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Serge-Lopez Wamba-Taguimdje

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Serge-Lopez Wamba-Taguimdje. Smart cities and open data. Barriers, challenges of adoption and use of open data ecosystem. Business administration. 2021. dumas-03482718

HAL Id: dumas-03482718

<https://dumas.ccsd.cnrs.fr/dumas-03482718v1>

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Smart Cities and Open Data

Barriers, Challenges of Adoption and Use of Open Data Ecosystem

Presented by: Serge-Lopez Wamba-Taguimdje

Date: from 01/04/2021 to from 12/06/2021

**University advisors: Carine Dominguez-Péry
Samuel Fosso Wamba**

**Master 2 Research
Program ARAMIS
2020 - 2021**

Research dissertation

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Abstract

Purpose: This thesis is part of a study on “*smart cities and open data*” in collaboration with the Grenoble metropolis. In the specific case of this study, we focused on the challenges and barriers to the adoption of the open data ecosystem. Based on a literature review, we have outlined the beginning of a theoretical research model that will be empirically tested in future studies via a mixed methodology (quantitative and qualitative approaches).

Methodology: We combined studies on open data from practitioners and researchers to better understand the stakes, challenges, and ecosystem surrounding open data. These documents from these actors were analyzed in conjunction with a literature review, which revealed gaps in previous research on open data.

Findings: Open data has been creating a tremendous buzz for years, both among practitioners and the scientific community. Based on the research gaps observed in the literature review, we have developed a research model that will allow us to study the adoption of an open data ecosystem and thus the exploitative and explorative use of open data. Subsequently, some hypotheses have been put forward, and methodological approaches will allow us to confirm or refute these hypotheses. Moreover, the research model we have developed could take into account all the actors generally involved in an open data ecosystem.

Conclusion: We recognized that open data studies continue to necessitate extensive hypothesis testing. The time constraints of this study prevented us from collecting data to test our conceptual research model. Nonetheless, we have outlined all of the rules and procedures that should be followed to ensure the study's continuity. First, we will consolidate the research model proposed in this Master's thesis through qualitative and exploratory studies in future studies. Then, we will use PLS-EM and fsQCA to obtain more advanced results that will satisfy the scientific community and open data professionals.

Keywords: Open Data Ecosystem, Smart City, Challenges, Barriers, Use, Adoption

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1. INTRODUCTION

Today, no issue is unaffected by the use of data. Even governments that are generally opposed to technological innovation have recognized the risks associated with the latter. This is the case in the Manche department, where data (open data) is used to promote economic development and employment (Olivier, 2021). This department was having difficulty recruiting seasonal employees. To facilitate the recruitment of profiles relevant to the hotel and restaurant industry, tourism, agriculture, and aquaculture, it has established a dedicated structure for disseminating job offers via the “*Pôle Emploi*” platform (Olivier, 2021). The advertisements have been supplemented by an interactive map from the territorial tourist information system that details modes of transport and accommodations (partially open) (Olivier, 2021). This is the cross-cutting capability of data that enables the establishment of an ecosystem in which all actors (public/private companies, individuals) benefit from innovative services and products. It should be no surprise that organizations and governments are increasingly seeking to improve their performance and sustainability through Information and Communication Technologies (ICT) due to globalization and recent technological advances (the advent of the fourth industrial era 4.0). Aside from globalization, citizens' evolving needs and expectations concerning their governments necessitate increasing technological input (Goh & Arenas, 2020; Kitsios, Papachristos, & Kamariotou, 2017; Zygiaris, 2013). As a result, governments are increasingly investing in technological tools through digital transformation projects to improve citizens' lives and the city's performance, making it more appealing to citizens, tourists, and other institutions involved in the ecosystem (Goh & Arenas, 2020; Hasija, Shen, & Teo, 2020; Lee, Hancock, & Hu, 2014). The incentives of (local) governments and their constant calls for more performance, efficiency, and commitment to the local, national, and global economy are increasingly influencing these facts. As a result, to ensure their sustainability and solve other problems related to their territory, metropolises, cities are increasingly turning to technological innovations (Hasija et al., 2020; Lee et al., 2014; Lytras & Visvizi, 2021). Several cities worldwide have taken steps to install various applications that will change the lives of their citizens, having recognized the importance of technology and its contribution to daily life (Hasija et al., 2020; Lee et al., 2014; Yigitcanlar & Lee, 2014). Technology deployment in the city is expected to yield positive results (Goh & Arenas, 2020; Lytras & Visvizi, 2021). Because the people to be satisfied are citizens and the goal is not solely profit, the stakes are slightly different for the city than for the enterprise. The purpose of new ICT in an organization is to boost productivity, which necessitates a certain level of user-friendliness. End users (citizens, individuals, private or

public companies) should expect similar outcomes in a city when these innovative ICTs are implemented. Furthermore, these metropolises, cities, and towns face numerous challenges as a result of rapid urban demographic growth, including transportation, water, and waste treatment, housing, and overall quality of life (Lee et al., 2014; Mondschein, Clark-Ginsberg, & Kuehn, 2021; Yigitcanlar & Lee, 2014). As a result, they have seen the need to build a city that meets current needs while also conserving resources for the future. The concept of a smart city was born out of the critical importance of creating safe and sustainable cities. Its goal can be summed up in three points: increase residents' comfort while improving transportation and energy systems and respecting the environment (Lee et al., 2014; Mondschein et al., 2021; Yigitcanlar & Lee, 2014). In practical terms, this encompasses several areas of development: for example, increasing overall energy performance by constructing more positive energy buildings or insulating during renovations (Hasija et al., 2020; Rudolf et al., 2007; Yigitcanlar & Lee, 2014). Other smart city characteristics include developing environmentally friendly modes of transportation, optimizing waste management, public lighting, and telecommunication networks that will enable innovative services to be delivered in real-time to connected users, and increasing citizen safety (Lee et al., 2014; Mondschein et al., 2021; Yigitcanlar & Lee, 2014). The smart city allows urban and human development to be reconciled in this way. In summary, according to CNIL (2021), the *“smart city is a new concept in urban development that aims to improve city dwellers' quality of life by making cities more adaptive and efficient through the use of new technologies that rely on an ecosystem of objects and services. Public infrastructure (buildings, street furniture, home automation, etc.), networks, transportation (public transportation, roads, and smart cars, carpooling, soft mobility-by bike, on foot, etc.), and e-services and e-administration are all part of this new way of managing cities.”*

The transportation, electricity, and construction markets are the main segments of the global (future) smart city marketplace, with investment in smart city projects doubling between 2018 and 2023, from \$81 billion in 2018 to \$189.5 billion in 2023 (Statista, 2020b, 2020c). By 2025, all three divisions would have a combined provision of more than \$150 billion (Statista, 2020b, 2020c). In addition, cities/metropolises and municipalities promote citizen engagement, create innovative digital services to make life easier for their residents, or optimize network management to save money and reduce their environmental effects, based on their political, economic, and social preferences (Barba-Sánchez, Arias-Antúnez, & Orozco-Barbosa, 2019; Khan et al., 2020; Rudolf et al., 2007). In specific terms, this corresponds to real-time data collection on residents' uses and views and the instantaneous condition of water, power, heating, and

transportation networks, as calculated by sensors (Raghuvanshi & Singh, 2020; Statista, 2020c; Zygiaris, 2013). Data is everywhere these days, thanks to the exponential growth of connected things, and it is the focus of all attention in the first smart city initiatives (Raghuvanshi & Singh, 2020; Statista, 2020c; Zygiaris, 2013). For example, in the case of the internet of things, global infrastructure investment on smart city projects totaled \$104 billion in 2019 (Statista, 2020a).

The question now isn't just how to collect or use them, but how to share them as well. Since no single actor has all of the information, the smart and linked city/metropolis/community relies on it. There are numerous opportunities for territories to pursue their growth. As a result, open data has become an important asset for any (future) smart city, town to foster creativity, renewable energies, and energy savings. Open data can change not only every field of the (smart) city/territories/municipalities economy but also unlock more than \$3 trillion in global economic value each year, according to Michael, Diana, and Kate (2014). Simultaneously, the open data movement encourages governments to identify, structure, and publish public data to improve transparency and governance (Altayar, 2018; Bonina & Eaton, 2020; Kassen, 2017). Even if the original open data initiatives aimed to increase data circulation so that it could be better exploited, open data now allows us to break down silos by bringing previously dispersed truly and non-standardized data together in a single interface (Altayar, 2018; Janssen, Charalabidis, & Zuiderwijk, 2012; Kitsios et al., 2017). Despite the success of national initiatives in many cities (for example, in Grenoble), local initiatives have quickly fizzled out. This is due to two factors.

To begin with, anonymous public or private platforms on which anyone can expose or retrieve data raise concerns about the quality of data made available (Altayar, 2018; Janssen et al., 2012; Kitsios et al., 2017). Second, open data is never completely up to date and thus never perfectly exploitable, posing a second limit to their use within cities, metropolises, communes according to stock logic (Altayar, 2018; Janssen et al., 2012; Kitsios et al., 2017). Open data remains a blind spot in the smart city, with some smart city managers preferring to make complicated agreements and guard their data jealously. Furthermore, the following issues with open data have been observed in some contexts: (1) confusion (data is often presented as something confusing and overly technical); (2) unfamiliarity with data (in most organizations, no one knows what data they have); (3) organizational silos (data has trouble flowing through the organization); (4) irrelevance (dashboards and summary metrics for management prevent departments from digging into the data); (5) boredom (producing and using data is often presented as a boring task); and (6) a "*chief information officer (CIO)-centric thinking*" (data is

often locked away at CIO) (Altayar, 2018; Janssen et al., 2012; Kitsios et al., 2017; Ma & Lam, 2019; Wang & Lo, 2016). Should we declare a separation between open data and the smart city, even if not all data can be made public? Is open data a dogma defended by a few nostalgic people (local experts, practitioners, and researchers in smart cities and open data) and use only for transparency at the expense of efficiency in the “metropolis, city, municipality of tomorrow,” or is it just a dogma defended by a few nostalgic people (local experts and researchers in smart cities and open data), and useful only for transparency at the expense of efficiency? The adoption and use of open data by government or local authorities, like any other technological or organizational innovation, face barriers and challenges that may slow its adoption, implementation, and use in cities, municipalities (Janssen et al., 2012; Ma & Lam, 2019; Wang & Lo, 2016). In addition, there are few studies on open data in municipalities and territories. While the latter is connected to cities and smart cities via services, they also contribute to their growth. Some more advanced communities in these areas go even further by incorporating all of the data generated on their territory into their approach.

As some studies have shown, open data will play an important role in the development of (smart) cities, municipalities (e.g., Ahmadi Zeleti, Ojo, and Curry (2016), Kassen (2017), Mergel, Kleibrink, and Sörvik (2018), Neves, de Castro Neto, and Aparicio (2020), and Wilson and Cong (2021)). Water and electricity consumption statistics, lists of those who have benefited from various public policies, real-time data on public transportation and the road network, and farm typology are all examples of data produced by state and local governments that are considered the black gold of future smart cities/territories and private companies (Altayar, 2018; Estermann, 2018; Michael et al., 2014; Priol, 2017). Considering the ethical and societal issues raised by digital data today, smart cities, territories in full transition to a digital ecosystem should rely on three fundamental principles: protect personal data, support innovation, and protect individual freedoms via the open data approach (Janssen et al., 2012; Ma & Lam, 2019; Priol, 2017). Local governments play a critical role in driving this data-opening and sharing dynamic, which is critical to developing (smart) cities. They should encourage the ecosystem's various players to produce and share data while respecting individual privacy and create a dynamic that allows them to innovate and invent services that meet citizens' needs (Altayar, 2018; Estermann, 2018; Priol, 2017). These (open) data platforms address the need to centralize data and make it accessible through a third party. The data remains the property of those who inject it to be shared with or without restrictions. Within these data platforms, raw data from various actors

is cross-referenced in order to produce aggregated data that can be shared and used to develop new services in an open data ecosystem (Altayar, 2018; Estermann, 2018; Kitsios et al., 2017).

Unfortunately, our literature review reveals a dearth of studies that synthesize knowledge from scientific articles and practitioner reports. However, open data is no longer exclusive to the scientific community; local and national governments are conducting studies and establishing mechanisms to facilitate its adoption at the national or territorial level. Additionally, many cities, municipalities, and territories lack an observatory for tracking the progress of open data projects (Jacques, 2019; Priol, 2017). More precisely, it is difficult for them to precisely determine the brakes and barriers to open data adoption and use today. In France, only 351 local authorities (municipalities, “*Établissement public de coopération intercommunale*” [EPCI], departments, and region) published data in an open format in 2019. Two years later, this figure has increased to 594, including 351 municipalities (Jacques, 2019; Priol, 2017). This demonstrates that numerous issues surrounding the adoption of open data remain unresolved to ensure the latter's political, economic, and social impacts. For the studies included in this literature review, the concept of open data is frequently analyzed in terms of national or local impact, with a particular emphasis on public services or smart cities. As with the majority, it overlooks the fact that open data is not just about making government data (central and local) available to users/actors, but also about making data from other actors deeply involved in the economic, social, and political life of cities, municipalities, and territories available to users/actors. Additionally, we notice a dearth of publications on the open data ecosystem, even though open data is at the heart of knowledge creation in cities/municipalities, as well as the generation of new services because it is collected from the various actors that operate within an ecosystem. Thus, in this study, we propose to consider open data ecosystems (ODEs) that include communes because these territories are inextricably linked to smart cities (metropolises) in terms of sharing resources (particularly data) to re-imagine services at the optimal scale. This brings us to our research question: what are the barriers, challenges of adoption, and use of an open data ecosystem?

To provide an initial response to our research question, we have conducted a literature review and propose a conceptual research model (for a future study). The remainder of our thesis is organized as follows: we will begin by describing our methodology, followed by a section on the literature review, which will discuss previous research on open data, as well as associated concepts and research gaps; and hypothetical development. We will conclude with

a conclusion that details the research's potential limitations and the solutions that will be found in future studies.

2. METHODOLOGY

Due to its novel nature, which encompasses citizens, individuals, public and private sector businesses, we combined practitioners' and researchers' knowledge to better understand the concept of open data. Thus, to address a gap in the literature regarding the adoption of the open data ecosystem, we followed the methodology used by [Bawack, Wamba, and Carillo \(2019\)](#) and [Bawack, Fosso, and Carillo \(2019\)](#) in an artificial intelligence study. It entails conducting a review of the literature on both practitioners and the scientific community.

2.1. PRACTICE-BASED REVIEW

Through the Google search engine, we selected and analyzed articles and reports published by information technology companies (e.g., Schneider Electric, Cisco, Microsoft, Huawei, IBM), research institutions (e.g., IoT Consortium, Swinburne, Eden Strait), consulting firms (e.g., Deloitte, IDC, KPMG), and expert reviews and magazines (e.g., Forbes Magazine, Usine Digitale, Echos). Indeed, the keywords: “open data”, “smart city”, “données ouvertes”, “adoption”, “use”, “open data ecosystem” used on Google or the websites of its practitioners. We chose these businesses and institutions because they are pioneers in the field of innovative technology studies and solution proposals. Thus, practitioners' use enables us to consistently identify the open data (ecosystem) of (smart) city's most significant and recurring actors and underlying concepts, which aids in identifying research gaps. We chose these businesses and institutions because they are pioneers in the field of innovative technology studies and solution proposals. Thus, the use of practitioners enables us to summarize the challenges and obstacles associated with open data, the issues faced by public actors in their open data ecosystems, the most significant and recurring actors, and the underlying concepts of open data in the smart city, smart territory, and municipalities, thereby identifying research gaps. We selected a dozen of the most relevant practitioner articles that focused on open data in general [specific] context and an interesting link to (smart) cities and municipalities and describing the challenges and issues underlying an appropriate open data ecosystem for a (smart) city and its municipalities (see **Appendix A**). Furthermore, we used a structured qualitative methodology based on practitioner literature. This enabled us to determine the scope, size, consistency, and strength of evidence based on open data (ecosystem) and synthesize the necessary knowledge for research. Finally, Because the term “open data platforms” frequently appears in practitioners'

open data reports, we then visited their open data portal to better understand how multiple sources of structured data are made available to any third party (See **Appendix B**).

Once we read and synthesized the practitioner reports, we searched for scientific articles in scholarly databases.

2.2. RESEARCH ON OPEN DATA AND SMART CITIES IN IT/IS SCHOLAR JOURNALS

According to the ARAMIS master thesis writing guide, we should concentrate on articles published in scholarly journals devoted to information systems/technologies and supply chain management. Using the CNRS, ABCD classifications, and the HCERES list, we prioritized articles published in the top five journals (classified as “level 1”), followed by articles published in journals classified as “level 2”, and finally, articles published in other journals as a last resort. Based on these lists and classifications, we used keywords like, “adoption”, “barriers”, “challenges”, “smart city”, “ecosystem”, “open data”, to which we combined logical operators (AND, OR). Subsequently, these keywords were tested in databases such as Science Direct, Google Scholar, Web of Science, Taylor and Francis Online, IEEEExplore, CAIRN.

As a result, all articles deemed pertinent to our study were downloaded. The following section, which is devoted to the literature review, attempts to highlight the knowledge gleaned from these articles and practitioner reports, while also highlighting the gaps in the publications. Following that, a conceptual research model was developed and a methodology for testing it in future studies.

3. LITERATURE REVIEW

Given our research question to be presented in the introductory section and our readings from the articles, we will be able to talk about open data without mentioning the smart city/territory, because whether practitioners or researchers, the two concepts are often presented together. Even if we look at the territories, municipalities, and cities that have adopted open data, some of them claim the label of smart territory/city. We will therefore address in the smart city section, then link smart city and open data. Then we describe and explain the concept of open data (government) and the research gaps.

3.1. UNDERSTANDING THE SMART CITY AND THE CONCEPTS UNDERLYING IT

Metropolises, cities, municipalities are engines of economic growth: they are teeming with ideas, economic life, scientific projects, innovations... If well planned and organized, they can promote the long-term economic, social and environmental development of societies (Lee et al., 2014; Neves et al., 2020; Verhulst & Young, 2017; Yigitcanlar & Lee, 2014). Faced with very strong urban demographic growth, cities are confronted with many challenges: transportation, water, and waste treatment, housing, quality of life. Building a city that is adapted to the needs of the present while preserving resources for the future has given rise to the concept of smart cities. Commonly confused with the terms “digital city,” “information/knowledge city,” “Ubiquitous city,” “intelligent city,” “eco-city,” and “ubiquitous-eco-city” (Table 1); a smart city is considered an extension and development of the digital city as the smart city focus on improving the conditions and quality of life of citizens through the use of digital and information technologies (Lee et al., 2014; Lytras & Visvizi, 2021; Neves et al., 2020; Verhulst & Young, 2017; Yigitcanlar & Lee, 2014). While, in general, the digital city (modern community) is regarded as an information system that gathers digital information about the current city and makes it accessible in a virtual public space where people can consult as well as communicate with the system and other users (Lee et al., 2014; Neves et al., 2020; Verhulst & Young, 2017; Yigitcanlar & Lee, 2014). The key contrast between the digital city and the smart city concept is the emphasis placed on ICT. According to Abella, Ortiz-de-Urbina-Criado, and De-Pablos-Heredero (2017, p. 47), smart cities “are key elements to cope with certain of the largest challenges facing society, such as overpopulation, transport, pollution, sustainability, security, health, and the creation of new firms”. For Hasija et al. (2020, p. 1), “smart cities use data and technology to create efficiencies, improve sustainability, create economic development, and enhance the quality of life factors for people living and working in the city”. Besides, for Lee et al. (2014, p. 82) “a smart city aims to resolve various urban problems (public service unavailability or shortages, traffic, over-development, pressure on land, environmental or sanitation shortcomings and other forms of inequality) through ICT-based technology connected up as an urban infrastructure... Smart cities are envisioned as creating a better, more sustainable city, in which people's quality of life is higher, their environment more livable and their economic prospects stronger”

Table 1. Smart city-related concepts

Concepts	Definitions/descriptions
Digital city	“a connected community that combines broadband communications infrastructure, a flexible, service-oriented computing infrastructure based on open industry standards; and

Concepts	Definitions/descriptions
	<i>innovative services to meet the needs of governments and their employees, citizens and businesses” (Lee et al., 2014, p. 81).</i>
Information / Knowledge city	It is a city that gathers information’s/knowledge from various locations and makes it accessible to the public through the Internet (Lee et al., 2014, p. 81; Lytras & Visvizi, 2021). Furthermore, ICT is regarded as a crucial catalyst for the availability of creative online services in these towns (Lee et al., 2014, p. 81; Lytras & Visvizi, 2021).
Ubiquitous city	Originally from the South Korean government, the term ubiquitous city refers to a city that is “operated by a network and provides... people, citizens with facilities/services/products and content across the network... with a fixed u-City infrastructure and a flexible u-City infrastructure focused on cutting-edge technology like sensors and IoT” (Lee et al., 2014, p. 81).
Intelligent city	It’s a city which “Focuses on the outperformance of a smart city as this is achieved through innovation in three dimensions: 1) Intelligence, inventiveness, and creativity; 2) Collective intelligence and 3) Artificial intelligence” (Lee et al., 2014, p. 81). Indeed, it's a city in which service providers can use ICT to co-create and co-design systems, usually through the structural application of integrated modes of technology, including sensors and interactive media (Lee et al., 2014).
Eco-city	“Smart eco-city is, in a broad sense, described as an ecologically healthy city using advanced technologies and having economically productive and ecologically efficient industries, a systematically responsible and socially harmonious culture, and a physically aesthetic and functionally vivid landscape” (Yigitcanlar & Lee, 2014, p. 100).
Ubiquitous-eco-city	“is to provide a high quality of life and place for residents, workers and visitors with low-to-no negative impacts on the natural environment with support from state-of-the-art technologies in their planning, development, and management” (Yigitcanlar & Lee, 2014, p. 101).

According to **Table 1**, the priorities of all smart cities are as follows: carbon emissions reduction and neutrality; energy efficiency; ICT leverage; climate improvement; creating the greenest community; promoting access to information; supporting economic prosperity and quality of life; establishing healthy communities; maintaining social harmony; and the development of smart city living laboratories (Hasija et al., 2020; Lytras & Visvizi, 2021; Rudolf et al., 2007; Yigitcanlar & Lee, 2014). Achieving these main goals requires the use of ITCs, IoTs, which allow these smart city official to interact directly with the community and the city infrastructure and to monitor (i) what is happening in the whole city, (ii) how the city is

evolving, and (iii) how to enable a better quality of life for the citizen (Hasija et al., 2020; Lee et al., 2014; Rudolf et al., 2007; Velsberg, Westergren, & Jonsson, 2020). The concept of sustainability comes up every time we talk about smart cities. As Lee et al. (2014) demonstrate in a study conducted in two of the best smart cities in the world: Seoul and San Francisco. The empirical findings of Lee et al. (2014) study show that efficient and sustainable smart cities arise from complex systems through which public and private sector players organize their efforts and resources on a transparent innovation platform. These actors' diverse and complementary linkages should be more aligned in terms of their developmental stage and embodied cultural and social capacities. Indeed, from the different definitions presented in the literature, the components of the smart city are a smart economy linked to industry; a smart citizen education; smart governance in terms of e-democracy; smart mobility linked to logistics and infrastructure; a smart environment linked to sustainability and a smart life linked to security and quality (Neves et al., 2020; Rudolf et al., 2007). Therefore, the key dimensions of smart cities are the IT infrastructure, the quality of life of citizens, the environment, and people (Neves et al., 2020; Rudolf et al., 2007). Therefore, the applications can be of the following types: smart healthcare, traffic congestion, waste management, smart environment, smart water, and smart and safe citizenship. Besides these types that we have been able to identify, there are others such as smart mobility, smart security, and smart economy (Neves et al., 2020; Rudolf et al., 2007). A real smart city should have implemented all these solutions, but a city only needs one of these smart applications to be considered a smart city. **Table 2** highlights the characteristics, factors, and typical benefits of a smart city.

Table 2. Characteristics, factors, and typical benefits of a smart city

Dimension Characteristics	Contextual Factors	Typical smart city benefits
Smart economy (competitiveness)	<i>“Innovative spirit, entrepreneurship, economic image & trademarks, productivity and competitiveness, the flexibility of labor market, international embeddedness, transformational capacity”.</i>	<ul style="list-style-type: none"> - Products and services are shared in a peer-to-peer model (sharing economy, from possession to use). - The Smart City mark affects the pace of entrepreneurship (Barba-Sánchez et al., 2019).
Smart mobility (transport and ICT)	<i>“Local accessibility, (inter-)national accessibility, availability of ICT-infrastructure, sustainable,</i>	<ul style="list-style-type: none"> - Make greater use of highway facilities to reduce congestion and waste (roads, parking places)

Dimension Characteristics	Contextual Factors	Typical smart city benefits
	<i>innovative and safe, transport systems”.</i>	
Smart governance (participation)	<i>“Participation in decision-making, public and social services, transparent governance, political strategies & perspectives”.</i>	<ul style="list-style-type: none"> - More targeted interventions and quantifiable evidence of effectiveness benefit from data-driven policy-making. Co-creation of decision-making, new forms of digital democracy, and participatory governance are all examples of participatory governance.
Smart environment (natural resources)	<i>“Attractivity of natural, conditions, pollution, environmental protection, and sustainable resource management”.</i>	<ul style="list-style-type: none"> - Energy efficiency can be achieved by combining real-time energy usage insights with gamification concepts. - Household appliances that are affected by changing electricity markets adjust energy demand to meet supply. - Waste containers with sensors make for more efficient waste storage. - Data collected from water distribution network sensors detect leakage and allows for fast repairs.
Smart people (Social and human capital)	<i>“Level of qualification, an affinity for lifelong learning, social and ethnic diversity, flexibility, creativity, cosmopolitanism/open-mindedness, participation in public life”.</i>	<ul style="list-style-type: none"> - People form diverse groups and communities to work together on common goals.
Smart living (Quality of life)	<i>“Cultural facilities, health conditions, individual safety, housing quality, education facilities, touristic attractivity, and social cohesion”.</i>	<ul style="list-style-type: none"> - Sensor and surveillance camera video data are processed in real-time, allowing for faster response to public safety threats. - Improved diagnostics and personalized treatment based on a large amount of patient data using cutting-edge technology (artificial intelligence, big data, IoT).

Source: Adapted from [Neves et al. \(2020, p. 3\)](#), and [Rudolf et al. \(2007, pp. 10-12\)](#)

More precisely, the smart city is more than a connected city (i.e., one that has incorporated new technologies into its way of life), where new technologies are not a means to an end. While it operates based on massively collected and processed data, it is necessary to understand that

all of the actors involved should exist within a kind of ecosystem. Additionally, the citizen should be central to its approach, acting as an actor, a decision-maker, and even a judge (Barge, 2017). Even if it appears to be a miracle solution for evolving and innovating our cities and towns at the moment, there are still numerous challenges to overcome.

3.2. CHALLENGES AND OPPORTUNITIES TO TRANSFORM METROPOLISES, CITIES, TERRITORIES INTO THE (SUSTAINABLE) SMART CITY

The transformation of a metropolis into a smart city necessitates the existence of reference models and frameworks that facilitate this transformation. The literature enables the incorporation of dimensions of smart cities into a conceptual model of reference. Green cities, connected living, smart communities, innovation ecosystems, environmental and social sustainability are all related to urban development in the creative urban policy representations examined (Kitsios et al., 2017; Kutty, Abdella, Kucukvar, Onat, & Bulu, 2020; Yigitcanlar & Lee, 2014). It is important to note that a smart city master plan necessitates the presence of an "orchestrator" with executive authority and policy-making authority, such as the City Council. Building a smart city from the ground up necessitates strong leadership to ensure that the strategy is followed. This master planning strategy in smart cities like Grenoble should be matched with the opportunity to include local citizens, as has been done in top smart cities like Singapore, Helsinki, Zurich, Auckland, Oslo, Copenhagen, Geneva, Taipei, Amsterdam, and New York, in a model that blends city oversight with neighborhood/community engagement (Zygiaris, 2013). **Figure 1** presents Zygiaris (2013, p. 219) smart city, conceptual reference model. The conceptual reference model takes a multi-layered approach to explain smart urban designs.

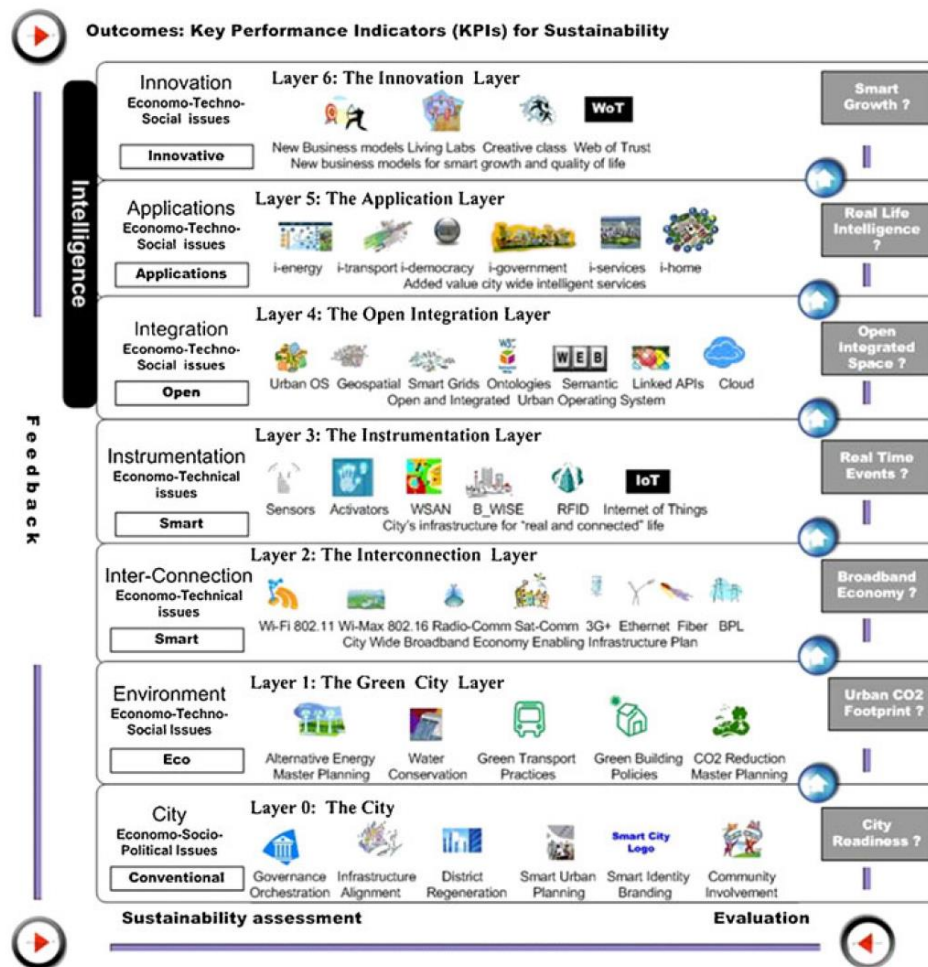


Figure 1. Smart city conceptual reference model ((Zygiaris, 2013, p. 230))

A smart city has seven (07) layers, as seen in **Figure 1**. The first is the city layer (layer 0). Governance, infrastructure coordination, district regeneration, urban planning, branding, and community engagement are all included (Zygiaris, 2013, p. 230). The green city is the next layer, which includes environmentally friendly activities. A city's sustainable future is connected to smart city structures (Yigitcanlar & Lee, 2014; Zygiaris, 2013, p. 230). Green cities emerge in smart cities that are focused on sustainability. The green city infrastructure creates a fertile environment in this layer, where built broadband networks, sensors, and grids can drive knowledge and have an environmental impact (Yigitcanlar & Lee, 2014; Zygiaris, 2013). The green layer symbolizes the smart city's sustainability and competes with the narrow ICT-based architecture. As a result, technical advancements, people, and innovation processes all depend on the green city to ensure a sustainable future (Yigitcanlar & Lee, 2014; Zygiaris, 2013). As a result, the green economy simplifies the decision to invest in smart cities. The best feature of the urban transition to a smart city is the city's access to real-time information (Yigitcanlar & Lee, 2014; Zygiaris, 2013). The networks and interconnection of the inhabitants are then in the

interconnection layer. The instrumentation layer includes the instruments and technologies used, followed by the integration layer, which contains the software packages and integrated systems (Zygiaris, 2013, pp. 221-222). Finally, there are the application and innovation layers (Zygiaris, 2013, pp. 222-223). Thus, interconnected layers and applications are distinct indicators for estimating the city's "smartness". Although historical processing data through data mining and agents is a valuable intelligence capability for revitalizing urban economies, real-time data intelligence strengthens smart cities' "real city" definition. To minimize digital dividends in the integration layer, smart cities should implement open access strategies (Barba-Sánchez et al., 2019; Duval & Brasse, 2014; Kitsios et al., 2017). To avoid vendor monopolies and provide unlimited data to all residents, the aim of the smart city should be accomplished by integrated urban operating systems governed by the people (Barba-Sánchez et al., 2019; Duval & Brasse, 2014; Kitsios et al., 2017). The success of a city is determined not only by its smart resources, but also by the availability and, most importantly, the quality of its human and social capital (Barba-Sánchez et al., 2019; Duval & Brasse, 2014; Kitsios et al., 2017). At the level of innovation, innovation ecosystems may provide community leaders with the ability to approach potentially intractable challenges from a smart perspective and capitalize on emerging smart city business models (Barba-Sánchez et al., 2019; Duval & Brasse, 2014; Kitsios et al., 2017; Zygiaris, 2013).

Legislation and regulations, funding, infrastructure, and technical factors all pose obstacles to the sustainable growth of smart cities (Khan et al., 2020; Kutty et al., 2020; Rudolf et al., 2007). While several studies have highlighted the value of sustainability principles in city growth, little study has focused on the challenges and opportunities of transitioning from metropolises, cities, countries to sustainable smart cities. For example, Khan et al. (2020) provide an example of a conceptual framework that outlines the critical problems faced by private and public sector organizations and the solutions to those challenges for the growth of sustainable smart cities. Thus, "*ICT infrastructure support, lack of coordination and externalities, the complexity of public-private partnerships, speedy urbanization and lack of wisdom from government, and sustainable smart cities implementation issues*" are the main obstacles to the growth of smart cities (Khan et al., 2020, p. 1509). Furthermore, these obstacles can be classified into the four (04) dimensions of sustainability such: economical (budgetary constraint, lack of resources [finance, technology, human, equipment, and sensors], lack of an overreaching institution to create a governance structure); social (social acceptability, and lack of awareness amongst residents of smart cities); technological (e.g., lack of institutional capacity to deliver technology, lack of system integration, need to drive towards content development); and environmental (lack of

strategic approach for smart cities transformation, lack of sustainable focused strategies, lack of smart cities operational framework) (Khan et al., 2020, pp. 1512-1514). According to Kutty et al. (2020), the transition from city to smart city/territory necessitates a conceptual model centered on the United Nations Sustainable Development Goals, to implement strong policy initiatives and best practices for designing policies to promote the transformation of smart cities to the futuristic mark of sustainable cities. Since smart cities are synonymous with innovative technologies, there are many challenges and problems related to these technologies (Khan et al., 2020; Kutty et al., 2020; Raghuvanshi & Singh, 2020; Rudolf et al., 2007). In the case of IoT, issues and challenges are focused on the: lack of skilled workers, privacy concerns, technology immaturity, no connectivity or embedded sensor, uncertain return over investment, security concerns, and lack of interoperability (Raghuvanshi & Singh, 2020, p. 2). According to most smart city studies, a smart city project is not a technical aim but rather a socioeconomic development goal for any metropolis, city, or country (Khan et al., 2020; Kutty et al., 2020; Zygiaris, 2013). As a result, the primary goal of introducing and implementing a smart city solution is to support people in terms of urban space use and appropriation. In this sense, the smart city should not be technology-driven and limited: it may serve the aspirations of people, who should be active from the outset. Some cities and metropolises are developing unique themes to integrate people, using digital technology as a “vector for accelerating the connection with citizens”. The Grenoble Metropolis, for example, has launched a “*Grenoble, City of Tomorrow*” project (<https://www.grenoble.fr/655-ville-de-demain.htm>) to focus on major themes such as global warming, the digital revolution, the growth of the collective economy, new ways of cooperation, and so on. This platform also brings together elected officials, city agencies, and individuals from civil society, science, universities, and the business world (e.g., start-ups). Another issue is the development of a smart city based on metropolis (city, municipalities) trade. One of the smart city's main goals is to transform municipal services, whether they are waste disposal, public lighting, green space watering, protection, public transportation, or medical monitoring of the elderly. These advances are made possible by deploying connected objects, platforms for managing them, and new processes built in partnership with public services and their employees (Khan et al., 2020; Kutty et al., 2020; Zygiaris, 2013). Indeed, the smart city's new services would shake up everyone's roles and obligations, potentially leading to disputes if change management is not addressed collaboratively. Furthermore, a smart city project within a metropolis, city, should connect the physical and digital worlds rather than replacing physical structures and infrastructures (Khan et al., 2020; Kutty et al., 2020; Zygiaris, 2013). Thus, when establishing a smart city, the context of the city and geographical aspects

should be taken into account. Suppose several inventions are made from different experiments. In that case, the city should bear in mind that each experiment should match with the entire urban environment in question as well as the everyday lives of the people ([Khan et al., 2020](#); [Kutty et al., 2020](#)).

A smart city should also have power over its technological decisions. Smart city solution providers often approach city officials, touting their benefits. However, the smart city industry, and more broadly, the IoT market, is not structured today: a plethora of technologies, players, and protocols exist and function without interoperability or long-term viability in a rapidly changing market. As a result, cities should be cautious in their solution selection because they are limited by budgetary constraints and have a duty to make sustainable and useful investments. Furthermore, cities should be careful about the technical mastery of the chosen solutions to prevent financial slippage. The risks are as follows: inability to claim ownership of the adopted solution, difficulty evading existing agreements, and simultaneous obsolescence of the entire fleet (technologies, services, and products). For example, the Grenoble metropolitan area has redefined a “smart city” policy that is more transparent and interoperable, relying on open data and free software to stay as open as possible and to address interoperability challenges.

Furthermore, transversality is one of the main challenges of smart cities. Smart city policies can affect all public services, but they will also have an impact on all city processes and agencies, ranging from institutional communication to information systems, including those of the city's partners and operators (transport, waste, security, etc.). As a result, cities should have a holistic and cross-cutting vision of their digital ventures to set up an effective operation and governance. All should collaborate to create a system that is usable, effective, and optimized. The establishment of open data platforms and ecosystems (c.f. [Duval and Brasse \(2014\)](#), [Ruijter et al. \(2017\)](#), [Kitsios et al. \(2017\)](#), [Neves et al. \(2020\)](#), and [Bonina and Eaton \(2020\)](#)), which integrate the various actors of the metropolis, region, municipalities, is one solution that is already being implemented in several smart cities. Finally, as noted in the literature review, a smart city is not limited to the local domain. The development strategy of the technologies implemented by cities should, to the greatest extent possible, take into account issues of national coherence, which will enable, in the long run, to guarantee the interoperability of the technologies implemented and generate economies of scale ([Palm, Södergren, & Bocken, 2019](#); [Zvolska, Lehner, Voytenko Palgan, Mont, & Plepys, 2019](#)). This interoperability should allow solutions to be connected and provide people with a single service ([Palm et al., 2019](#); [Zvolska et al., 2019](#)). As a result, other

ideas such as urban sharing and city sharing have arisen (Palm et al., 2019; Zvolška et al., 2019). The idea of urban sharing defends an economic model of "strong social values" while encouraging institutions/companies to spend less, within a favorable legal structure and policies that promote the development of businesses associated with the collaborative economy (Palm et al., 2019; Sánchez-Vergara, Ginieis, & Papaioikonomou, 2021; Zvolška et al., 2019). Integrating the principles of urban sharing and sharing cities into smart city governance policies will redefine the critical position of residents, companies, and local governments, as well as create a sense of belonging to the city (Palm et al., 2019; Sánchez-Vergara et al., 2021; Zvolška et al., 2019). Furthermore, as a result of "sharing cities" programs, smart cities can envision governance that is partially shared with other cities in order to share and learn from information and experiences (Salvia & Morello, 2020; Sánchez-Vergara et al., 2021).

Finally, the huge data collection creates new problems for local governments. The way they react to these problems can differentiate them, and the levers of intervention are political rather than technical. The sensors embedded with real-time monitoring systems first gather data from people who use the city's services; from devices that facilitate the connection between the city and citizens (Kassen, 2017; Mondschein et al., 2021; Neves et al., 2020; Ruijter et al., 2017). These data are collected and analyzed to produce awareness and expertise that can be used to tackle inefficiency within the smart city. As a result, smart cities integrate data from public and private infrastructure, residents and entities, sensors and IoT captors, communities and neighborhoods, non-profit agencies, academia, and social media (Abellá-García, Ortiz- de-Urbina-Criado, & De-Pablos-Heredero, 2015; Hasija et al., 2020; Ma & Lam, 2019; Neves et al., 2020). So, it's not just the city's infrastructure; it's all the people who contribute to the city's infrastructure. In certain cities, the transportation, water, and power networks are likely not owned by the city. We should investigate and use all various resources to ensure the city's successful incorporation and resilience. The data is growing at a rate of one hundred thousand records every day (a huge tsunami of data). The issue is the omnipresence of a wall of data and the torrent of data coming in a variety of ways since there are no protocols in place to standardize this data in the region. To regulate the smart city data tsunami, the idea of openness falls into play. Shaikh and Vaast (2016) assert that this concept of openness has already been demonstrated in open-source communities.

To summarize, transforming a city into a smart city entails overcoming numerous challenges and barriers. Additionally, because these smart cities are data-driven, they should find new ways to promote innovation through them. The concept of open data appears to be

one solution that would allow for the inclusion of all actors involved in the city's operation. However, it will be necessary to consider other communities that are frequently overlooked in studies on smart cities, although they generate extremely useful data and contribute to the development, economic, social, and environmental sustainability of smart cities.

3.3. UNDERSTANDING THE OPEN DATA CONCEPT, AND ITS ADDED VALUE

Data is one of the essential prerequisites for the emergence of the (smart) city (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Mondschein et al., 2021). If many experiments already demonstrate the technical capabilities of metropolises, and cities to capture, centralize and process data, it is now necessary to work on the organization, utilization, value, and governance of (open) data (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Mondschein et al., 2021). And above all, smart cities/territories cannot be created without redefining the interactions between the various actors in urban life (private, public, consumers, citizens). There can be no smart city/commune without intelligent data sharing. The smart city is the city's digital transformation at the citizen's service and sustainable development (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Mondschein et al., 2021). The ambition of the smart city is to improve the quality of life of city dwellers by making the city more adaptive and efficient, using new technologies that rely on an ecosystem of objects and services (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Mondschein et al., 2021). This transformation is already underway in many cities worldwide, and many solutions are already deployed and operational. Although technical solutions exist, their large-scale deployment remains difficult to initiate, as the complexity of integrating a solution with already existing institutions, organizations, and structures should be overcome. It is therefore necessary to clarify the roles and perimeters of each party, in particular, who owns the data generated and who has access to the information. Moreover, this issue of data governance is now exacerbated by the wealth of services/products to be invented, which depends directly on the ability to cross-reference data from different sources: buildings, networks, connected objects (IoT) incorporated into furniture/urban assets, social sensors, etc. But how can raw data from different actors (citizens, individuals, private and public sector organizations), and sometimes competitors, be combined while protecting each other's data access and ownership? How can we make data a new common good to foster innovation within metropolises, cities, and municipalities? Part of the answer lies in the development of open data platform/ecosystem.

The term open data refers to data that anyone can access, use, or share (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Janssen et al., 2012; Neves et al., 2020). As a rule, this data does not

contain any information about individuals for obvious privacy reasons (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Janssen et al., 2012; Neves et al., 2020; Zhenbin, Kankanhalli, Ha, & Tayi, 2020). Open data is only non-personal data. Most of the time, open data comes from the government and the public sector (Cheliotis, 2009; Hossain, Dwivedi, & Rana, 2016; Zhenbin et al., 2020). It is usually budgets, maps, or results from scientific research, elections. However, companies, universities, NGOs, startups, charitable foundations, communities, or individuals can also offer open data (Hossain et al., 2016; Kitsios et al., 2017; Verhulst & Young, 2017). Open information can be found in the sectors of transportation, science, products, education, environment, cartography, libraries, land use, urban planning, economy, culture, development, business, design, or finance. The term also applies to data (including big data) and content such as images, videos, text, and music (Cheliotis, 2009; Hossain et al., 2016; Verhulst & Young, 2017; Zhenbin et al., 2020). Open data is a raw material for the digital age, but unlike coal, wood, or diamonds, anyone can use it at any time. The key criteria for open data are availability, reuse and distribution, and universal participation (Abella et al., 2017; Ahmadi Zeleti et al., 2016; Janssen et al., 2012; Neves et al., 2020). The concept of open data is closely related to that of open knowledge, which refers to *“is any content, information or data that people are free to use, reuse and redistribute - without any legal, technological or social restriction”* (Cheliotis, 2009; Michael et al., 2014; Neves et al., 2020; Zhenbin et al., 2020). From this point of view, the main characteristics of openness that these data should respect are the following: (1) availability and access; (2) reuse and redistribution, and (3) universal participation. We will then discuss the significance of these characteristics for open data interoperability. Because if we are to promote the concept of an open data ecosystem, it is critical to consider the interoperable nature of open data as a result of its default characteristics.

3.3.1. AVAILABILITY AND ACCESS

The data should be fully accessible, at a reasonable cost of reproduction. It should be available in a common form that machines and even humans can read. Preferably, it can be easily downloaded from the Internet (Bentley, Chib, & Poveda, 2019; Janssen et al., 2012; Neves et al., 2020; Verhulst & Young, 2017). Even more, the form should be comfortable and editable. For example, on the open data platform of the city of Grenoble¹, the data are available and downloadable in several formats without the need to have an account or to pay any amount, they are simply free.

¹Grenoble open data portal: <https://data.metropolegrenoble.fr/ckan/dataset>, consulted on 10/06/2021

3.3.2. REUSE AND REDISTRIBUTION

This property denotes the fact that the data should be provided under conditions that allow for reuse and redistribution, including blending with other data sets available within the city, town, institutions, and other organizations (Bentley et al., 2019; Janssen et al., 2012; Neves et al., 2020; Verhulst & Young, 2017). Like the case of the city of Grenoble which is setting up policies to reuse its open data. For example, “*Grenoble Patrimoine*²” uses a dataset (evolution of the geographical area of Grenoble since the 3rd century) to describe the evolution of Grenoble, from the town of “*Cularo*” inside the Roman walls to the contemporary city. Or consider “*Ma Petite Poubelle*³”, an app that enables users to determine which garbage can a piece of waste should be disposed of in based on its type, to learn more about the waste's fate, its point of transformation, and to locate the nearest voluntary disposal point (glass garbage cans). Additionally, it guides how to modify certain behaviors to reduce waste and its carbon footprint. Finally, it enables the user to monitor the sorting process's quality and the amount of waste generated on an individual and building level.

3.3.3. UNIVERSAL PARTICIPATION

Everyone should be able to use, reuse and redistribute the data without restriction (Bentley et al., 2019; Janssen et al., 2012; Neves et al., 2020; Verhulst & Young, 2017). There should be no discrimination regarding the purposes of use, or against individuals or groups. For example, non-commercial restrictions that prevent commercial use, or restrictions of use to certain sectors or institutions, are not compatible with the concept of open data (Bentley et al., 2019; Janssen et al., 2012; Neves et al., 2020; Verhulst & Young, 2017). Thus, open data should be licensed. This license should allow free use and allow users to transform, combine and share this data, even for commercial purposes (Janssen et al., 2012; Neves et al., 2020; Verhulst & Young, 2017).

3.3.4. OPEN DATA INTEROPERABILITY AND ADD VALUE

Availability and access; reuse and redistribution, and universal participation are the three criteria that are the essence of open data, as they enable interoperability, which refers to the ability of different companies/organizations/actors or systems to work together (Janssen et al., 2012; Ma & Lam, 2019; Neves et al., 2020; Verhulst & Young, 2017). In (smart) cities, interoperability is the ability to mix different data sets. This interoperability is important

²Grenoble Patrimoine, <https://www.grenoble-patrimoine.fr/1044-grenoble-plus-de-2000-ans-d-histoire.htm> consulted on 10/06/2021

³ Ma p'tite poubelle, <https://data.metropolegrenoble.fr/1395-2/> consulted on 10/06/2021

because it allows different components to work together in the same ecosystem. It is what allows the creation of large, cross-functional, and complex systems. Without interoperability, it is simply impossible for a city/municipality to capitalize on open data. In the case of data, pooling relies on the possibility to freely mix data from several actors (private or public) (Verhulst & Young, 2017). This interoperability is essential to reap the benefits of openness. It is then possible to develop products and services in greater quantity and of better quality to facilitate the lives of citizens and any other entities (Hossain et al., 2016; Janssen et al., 2012; Ma & Lam, 2019; Neves et al., 2020). Moreover, this interoperability does not only rely on data sharing. It requires that the data sets use a common programming language or that a programmatic element mediates between the information (e.g., application programming interface [API]) (Kitsios et al., 2017). Besides, the creator of the data should in this case respect particular criteria: certify the origin of the data, indicate the related metadata (typically the date and time of creation), guarantee the quality of the information, and if possible, its author, and others characteristics (Ma & Lam, 2019; Verhulst & Young, 2017). Thus, open data can transform the interaction between governments, businesses, and individuals. It has the potential to improve services, contribute to economic growth, and save our planet from human-caused destruction (when used for ecological and sustainable development purposes) (Ahmadi Zeleti et al., 2016; Mergel et al., 2018; Neves et al., 2020; Verhulst & Young, 2017). Even more, businesses, governments, institutions and individuals can use open data to create social, economic and environmental benefits (Kassen, 2017; Ma & Lam, 2019; Mergel et al., 2018; Smith & Martín, 2021; Verhulst & Young, 2017). Open data has the power to produce diverse benefits for governments, businesses, and civil society. For example, for government transformation, where open data enables greater transparency for governments. It can help prove that public funds are well spent and that policies and laws are well implemented (Bentley et al., 2019; Kassen, 2017; Smith & Martín, 2021). As demonstrated by David (2010) open data saved Canadian citizens \$3.2 billion in fraudulent donations to charities in 2010. This is also the case in Sweden, where the "Lexbase" platform (<https://www.lexbase.se/>) provides public information from Swedish courts and other authorities on judgments in criminal and civil cases involving individuals and companies (Kassen, 2017). This platform aims to ensure the well-being of citizens by providing them with information about crime in different areas, such as their neighborhoods (Kassen, 2017). In two major Spanish cities (Madrid and Barcelona), open data digital platforms are used for urban democracy (Smith & Martín, 2021). They allow citizens to debate urban issues with other stakeholders, propose developments, plans and policies to city authorities and influence how municipal budgets are spent within the city (Smith & Martín, 2021). Even in underdeveloped

and developing countries, open-source is proving its worth. Such is the case in Nigeria where the “*Follow the Money*” platform (<http://followthemoneyng.org/>) ensures that public funds are used to implement policies promised to the people (Engel & Mattheis, 2019; Fenton, 2016; Verhulst & Young, 2017). Aside from government transparency, open data opens up new opportunities for companies and start-ups to connect with their customers (Abella et al., 2017; Duval & Brasse, 2014; Hasija et al., 2020; Janssen et al., 2012). In smart cities like London, Paris, Singapore, open data has enabled the creation of over a hundred transportation applications (Hasija et al., 2020; Mergel et al., 2018). Also, open data can use as leverage for citizens empowering : e.g., in Kenya, with “*GotToVote!*” project for improving voter turnout with open data; the open education dashboards in Tanzania, in order to improving education; and the South Africa’s medicine price registry, cheaper medicine for consumers (Verhulst & Young, 2017, pp. 126-152).

Moreover, open data helps to achieve one of the main goals of smart cities: to protect our planet. The web has become an integral part of our infrastructure and open data will contribute to this development. For example, open data on weather allows for early warning of natural disasters (UN). This is also the case in the UK where open data helps consumers understand their impact on the environment and take action to improve it (Edward, 2011). In New York, A cab ride-sharing service connects trips with similar start and end points, using open data to save 22.42% of travel time and 2,892,036 km of distance per week (Barann, Beverungen, & Müller, 2017).

Open data is already demonstrating its capacity to revitalize specific sectors of the economy or to address specific social problems. Open data's interoperability demonstrates its value as a lever for innovation in an ecosystem comprised of diverse actors. Indeed, while open data has the potential to add significant value to cities, municipalities, citizens, and individuals, their adoption today requires additional research, as open data is often compared to a digital transformation project (at the scale of a country, a city, or one or more municipalities) (Barge, 2017; Priol, 2017). As a result, it is a complex concept whose adoption and use raises some issues.

3.4. CHALLENGES, ADOPTION, IMPLEMENTATION, GOVERNANCE, AND IMPACTS OF OPEN DATA WITHIN (SMART) CITIES/TERRITORIES, AND MUNICIPALITIES

3.4.1. CHALLENGES RELATED TO ADOPTION AND IMPLEMENTATION OF OPEN DATA (GOVERNMENT) PLATFORM

Open data “*is data that anyone can access, use and share*” (Janssen et al., 2012, pp. 262-263). Governments, organizations, and citizens/individuals can use open data to create social, economic, and environmental benefits (Janssen et al., 2012; Kassen, 2017; Neves et al., 2020; Ruijer et al., 2017). As demonstrated by Janssen et al. (2012, p. 261), on a study of the benefits, barriers to adoption and myths about open data and open government, the benefits of open data can be classified into three (03) categories: political and social (e.g., transparency and trust in government, improvement of citizen services, citizen satisfaction, and policy-making processes); economic (e.g., stimulation of competitiveness and innovation, development of new products and services which indirectly influence the creation of a new sector adding value to the economy), operational and technical (e.g., improvement and optimization of administrative processes and public policies). And as far as adoption barriers are concerned, they are classified into six (06) categories: institutional, task complexity, use and participation, legislation, information quality, and technical (Janssen et al., 2012, pp. 262-263). As for Ruijer et al. (2017, p. 475), he classified the barriers of open data use into structural barriers (citizens: technical, access; government: resources and management, ownership and privacy) and cultural barriers (citizens: knowledge and interest, use and value; government: fear of losing control, extra work) and grouped according to the two key actors of the cities/municipalities: citizens and government. In addition to these barriers related to the adoption of open data in smart cities, Ma and Lam (2019, p. 40) add the legal & licensing barrier in relation with several stakeholders (project initiator [e.g., local/government authorities], public data providers, private data providers, and data providers from Non-Governmental Organization [NGOs]). Indeed, the lack of an open data policy should be addressed as a priority in all open data adoption projects (Ma & Lam, 2019). This should be followed by improving the open mindset and IT literacy within government organizations (Ma & Lam, 2019).

Indeed, Janssen et al. (2012, p. 264) try to highlight the large gap between the promises and obstacles of open data in (smart) cities. Even more so, some cities during the adoption phase point to the potential benefits, but without knowing how to achieve the promised benefits (Janssen et al., 2012, p. 264). Also, for several open data projects, many local governments believe that: (1) publishing data will automatically produce benefits; (2) all data and information should be made publicly available without restriction; (3) smart cities/territories managers believe that it is simply a matter of publishing public data; (4) every citizen can use open data and related platforms; and (5) open data will automatically produce benefits (Janssen et al., 2012, pp. 264-266). As a consequence, in some cities, we observe that open data is dead at the expense of open

data platforms. These data platforms address the need for data to be centralized and made available by a trusted third party. The data remains the property of those who inject it and can thus be shared with or without conditions. The cross-referencing of raw data from different actors is then carried out within these data platforms to produce aggregated data that can be shared and used to develop new services (Janssen et al., 2012; Neves et al., 2020; Ruijer et al., 2017). With these secure open data platforms, exchanges will naturally intensify to give rise to an ecosystem of supplier users linked by the interdependence of their respective data. Indeed, they allow the different applications and business software to feed each other with the exchanged data (Ruijer et al., 2017). Furthermore, this open data be beneficial for all stakeholders; they should be able to connect societal issues, users, and data (Ruijer et al., 2017). Also, to design and implement an open data platform that meets the needs of citizens, societal issues can be the starting point, *“as one should not only focus on generic user requirements but also on context-specific user requirements”* (Ruijer et al., 2017, p. 1). For Neves et al. (2020), the impacts of open data initiatives on (smart) cities dimension (economy, people, governance, mobility, environment, and living) are moderated by the societal challenges (with ICT and analytics: artificial intelligence, IoT, and big data). Thus, municipalities should have a framework to measure impacts to ensure that the goals have been met. Neves et al. (2020, p. 10) argue that argues that this avoids *“misalignments that can occur between open data and smart city initiatives, as well as a mismatch between public expectations and government transparency in data release”*. According to Ma and Lam (2019, p. 44), these misalignments that appear are characterized by several causes presented in Figure 2.

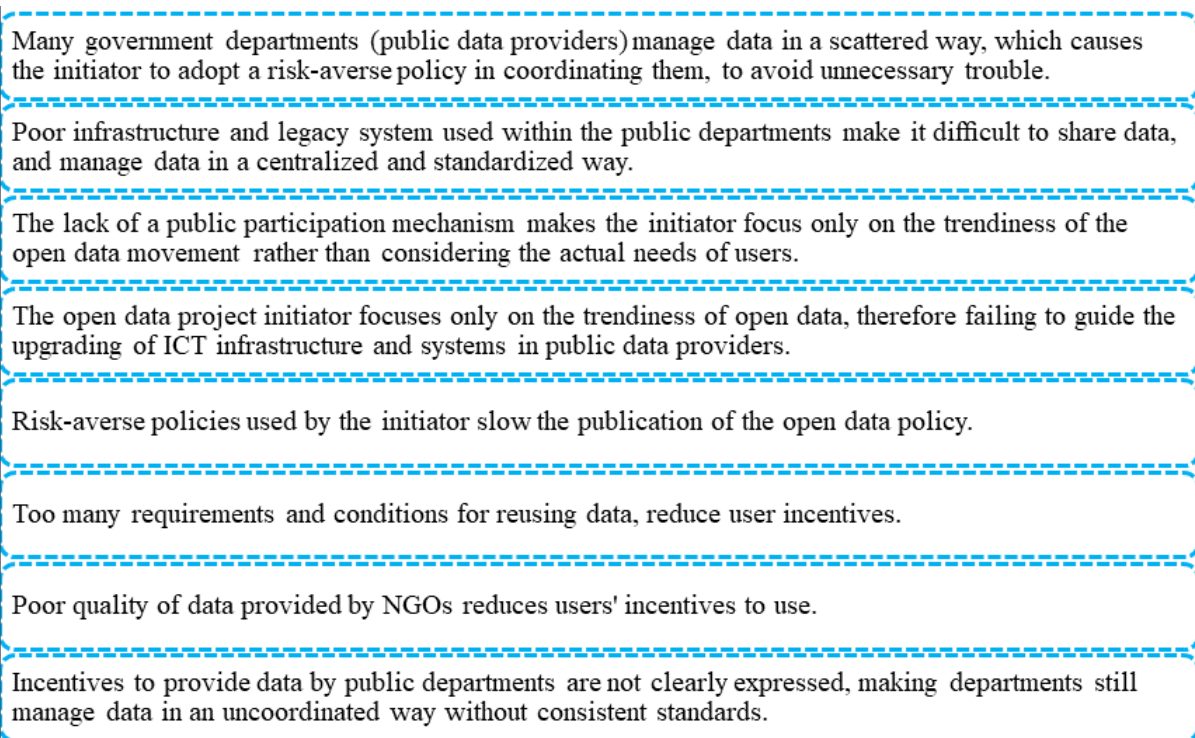


Figure 2. Causes of misalignments between open data and (smart) city initiatives (Ma and Lam (2019, p. 44))

3.4.2. IMPACTS AND BUSINESS MODELS OF OPEN DATA WITHIN (SMART) CITIES/TERRITORIES, AND MUNICIPALITIES

Even if the development of these secure platforms makes it possible to resolve the first issue related to the quality of the information. Because the provider/user ensures the quality of the information publishes to maintain his credibility and use, in turn, qualified data exposed on the platform. However, data is very much present and focuses on the first smart city projects. The issue is no longer just collecting or using it, but even more so, sharing it. Smart and connected cities/territories depend on it because no one actor has all the information. There are so many opportunities that territories want to seize to pursue their development. This is why several studies are looking at developing viable business models that can help cities and municipalities in their adoption process of open data. To determine how to ensure the economic viability of open data (platforms), Duval and Brasse (2014) conducted a comparative analysis of the business models of different websites and platforms offering open data. They proposed a business model canvas for an open data (platform) based on the three main business models generally used on the internet (free, freemium, and premium) (Duval & Brasse, 2014). To facilitate the explication and detail analysis of existing open data business models in practice, Ahmadi Zeleti et al. (2016) developed a 6-Value (6-V) business model framework, which takes into consideration all the

components of a well-designed business model like value network, actors, supporting infrastructure, value proposition, offer, channel, value, value-adding process, operational, strategic planning, knowledge management, value in return, the volume of sale, income, future income opportunities, value capture, market size, profit/margin model, value management. model, discipline, governance, structure, administration, in practice. Through the different business models (e.g., freemium, premium, cost-saving, indirect benefit, parts of tools) established by [Ahmadi Zeleti et al. \(2016\)](#), governments and local authorities can identify how the adoption and implementation of open data might be done in a way that creates value for the general public and facilitates the development of free and commercial products and services. Indeed, as shown by [Kitsios et al. \(2017\)](#), there is a need to build an integrated and collaborative open data ecosystem, which can help to boost entrepreneurial practices/activities within the cities as well as the business model elements needed in open data-based business. Through the business model canvas, [Kitsios et al. \(2017\)](#) show that, while actors are involved in utilizing open data, there is a need for a different type of business environment (open data ecosystem) that allows all actors (application users, data providers, service providers, infrastructure providers, application developers) in the open data environment to win. Since the actions of each actor affect the other and the whole enterprise, the environment establishes a value chain. Actors may develop contracts that would maximize their collaboration and freely distribute data among themselves ([Kitsios et al., 2017](#)). Finally, [Kitsios et al. \(2017\)](#) argue that the business models built by various players (e.g., application developers) do not prioritize the commercialization of their services/products (applications) and the increase of revenues. They can just consider data's social importance ([Kitsios et al., 2017](#)). As a result, mentors and companies should invest in the open data ecosystem to assist them in extending their services/products (applications) and optimizing economic development ([Kitsios et al., 2017](#)). Through upgrading services and introducing fresh content and innovations, open data expands the opportunities for new businesses and helps to sustain existing ones ([Kitsios et al., 2017](#)). [Abella et al. \(2017\)](#) presented a new model describing the mechanisms for value creation as a consequence of data release in smart cities. The first stage of this model focuses on the reusability degree, which helps to understand that the value generation process depends on analyzing the reusability of open data within the smart cities ([Abella et al., 2017](#)). The second stage, reuse value, focuses on the innovation created by the agents/stakeholders reusing data in the cities to develop new products/services ([Abella et al., 2017](#)). The last stage, economic and social value, analyzes the impact of data-driven products and services created by the smart city's ecosystem following the social and economic views ([Abella et al., 2017](#)). Besides, reusing (smart) city data to create added

value and innovative services/products is key to improving citizens' quality of life by developing and optimizing smart ecosystems (Abellá-García et al., 2015). Furthermore, Abellá-García et al. (2015), Abella et al. (2017), and Mondschein et al. (2021) highlight the crucial role of actors (citizens, organizations [private or public], businesses and city managers) in the digital ecosystem around the smart cities. Indeed, as smart cities can be viewed as large technological systems, organizational challenges create unique obstacles for smart cities. Moreover, the governance of an open data ecosystem within (smart) cities should firstly be centered on citizens. Meijer and Potjer (2018) discovered that citizen-generated data can also offer better evidence for democratic policy, but that it can also be used to criticize existing roles and power systems. The importance of citizen-generated data to public policy can therefore be interpreted in terms of both cooperation and competitiveness (Meijer & Potjer, 2018).

With an increasing global interest in Open Government Data (OGD), there is a growing need for research into the factors that affect OGD adoption. Furthermore, according to the literature review, the problems relating to the implementation of open data are often related to government or local authorities. As shown by Altayar (2018), the adoption of open data by the government provides benefits and advantages like transparency and accountability, facilitating access to government data, supports innovation, improves government services, operational benefits, encourages participation. In some contexts, government agencies' adoption of open data is influenced by external pressures, perceived benefits, and organizational readiness (Wang & Lo, 2016). According to Estermann (2018), and Altayar (2018), the open data initiative is a crucial pillar of e-government, in response to the digitization of society. Furthermore, the wide benefits of open data are: data and knowledge are shared across government departments, and systems are developed to break down organizational silos to provide streamlined services to consumers/citizens.

3.4.3. GOVERNANCE OF OPEN DATA PLATFORM

Opening your data on a platform is good. Making reuses of it and showing how this data can be useful is better. Thus, open data should not be an end in itself. When an organization, a municipality, a city, a ministry, or a company makes its data available to all, it should instead be a means to encourage beneficial and sustainable transformations (Bonina & Eaton, 2020; Kitsios et al., 2017). These transformations impact not only the organization and its agents (accelerating the march towards greater transparency, rebuilding the bond of trust between administrations and citizens, structuring information within the organization) but also the

citizens and users at the end of the chain (improving the offer of public services, the right to have a look at economic and public life, better access to knowledge and cultural goods) (Barba-Sánchez et al., 2019; Bonina & Eaton, 2020; Kitsios et al., 2017). Therefore, it is essential to set up tools/methods to cultivate open (government) data platform ecosystems through governance (Bonina & Eaton, 2020; Wilson & Cong, 2021). Because, the lack of monitoring/governance mechanisms makes it difficult to evaluate the broader effects of the use of open data (Wilson & Cong, 2021). Thus, fostering innovation strongly depends on the accuracy of the open data governance model (Bonina & Eaton, 2020). Besides, this governance model is analyzed according to seven (07) constructs: core architecture, peripheral architecture, platform owner, contributors, developers, tools (e.g., information/software/social tools), and rules (e.g., contractual rules) (Bonina & Eaton, 2020, p. 3). Furthermore, the interplay of governance and platform ecosystem cultivation should focus on four main axes, which each answer a specific question (Bonina & Eaton, 2020, p. 11). Firstly, the manager of an open data ecosystem should look for the enabling actors, to know “*how enabling actors interact amongst themselves and form OGD networks*” (Bonina & Eaton, 2020, p. 11). Secondly, analyze the governance intervention, to highlight “*the scope and degree to which the OGD platform owner governs platform with and without government action*” (Bonina & Eaton, 2020, p. 11). Thirdly, explore interaction & communication, to look at “*how interaction is enabled between platform owner and ecosystem*” (Bonina & Eaton, 2020, p. 11). Finally, the dynamics over time & contextual responsiveness respond to “*how OGD platform evolves in response to the environment*” (Bonina & Eaton, 2020, p. 11). Bonina and Eaton (2020, p. 13) argue that to establish and cultivate the open data platform, (1) there is a need for governments to legitimize an open data platform owner before a platform is created; and (2) critical governance tools and rules to be established at the moment an open data platform is introduced. (3) the implementation of social resources to promote ecosystem engagement with an open data platform; and (4) the deliberate timing and orchestration of the creation and implementation of tools and rules in light of their interplay between the supply and demand sides of the platform environment.

3.5. RESEARCH GAPS

To summarize, whether it is a project aimed at establishing an open data ecosystem within a (smart) city or a project aimed at establishing an open data ecosystem within a (smart) city, a municipality, or a (smart) city with its community of municipalities, they all refer to territorial or inter-municipal digital transformation projects with a primary focus on socio-economic

development rather than technological advancement. This is distinct from the digital transformation processes that are frequently observed in businesses. Additionally, this territorial digital transformation process is more complex because it involves multiple heterogeneous actors, the majority of whom are distinct municipalities (Albouy et al., 2020; Hinings, Gegenhuber, & Greenwood, 2018). Indeed, each territory (city, municipalities) has an actor system made up of institutional decision-makers, businesses, citizens, and associations charged with animating, improving, and transforming it (Albouy et al., 2020; Hinings et al., 2018). Each territory is unique and should maximize its resources through a combination of intelligence and collaboration between the public and private sectors. Thus, the adoption and implementation of an open data ecosystem cannot be dictated or constrained by technology; it should serve the aspirations of citizens and all other stakeholders, who should be involved from the start. Additionally, when we discuss digital transformation and innovation, as with open data ecosystems, it is critical and urgent to develop new theories for the era of digital innovation and transformation (Hinings et al., 2018). Since innovation processes are themselves being digitized, established innovation theories are no longer applicable (Hinings et al., 2018). Additionally, for these digital transformation projects to succeed, they will need to rethink their operational and communication strategies, both internally and in their interactions with citizens. Open data ecosystems are considered institutional digital infrastructures (ecosystem) from an institutional perspective because they enable, constrain, and coordinate the actions and interactions of numerous actors in ecosystems, domains, or industries. (Hinings et al., 2018) argues that existing theories are either too limited or insufficient because they do not adequately account for digital innovation and transformation. The review of the literature reveals that only a few studies have attempted to analyze these open data ecosystems institutionally. According to the literature review, when we talk about smart cities, we are referring to data-driven innovation (e.g., open data ecosystem), or more precisely, to an institution's digital transformation. Thus, the traditional theories and models commonly used to study adoption and use are constrained by this fact, because when we discuss the open data ecosystem in a (smart) city, several entities are at stake. Additionally, smart city manufacturers' commercial strategy continues to focus on large and even medium-sized cities, which are believed to have more accessible markets and higher expected profitability.

Furthermore, the ethical implications of individuals' private digital data present enormous challenges to society. Thus, successful adoption and use of open data require additional research, as we have demonstrated that we cannot do what other technosocial innovations do.

Additionally, the open data ecosystem is comprised of a diverse set of actors, institutions, and organizations, each with a distinct set of objectives, goals, and operating structures (Neves et al., 2020). Additionally, they are exempt from the same pressures, regulations, and laws. However, they should all be incorporated into an open data strategy to promote the economic, social, and political development of cities, towns. As a result, processes and approaches for addressing privacy concerns within open data ecosystems are required. Additionally, the open data ecosystem has garnered widespread praise to the point where many local governments are embarking on transformative projects across their territories/municipalities. However, the issue of how to utilize this open data and govern these platforms and ecosystems arises.

Additionally, the review of the literature reveals that large cities and metropolises have already leveraged digital technology to optimize their services: innovation hubs, new modes of transportation, intelligent lighting, and innovative water and waste management, to name a few. What about (non-metropolitan) municipalities? While their elected officials and decision-makers recognize that digital technology has the potential to improve service management and increase the territory's attractiveness, they are frequently unaware of the specific ways in which it can do so, and point to gaps in awareness, engineering and financing, expertise, infrastructure, and governance in the future of this open data ecosystem. However, new value can be extracted from this data by cross-referencing data from various sources and utilizing techniques for massive data analysis (big data) and artificial intelligence. These cities and metropolises, for the time being, require experience extracting value from data.

Furthermore, the smart city, or more broadly the smart territory, is not limited to large cities (metropolises); it would be dangerous - from the perspective of territorial cohesion - to allow them to get ahead of the game before attempting to replicate an unsuitable model. The pressing need to save money for communes, and local governments, the convergence of technologies via the innovations of the fourth industrial revolution, the densification of networks, and data management all strongly encourage local elected officials to think smart. Local governments or commune communities play a critical role in this regard. Local governments play a critical role in advancing this dynamic of data sharing and openness, which is critical for the development of smart cities. They should encourage the ecosystem's various actors to generate and share data while respecting individuals' privacy, and instill a dynamic that enables them to innovate and invent services that meet the needs of all the ecosystem's actors (e.g., citizens, NGOs, public and private organizations [cf. (Wamba-Taguimdje, Dominguez-Péry, & Wamba, 2021)]).

To summarize, while the majority of previous research has concentrated on the impact of open data at the national (government) level, as more municipalities engage in open data projects, it is necessary to understand the barriers and challenges associated with open data adoption and use, as management policies (governance) differ between municipalities and large cities and metropolises. Furthermore, some of these studies linking open data to cities/governments focus exclusively on the impact (but not the adoption and use) of the latter, omitting other municipalities and actors entirely. We are well aware that technology, a method, or a technique can only provide genuine benefits and advantages if the actors have recognized and overcome all of the obstacles and challenges associated with its adoption. There are very few empirical studies on adoption in the open data ecosystem, as summarized in our literature review. Numerous studies take a qualitative approach, relying on the opinions/knowledge of a small number of actors involved in open data projects. Additionally, because open data is a component of an ecosystem, it would be interesting to examine the adoption of an open data ecosystem not just in one city/territory as observed in the literature review, but across all entities involved in the open data ecosystem's life cycle. Additionally, the dwindling number of studies employing mixed methodological approaches in the literature review helps to justify the methodological choices we have made for future studies.

The purpose of this study is to establish a link between open data adoption and use by answering the following question: What are the barriers, challenges of adoption, and use of open data ecosystem.

In the next section, we will develop a research model based on the literature review and hypothesis development.

Table 3. Reviewed research studies on the open data initiatives on smart cities

Study	Type, Method	Summary
Wang and Lo (2016)	Empirical, Survey	Explores the factors influencing the adoption of Open Government Data (OGD) among Taiwanese government agencies, with a research model that incorporates the technology–organization–environment (TOE) paradigm. They investigated this model using survey data from 342 Executive Yuan government agencies in Taiwan. The findings reveal a strong positive association between potential advantages, operational preparation, and external pressures, and government agency acceptance of OGD.

Study	Type, Method	Summary
Ruijter et al. (2017)	Empirical, scenario-based design methodology	They argue that the creation of an open data platform will begin with various societal issues. To demonstrate the importance of this context-specific technique, we use scenario-based modeling methodology in the Dutch province of Groningen. (1) When developing an open data framework, we should recognize not just general but also context-specific usage specifications. (2) Societal challenges will serve as a springboard for the creation of an accessible data infrastructure. (3) Scenario-based modeling will assist government departments and planners in developing accessible data platforms that address citizens' needs.
Altayar (2018)	Empirical, qualitative (interviews, and documentation)	This analysis aims to look into the factors that motivate government institutions in Saudi Arabia to follow OGD. The study's observations are interpreted and clarified using elements of institutional philosophy. It demonstrates that current institutional arrangements affect the implementation of open data and that internal and external structural pressures have an effect on the initiative. Indeed, organizations analyzed perceived many advantages, which can be defined as openness and accountability. OGD rationalized misconceptions, such as increased access to government records.
Estermann (2018)	Empirical, Survey	Examine how successive generations of e-government maturity models predicted these transitions and objectively evaluates emerging stage models. An empirically tested maturity model with the diffusion of innovation theory for the introduction of open governance is provided based on a study of 1560 heritage institutions in 11 countries. They result in more integrated services, participatory practices, an evolving collaborative community, and the dismantling of private data silos and their substitution with a commonly used data system that allows data to be widely shared, interconnected and re-used.
Meijer and Potjer (2018)	Empirical, explorative comparative case study	Performed an exploratory comparative case study review of 25 cases from multiple countries better to appreciate this multi-actor partnership within the open data ecosystem. Personal, group, and political interests – and ‘fun’ are motivating factors for the citizen to generate open data. citizen-generated open data projects are managed by public and private actors and are often partnerships between different actors. Citizen-generated open data can assist in collaborative governance, but it can also contribute to the scrutiny of government policies. Citizen-generated accessible data are critical not just for finding answers to social challenges, but also for political participation.

Study	Type, Method	Summary
Neves et al. (2020)	Conceptual, Review	Examine the effects of open data on the smart city's complex ecosystem. For the assessment of open data policies, an approach based on Randomized Controlled Trials (RCT) is presented. This research addresses an awareness gap between open data impacts and smart city sustainability growth, and it provides a structure (and a model based on 27 open data effect variables and six smart city dimensions) for evaluating the impacts and results of open data projects in the sense of smart cities. In a smart city setting, the effects of open data projects may be measured, tracked, and changed.
	Empirical, literature review, comparative case study, interviews, participant observation, and secondary data	With a comparative case study (03 platforms in Latin American cities) and literature review, they explore how service creativity is focused on open government data. They provide a theoretical model that describes how an open data platform owner should regulate/govern the demand and supply sides of its platform to promote the creation of a platform ecosystem. Also, highlight a series of guidelines for emerging-country governments on creating and maintaining a vibrant open data ecosystem.

4. RESEARCH MODEL AND HYPOTHESIS DEVELOPMENT

We cannot discuss adoption without mentioning the pioneering theories in information systems and information technology that continue to guide research on the adoption and use of technologies and systems.

4.1. THEORIES AND MODELS OF INFORMATION TECHNOLOGY AND INFORMATION SYSTEMS ADOPTION

Numerous studies in information technology have been conducted on the adoption and use of technologies. Indeed, the literature reveals a plethora of factors that influence the adoption and use of IT/IS, either directly or indirectly. perceived usefulness, social influence, perceived ease of use, facilitating conditions, performance/effort expectancy are all significant factors. Additionally, the impact of these factors on adoption and use is frequently moderated by moderating variables (e.g., age, experience, gender, and even level of education) (Kala Kamdjoug, Wamba-Taguimdje, Wamba, & Kake, 2021; Lai, 2017; Venkatesh, Morris, Davis, & Davis, 2003). The following theories and models are the most frequently used in the

literature: “*the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Diffusion of Innovation theory (DOI), the Theory of Planned Behavior (TPB), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technology-Organization-Environment Framework (TOE)*” (Kala Kamdjoug et al., 2021; Lai, 2017).

Thus, these theories are still extremely used to study adoption today; in the case of the open data, pioneer articles adopt either more classical theories (e.g. TOE or UTAUT), to which the authors occasionally add institutional theory variables (concepts) (cf. [Zuiderwijk, Janssen, and Dwivedi \(2015\)](#), [Wang and Lo \(2016\)](#), and [Altayar \(2018\)](#)).

4.2. HYPOTHESIS DEVELOPMENT

Our conceptual research model (Figure 4) is built upon the literature review, as shown in. More precisely, it is focused on [Janssen et al. \(2012\)](#), [Zuiderwijk et al. \(2015\)](#), [Verhulst and Young \(2017\)](#), [Altayar \(2018\)](#), [Neves et al. \(2020\)](#), and [Lytras and Visvizi \(2021\)](#) research. Based on these studies, [Wang and Lo \(2016\)](#) conducted an empirical study using a quantitative methodology to examine the adoption of open government data by Taiwanese government agencies. With the TOE framework, these authors have demonstrated that “*perceived benefits*”, “*external pressures*”, and “*organizational readiness*” all influence government agencies' adoption of open data. In a similar vein, [Altayar \(2018\)](#) used institutional theory in a qualitative approach based on the research of [Janssen et al. \(2012\)](#), [Zuiderwijk et al. \(2015\)](#), to conduct an institutional analysis of governments' adoption of open data. As a result of their findings, they conclude that open data adoption is largely determined by perceived benefits (e.g., transparency and accountability, ease of access to government data, support for innovation, improvement of government services, operational benefits, and open data [government] encourages participation) and motivating factors (e.g., political reform, institutional pressures, widespread adoption of OGD, and user expectations). Additionally, insists on testing its variables empirically (quantitatively) to illuminate any relationships that may exist between them. [Zuiderwijk et al. \(2015\)](#) extend open data to open data technologies and uses a modified UTAUT model to empirically identify predictors of open data acceptance and use. Their findings demonstrate how the predictors performance expectancy, effort expectancy, social influence, and voluntariness of use all have an effect on people's behavioral intention to adopt and use open data technologies.

These authors have attempted to investigate the obstacles (challenges) to acceptance (adoption) and the use of open data in turn. These authors classified barriers and challenges into several categories. And demonstrated their importance in the adoption and use of open data. The studies are innovative in the sense that they did not use classical social science and management theories of adoption, but rather innovative theories and approaches. That is why in this study we will adopt the variables (constructs) developed or used by the latter in a study on the open data. Furthermore, we examine the open data ecosystem in this study; we were inspired by [Wamba-Taguimdje et al. \(2021\)](#) study, which demonstrates the added value and importance to build a Unified Open Data Ecosystem (UODE). **Figure 3** illustrates this UODE with the different actors and their roles/relations, which is adapted for a (smart) city and communities of municipalities. In this study, we will analyze open data adoption according to the ecosystem's primary actors (the city [or smart city], the communities surrounding the main city, and the users [e.g. private companies, associations]), because it would be difficult to talk about an open data ecosystem without their active involvement in open data projects ([Wamba-Taguimdje et al., 2021](#)).

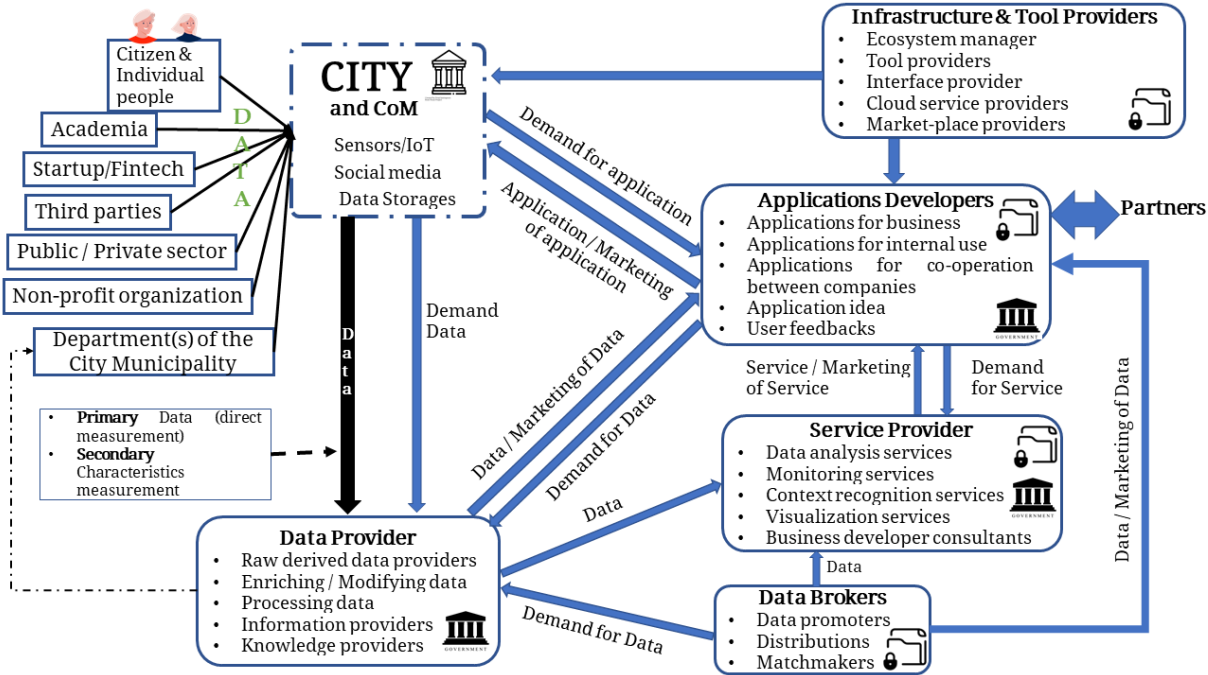


Figure 3. Roles in the UODE of (smart) cities (([Wamba-Taguimdje et al., 2021, p. 8](#)))

Indeed, based on the results produced by these authors, Our hypotheses will be developed in consultation with some open data ecosystem's stakeholders (main city, communities of municipalities, private companies, associations, and citizens). We will begin with hypothesis H1, and this distinction will hold for hypotheses H2, H4, H6, and H7. On the other hand,

hypothesis H3 encompasses all actors except private companies, whereas hypothesis H5 encompasses only the city and communities of municipalities. We make the following hypotheses:

Hypothesis H1a: *the perceived benefits of an open data ecosystem influence its adoption by the main (smart) city.*

Hypothesis H1b: *the perceived benefits of an open data ecosystem influence its adoption by the communities of municipalities.*

Hypothesis H1c: *the perceived benefits of an open data ecosystem influence its adoption by private companies*

Hypothesis H1d: *the perceived benefits of an open data ecosystem influence its adoption by associations*

Hypothesis H1e: *the perceived benefits of an open data ecosystem influence the adoption by citizens*

Hypothesis H2: *The perceived barriers of an open data ecosystem influence its adoption.*

Hypothesis H3: *the external factors are significantly related to the adoption of an open data ecosystem.*

Hypothesis H4: *the support orientation influence the adoption of an open data ecosystem.*

Hypothesis H5: *the work-life interface influence the adoption of an open data ecosystem.*

Taking into consideration the properties of open data that spur adoption and re-use, we have deemed it prudent to examine how an open data ecosystem encourages exploitative and exploratory use of open data. Because reuse generates additional value. Based on information systems and information technologies studies, we study how adoption influences exploitative and explorative use. According to [Osiyevskyy and Dewald \(2015\)](#), [Koo, Chung, and Kim \(2015\)](#), and [Kala Kamdjoug et al. \(2021\)](#) the term exploitative use refers to “*the routine utilization of a system and its components*” ([Kala Kamdjoug et al., 2021, p. 7](#)). On the other hand, “*exploitation use concepts indicate the degree to which individuals (users) benefit from a system's features—the more a system is used, the more the user benefits*” ([Kala Kamdjoug et al., 2021, p. 7](#)). As a result, these characteristics contribute to an open data ecosystem. While explorative use refers to “*the pursuit of novel applications of system functions*” (or one of an open data ecosystem) ([Kala Kamdjoug et al., 2021, p. 7](#)).” The latter includes concepts for determining “*whether users actively revise their system's use in response to changes in the context of use to achieve a better*

fit between the system and the context in which it is used” (Kala Kamdjoug et al., 2021, p. 7). In the case of open data, this refers to how open data is used, reused, and created in new ways to generate economic and social value that benefits all actors in the open data ecosystem. As a result, the following hypotheses are formulated:

Hypothesis H6: the adoption of an open data ecosystem influences the explorative use of open data.

Hypothesis H7: the adoption of the open data ecosystem influences the exploitative use of open data.

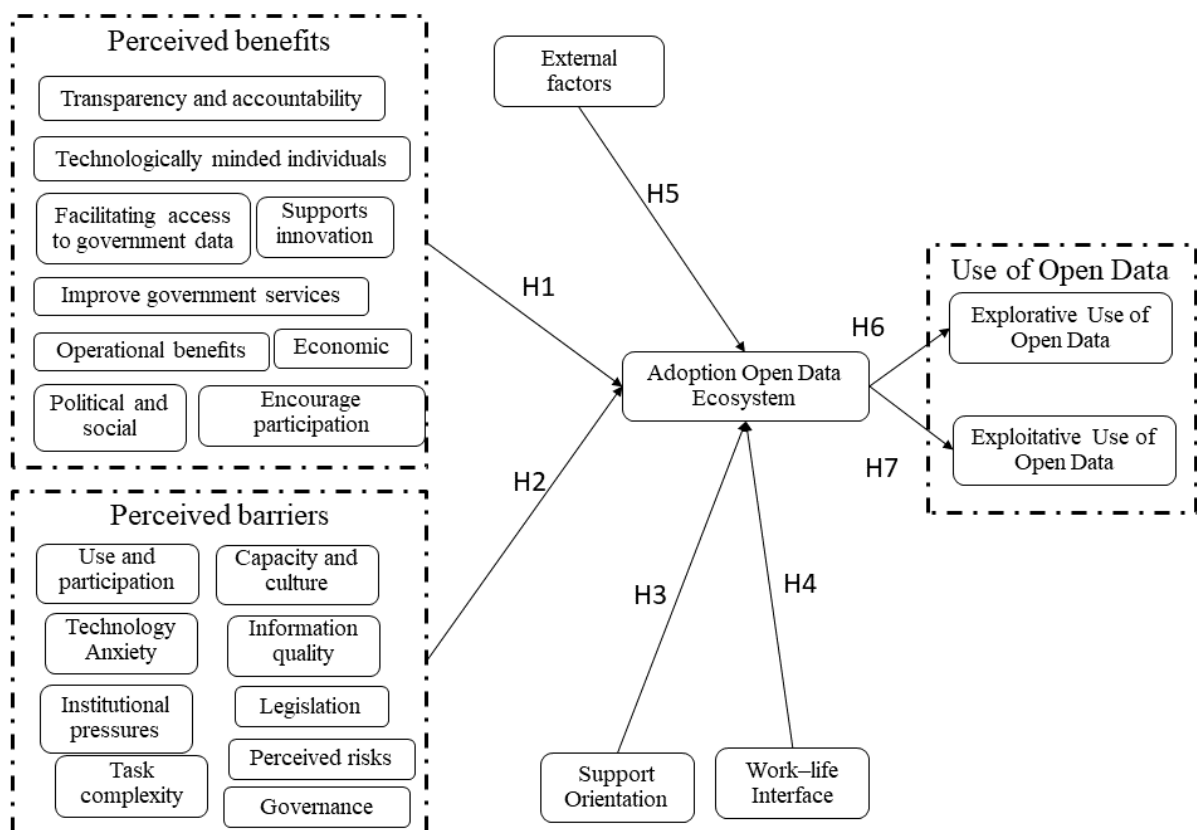


Figure 4. Conceptual research model

Furthermore, in this study, we focus on the open data ecosystem and not just the open data in the previous studies. For a better understanding of what might drive or inhibit the adoption and use of the open data ecosystem, we put the variables together as first- and second-order constructs. Because the IT/IS theories related to adoption and usage are already showing their limits in the literature review, we deemed it appropriate to build our research model based on previous studies that have adopted a qualitative approach and therefore the results refer to variables and concepts to study the adoption and usage of open data. In addition, in these studies, some authors have mobilized new theories (e.g., institutional theory, Janssen et al.

(2012)). In the case of our research, we will use this research model as a starting point, but certain constructs (and items) will be introduced or omitted later based on the findings of our future qualitative/quantitative study.

5. CONCLUSION

Today, data is a necessary condition for the formation of organizations and governments. While numerous examples demonstrate these actors' ability to develop new services and products based on this data, the time has come to transition to open data ecosystems. The breadth of services/products enabled by open data raises several concerns about the collection and use of personal data, as well as the system's security. The issues raised by open data ecosystems today require additional empirical research to identify and overcome the latter's challenges and barriers.

5.1. LIMITATIONS

We were unable to collect data to test the reliability and robustness of our research model. This could allow us to quantify on a large scale the barriers and challenges of adoption and use of the open data ecosystem. Moreover, an exploratory study would have been necessary to consolidate and refine our research model, especially since the open data ecosystem does not only concern the scientific community, but also practitioners, cities, municipalities, and governments who see in it an infinity of benefits.

5.2. FUTURES RESEARCH

The idea of an open data platform or ecosystem is complex and multidimensional, which poses a scientific challenge. To better understand these concepts and provide some answers that are still lacking in the literature on the open data ecosystem, we will take a mixed approach in our research, mixing qualitative and quantitative studies (Ågerfalk, 2013; Laumer, Maier, & Weitzel, 2017; Mattke, Maier, Reis, & Weitzel, 2020). Indeed, many research projects employ a combination of quantitative and qualitative methods to provide a more complete picture of the problem than either quantitative or qualitative research alone could provide (Ågerfalk, 2013; Mattke et al., 2020). Thus, by utilizing multiple sources of information or data collection methods in our study, we will be able to compare data collected through two or more distinct and independent observational approaches, thereby increasing the richness and validity of our findings.

We'll begin with a qualitative approach, conducting qualitative semi-structured interviews with open data practitioners at the “*Grenoble Metro*” and open data users. Qualitative research aims to establish ideas that help us understand social phenomena in natural (rather than experimental) settings, with an emphasis on all participants' meanings, experiences, and perspectives (Alexander, 2000; Conboy, Fitzgerald, & Mathiassen, 2012). It will allow us to evaluate and comprehend phenomena (e.g., the open data project roadmap and ecosystem, participants, and their motivations), group actions (e.g., open data use cases), information, or topics (e.g., the challenges of adoption of open data in the city/metropolis and its community of municipalities). As a result, semi-directive interviews will be conducted. We will also include a documentary set, which will enable us to gather knowledge from previously published works on our research subject (e.g., websites, implementation plan and roadmap of the project, internal documents, brochures, activity reports, and organization chart).

Secondly, based on the research model derived from the literature review and the qualitative study results, we will use a hypothetical-deductive approach to test the various hypotheses of our conceptual research model. This approach consists of formulating hypotheses, collecting data, and then testing the results obtained to refute or support the different hypotheses. We'll use the Partial Least Square (PLS) approach and structural modeling equations (SEM) in particular. This method has revolutionized the field of statistical analysis because it can handle conditions that no first-generation method can, such as treating several sets of observed explanatory and explained variables at the same time, analyzing the links between unobservable theoretical variables when accounting for measurement errors, the capacity to produce good results even with very limited sample sizes, as well as confirmatory applications. Structural equation methods aim to propose a model of several variables' causal relationships (Bagozzi, 1980; Hair, 2021; Hair, Howard, & Nitzl, 2020). The unique feature of structural equation methods is that they can involve multiple explanatory variables as well as multiple described variables (Bagozzi, 1980; Hair, 2021; Hair et al., 2020). Multi-item sizes, as well as latent variables. Structural equation methods are used to quantify the intensity of relationships between objects and the latent variables they evaluate, as well as between these latent variables, in a very traditional way (Bagozzi, 1980; Hair, 2021; Hair et al., 2020).

Furthermore, this method includes key steps that allow for testing the data collection tool and research model (pilot testing and pretesting) before the final data collection, ensuring that data errors and biases are reduced during the analysis (Hair, 2021). Finally, since the PLS approach's various methods of analysis are focused on metrics, we can use the different

thresholds learned from the literature review to validate the study's reliability, robustness, and reproducibility (predictive power) in another context (Bagozzi, 1980; Hair, 2021; Hair et al., 2020). Furthermore, our research model is based on the most widely used models and hypotheses in social science and management research, which have been confirmed in studies of service and technology acceptance, usage, and impacts. If the research model (Figure 4) created in this study is not stable after all of these measures, we will revise some of the construct measurement objects, remove or add some constructs.

The analytical methods presented above, whether qualitative or quantitative, are not perfect. First and foremost, it is difficult to suggest a systematic qualitative approach that allows for causality analysis (Fiss, 2011; Ragin, 2009). Second, different qualitative approaches for conducting comparative studies are available. In terms of quantitative techniques, only a few have been adapted for small samples (Fiss, 2011; Ragin, 2009). When dealing with complex combinations of variables, these approaches are often constrained (Fiss, 2011; Ragin, 2009). Finally, these approaches only allow for a single collection of potential causes to be considered when explaining a phenomenon (linear algebra) (Fiss, 2011; Ragin, 2009). Therefore, we will also adopt the comparative qualitative analysis (QCA) to address these limitations. This method is adapted to the study of complex situations because it highlights several combinations (configurations) of possible conditions (variables) to explain the same phenomenon. To overcome these limitations, we will use a fuzzy set comparative qualitative analysis (fsQCA). This method is adapted to the study of complex situations because it allows highlighting several combinations (configurations) of possible conditions (variables) to explain the same phenomenon (Mattke et al., 2020; Mikalef & Krogstie, 2020; Ragin, 2009). It helps one to consider the unique characteristics of each case while maintaining a holistic and comprehensive approach, integrating the benefits of qualitative and quantitative approaches (Fiss, 2011; Mikalef & Krogstie, 2020; Ragin, 2009). By defining “*minimal combinations of appropriate/sufficient causes*”, the obtained result allows many interpretations of the studied phenomenon (open data ecosystem) to be highlighted (Fiss, 2011; Mikalef & Krogstie, 2020; Ragin, 2009).

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APPENDICES

APPENDIX A. DATABASES SCHOLARLY ARTICLES AND PRACTICIANS DATABASES CONSULTED

	Entity	URL
	Microsoft	https://www.microsoft.com/en-us/industry/government (Access date: 25/01/2021)
	Swinburne	https://www.swinburne.edu.au/research/institutes/smart-cities (Access date: 25/01/2021)
	Statista	https://www.statista.com/ (Access date: 25/01/2021)
	Forrester	https://www.forrester.com/Smart-Cities (Access date: 25/01/2021)
	KPMG	https://home.kpmg/xx/en/home.html (Access date: 25/01/2021)
	Schneider Electric	https://blog.se.com/smart-cities/ (Access date: 25/01/2021), https://www.se.com/fr/fr/ (Access date: 25/01/2021)
	Huawei	https://e.huawei.com/en/solutions/industries/government/smart-city , https://www.ibm.com/ (Access date: 25/01/2021)
	Boston Consulting Group	https://www.bcg.com/ (Access date: 25/01/2021)
Practitioners	McKinsey & Company	https://www.mckinsey.com/search?q=smart%20cities (Access date: 25/01/2021)
	IDC	https://www.idc.com/ (Access date: 25/01/2021)
	IBM	http://www.smartercitieschallenge.org/ (Access date: 25/01/2021)
	Gartner	https://www.gartner.com/en (Access date: 25/01/2021)
	Deloitte	https://www2.deloitte.com/us/en.html (Access date: 25/01/2021)
	Cisco	https://www.cisco.com/c/en/us/index.html (Access date: 25/01/2021)
	Smart City Institute	https://guidesmartcity.be/ (Access date: 25/01/2021)
	Eden Strategy Institute and ONG&ONG (OXD)	https://www.smartcitygovt.com/ (Access date: 25/01/2021)
	Internet of Things Consortium: IoTC	https://iofthings.org/ (Access date: 25/01/2021)
	Databases of scholarly articles	Science Direct
Web of Science		https://webofknowledge.com/
Google Scholar		https://scholar.google.com/

Entity	URL
IEEEExplore	https://ieeexplore.ieee.org/
Taylor and Francis Online	http://www.tandfonline.com
CAIRN	http://www.cairn.info

APPENDIX B. OPEN DATA PORTAL LINKS

Cities	URL	Cities	URL
Amsterdam	https://data.amsterdam.nl/ (Access date: 25/01/2021)	New Delhi	https://data.gov.in/ (Access date: 25/01/2021), https://opendata.iiitd.edu.in/data/s-tatic/ (Access date: 25/01/2021)
Barcelona	https://opendata-ajuntament.barcelona.cat/en (Access date: 25/01/2021)	New York	https://opendata.cityofnewyork.us/ , https://data.ny.gov/ (Access date: 25/01/2021)
Beijing	https://opendata.pku.edu.cn/dataset.xhtml?persistentId=doi:10.18170/DVN/MEDTS3&language=en (Access date: 27/01/2021), https://www.beijingcitylab.com/data-released-1/external-data/ (Access date: 21/01/2021)	Oslo	http://statistikkbanken.oslo.kommune.no/ (Access date: 25/01/2021)
Berlin	https://daten.berlin.de/ (Access date: 25/01/2021)	Paris	https://opendata.paris.fr/ (Access date: 25/01/2021)
Bordeaux	https://opendata.bordeaux-metropole.fr/pages/accueil/ (Access date: 25/01/2021)	Rio de Janeiro	https://www.data.rio/ (Access date: 25/01/2021)
Boston	https://data.boston.gov/ , https://bostonopendata-boston.opendata.arcgis.com/ (Access date: 21/01/2021)	San Francisco	https://datasf.org/opendata/ (Access date: 25/01/2021)
Chicago	https://data.cityofchicago.org/ (Access date: 22/01/2021)	Seattle	https://data.seattle.gov/ (Access date: 25/01/2021)

Cities	URL	Cities	URL
Copenhagen	https://www.opendata.dk/ (Access date: 22/01/2021)	Seoul	https://data.seoul.go.kr/index.do (Access date: 25/01/2021)
Dubai	https://bayanat.ae/ (Access date: 25/01/2021)	Shanghai	https://data.world/datasets/shanghai (Access date: 25/01/2021), https://data.sh.gov.cn/ (Access date: 25/01/2021)
Grenoble	https://data.metropolegrenoble.fr/ (Access date: 25/01/2021)	Singapore	https://data.gov.sg/ (Access date: 25/01/2021), https://www.smartnation.gov.sg/resources/open-data-resources (Access date: 25/01/2021)
Helsinki	https://hri.fi/en_gb/ (Access date: 25/01/2021)	Stockholm	https://start.stockholm/ (Access date: 25/01/2021)
Hong Kong	https://data.gov.hk/tc/ (Access date: 25/01/2021), https://geodata.gov.hk/gs/ (Access date: 25/01/2021)	Strasbourg	https://data.strasbourg.eu/ (Access date: 25/01/2021)
London	https://data.london.gov.uk/ (Access date: 25/01/2021), https://opendata.london.ca/ (Access date: 25/01/2021)	Sydney	https://data.cityofsydney.nsw.gov.au/ (Access date: 25/01/2021)
Los Angeles	https://data.lacity.org/ (Access date: 25/01/2021)	Taipei	https://data.taipei/#/ (Access date: 25/01/2021)
Lyon	https://data.grandlyon.com/ (Access date: 25/01/2021)	Tel Aviv	https://opendata.tel-aviv.gov.il/en/Pages/home.aspx (Access date: 25/01/2021)
Melbourne	https://data.melbourne.vic.gov.au/?_ga=2.217398486.1598979002.1612237047-1558503874.1612237047 (Access date: 25/01/2021)	Tokyo	https://ckan-tokyochallenge.odpt.org/dataset , https://www.odpt.org/ (Access date: 25/01/2021)
Montréal	https://donnees.montreal.ca/ (Access date: 25/01/2021)	Vancouver	https://opendata.vancouver.ca/ (Access date: 25/01/2021)

Cities	URL	Cities	URL
Nantes	https://data.nantesmetropole.fr/pages/home/ (Access date: 25/01/2021)	Vienna	https://www.data.gv.at/auftritte/?organisation=stadt-wien (Access date: 25/01/2021)

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