisions biased.

IO1, IO2, IO3 and CT3 all identify privacy issues as a major concern, the need for a balance between opening up data for people to use and empower themselves but not too much detailed information that allows people to be identified. It is mentioned the need for accuracy but also that data can be used in a way that is not linked with personal data so it can be safe and prevent citizens identification.

IO3 adds the concern around safety, as information that may require confidentiality or sensitivity of data and may not find its place in open data sources.

5 Discussion, Conclusions, and further research

In increasingly complex times, with economic and social changes hard to predict (as Covid-19 pandemic showed in 2020 and 2021), disasters are not always preventable and urban systems must learn how to manage risk and even, using the data available, evolve and learn with it. Open data is a relatively recent phenomena, particularly in what concerns to cities. This fact, besides widely mentioned on literature is also supported by the survey's results in this study. This research, which was essentially exploratory, was able to support previous findings and tried to shed some light on details that literature hadn't adequately covered yet.

One important conclusion from this research has to do with **factors that affect performance of open data initiatives and that differ based on the environment and context. These can be considered as enabling factors** and can transform the actions or initiatives into success or failure. Abella et al (2017), mentioned during the literature review, argued that open data initiatives success depends on being able to correspond the supply with the demand of open data for its effective use and for the need of further research on the enabling conditions for this. This research found enabling factors, or relevant components for open data to influence and improve urban resilience that were added to the methodology.

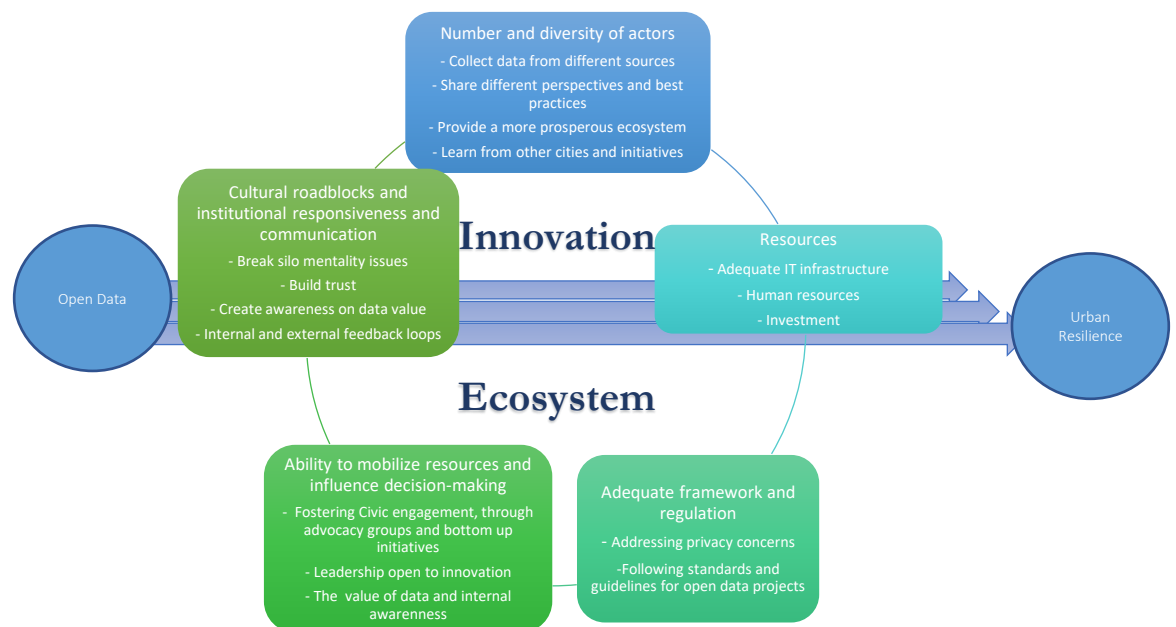


Figure 8. Final framework. Author

These enabling factors are factors that make possible (or easier) for cities to be successful in opening and using open data for urban resilience purposes and overcome roadblocks. It shall be highlighted the importance of a new dimension: “Adequate framework and regulation”, as it became clear from the analysis that privacy issues, as well as standards and guidelines are critical issues for the success of open data initiatives in this regard. Some other enabling factors were added to the other 4 dimensions as they are relevant to explain the influence of open data on urban resilience and, particularly, the role of the innovation ecosystem.

As mentioned in the literature review, Van Winden and Carvalho (2017) argue that there is a growing recognition that government data should increasingly become available and easily accessible as through open data format. This argument finds **support on this research as all six interviewees assumed that cities don't yet publish enough open data.** This is particularly relevant considering the fact that half of the experts interviewed work in international organizations dealing with several cities. **We can conclude that, in general, cities have still a large margin to improve on the amount of data but also the quality of data that have been published.**

Cities, as innovation ecosystems, are different from marketplaces, where essentially competition, supply and demand can be found. As Appio et al. (2019) argues, in places where knowledge creation and knowledge transfer can be found, adequate local governance, can lead to more competitive and attractive local environments. Local governments appear to have particular importance on developing strong stakeholder engagement, with “platform policies” (Asheim et al., 2011). Quadruple helix clusters implies more institutional complexity than just an agglomeration of people and organizations (Russell and Smorodinskaya, 2018).

Open data can also be regarded as a strategic and technological niche (Zeleti and Ojo, 2017). Technology actors, such as local governments, introducing new technologies tend to initially forget certain actors and focus on optimizing the technological side first while neglecting other social aspects, argues (Schot and Geels, 2008). The same authors argue that building social networks is important to create a community behind new technologies, enabling interactions between relevant stakeholders, and supplying the necessary resources. These ideas reiterate the importance of two of the enabling factors presented, City Leadership and Civic Engagement referred previously. We can conclude also on **the importance of local governments leadership to effective stakeholders' platforms and stakeholders' engagement. To overcome the roadblocks, cities need to implement a culture of**

valorisation of open data, which can only happen with leaderships that improve communication, foster a confidence environment, set clear frameworks and guidelines and build an ecosystem in which stakeholders can trust and feel that they are part of.

In the literature, we could find evidence that resilience oriented urban planning should involve as many stakeholders as possible and start as a co-design challenge (Schauppenlehner-Kloyber and Penker, 2016). Alongside, this research concludes **that not only the number is relevant but also the diversity of actors** (NGOs, developers, private sector, academia, etc.), are relevant primary conditions to open data policies and initiatives that translate to more resilient cities. **The number and diversity of stakeholders enhance trust and collaboration in the innovation ecosystem and different backgrounds and perspective bring different and original ideas.** Diversity also combines more information to be shared among different groups and communities, facilitating transparency, but is also important to broaden the scope of open data impacts. One other conclusion related to the previous is that **open data is also relevant to improve collaboration and relations between the stakeholders.** To the particular question: “Does open data enhance an inclusive and constructive collaboration between all actors involved in city decision-making?” the average value was 4,2, the highest mark in the individual questions in the survey.

It is clear that citizens participation is a core matter for urban resilience through open data. Villagra et al. (2016) expresses an analogous idea, highlighting how adaptation and resilience building require direct participation and input from the local community. **Dynamic, dialoguing, innovative leaderships are better capable of boosting community resilience and responding to disaster risks.** Open data also influences resilience by empowering citizens and communities, handing them knowledge and information to participate in policy design and innovative initiatives. According to Sharifi and Yamagata (2018), the devolution of power to local communities, a culture of collaboration, effective communication strategies are critical factors for adaptive management strategies in urban planning efforts. This is also the case with open data, as opening up data helps in these elements, particularly in the empowerment of communities and civic participation. We could also conclude **open data improves the empowerment of organizations and citizens by giving back power, through information and knowledge, to local communities and**

through that fosters urban resilience allowing communities to responsibly participate in new solutions for city problems.

For Prior and Eriksen (2013) public participation and citizen engagement are critical to mitigation and risk communication efforts and to improve social awareness and knowledge, widely believed to be essential components of urban resilience. Our findings support this, highlighting citizen participation as a critical issue to the use of open data to improve urban resilience.

Cities seem to regard, however, **open data more as a tool for management and planning the city than for disaster risk reduction and disaster management.** Categories as “effective safeguards to human health and life” (3,2) and “minimal human vulnerability” (3,2) were the two categories less valued in the survey results in opposition to “integrated development planning” (4,2) and “effective leadership and management” (4,2). This differences are considered worthy of further research, particularly if open data has more potential to help on a strategic and planning perspective, in a more disaster management level (during a shock, as with Covid-19 pandemic) or both.

Open data changes how citizens and organizations access, use, and work with data.

As Schot and Geels (2008) argue, local projects frequently create test beds for niche ideas allowing them to grow and also grow room for new ideas. Because it is a relatively recent shift on how cities deal with data (and therefore as mentioned might be considered a strategic and technological niche), cities need to communicate its advantages and wins in a clear and simple way for citizens to support the technological shift. This makes particularly relevant that open data initiatives lead to cost savings and quick wins or popular improvements at low cost as this are easier to communicate and understand. This issue seems to be absent from literature. **Open data projects that improve urban resilience need these quick wins in citizen-facing issues to be able to gain social and political support to justify wider changes and initiatives.** This leads us also to the importance of communication, present in literature particularly in Sharifi and Yamagata (2018) research. This research stressed the relevance of clear, inclusive and streamlined communication processes **both internally by eliminating silo mentality issues and raising awareness on data value, but also externally, creating and sharing a vision with stakeholders and with other cities and organizations to learn and share best practices.**

It is also acknowledged that lack of public and private sectors cooperation on open data and resilience matters. Private sector organizations, from small businesses to large companies, participate in the open data ecosystem in three key ways: as data users, as data intermediaries, and as data providers argues (Davies et al., 2019). We conclude that corporations collaborate with cities because they are trying to obtain data to develop new business models, but there is still potential to largely improve cooperation. Incubators and accelerators support companies in applying and using open data, but open data remains largely an unexploited resource with much more work needed to small and medium-sized enterprises realize the benefits it can bring to them and ultimately improve cities' resilience. This is particularly relevant regarding cities potential for cooperation with large technological companies that collect large amounts of data on citizens, their mobility, habits and characteristics. This data is important to better assess and prevent risks, cooperation models could be designed and implemented.

One other mention worthy conclusion from the interviews **is the importance of being able to extract knowledge and meaningful information from open data**, as data for itself has little value. The literature supports this conclusion, as Lim et al. (2018) argue that the effectiveness and efficiency of using urban open data can increase considerably when data-related activities are service oriented. Naturally, it is not viable to have service oriented (which connects with the previously mentioned citizen-facing quick wins) data-related initiatives without extracting value from the datasets.

Open data needs to be appealing for reuse in order to have an impact and influence the city. The reuse of data will improve public policies but also generate innovative products and services from the private sector. Finally, these innovative products and services will have an impact on society and in the city in particular. This consideration finds also support on the literature from Abella et al. (2017), but we must add that context-sensitive open data design can facilitate the transformation of raw data into meaningful information. This information can be subsequently used to make data-driven decisions on infrastructure, urban planning and other resilience initiatives. With open data citizens and organizations can use and reuse data in a free manner, converting data into insights is no longer constrained to the provider (previously owner) of the data. Anyone who access these data can obtain the information and knowledge it contains. And none of this can easily be done without a skilled

team. **Skills, a crucial resource mentioned previously, are also related with all other challenges as the development and implementation of policies, guidelines, standards, interoperability processes and regulations.**

Cities are the study focus for many disciplines, ranging from social, economic and environmental sciences, architecture, design and urban planning to social network analysis, sensor networks and human sensors (Degbelo et al., 2016). In addition, as explained, open data offers diverse opportunities and noteworthy benefits to governments and citizens. Nonetheless, there are also risks that should be taken in consideration and addressed properly that were identified during this research:

- Having too much information makes more difficult to get the right value out of it, eventually leading to poor decisions.
- The digital literacy gap. The “digital divide” that leads to open data, depending how it is used and communicated, can provide particular benefits to advantaged groups, leading to a potentially bias, or at least exacerbate inequality with digitally disadvantaged groups.
- Biased insights. Bias on publishing partial data and bias based on selection, which leads to faulty decisions.
- Privacy issues. There are risks while managing and working with personal identifying information. This refers not just to the granularity of the individual data sets but also how easily someone can cross references.
- Lack of data quality. If the data lacks quality (if it is outdated, not well managed or well read) the decision-making process will be influenced by it.

The identified risks are recognized, in a different angle, by the literature. For instance, and as duly mentioned in the literature review, to Verhulst and Young (2017) there are five major concerns over open data: privacy, data security, poor decision-making, power asymmetries and open washing, which, in a different perspective cover the 5 risks identified in this research. We can, however, argue that “poor decision-making” is an excessively broad approach and that should be divided into different categories, which also asks for further research.

6 Bibliography

- 100 Resilient Cities. (2019). *Resilient Cities, Resilient Lives—Resilient Cities, Resilient Lives—Learning from the 100RC Network*.
- A European strategy for data*. (2020). European Commission.
- Abella, A., Ortiz-de-Urbina-Criado, M., & De-Pablos-Heredero, C. (2017). A model for the analysis of data-driven innovation and value generation in smart cities' ecosystems. *Cities*, 64, 47–53. <https://doi.org/10.1016/j.cities.2017.01.011>
- Ackoff, R. L. (1971). Towards a system of systems concepts. *Management Science*, 17(11), 661–671. <https://doi.org/10.1287/mnsc.17.11.661>
- Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, 84, 98–107.
- Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal*, 31(3), 306–333. <https://doi.org/10.1002/smj.821>
- Ahern, J. (2011). From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. *Landscape and Urban Planning*, 100(4), 341–343. <https://doi.org/10.1016/j.landurbplan.2011.02.021>
- Ahlgren, B., Hidell, M., & Ngai, E. C.-H. (2016). Internet of things for smart cities: Interoperability and open data. *IEEE Internet Computing*, 20(6), 52–56. <https://doi.org/10.1109/MIC.2016.124>
- Allam, Z., & Dhunny, Z. A. (2019). On big data, artificial intelligence and smart cities. *Cities*, 89, 80–91. <https://doi.org/10.1016/j.cities.2019.01.032>
- Allen, P. M. (1997). *Cities and regions as self-organizing systems: Models of complexity*. Gordon and Breach.

- Alexopoulos, C., Zuiderwijk, A., Charapabidis, Y., Loukis, E., & Janssen, M. (2014). Designing a second generation of open data platforms: Integrating open data and social media. Em M. Janssen, H. J. Scholl, M. A. Wimmer, & F. Bannister (Eds.), *Electronic Government* (pp. 230–241). Springer. https://doi.org/10.1007/978-3-662-44426-9_19
- Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting and Social Change*, 142, 1–14. <https://doi.org/10.1016/j.techfore.2018.12.018>
- ARUP. (2015). *City Resilience Index*. <https://www.rockefellerfoundation.org/wp-content/uploads/CRI-Revised-Booklet1.pdf>
- Asefi, S., Resende, D. N., & Amorim, M. P. C. (2020). Modeling a successful innovation ecosystem toward a sustainable community: The I-Reef (A review study). *Energy Reports*, 6, 593–598. <https://doi.org/10.1016/j.egy.2019.09.031>
- Attard, J., Orlandi, F., Scerri, S., & Auer, S. (2015). A systematic review of open government data initiatives. *Government Information Quarterly*, 32(4), 399–418. <https://doi.org/10.1016/j.giq.2015.07.006>
- Berrone, P., Ricart, J. E., & Carrasco, C. (2016). The open kimono: Toward a general framework for open data initiatives in cities. *California Management Review*, 59(1), 39–70. <https://doi.org/10.1177/0008125616683703>
- Bertot, J. C., & Choi, H. (2013). Big data and e-government: Issues, policies, and recommendations. *Proceedings of the 14th Annual International Conference on Digital Government Research*, 1–10. <https://doi.org/10.1145/2479724.2479730>
- Bohland, J. R. (Ed.). (2018). *The disaster resiliency challenge: Transforming theory to action*. Charles C. Thomas, Publisher, Ltd.
- Boyd, E., & Juhola, S. (2015). Adaptive climate change governance for urban resilience. *Urban Studies*, 52(7), 1234–1264. <https://doi.org/10.1177/0042098014527483>

- Brown, K. (2014). Global environmental change I: A social turn for resilience? *Progress in Human Geography*, 38(1), 107–117. <https://doi.org/10.1177/0309132513498837>
- Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in europe. *Journal of Urban Technology*, 18(2), 65–82. <https://doi.org/10.1080/10630732.2011.601117>
- Carlsson, B., Jacobsson, S., Holmén, M., & Rickne, A. (2002). Innovation systems: Analytical and methodological issues. *Research Policy*, 31(2), 233–245. [https://doi.org/10.1016/S0048-7333\(01\)00138-X](https://doi.org/10.1016/S0048-7333(01)00138-X)
- Carvalho, L. (2020). *Can startups solve urban sustainability challenges?*
- Charalabidis, Y., Zuiderwijk, A., Alexopoulos, C., Janssen, M., Lampoltshammer, T., & Ferro, E. (2018). *The world of open data: Concepts, methods, tools and experiences*. Springer.
- Crowe, P. R., Foley, K., & Collier, M. J. (2016). Operationalizing urban resilience through a framework for adaptive co-management and design: Five experiments in urban planning practice and policy. *Environmental Science & Policy*, 62, 112–119. <https://doi.org/10.1016/j.envsci.2016.04.007>
- Coaffee, J. (2013). Towards next-generation urban resilience in planning practice: From securitization to integrated place making. *Planning Practice and Research*, 28(3), 323–339. <https://doi.org/10.1080/02697459.2013.787693>
- Davies, T., Walker, S. B., & Rubinstein, M. (2019). *The state of open data: Histories and horizons*. <https://www.deslibris.ca/ID/10100694>
- Degbelo, A., Granell, C., Trilles, S., Bhattacharya, D., Casteleyn, S., & Kray, C. (2016). Opening up smart cities: Citizen-centric challenges and opportunities from giscience. *ISPRS International Journal of Geo-Information*, 5(2), 16. <https://doi.org/10.3390/ijgi5020016>
- Desouza, K. C., & Flanery, T. H. (2013). Designing, planning, and managing resilient cities: A conceptual framework. *Cities*, 35, 89–99. <https://doi.org/10.1016/j.cities.2013.06.003>

Edquist, C. (2006). *Systems of innovation: Perspectives and challenges*. Oxford University Press.

<https://doi.org/10.1093/oxfordhb/9780199286805.003.0007>

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From National Systems and “Mode 2” to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2), 109–123. [https://doi.org/10.1016/S0048-7333\(99\)00055-4](https://doi.org/10.1016/S0048-7333(99)00055-4)

European Commission, & Joint Commission Resources, I. (2019). *The future of cities: Opportunities, challenges and the way forward*. Publications Office of the European Union.
<https://data.europa.eu/doi/10.2760/375209>

Fagerberg, J., & Srholec, M. (2008). National innovation systems, capabilities and economic development. *Research Policy*, 37(9), 1417–1435.
<https://doi.org/10.1016/j.respol.2008.06.003>

Fagerberg, J., & Verspagen, B. (2020). Innovation–diffusion, the economy and contemporary challenges: A comment. *Industrial and Corporate Change*, 29(4), 1067–1073.
<https://doi.org/10.1093/icc/dtaa019>

Figueiredo, L., Honiden, T., & Schumann, A. (2018). *Indicators for resilient cities*.
<https://doi.org/10.1787/6f1f6065-en>

Five stars of open data. (2010). Retrieved July 18, 2020, from

<https://opendatahandbook.org/glossary/en/terms/five-stars-of-open-data/>

Florida, R., Adler, P., & Mellander, C. (2017). The city as innovation machine. *Regional Studies*, 51(1), 86–96. <https://doi.org/10.1080/00343404.2016.1255324>

Freeman, C. (1987). *Technology, policy, and economic performance: Lessons from Japan*. Pinter Publishers.

Freeman, C., & Perez, C. (1988). Structural crises of adjustment: Business cycles and investment behavior. *Technical Change and Economic Theory*, 38–66.

- Geels, F., & Deuten, J. J. (2006). Local and global dynamics in technological development: A socio-cognitive perspective on knowledge flows and lessons from reinforced concrete. *Science and Public Policy*, 33(4), 265–275. <https://doi.org/10.3152/147154306781778984>
- Georghiou, L. (1993). National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning *edited by Bengt-Ake Lundvall* (Pinter publishers, london. 1992) pp. Xiii + 342, £45, ISBN 1-85567-063-1. *Prometheus*, 11(2), 291–291.
<https://doi.org/10.1080/08109029308629360>
- Goldsmith, S., & Crawford, S. (2014). *The responsive city: Engaging communities through data-smart governance*. Jossey-Bass.
- Gomes, L. A. de V., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. *Technological Forecasting and Social Change*, 136, 30–48. <https://doi.org/10.1016/j.techfore.2016.11.009>
- Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. *Technovation*, 90–91, 102098.
<https://doi.org/10.1016/j.technovation.2019.102098>
- Gunderson, L. H., & Holling, C. S. (2002). *Panarchy: Understanding transformations in human and natural systems*. Island Press.
- Höchtel, J., Parycek, P., & Schöllhammer, R. (2016). Big data in the policy cycle: Policy decision making in the digital era. *Journal of Organizational Computing and Electronic Commerce*, 26(1–2), 147–169. <https://doi.org/10.1080/10919392.2015.1125187>
- Hommels, A. (2018). How resilience discourses shape cities: The case of resilient rotterdam. In S. Amir (Ed.), *The Sociotechnical Constitution of Resilience: A New Perspective on Governing Risk and Disaster* (pp. 265–284). Springer. https://doi.org/10.1007/978-981-10-8509-3_12
- ICLEI (2019) Resilient cities, thriving cities: The evolution of urban resilience. Bonn, Germany

- Irwin, S., Schardong, A., Simonovic, S. P., & Nirupama, N. (2016). ResilSim—A decision support tool for estimating resilience of urban systems. *Water*, 8(9), 377.
<https://doi.org/10.3390/w8090377>
- Iturriza, M., Labaka, L., Hernantes, J., & Abdelgawad, A. (2020). Shifting to climate change aware cities to facilitate the city resilience implementation. *Cities*, 101, 102688.
<https://doi.org/10.1016/j.cities.2020.102688>
- ITU-T. (2016). *Shaping smarter and more sustainable cities: Striving for sustainable development goals*. United Nations. <http://www.itu.int/pub/T-TUT-SSCIOT-2016-1>
- Janssen, M., Charalabidis, Y., & Zuiderwijk, A. (2012). Benefits, adoption barriers and myths of open data and open government. *Information Systems Management*, 29(4), 258–268.
<https://doi.org/10.1080/10580530.2012.716740>
- Johnson, P., & Robinson, P. (2014). Civic hackathons: Innovation, procurement, or civic engagement? : civic hackathon: procurement or civic engagement? *Review of Policy Research*, 31(4), 349–357. <https://doi.org/10.1111/ropr.12074>
- Kattel, R., & Mazzucato, M. (2018). Mission-oriented innovation policy and dynamic capabilities in the public sector. *Industrial and Corporate Change*, 27(5), 787–801.
<https://doi.org/10.1093/icc/dty032>
- Khan, Z., Anjum, A., Soomro, K., & Tahir, M. A. (2015). Towards cloud based big data analytics for smart future cities. *Journal of Cloud Computing*, 4(1), 2.
<https://doi.org/10.1186/s13677-015-0026-8>
- Kim, D., & Lim, U. (2016). Urban resilience in climate change adaptation: A conceptual framework. *Sustainability*, 8(4), 405. <https://doi.org/10.3390/su8040405>
- Klein, R. J. T., Nicholls, R. J., & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*, 5(1), 35–45.
<https://doi.org/10.1016/j.hazards.2004.02.001>

- Kucera, J., & Chlapek, D. (2014). Benefits and risks of open government data. *Journal of Systems Integration*, 30–41. <https://doi.org/10.20470/jsi.v5i1.185>
- Lammi, M., & Pantzar, M. (2019). The data economy: How technological change has altered the role of the citizen-consumer. *Technology in Society*, 59, 101157.
<https://doi.org/10.1016/j.techsoc.2019.101157>
- Landry, C. (2015). *Cities of ambition*. Comedia.
- Landry, J.-N. (2018). *Open data and urban development*.
<https://stateofopendata.od4d.net/chapters/sectors/urban-development.html#fnref:21>
- Letterkenny Institute of Technology (Letterkenny, Ireland), Brown, K., Larionova, V. A., Ural Federal University, Lally, V., & University of Glasgow (Glasgow, United Kingdom). (2018). Lifelong learning as a tool for the development of smart cities: Technology enhanced learning as an enabler. *R-Economy*, 4(3), 133–143.
<https://doi.org/10.15826/recon.2018.4.4.018>
- Lim, C., Kim, K.-J., & Maglio, P. P. (2018). Smart cities with big data: Reference models, challenges, and considerations. *Cities*, 82, 86–99.
<https://doi.org/10.1016/j.cities.2018.04.011>
- Lovering, J. (1999). Theory led by policy: The inadequacies of the ‘new regionalism’(Illustrated from the case of wales). *International Journal of Urban and Regional Research*, 23(2), 379–395.
<https://doi.org/10.1111/1468-2427.00202>
- Lu, P., & Stead, D. (2013). Understanding the notion of resilience in spatial planning: A case study of Rotterdam, The Netherlands. *Cities*, 35, 200–212.
<https://doi.org/10.1016/j.cities.2013.06.001>
- Lundvall, B.-A. (Ed.). (1992). *National systems of innovation: Towards a theory of innovation and interactive learning*. Pinter Publishers ; Distributed exclusively in the USA and Canada by St. Martin’s Press.

- Maduro, M. P., Pasi, G., Misuraca, G., & European Commission. (2018). *Social impact investment in the EU financing strategies and outcome oriented approaches for social policy innovation: Narratives, experiences, and recommendations*. <https://doi.org/10.2760/159402>
- Marana, P., Eden, C., Eriksson, H., Grimes, C., Hernantes, J., Howick, S., Labaka, L., Latinos, V., Lindner, R., Majchrzak, T. A., Pyrko, I., Radianti, J., Rankin, A., Sakurai, M., Sarriegi, J. M., & Serrano, N. (2019). Towards a resilience management guideline—Cities as a starting point for societal resilience. *Sustainable Cities and Society*, 48, 101531. <https://doi.org/10.1016/j.scs.2019.101531>
- Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, 147, 38–49. <https://doi.org/10.1016/j.landurbplan.2015.11.011>
- Millard, J. (2018). Open governance systems: Doing more with more. *Government Information Quarterly*, 35(4), S77–S87. <https://doi.org/10.1016/j.giq.2015.08.003>
- Montano, E., Silva, D., Pawelke, A., Alonso, J., Shekar, S., Zigoni, C., & Canares, M. (2014). *Exploring emerging impacts of open data in developing countries: Phase one*. webfoundation.org/docs/2016/07/ODDC1-Followup-Evaluation-Final-Version.pdf
- Nelson, R. R. (Ed.). (1993). *National innovation systems: A comparative analysis*. Oxford University Press.
- Neves, F. T., de Castro Neto, M., & Aparicio, M. (2020). The impacts of open data initiatives on smart cities: A framework for evaluation and monitoring. *Cities*, 106, 102860. <https://doi.org/10.1016/j.cities.2020.102860>
- Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, 41(1–2), 127–150. <https://doi.org/10.1007/s10464-007-9156-6>

Open data and the re-use of public sector information, n. 2019/1024, European Commission (2019).<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019L1024>

Open Data Institute. (2016). *Principles for strengthening our data infrastructure – The ODI*.
<https://theodi.org/article/principles-for-strengthening-our-data-infrastructure/>

Open State Foundation. (2015). *10 challenges for open data*.

<https://openstate.eu/en/2015/08/english-10-challenges-for-open-data/>

Pallot, M., Trousse, B., Senach, B., Schaffers, H., & Komninos, N. (2011). *Future internet and living lab research domain landscapes: Filling the gap between technology push and application pull in the context of smart cities*. <https://www.semanticscholar.org/paper/Future-Internet-and-Living-Lab-Research-Domain-%3A-in-Pallot-Trousse/cfdf331f744b9f1fa376602ab8a4d7794f829624>

Perez, C. (2010). Technological revolutions and techno-economic paradigms. *Cambridge Journal of Economics*, 34(1), 185–202.

Peyroux, E. (2015). Discourse of urban resilience and ‘inclusive development’ in the johannesburg growth and development strategy 2040. *The European Journal of Development Research*, 27(4), 560–573. <https://doi.org/10.1057/ejdr.2015.52>

Researching the emerging impacts of open data: Revisiting the ODDC conceptual framework | *The Journal of Community Informatics*. (n.d.). Retrieved October 11, 2020, from <http://www.cij-journal.net/index.php/ciej/article/view/1281>

Ritala, P., & Almpantopoulou, A. (2017). In defense of ‘eco’ in innovation ecosystem. *Technovation*, 60–61, 39–42. <https://doi.org/10.1016/j.technovation.2017.01.004>

Rodger, L. (2015). *Smart Cities: Technology challenges*. <http://urbanopus.net/smart-cities-technology-challenges/>

Rojas, L. A. R., Bermúdez, G. M. T., & Lovelle, J. M. C. (2014). Open data and big data: A perspective from colombia. In L. Uden, D. Fuenzaliza Oshee, I.-H. Ting, & D. Liberona

- (Eds.), *Knowledge Management in Organizations* (pp. 35–41). Springer International Publishing.
https://doi.org/10.1007/978-3-319-08618-7_4
- Russell, M. G., & Smorodinskaya, N. V. (2018). Leveraging complexity for ecosystemic innovation. *Technological Forecasting and Social Change*, 136, 114–131.
<https://doi.org/10.1016/j.techfore.2017.11.024>
- Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In J. Domingue, A. Galis, A. Gavras, T. Zahariadis, D. Lambert, F. Cleary, P. Daras, S. Krco, H. Müller, M.-S. Li, H. Schaffers, V. Lotz, F. Alvarez, B. Stiller, S. Karnouskos, S. Avessta, & M. Nilsson (Eds.), *The Future Internet* (Vol. 6656, pp. 431–446). Springer Berlin Heidelberg.
https://doi.org/10.1007/978-3-642-20898-0_31
- Schaffers, Hans & Komninos, Nicos & Pallot, Marc. (2012). Smart cities as innovation ecosystems sustained by the future internet. FIREBALL White Paper, EU. 1-65.
- Schauppenlehner-Kloyber, E., & Penker, M. (2016). Between participation and collective action—From occasional liaisons towards long-term co-management for urban resilience. *Sustainability*, 8(7), 664. <https://doi.org/10.3390/su8070664>
- Schilderman, T., & Lyons, M. (2011). Resilient dwellings or resilient people? Towards people-centred reconstruction. *Environmental Hazards*, 10(3–4), 218–231.
<https://doi.org/10.1080/17477891.2011.598497>
- Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management*, 20(5), 537–554. <https://doi.org/10.1080/09537320802292651>
- Sellberg, M. M., Wilkinson, C., & Peterson, G. D. (2015). Resilience assessment: A useful approach to navigate urban sustainability challenges. *Ecology and Society*, 20(1), art43.
<https://doi.org/10.5751/ES-07258-200143>

- Sharifi, A., & Yamagata, Y. (2016). Principles and criteria for assessing urban energy resilience: A literature review. *Renewable and Sustainable Energy Reviews*, 60, 1654–1677.
<https://doi.org/10.1016/j.rser.2016.03.028>
- Sharifi, A., & Yamagata, Y. (2017). Towards an integrated approach to urban resilience assessment. *APN Science Bulletin*, 7(1). <https://doi.org/10.30852/sb.2017.182>
- Sharifi, A., & Yamagata, Y. (2018). Resilience-oriented urban planning. In Y. Yamagata & A. Sharifi (Eds.), *Resilience-Oriented Urban Planning* (Vol. 65, pp. 3–27). Springer International Publishing. https://doi.org/10.1007/978-3-319-75798-8_1
- Smart cities with big data: Reference models, challenges, and considerations. (2018). *Cities*, 82, 86–99. <https://doi.org/10.1016/j.cities.2018.04.011>
- Smith, L. (2017). *Benefits of open data for smart cities*.
<https://hub.beesmart.city/en/solutions/benefits-of-open-data-for-smart-cities>
- Tabibian, M., & Movahed, S. (2016). Towards resilient and sustainable cities: A conceptual framework. *Scientia Iranica*, 23(5), 2081–2093. <https://doi.org/10.24200/sci.2016.2273>
- Tackling Corona Virus: Contributing to a global effort, Cities Policy Responses (OECD)*. (2020). OECD.
https://read.oecd-ilibrary.org/view/?ref=126_126769-yen45847kf&title=Coronavirus-COVID-19-Cities-Policy-Responses
- The 8 principles of open government data*. (2007). <https://opengovdata.org/>
- Tokyo Metropolitan Government. (2020). *Tokyo covid-19 information website*. Tokyo COVID-19 Website. <https://stopcovid19.metro.tokyo.lg.jp/en>
- Tyler, S., & Moench, M. (2012). A framework for urban climate resilience. *Climate and Development*, 4(4), 311–326. <https://doi.org/10.1080/17565529.2012.745389>
- (n.d.). Oecd. Retrieved September 17, 2020, from https://read.oecd-ilibrary.org/view/?ref=126_126769-yen45847kf&title=Coronavirus-COVID-19-Cities-Policy-Responses

- Umbrich, J., Neumaier, S., & Polleres, A. (2015). Quality assessment and evolution of open data portals. *2015 3rd International Conference on Future Internet of Things and Cloud*, 404–411. <https://doi.org/10.1109/FiCloud.2015.82>
- United Nations, Department of Economic and Social Affairs, & Population Division. (2019). *World urbanization prospects: The 2018 revision*.
- Van Winden, W., & Carvalho, L. (2017). *How digitalization changes cities: Innovation for the urban economy of tomorrow*. <https://doi.org/10.13140/RG.2.2.27447.83362>
- van Winden, W., & Carvalho, L. (2019). Intermediation in public procurement of innovation: How Amsterdam's startup-in-residence programme connects startups to urban challenges. *Research Policy*, 48(9), 103789. <https://doi.org/10.1016/j.respol.2019.04.013>
- Verhulst, S., & Young, A. (2017). *Open data in developing economies: Toward building an evidence base on what works and how*. African Minds Publishers.
- Wang, V., & Shepherd, D. (2020). Exploring the extent of openness of open government data – A critique of open government datasets in the UK. *Government Information Quarterly*, 37(1), 101405. <https://doi.org/10.1016/j.giq.2019.101405>
- Yigitcanlar, T., Desouza, K. C., Butler, L., & Roozkhosh, F. (2020). Contributions and risks of artificial intelligence (Ai) in building smarter cities: Insights from a systematic review of the literature. *Energies*, 13(6), 1473. <https://doi.org/10.3390/en13061473>
- Zeleti, F. A., & Ojo, A. (2017). Open data value capability architecture. *Information Systems Frontiers*, 19(2), 337–360. <https://doi.org/10.1007/s10796-016-9711-5>
- Zhang, F., & Wu, F. (2019). Rethinking the city and innovation: A political economic view from China's biotech. *Cities*, 85, 150–155. <https://doi.org/10.1016/j.cities.2018.09.003>

Annex A

Interview script to interviews

Some questions may not apply to all interviewees

General questions

1. How do you see the connection between open data and city resilience? How can that contribution be assessed?
2. To what resilience dimensions (12 Goals) does open data contribute the most? Why?
3. Can you see any negative consequences of open data in city resilience?
4. Do cities publish enough open data? Why not?
5. Which open data projects or initiatives (in general / in your city) you consider to be more successful regarding their impact in city resilience? Why?
6. What can cities do to maximize open data impacts, particularly, in their resilience?

Number and diversity of actors in the ecosystem and their relations or partnerships

7. Regarding open data strategies or movements in the city/cities, which stakeholders you can identify as being actively part of this ecosystem?
8. Does the diversity of stakeholders involved foster the city/cities' open data strategy and projects or initiatives success? Why? Which actors are more important?
9. How would you describe different the stakeholder's relations and partnerships?

10. In your opinion, open data initiatives benefit most from some degree of informality (and hence more flexibility) or from formal partnerships that somehow legitimate their work?
11. Does international partnerships help in some extent to the development of successful open data initiatives, or you see them as useful as local/regional/national partnerships?

Resources (Quality of data and its infrastructure, tech skills and other resources)

12. Are the cities/is your city adequately covered with IT and data infrastructure to the development of open data initiatives?
13. What about data quality (5 stars of open data)? In general,
 - a. Is it available with an open license?
 - b. Structured and machine-readable (ex. .xls)?
 - c. In non-proprietary machine-readable file format, structured format, e.g., CSV?
 - d. Does it use URIs as its identifiers (see also RDF), to identify things?
 - e. Does it link data to other organizations' and people's data to provide context?
14. Who opens data in the city?
15. Do actors in the ecosystem (both inside and outside the municipality) have enough tech skills and tech literacy, or the lack of it restricts the success of the initiatives?
16. What other resources you find useful to the origin and scaling up of open data based projects or initiatives?

Ability to mobilize resources and influence decision-making

17. Do the stakeholders usually possess the ability to mobilize the existing resources to their goals? Towards what objectives do they mobilize those resources?
18. Is there an effective coordination between the different stakeholders? What limitations exist to a more effective one?
19. Do stakeholders, and particularly, the open data project managers influence cities' governance policies and decision-making? In what sense?

Cultural roadblocks and institutional responsiveness

20. What type of cultural roadblocks you find relevant in blocking the surge of more open data projects and applications?
21. How do you think those cultural roadblocks could be overcome?
22. The cities' governance structure assures institutional responsiveness to the other stakeholders and particularly to the open data projects managers?

Annex B

Survey

Context and introductory remarks

This short survey seeks to gain insight into the relation between open data and urban resilience. How can open data contribute to risk management at the city level, increasing resilience to different types of shocks, be they environmental and climate-related, pandemic, natural disasters or cyberattacks?

For this survey, in line with common definitions⁵, open data is considered as nonperson-specific data that is generated by public authorities or through public funding, open to anyone, with a possibility of further integration, without restrictions. This questionnaire is carried out under the setting of an educational programme in Innovation Management at the University of Porto, and we kindly thank Eurocities for their support.

Filling the questionnaire shall not take more than 5 minutes. Data collected for this research will be used on an aggregate level and no respondents will be identified. However, if you are interested in receiving the final results, please leave your email contact at the end of the survey.

Should you have any question please contact me through my email address: luiscbrebello@gmail.com

⁵ <https://www.oecd.org/digital/digital-government/open-government-data.htm>

“ABOUT YOUR CITY”

What country does your city belong to?

How many inhabitants does your city have (consider the municipality’s population)?

Population:

<100.000

>100.000 and <500.000

>500.000 and <1.000.000

>1.000.000

YOUR CITY AND OPEN DATA

For how many years now is your city administration actively engaged with open data (e.g., formalized open data efforts; releasing open data; organizing events; developing new data-driven solutions, etc.)?

For more than 10 years

About 5-10 years

Less than 5 years

We are not active yet with open data

How much do you consider open data has achieved so far in your city, in terms of:

- transparency and accountability to citizens and other parties
- making city services and provisions more efficient
- developing innovations for urban problems
- creating new jobs and supporting data-driven companies
- engaging with citizens and organizations

(Very little – very much, for each of them)

OPEN DATA AND URBAN RESILIENCE

Please answer the questionnaire bearing in mind the specific context of your city. Consider not only what open data has already achieved, but also foreseeable contributions open data may have in the future of your city.

Topic	Rate the influence of open data initiatives in the city regarding the following matters:	From 1(not relevant or applicable) to 5	Goal
BUSINESS AND ECONOMY	Contributes to a thriving, adaptable and sustainable local business environment?		Diverse livelihoods and employment
BUSINESS, FINANCE and ECONOMY	Enables businesses to adapt to changing circumstances and put in place contingencies for shock events?		Diverse livelihoods and employment

BUSINESS, FINANCE and ECONOMY	Fosters business collaboration across both public and private sector?		Sustainable economy
BUSINESS, FINANCE and ECONOMY	Promotes a robust, flexible and diverse local economy?		Sustainable economy
BUSINESS, FINANCE and ECONOMY	Helps to a stronger integration between the city's economy and wider economic systems?		Sustainable economy
CITIZEN PARTICIPATION and AWARENESS	Contribute to cohesive communities across the city?		Collective identity and community support
CITIZEN PARTICIPATION and AWARENESS	Helps citizens to be actively engaged, expressing opinions and participating within society?		Collective identity and community support
CITIZEN PARTICIPATION and AWARENESS	Improves the mechanisms for communication and coordination between the city government and citizens, in an inclusive, integrated and transparent manner?		Empowered stakeholders
CITY DATA	Enables the regular monitoring and analysis of relevant data undertaken to inform city planning and decision-making?		Integrated Development Planning
CRIME and POLICING	Promotes fighting corruption or fair justice?		Comprehensive security and rule of law

CULTURE	Fosters local identity and culture and a feeling of a sense of belonging in the city?		Collective identity and community support
DISASTER MANAGEMENT	Improves emergency response services?		Effective safeguards to human health and life
DISASTER MANAGEMENT	Contributes to effective systems in place to monitor potential hazards and assess risks?		Reduced exposure and fragility
DISASTER MANAGEMENT	Enhances public awareness of risks?		Empowered stakeholders
DRAINAGE AND SANITATION	Improves city's safe, reliable and affordable sanitation?		Minimal human vulnerability
EDUCATION	Improves access to affordable, quality education for citizens?		Empowered stakeholders
EMPLOYMENT	Promotes inclusive labor policies and standards, an effective welfare system or social support?		Diverse livelihoods and employment
EMPLOYMENT	Facilitates mechanisms for matching people's skills to the employment market place?		Diverse livelihoods and employment
EMPLOYMENT	Contributes to resourceful and inclusive measures in place to support businesses and workers following a shock?		Diverse livelihoods and employment

ENERGY	Supports sufficient and/or affordable energy supply for the citizens?		Minimal human vulnerability
ENVIRONMENT	Provides understanding and acknowledgement of the role of natural ecosystems in providing physical protection to the city?		Minimal human vulnerability
ENVIRONMENT	Improves the robustness of mechanisms in place to maintain and enhance the services that benefit city's environment?		Effective provision of critical services
FOOD	Helps in the provision of sufficient and affordable food supply for residents?		Minimal human vulnerability
GOVERNANCE	Makes decision-making and leadership more transparent and inclusive?		Effective leadership and management
GOVERNANCE	Promotes a better integration and flexible communication and collaboration between city, state, and national government?		Effective leadership and management
GOVERNANCE	Enhances an inclusive and constructive collaboration between all actors involved in city decision-making?		Effective leadership and management
HEALTH	Supports a robust monitoring and mitigation of public health risks?		Effective safeguards to human health and life

HEALTH	Contributes to residents adequate and inclusive access to quality general healthcare?		Effective safeguards to human health and life
HEALTH	Fosters adequately resourced emergency medical services?		Effective safeguards to human health and life
HOUSING	Works towards safe and affordable housing to city residents?		Minimal human vulnerability
INFORMATION AND COMMUNICATION TECHNOLOGY	Promotes effective and reliable communication systems?		Reliable mobility and communications
INFORMATION AND COMMUNICATION TECHNOLOGY	Enhances mechanisms to protect the information and operational technology systems on which the city is dependent?		Reliable mobility and communications
LEGAL and JUSTICE	Promotes justice and resolve civil disputes?		Comprehensive security and rule of law
PROTECTIVE INFRASTRUCTURE	Provides a network of protective infrastructure that reduces vulnerability and exposure of citizens and critical assets?		Reduced exposure and fragility
TRANSPORT	Improves integrated transport networks, providing flexible and affordable travel around the city for all?		Reliable mobility and communications

TRANSPORT	Enables effective management of the city's transport network to provide quality, safe transport?		Reliable mobility and communications
URBAN PLANNING	Supports transparent and inclusive process to develop planning policies and strategies?		Integrated development planning
URBAN PLANNING	Helps an integrated and flexible land use and zoning plans to ensure appropriate planning and development of the city?		Integrated development planning
UTILITIES	Contributes to critical services and/or infrastructure?		Effective provision of critical services
UTILITIES	Promotes a flexible use of key resources?		Effective provision of critical services
UTILITIES	Supports monitoring, maintenance and renewal of essential utility infrastructure or effective contingency planning?		Effective provision of critical services
UTILITIES	Contributes with data to plans to maintain utility services to critical assets during emergency situations?		Effective provision of critical services
WATER SUPPLY	Helps residents to have access to adequate supply of safe drinking water?		Minimal human vulnerability