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DATA VALLEY

White Paper

Use and re-use of urban data in the smart city domain

Analysis of technological solutions and legal frameworks to enabling the sharing of data in the urban context

v. 01/2023

▸ Partners

Data Valley Consulting is a technology integration and strategic consulting firm related to data use, and as part of these initiatives, aims to foster dialogue and networking around specific issues to define best practices for implementing data sharing.

In particular, it is actively engaged in promoting and exploring issues related to smart cities and data sharing in the urban context.

City Vision is the events and news platform for smart cities. Blum (blum.vision) and Padua Hall (padovahall.com) are the co-creators of this project.

City Vision brings together hundreds of public administrators and officials, facilitating the exchange of ideas and smart transformation experiences among them. Firms, professionals, researchers and innovators are involved in the project too.

A special online section of Repubblica newspaper is dedicated to City Vision (repubblica.it/green-and-blue/dossier/city-vision/).

▸ The following people collaborated in drafting this White Paper:

This White Paper is the result of a roundtable discussion among a number of practitioners involved in the development and promotion of smart city projects or technological solutions to serve it. The study and in-depth work began and has been going on for 1 year starting in October 2022.

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Data Sharing and Data Re-use in the Urban Context

Introduction

Carlo Rossi Chauvenet and Silvia Martinelli

The evolution of the discipline for managing, governing and regulating the use of data continues its progression towards greater use of the new resource, the lifeblood of the new data economy[1]. Data have revolutionized personal identity and, with it, personality rights, multiplying and dispersing the information that concerns us. Nonetheless, we could now highlight a second phase of this revolution that data has brought about, in which they become not only more widespread and accessible, but also intensely reworked by the algorithms for the creation of goods and services that are based on them.

Furthermore, the use of the data collected for the creation of new digital services is gradually emerging, placing the data itself at the basis of their functioning and of the same business model. With the greater diffusion of the Internet of Things and interconnected sensors, in particular, the ability to collect and analyze information will increase exponentially and, with them, the solutions to manage, process and exploit them.
On the other hand, the European Union is fostering data accessibility. The Data Governance Act, in particular, creates a new European way of data governance based on increasing trust in data sharing, focusing both on data sharing of public sector data and on mechanisms for public sector bodies to access and use data held by the private sector.

Data Valley, in its consultancy and advisory activities, found the problems of this particular exchange of information between private and public sector a serious obstacle to the development of new services for citizens and consumers and decided to create a dedicated working table.

Data Valley is a company, a think tank, and a community focused on the development of data-driven business models, data-sharing and data spaces models, as well as the opportunities and constraints in the use of AI applications.
The team consists of university researchers, startup specialists, lawyers with expertise in data models and compliance, and professionals adept in artificial intelligence. Specifically, the team is engaged in designing strategies for data handling, governance, and monetization while crafting data-driven business and platform models. The scope of Data Valley's work extends to examine the interactions and integrations between big techs and SMEs. Furthermore, Data Valley fosters environments and networks aiming to create data spaces and sharing models. It is also dedicated to the assessment, both technical and ethical, of artificial intelligence systems and the meticulous

[1] EUROPEAN COMMISSION, COM(2020)66 - A European strategy for data, 2020.

management of associated risks. Every aspect is intertwined, aimed at evolving and enhancing the way data and AI intersect with business landscapes of varied scales and complexities.
The approach is based on an in-depth knowledge of the world of data and of the products and services that are the basis of new business models (Saas, supply and demand meeting platforms, ranking systems, etc.), gained in the continuous confrontation with companies and the academic world.

Data is a valuable asset that can be transformed by businesses into added value. However, some obstacles often stand between small and medium-sized businesses and the ability to make the most of this resource. In particular: the business management, from a legal standpoint, and the vertical integration of technological solutions with their product or service require specific skills, which SMEs do not always possess; companies have to develop their products within a certain, and therefore secure, regulatory context: to do this, it is important to establish a continuous dialogue with institutions, academia, and other market players; and to use data effectively, it is important to acknowledge the risks of careless use and the best solutions, to be able to adopt the most appropriate tools for the specific business.

The project aims to be the solution to overcome these obstacles and take full advantage of the potential of the digital market. Accordingly, Data Valley accompanies companies on this path, building together with them an effective data strategy based on their particular needs.

One of the way used by Data Valley to improve knowledge on data sharing rules, models and technologies is the organization of Working Tables with the participation of stakeholders from different sectors to share experiences, analyze regulations and propose policies and protocols that facilitate the sharing and reuse of data in the individual supply chains and for a specific target area. Last year we presented a first White Paper, based on the works and contribution of the participants of the working table dedicated to E-health data sharing, now also published and presented in a second version: “E-health Data Sharing: Best practices and solutions for data sharing, anonymization, and data lake creation of health data”, available at the following link https://datavalley.it/introducing-the-new-version-of-the-data-valley-white-paper-on-e-health-data-sharing/

The working table and the White paper become tools for sharing knowledge and ideas, not only between participants, but also with regulators, experts and new partners. The White papers was presented in Universities and international conferences and it received further feedback, comments. It became the starting point for new projects. In our idea, it remains a tool, to improve knowledge with the sharing of experiences in a process that never ends.

From October 2022 a new working table started this work on the “Use and re-use of urban data in the smart city domain”, to give an “Analysis of technological solutions and legal frameworks to enabling the sharing of data in the urban context” and we are now happy and proud to present it, grateful to all the authors and for all the contributions.

The published version is only the first one and we are still waiting for some further contributions. We also invite the reader to contact us to take part to this project and contribute with his expertise or new use cases.

The White Paper is composed of four sections. The introductory section identifies the scope and scenario. The smart city is defined as "a place where traditional networks and services are made more efficient through the use of digital solutions for the benefit of the inhabitants and businesses that inhabit it" and the focus of the White Paper is on the data sharing and data re-use in this particular context. The use of data analysis in the government of the city and for the creation of services for citizens enable new possibilities, to simplify, personalize and support decision-making processes. The complex and evolving regulatory scenario is analyzed to identify not only the applicable law, but also the European direction and the impact of the new rules on data sharing. The idea of transforming cities into data-sharing hubs, from "City Data Governance" to "Data for City Governance" is delineated. Finally, the impact of the new technologies on the city is analyzed in the lens of sustainable development, as a way to improve innovative forms of public-private engagement, smarter urban transport networks, transformative services and better access to culture thanks to the digitization of cultural heritage.

The second section focuses on the raw material, the data, the applicable discipline and the sharing models. New legal frameworks for data sharing are analyzed, as well as a new emerging subject, the Data Intermediary.

The third part is dedicated to the importance of data in the urban context and on the possibilities to use it. Data may enable the public service improvement: the reprogramming of local public services from the demand side, the design and development of new product and service within the urban context and using the urban data, as well as new projecting and managing of the city, as the Telco industry example shows.

The final section includes the technologies for urban data collection, sharing and reuse. Technologies for data collection, data storage, data sharing, data analysis and data anonymization, as well as the use of synthetic data, are described with use cases. The Section includes technologies for audience measurement, mobility data, sustainable waste management, air quality, satellite data.

The importance of data sharing and reuse in the smart city context

Sveva Ianese

The expression "smart city" has been used over time to define different phenomena of urban innovation and redesign[2] (e.g. the so-called smart-from-the-start cities, retrofitted smart cities and social cities[3]). It is a polyvalent and multifaceted concept whose connotations are still ambiguous, to some extent, also due to the lack of a comprehensive legislative definition[4].

According to the European Commission, smart city can be defined as "a place where traditional networks and services are made more efficient through the use of digital solutions for the benefit of the inhabitants and businesses that inhabit it."[5]

Such a conceptualization requires considering the smart city as something that goes beyond the simple application of digital technologies within urban spaces. It encompasses the efficient use of natural and economic resources, the delivery of adaptive and effective urban services, the introduction of new ways of interaction between citizens and Public Administration, and the ability to meet the needs of an aging population.

If, according to the European Commission, the concept of "smart city" cannot be traced back to that of digital technologies, it is also true that such technologies (e.g., artificial intelligence, IoT devices, 5G) end up being the "lowest common denominator" of any urban redesign initiative.

In the European Commission's perspective, the concept of "smart city" thus corresponds to a bundle of initiatives devoted to efficiency and balance that do not coincide with urban technologies *per se*. However, it needs the latter to be implemented and replicated.

On the other hand, various interpretations of the "smart city" expression tend to decompose it into six different sub-components, which constitute the main lines of development of any smart city project. These components are the following:

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[2] This concept has repeatedly been described as "nebulous" by scholars, as pointed out in Halegoua G. R., Smart Cities, MIT Press, Cambridge, MA. 2020, p. 1.

[3] Halegoua G. R., op. cit., p. 43.

[4] As pointed out by Cartei, the only normative reference to the smart city concept seems to be the one provided by Art. 20 of D.l. 18.10.2012, no. 179 conv. in L. 17.12.2012, no. 221, which mentions "smart communities." See Cartei G. F. The smart dimension of urban space: smart cities and urban regeneration in Ferrari G. F. (ed.) Smart City. The evolution of an idea, Mimesis, Milano-Udine, 2020, pp. 105 seg.

[5] EU Commission, "Smart cities". Available at: https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

1. Smart economy;
2. Smart mobility;
3. Smart environment;
4. Smart people;
5. Smart life;
6. Smart governance.

In this case, the definition of a "smart city" is built on the "smartness" dimension which can be divided into the various sub-components mentioned above.

These two definitions of the "smart city" seem to be mutually exclusive. Consequently, it is necessary to reconcile them in order to offer an all-encompassing definition whose foundational dimensions - the technological one and the smartness one - are both included.

But what does "technological dimension" really mean? And what is the real meaning of “smartness”?

I would try to offer an answer to all these questions.

In my opinion, the "technological dimension" of a smart city embraces two different aspects: (i) the hardware/software solutions used within or as a by-product of the urban environment, and (ii) the data that are collected or processed by such devices - meaning, the so-called "urban data”.

The outline of the "technological dimension" is very intuitive.

Firstly, it includes hardware and software solutions (e.g., artificial intelligence, IoT devices, 5G) that interact with each other and with other urban components in order to achieve specific objectives. They might be used for increasing the quality and efficiency of public services, for citizens’ safety, for ensuring an easier interaction with the Public Administration, and so on.

Less obvious might be the concept of "urban data". I am referring to the information collected within urban spaces either through public sensors (e.g., IoT devices, sensors on the road surface, etc.) or through residents' or tourists' personal devices - which are used by them for individual purposes - or, again, through additional touchpoints (e.g., CCTV cameras, monitoring devices and other technologies that enable data collection within the city[6]). Urban data may be personal data or non-personal data. This distinction is strictly linked with the obligation to comply with Data Protection legislation (primarily, GDPR), which arises only when personal data are collected. They might also be public data or private data, depending on the party that owns such information, i.e., the Public Administration or private entities such as enterprises, NGOs, etc.

[6] For example, instant urban noise mapping devices, traffic management and control and lane optimization sensors, and smart lighting sensors. They can be installed on guard rails, on vertical signage or street lighting poles, or in other (often particularly busy) public places.

Regardless of the nature and characteristics of urban data - which will be better analyzed in the following paragraphs of this White Paper - such information is necessary for the development of any smart city initiative. Indeed, the common trait of all innovative urban models is the need to collect, analyze, classify, process, store and share the data collected within the metropolitan context in order to ensure a more efficient organization of public services and the improvement of citizens' quality of life.

After analyzing the "technological dimension" of the smart city, it seems appropriate to move forward by also deeply understanding the concept of smartness.

The term "smartness" is usually associated with something that is fast, intuitive or easy to use. However, this correlation is reductive. The "smartness" refers to the ability of a good or a service to simplify some activities or to adapt itself to its user's needs[7], supporting him/her in making rational decisions. Thus, the key-elements of "smartness" are (i) simplification, (ii) personalization and (iii) support for decision-making processes.

These traits also recur in the concept of "smart cities". Here, the "smartness" of urban projects consists of the ability of such initiatives to simplify the activities of local citizens and enterprises in order to realize their interests; the personalization of goods and services provided by the Public Administration through a whole understanding of the civic needs; the adoption of better public decisions thanks to a deeper investigation of stakeholders' interests.

I hope it is clear now how intimately connected the two foundational dimensions of the smart city (the technological dimension and the smartness dimensions) really are.

The "smartness" requires the collection and the sharing of available and reusable information among the civic stakeholders. The data circulation, sharing and reuse within the urban space is the cornerstone of any smart city project.

However, ensuring the access or provision of large volumes of data can be a huge technological challenge for Public Administrators, due to the absence of technology systems interoperability and the lack of shared guidelines between all the actors.

In addition, the management of such large volumes of data requires a powerful, robust and secure urban infrastructure which is able to protect information against cyber attacks. As we know, the probability of such threats increases with the number of "smart" devices that are connected within the city so it is necessary to consider them very seriously.

Finally, the lack of European legislation about the data sharing and reuse in the smart city context poses an additional obstacle to the launch of such initiatives. The difficulty of identifying a

[7] The word "smartness" can be translated as 'intelligence,' 'effectiveness'; it shares the same etymological root as the word "sharp," the meaning of which is 'sharp,' 'sharp.' A smart good or service is such if it is 'tailored' to its user and is able to respond properly to his or her needs.

reference legislative framework for protecting citizens' rights in the urban context decreases the probability of innovative projects' success.

It is true, however, that some sectoral provisions have been adopted since 2020. They might be useful for defining a temporary legal framework for data sharing within urban contexts.

The most relevant is the EU Regulation/2022/868 (so-called *Data Governance Act*), which introduced the role of data intermediaries. This concept will be better analyzed in the following paragraphs of this White Paper. I would like to stress only that this subject performs intermediation activities in exchanging information, bringing together those who could share their data (whether personal or non-personal one) and those who are interested in using them.

This is a new regulatory framework that could offer a temporary legal framework for many data sharing and reuse initiatives within the urban context.

However, it cannot be considered to be enough on its own. It constitutes only the starting point for the development of a broader and more structured data strategy that takes into account the nature of the urban data that are processed, the risks underlying such initiatives (some of which have already been mentioned above), and the interests claimed by different stakeholders in order to foster a truly effective smart urban initiative.

It is therefore necessary to adopt a "smartness by design" approach that, right from the first stages, could manage the potential dangers underlying urban data sharing and reuse initiatives by designing a legal and technological model that can be reliable and scalable.

From "City Data Governance" to "Data for City Governance"

Domenico Lanzilotta

In the course of 2023, a consolidated partnership between Data Valley and City Vision led to the creation of this publication. This collaboration is the result of a lengthy process of identifying best practices, opportunities, challenges, and proposals aimed at turning data into a true asset for the growth of Italian cities and the improvement of services provided to citizens and private entities.
"Best practices" are key elements whose study this partnership is directed to. It involves analyzing successful experiences in various cities and regions, both in Italy and abroad, in order to understand how data has been effectively used to improve the quality of life for citizens and promote economic growth. This study allows for the identification of the most promising strategies and approaches that could be adapted to the Italian context.
"Opportunities" represent a crucial aspect of the analysis: we sought to identify sectors and areas where the use of data could lead to significant improvements such as mobility, water resource management, public safety, energy efficiency, and others. Data could serve as a driver of innovation and growth in these sectors.
At the same time, we do not overlook the "challenges". They include privacy issues, cybersecurity, data governance and the technological infrastructure needed to handle and analyze large amounts of information in real-time. In order to ensure the sustainable and lawful use of data, it is essential to deeply understand these challenges and develop strategies to effectively address them. Finally, the partnership aims to provide concrete "proposals" that could guide the transformation of data into a valuable asset for Italian cities. In conclusion, the partnership between Data Valley and City Vision represents a targeted commitment to fully investigate the potential of data in Italian cities.

From "Data Collection" to the "Data Marketplace"

In the current context, Italian cities are undergoing a huge transformation focused on data collection and utilization. This process is a response to the growing need for improving urban services and creating a smarter and more efficient environment for citizens and businesses. However, data collection activities are no longer sufficient to address urban issues.The real challenge now is to establish a “dialogue” among these data, integrating them into a cohesive and interconnected system.
This phase requires a fundamental shift in mindset and approach to data management in cities. Rather than treating data as isolated and fragmented entities, it is essential to consider them as elements of a broader information ecosystem. Both information and its sources must be compatible and interconnected in order to improve the urban quality of life through data.

The idea of transforming cities into data-sharing hubs is crucial in this evolution. It entails the creation of an urban ecosystem that facilitates seamless and collaborative data exchange among public entities, private enterprises and the whole community. This concept might be clarified through a powerful metaphor: if, in the past, cities built theaters or covered markets as places for social gathering and the exchange of goods, today they should focus on creating a "covered data market."
This platform should be designed to be open and inclusive, engaging a wide range of stakeholders, including public institutions, businesses, non-profit organizations, and citizens themselves. The goal should not be data speculation but rather the responsible and transparent use of data to improve urban life.
A "data marketplace" might offer significant benefits. Firstly, it enables efficient management of urban resources and services. For example, mobility information can be shared among public transportation, ride-sharing companies, and end-users to optimize routes and reduce traffic congestion.
Furthermore, it promotes innovation within cities by allowing startups and businesses to develop data-driven solutions in order to address urban challenges. For example, mobility data can be vital for other sectors - like tourism - for planning and managing their key activities more effectively.
Thirdly, it offers insights about the civic strategy through benchmarking and comparison activities that might be developed thanks to urban data.
However, there is a fundamental aspect that has to be considered in order to guarantee a successful "data marketplace" initiative : trust. For performing a "data marketplace" that is efficient, a high level of trust must be established among all involved parties. It requires rigorous data protection, security, and clear regulations on data usage. Only through robust governance and full transparency urban information can be harnessed for the common good with no abuse.
Considering this need, which organization is better suited than the Municipality to act as a guardian, mediator, and impartial subject in this project?

From "City Data Governance" to "Data for City Governance"

The promise of a future in which municipalities achieve comprehensive "city data governance" raises important considerations about the nature of the decision-making process. In our political era, which is characterized by a pursuit of immediate consensus, this challenge is decisive. This reflection goes beyond data acquisition and analysis; it focuses on the cultural and political transformation that is necessary to ensure a reliable data usage by public bodies for governance decisions.
Currently, many political decisions tend to be oriented towards short-term goals, driven by the need to achieve immediate results that can ensure electoral consensus. However, the shift to a data-driven governance model requires a change of paradigm, a step towards a longer-term vision. As Alcide De Gasperi said: "A politician looks to the next election. A statesman looks to the next generation."

Data genuinely drive governance decisions only if public administrators align their proposals with long-term citizens' well-being. It might also involve the adoption of unpopular short-term decisions if they are supported by solid evidence and expected to bring significant benefits in the future. In other words, administrators must be willing to invest in the long-term interest of the city, even if it may not translate into immediate political gains.
Furthermore, "city data governance" requires a significant capacity for data analysis and interpretation. Data-driven decisions must be based on accurate and reliable data, and this accuracy necessitates a robust data collection, storage, and analysis infrastructure, along with advanced analytical skills. Administrators must be able to understand the results of data analyses and to interpret them properly for making informed decisions.
Another significant challenge is communicating the results of data analyses to the citizenship. Openness and transparency are essential to ensure citizens' trust. Administrators must be able to communicate clearly and accessibly how data has been used to make decisions and what benefits it will bring to the city in the long run.
Finally, it's important to recognize that "city data governance" is not an isolated effort but requires collaboration between the public and private sectors, as well as citizens' engagement. It is a process that takes time to develop and consolidate.

The Lisbon Model

In the context of the "Lisboa Inteligente" (Smart Lisbon) strategy, the city of Lisbon has developed an application for city administrators, which is a concrete illustration of how "well-governed data" can aid in the "governance of the city." The mayor and city councilors have real-time access to a wide range of key information that can influence the city's daily life. This information includes traffic conditions, which can be used to manage vehicle flow and reduce road congestion, citizen and tourist flows, which can inform mobility and public service needs, ongoing construction projects to adequately plan infrastructure maintenance, air quality levels to address environmental concerns, and public spending to ensure responsible financial management.
The introduction of similar solutions in Italy poses significant challenges that go beyond the technical implementation of smart urban solutions.
The first challenge involves political and governmental issues. In fact, decision-makers and administrators must invest in urban infrastructures and resources that are necessary to develop and maintain system like the one mentioned above. Additionally, it's important to ensure that privacy laws and data security regulations are adequate to protect citizens' sensitive information. Data protection is a critical concern when collecting and sharing sensitive data, such as citizen movements or public spending.
Furthermore, it is important to actively involve citizens in this process. Transparency and communication are essential for ensuring public trust in data management and reassuring citizens that information about them is used for their benefit.
Last but not least, it is essential that public administrators genuinely leverage this opportunity by turning data into a real tool for urban governance policy planning. It is, in a nutshell, a largely cultural challenge.

A Cultural Challenge

During our travels across the country, we have closely observed two relevant trends that shape the political and economic landscape of Italian cities.
On one hand, we have noticed an interesting phenomenon of resistance and/or lack of interest by "smart city assessor" or "innovation assessor" , as compared to the one demonstrated by administrators having a more traditional role. This trend can be attributed to various causes. In part, it may reflect a resistance to change within existing administrative structures, where traditional roles and ex ante established priorities are often preferred. It may also result from a lack of awareness or understanding of the importance of innovation and advanced technologies in city management. This inertia may also be fueled by the idea that urban innovation is expensive, difficult to implement, or simply challenging to explain to the public.
However, there is a positive aspect to highlight. Over time, we have noticed a gradual but significant change among municipalities. A growing awareness of the importance of innovation and technology is shaping the attitude of policymakers. Local administrators are gradually recognizing the potential of innovative solutions to improve people's quality of life, optimize the use of urban resources, and promote sustainability.
This change can be attributed to several factors. The concrete experience of other cities and regions that have successfully adopted innovative solutions demonstrates that investments in innovation can have a tangible impact. Moreover, increasing pressure from citizens and communities for more efficient, sustainable, and individual-focused services is pushing local authorities to consider innovative solutions.
Another element that has contributed to that changing is the evolution of the global political and economic context. Environmental, social, and economic challenges require innovative responses, and cities are at the forefront of addressing them. Innovation has become a crucial lever to ensure the resilience and competitiveness of cities in the modern era.
Additionally, the widespread availability of internet networks and digital technologies has provided local authorities great tools for improving their communication, efficiency, and transparency in the delivery of public services.

The Birth of a Community

On the other side of the Italian political landscape, an interesting trend emerges. It represents a glimmer of hope for the future of city management. A movement among passionate administrators—individuals who not only recognize the potential of innovation in the urban context but are also determined to harness this potential for the benefit of the communities they serve - is slowly emerging. These passionate administrators stand out for their dedication and enthusiasm in seeking new solutions, implementing advanced technologies, and adopting innovative approaches to address urban challenges. They embody an ambitious vision of the future of Italian cities. These administrators see innovation as a fundamental lever to improve citizens' quality of life, promote environmental sustainability, and stimulate economic growth.

They are driven by a strong belief that smart urban transformation is not only possible but also imperative to address the complex challenges of the modern era.
However, the path of these administrators calls for new challenges. The adoption of new technologies and the implementation of innovative solutions requires financial resources, specialized expertise, and a long-term strategy. Additionally, they must fight resistance within local administrations and new ideas provided by them may encounter obstacles from those who prefer maintaining the status quo.
The commitment of City Vision has been and continues to be offering support and bridging this gap between passionate administrators and the resources they need to realize this vision. We provide essential support built on a strong community of administrators, professionals, researchers, and businesses who share the same vision of intelligent transformation for Italian cities.
This support is crucial because it helps overcome some of the challenges that these administrators may encounter in their journey. With access to content, experiences, success stories, they can develop well-thought-out strategies for implementing their innovative ideas. By collaborating with professionals and businesses, they may leverage the expertise and resources needed to advance urban transformation projects.
Furthermore, forming a community of individuals who share the same passion for urban innovation creates an environment for sharing ideas and best practices. This exchange of knowledge and experiences can further accelerate progress in smart city transformation.

Conclusions

In conclusion, the journey from "city data governance" to "data for the governance of the city" is multifaceted. It involves technical challenges, policy considerations, cultural shifts, and the active engagement of various urban stakeholders. However, it's a journey that holds immense promise for the future of Italian cities. It offers the opportunity to enhance the quality of life for citizens, promote economic growth, and address the complex challenges of our time.
Our commitment is to continue supporting the passionate administrators and innovators who are driving this transformation. Together, we will work towards building smarter, more resilient, and more inclusive cities that can thrive in an increasingly data-driven world.
We are excited to be part of this journey, and we look forward to the positive impact it will have on the lives of Italian citizens and the prosperity of their cities.

Smart cities and sustainable development

Silvia Rita Sedita

Smart cities are crucial in the sustainable development of places (Mori & Christodoulou 2012), especially according to the UN Sustainable Development Goals (SDGs) strategy, adopted in 2015, with the approval of the 2030 Agenda. The latter consists of a series of guidelines designed to channel global development towards wellbeing for all while guaranteeing that these improvements can be maintained over time and space in social, economic, and environmental terms (Marsal-Llacuna et al. 2015). Recently, the Guidelines of the National Recovery and Resilience Plan (NRRP), approved in its main contents by the Interministerial Committee for European Affairs, insist on the smart city concept. Among the six missions mentioned in the NRRP, the first is the digitization of businesses, services, and Public Administration to which 21% of the Plan's total resources (equal to 46.3 billion euros) will be devoted. Digital literacy in Italy is still in its infancy if compared to other more advanced European countries. Digital business networks and infrastructures are far less developed than what should be to sustain the competitiveness of firms in a tough global market and economic environment.

A smart city is expected to be a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and businesses. The development of a smart city relies on the implementation of a smart city ecosystem, based on a multi-stakeholder approach as described in the quadruple helix model (Carayannis & Campbell 2009). Alongside this broad and comprehensive framework, university-industry-government relations (the Triple Helix), media-based and culture-based public and civil society (the Quadruple Helix), and the natural environments of society are considered crucial actors for sustaining local innovation trajectories (Leydesdorff & Deakin 2011). Contrary to traditional double-sided marketplaces in which only two types of stakeholders participate (supply and demand), the smart city ecosystem involves a multitude of actors engaged in public and private consumption, production, education, research, entertainment, and professional activities (Appio et al. 2019). A multi-stakeholder ecosystem perspective on urban innovation frameworks has gained traction in public and private spheres and is considered to be benevolent for society.

This contribution adopts an approach that points to the logic of a cooperation model associated with the design and development of innovative city services, which complements the public sector with companies, academia, and citizens. Innovation management literature has long discussed the role played by innovation ecosystems in stimulating innovation and economic growth; economic geographers and regional scholars have pointed at their spatial dimension, but less is known on smart city ecosystem, and on the conditions under which it is possible to realize a convergence of public and private goals, as well as accomplish economic, environmental, and social sustainability objectives.

Despite the progress made in the field of smart city ecosystems, certain areas require further exploration and development.

- Innovative forms of public-private engagement. As shown by Rossi et al. (2022) digital crowdsourcing platforms are an example of this type of intermediaries, and they increasingly intercept public-private projects that can elicit innovative projects and ideas from various types of publics (including citizens) that increase the city's potential and improve life within the smart city (Blasi et al. 2022).
- Smarter urban transport networks. A growing body of literature recommends consolidation of hybrid last mile delivery fleets as a solution for urban logistics issues (Castillo et al. 2022; Mangiaracina et al. 2019) but little discussion has examined the perceptions of retailers or consumers or citizens toward those efforts and solutions.
- Transformative services. The production of transformative services plays a central role at the intersection of social innovation and sustainable development, supporting innovative urban regeneration fostered by both social innovators and community-based interventions (Anderson & Ostrom 2015; Fisk et al. 2018). Cultural and creative industries are transformative services that drive individual and collective well-being.
- The digitization of cultural heritage. Cities of art may represent new creative hubs able of contributing to the growth of other industrial sectors and working as laboratories for participatory scientific research, integrated with territories and communities. The adoption of technological solutions for the government of cities of art may have a positive impact on the network of cultural organization improving the management of visitors flows and increasing their livability and sustainability (Oliva et al. 2020; Lazzeretti 2020).

As we progress in building smart cities, focusing on these underdeveloped areas can unlock new opportunities and create more inclusive, innovative, and sustainable urban environments.
By leveraging data analytics, artificial intelligence, and innovative technologies, cities can unlock the full potential of their resources, engage citizens, and make data-driven decisions. With a concerted effort from all stakeholders, smart cities can truly fulfill their potential as drivers of positive change, meeting the aspirations of the UN Sustainable Development Goals and contributing to a better future for all.

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The European Legal Framework

European perspectives and new legal frameworks

Valentina Pagnanelli

Introduction

Cities, data spaces *ab origine*, leverage European-based norms that govern data collection, utilization, reuse, sharing, and conservation. Every city, regardless of its "intelligence," must manage data flows in ways that best achieve their purposes while ensuring the rights and freedoms of all actors within the urban digital ecosystem are respected.

Core Regulatory Texts

The fundamental rules for personal data processing are listed in the European Regulation 2016/679, aimed at facilitating free movement of personal data while safeguarding individual rights and freedoms. The General Data Protection Regulation (GDPR) sets principles and rules applicable to natural or legal persons and public or private entities, uniformly applying adaptation requirements except for particular cases. Principles like ‘accountability,privacy by design and by default need data controllers to adhere to, and demonstrate compliance with, data protection principles.

The circulation of non-personal data is assured by Regulation 2018/1807 (Free Flow of Data Regulation or FFD). To guarantee transborder data flows, Article 4 forbids member states from imposing internal data localization obligations, barring public security needs. Notably, Article 2, Paragraph 2, sets the management rules for mixed data sets, applying GDPR’s more protective discipline for natural persons to whole datasets if personal and non-personal data are inseparably linked.

Open Data Philosophy and Public Sector Information

Equally pivotal are policies for public sector information openness. For instance, the availability of data pertaining to urban mobility, enriched with traveler type, timings, and destinations, might empower private enterprises to innovate and offer intelligent mobility solutions. Over time, the philosophy of Open Data has facilitated private sector access to numerous non-sensitive, shareable data. Directive 2019/1024 regarding data openness and public sector information reuse was promulgated to “fully exploit the potential of public sector information for the European economy and society” (Recital 4).

The Evolving Landscape: From Data Governance Act to Data Altruism

The Data Governance Act (Regulation EU 2022/868), enhancing Directive 2019/1024, prescribes rules for reusing data held by public entities subjected to third-party rights, aiming to stimulate data availability and optimize usage by new economic entities and public actors. Its purpose is to counterbalance Big Tech from a pro-competitive perspective while enabling policy directive determination based, inter alia, on relevant information. Multiple mechanisms facilitate this, including compensated business-to-business data sharing, intermediation services, and voluntary, altruistically-motivated data donation by interested parties.

Particularly, in smart cities, public and private entities interact by valorizing information produced and shared across territories, significantly enhanced by citizen contributions. Citizens might consciously decide to actively participate in crafting the urban digital ecosystem by offering their data for general interest objectives, including healthcare, mobility improvement, and public service enhancement.

Emerging European Regulations on Artificial Intelligence and Data

Further, two European Regulations, still in the proposal stage – the Artificial Intelligence Regulation and the Data Act – are particularly pertinent. The former will undoubtedly shape smart city operational rules given the numerous obligations and prohibitions to which public and private entities must adhere. Specifically, it regulates data treatment used to feed AI systems, such as Article 10 which imposes data governance rules to ensure data quality, demanding the use of relevant, representative, error-free, and complete training, validation, and test data sets for AI systems.

If approved in its present form, the Data Act would significantly impact public sector data availability. It might permit public entities, albeit only in limited, exceptional cases, to access data held by the private sector, guaranteeing them only compensation for technical and organizational costs incurred to meet public actor requests.

Conclusion

While the emergence of smart cities underscores the paramount importance of having ample data at local Administration's disposal, regulations aimed at data openness have primarily facilitated G2B (Government to Business) data sharing. B2G (Business to Government) digital flows have remained secondary, partially due to the safeguarding of economic value of information held by private companies, including industrial secrets and intellectual property protection. The Data Act proposal aims to recalibrate data value distribution, providing potentially transformative impacts for the development of smart cities. The detailed data provision and usage procedures, including potential compensation recognized to holders for technical and organizational costs related to data provision and usage, offer a delicate yet potentially empowering framework within which

smart cities may flourish amidst a lattice of regulations, shared data ecosystems, and mutually beneficial digital data flows.

The European Data Strategy's Impact on Data Sharing in Urban Contexts

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Barbara Lazarotto

This project has received funding from the European Union's Horizon 2020 Innovative Training Networks under the Marie Skłodowska-Curie ITN grant agreement No 956562.

Data is an essential element in the construction of smart cities, they are the raw material that is processed to "feed" multiple technologies that make a city "smart" – such as information and communication technologies, and algorithms that can be used for multiple purposes –. Acknowledging the importance of data in today's world, the European Commission launched in 2020 the "European Data Strategy", a multi-regulatory plan that aims to create a single market for data, allowing its flow within the EU and across businesses.[8] This Strategy is composed of multiple Acts that may impact the use and re-use of urban data in smart cities since they aim to break data monopolies so this data can be used for public purposes while respecting European rules and values.

The first proposed Act of the Data Strategy was the Data Governance Act [9](DGA), which creates a mechanism for the re-use of public sector data by the private sector. The Act applies to public sector bodies, covering personal and non-personal data. By creating a set of innovative tools, such as data altruism (Chapter IV) and data sharing intermediaries (Article 2(11)) the DGA aims to increase trust for voluntary data sharing, bridging the divide between public and private sectors while protecting individuals' rights as enshrined by the GDPR[10].
Although the DGA seems promising, it is still to be seen if it will have a beneficial impact on data sharing and re-use of data in smart cities[11]. It is possible that the newly implemented mechanisms indeed influence the private sector to share data voluntarily, boosting smart city environments with the free flow of data between different sectors. Yet, it is also possible that access to publicly held data gives tech companies more power without any obligation to share their data in return, which can widen the gap between the public and private sectors in a smart city context, increasing power imbalances.

In parallel – not a part of the European Data Strategy, but still a great ally – the Open Data

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[8] European Data Strategy, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0066
[9] Regulation (EU) 2018/1724 (Data Governance Act)
[10] Regulation (EU) 2016/679, General data Protection Regulation.
[11] The Data Governance Act entered into force on June 23, 2022 and applies to organizations beginning of September 23, 2023.

Directive[12] entered into force on 16 July 2019. Having as a backdrop the further stimulation of digital innovation in products and services through the re-use of public sector data. By covering only already accessible documents held by all manners of public sector bodies (Article 1(2)), all actors of the market may re-use public data, for commercial and non-commercial re-use (Article 11, recital 46). The Directive may be valuable for data sharing and data reuse in smart cities since it also makes practical arrangements to ensure that high-value datasets are made available in a machine-readable format (Article 14).
However, the Directive has its downsides. First, due to the nature of Directives, Member States have been slow in implementing it[13]. Secondly, the Directive repeats the *modus operandi* of the Data Governance Act, which is to enhance the sharing and re-use of publicly available data to the private sector, without any obligation in return. Naturally, the public administration runs by a different set of principles which demands more transparency from this sector, however, when it comes to the sharing of data for the public good, the private sector lacks any meaningful contribution.

Having this thought in mind, the Data Act, the last proposed act of the EU's Data Strategy was proposed in February 2022[14], with the objective of enhancing access and use of IoT data and making business data available for the common good. Besides opening the possibility for small technological companies to access and use IoT data held by bigger companies, the Data Act also has mandatory business-to-government data-sharing clauses. Chapter V creates an obligation for the private sector to make data available based on exceptional circumstances, such as response to a public emergency, prevention of a public emergency, or other exceptional needs (Article 15)[15].
Although the Act is still at the Proposal stage, some recent modifications are quite promising for smart cities since they allow public sector bodies to request data for the purposes of carrying out their statutory duties in the public interest (Article 14(1)). Nevertheless, this is yet to be seen[16].

It is possible to observe between the lines that the European Commission has realized that data sharing and re-use is an essential tool for the development of smart cities, with a potential to bring several benefits for citizens. Yet, the current proposals still fall short on achieving a free flow

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[12] Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information.

[13] The Commission calls on 19 Member States to comply with EU rules on open data and the reuse of public sector information available at https://ec.europa.eu/commission/presscorner/detail/en/mex_21_4962

[14] Proposal for a Regulation Of The European Parliament And Of The Council on harmonised rules on fair access to and use of data (Data Act) available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A68%3AFIN

[15] Lazarotto, Barbara, The Data Act: empty promises for business-to-government data sharing? A critical analysis of the Proposal on the Data Act and its implications for the redistribution of data. (September 02, 2022). Paper originally published at Privacy in Germany (PinG) Datenschutz und Compliance Journal., Available at SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4588818

[16] Lazarotto, Barbara, The implications of the Proposed Data Act to B2G data sharing in smart cities (November 24, 2022). Available at SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4588821

of data between different stakeholders due to the legislative focus on providing public sector data to the private sector. It is safe to say that these measures ignore the fact that the private sector is already in an advantageous position when it comes to data collection and processing. As a result, the unbalance in these provisions maintains the *status quo* of data monopolies in the hands of the private sector.
The Data Act Proposal might be the light at the end of the tunnel in certain aspects, since it is the first European Regulation that will force the private sector to share some type of data – related to connected objects – to the public sector. For smart city contexts, this is a very advantageous possibility to expand the sharing and re-use of data for urban management purposes.

Nevertheless, the smart city sector is still under rapid development with specific power dynamics between private and public sectors, which demand a careful analysis from European legislators. It is essential to have in place strong Regulations that put a limit on data hoarding practices by the private sector while empowering the public sector to regain equilibrium in data access. This involves creating an ecosystem that fosters responsible and secure data sharing among various stakeholders, benefiting society.

New legal frameworks for data sharing: the data intermediary

Andrea Filippo Ferraris

In 2017 The World Economic Forum concluded that “the world’s most valuable resource is no longer oil, but data”.[17] The comparison between oil and data was first used by Clive Humby in 2006 who declared that “data is the new oil”. This quote has been exceedingly echoed causing a leakage of its initial meaning. The British mathematician wanted to highlight the importance of data in the modern area and underlying that, like oil, isn’t fruitful in its raw state and it needs to be refined, processed, and contextualized. Data is not inherently valuable, its value lies in its potential.

Why does data have a central role in the modern era? The evolution of technology, and the development of analytics tools and machine learning algorithms has fostered the ability to collect and store data, as well as the capability to analyze it and extract its value. A data-driven transformation has the potential benefit of boosting industrial productivity and trade, supporting new businesses and jobs, increasing speed, efficiency, and scope of scientific research, driving better delivery of policy and public services, improving decision-making, and creating a fairer society for all. The value of data is in its volume, variety, and the ways in which it can be processed and utilized. Nowadays, digital applications and services need data, science needs data, artificial intelligence needs data, and IOT needs data.[18] Simultaneously, the data value is exploited through these technologies for economic, social, and scientific progress purposes.

The Emergence and Significance of Data Intermediaries in the European Digital Landscape

In the contemporary European digital ecosystem, the emergence of data intermediaries carves a distinctive narrative—one that embarks on a journey from exclusive data exploitation towards a symbiotic ethos of sharing, co-creating, and mutually benefiting from data. This developmental arc plays a vital role not only in fostering an inclusive digital market but also in offering avenues for individuals and organizations who can adeptly navigate the potentials and challenges embedded in the datafication era.

Data as a Pivotal Entity: Understanding its Core Characteristics

Reflecting on the importance of data brings two primary attributes to the forefront: its non-rivalrous and multi-purpose nature. Data maintains its value even when utilized by multiple

[17] Schwab, K. (Ed.) The Fourth Industrial Revolution, illustrated ed.; Crown Business: New York, NY, USA, 2017. [Google Scholar]
[18] Ruohonen, J., Mickelsson, S. Reflections on the Data Governance Act. DISO 2, 10 (2023). https://doi.org/10.1007/s44206-023-00041-7

actors simultaneously or sequentially, allowing it to serve various, occasionally unforeseeable, purposes. Data sharing thereby is not only pivotal but also transformative, augmenting its intrinsic value and becoming a linchpin for maximizing social and economic yields.[19]

The potential value of data is extracted through its life cycle: the acquisition, analysis, storage, and curation of large-scale datasets. Given the complexity of these steps, it has become increasingly common for businesses to rely upon third-party services for various of these stages.[20] The data intermediation service has emerged as a new type of third-party service with the purpose of operating in the relation between data subjects, data holders, and data users. Specifically, Data intermediaries are a nascent class of techno-economic actors which might be both private or public entities that can have either a for-profit or non-profit orientation. Their model can range significantly from a more individualist model, with the establishment of a bilateral relation, or a more collective and multilateral approach.

In light of the OECD estimates, the European Commission has posited that enhancing data exchange among European businesses could cascade into macro-economic advantages, enhancing the European GDP by 1% to 2.5%.[21] The quintessence herein is that data, when shared, multiplies in value, revealing it as not merely a resource but an expansive utility capable of underpinning social and economic benefits.

Challenges and Nuances of Data Sharing

While data sharing unveils significant macroeconomic and societal benefits, it is interspersed with a myriad of challenges spanning cybersecurity, data security, privacy safeguarding, personal data protection, data accuracy, integrity assurance, volume management, interoperability issues, trust concerns, and the need to traverse organizational silos, not to mention the financial implications intertwined with data sharing initiatives.

The task thus arises to astutely balance the bountiful opportunities with the intrinsic risks, ensuring a measured approach that simultaneously mitigates the challenges of data-sharing, avoids unintended and unjustifiable barriers, and maximizes the socio-economic potential of data.

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[19] OECD (2015) 'Data-Driven innovation: Big data for growth and well-being'. available at https://www.oecdilibrary.org/science-and-technology/data-driven-innovation_9789264229358-en

[20] Curry, E (2016) 'The big data value chain: Definitions, concepts, and theoretical Approaches'. In: Jos´e Mar´ıa Cavanillas (ed), et al. (eds), New horizons for a data-driven economy: A roadmap for usage and exploitation of big data in Europe. Springer, pp. 29–37

[21] European CommissionCommission, SWD (2020) Commission staff working document - impact assessment Report accompanying the document proposal for a regulation of the parliament and of the Council on European data governance. SWD/2020/295 final. AND OECD (2019) 'Enhancing Access to and sharing of data: Reconciling risks and benefits for data Re-use across societies'. available at https://www.oecd-ilibrary.org/science-and-technology/enhancing-access-to-andsharing-of-data_276aaca8-en

A harmonized data-sharing framework is thus indispensable, requiring the incorporation of adept regulations, policies, and practices, and paving the way for robust data governance initiatives.

According to Article 10 of the DGA, data intermediaries serve as pivotal actors in streamlining data exchanges between diverse stakeholders, thereby ensuring enhanced utility and security of data. This role can be demarcated into three distinct models:

- **Bilateral and Multilateral Data Exchanges:** Intermediaries facilitate direct exchanges between data holders and users through creating platforms or databases that expedite data exchange and utilization, as well as by fostering the development of digital infrastructure.
- **Technical Solution Providers:** These intermediaries enable exchanges by bridging the gap between data subjects and data users, providing technical solutions and platforms to facilitate the exchange activities.
- **Data Cooperatives:** Aggregating data subjects - which may encompass individuals, public administrations (PAs), and small and medium enterprises (SMEs) - these entities collaboratively dictate the conditions under which their data is processed, empowering collective informed decision-making and the selection of trustworthy data users.

Pertinent to Article 11 of the DGA, several critical prerequisites delineate the operational paradigm for data intermediaries, ensuring ethical and secure data management and exchange:

- Neutrality: An imperative unbiased stance towards both data owners and users, maintaining an equitable platform for interaction.
- Fraud and Abuse Prevention: Establishing stringent protocols to prevent illegitimate or malicious access to data.
- Cybersecurity Assurance: Safeguarding data through robust physical and cyber-security mechanisms, protecting it both in transit and at rest.
- Transparent Accessibility: Guaranteeing fair, transparent, and non-discriminatory access to intermediary services.
- Constrained Usage: Restricting the intermediary's use of information solely to facilitating its availability to data users, prioritizing the best interests of data subjects.
- Interoperability Facilitation: Enabling seamless data exchange through ensuring interoperability amongst varied data formats and platforms.

While the previous are the requisites set forth by the European legislator, a different range of intermediation services are tackled by different research centers.

Indeed, the expansive digital panorama, the term "data intermediary" encapsulates a range of diverse entities, each fulfilling specific, sometimes overlapping roles, and offering unique models and frameworks for managing and sharing data. This diverse spectrum includes[22]:

- Data Trusts: In these structures, the intermediary assumes a fiduciary responsibility, managing the data supplier's data for predefined purposes and ensuring its usage aligns with agreed-upon principles and guidelines.
- Data Commons: Anchored in data altruism, data commons cater to the collective good, offering a shared data resource that is accessible and beneficial to a wider community, potentially enabling novel innovations and solutions.
- Data Cooperatives: Here, intermediaries manage and control data on behalf of its members, who delegate data authority to them, often driven by mutual benefits and shared decision-making processes.
- Data Collaboratives: This model encourages data exchange across various sectors, involving private companies, research institutions, and government agencies, aiming to solve common challenges through shared data insights and analytics.
- PIMS (Personal Information Management Systems): PIMS empower data providers with the ability to mediate, monitor, and control how their data is accessed, used, or shared, placing a pronounced emphasis on user agency and data control.
- Data Marketplaces: These platforms focus on creating an ecosystem where data can be bought, sold, or exchanged, establishing a viable market for data assets.
- Data Brokers: Operating with a focus on data trading, data brokers typically facilitate the buying and selling of data, often aggregating information from various sources and providing it to interested parties, sometimes without direct engagement with the original data subjects.

Each of these entities, while operating under the broader umbrella of "data intermediary," addresses diverse needs, stakeholder interests, and operational modalities in the data ecosystem. For example, a data trust might prioritize ethical management and usage of data, a data cooperative may emphasize member control and benefit, while data brokers might focus on maximizing the economic value of data through trade.

In the intricate landscape of data sharing and management, these intermediaries collectively facilitate a nuanced, multifaceted approach towards data utilization, ensuring that varied models are available to cater to diverse needs, objectives, and ethical considerations within the data economy.

[22] Dave Buckley, Christopher Thomas and Kimberley Moran (2021), Exploring the role of data intermediaries in supporting responsible data sharing, Centre for Data Ethics and Innovation

Data Intermediaries: Catalyzing Smart City Initiatives

The incorporation of data intermediaries within smart city projects avails multifaceted benefits, principally:

- Alleviating Trust Deficits: By providing a neutral, secure platform for data exchanges, intermediaries alleviate skepticism and facilitate enhanced trust amongst stakeholders.
- Cybersecurity Fortification: By ensuring secure data handling, intermediaries safeguard information integrity both during transmission and storage.
- Data Protection Enhancement: Robust mechanisms ensure that the data is protected and managed in compliance with legal and ethical standards.
- Decision-making Centralization: By consolidating data exchange decisions, intermediaries enable the management of more sophisticated, intricate data exchange scenarios.

Concluding Notes

With explicit recognition from the European legislator in the Data Governance Act regulation and forming a crucial cog in the European Data Strategy's implementation, data intermediaries, although in nascent stages, represent an opportunity for those discerning enough to leverage it.

They could provide startups, SMEs, and diverse organizations with new business models, diverging from an exclusionary principle towards one that endorses value creation through shared initiatives. In a broader context, data intermediaries stand to offer a mechanism through which we can more proficiently respond to contemporary societal, economic, and environmental challenges, providing a foundational base upon which greater access and data sharing can be achieved, driving forward the digital agenda in a balanced and equitable manner.

Private and public data

Pietro Giovanni Bizzaro

The European smart city ecosystem is witnessing a notable transformation driven by enhanced connectivity, data-centric innovation, and partnerships that span public and private sectors. This shift is further shaped by the reformation of data-sharing protocols and the restructuring of governance mechanisms, both deeply influenced by regulatory changes and strategic initiatives at the European level.

The European Commission, in 2020, introduced the European Data Strategy[23], aimed at cultivating a single market for data. This initiative promotes the free flow of data across EU Members and industries while upholding data protection and privacy standards. The Strategy is pivotal for fostering innovation, generating employment, and facilitating socio-economic development, aiming to flourish a data-conscious economy.

The objectives of the European Data Strategy are articulated through key actions, including the introduction of the Data Governance Act (DGA)[24]. This legislation is crucial in creating trustworthy data-sharing frameworks and enhancing the availability and use of both public and private data. The DGA, with its focus on data altruism and intermediaries, amplifies the magnitude of the data-sharing trend through a bottom-up approach. Furthermore, Smart Cities, characterized by the amalgamation of diverse data sources from public authorities, private entities, and citizens, are directly impacted by the Strategy and legislative reforms. These developments aim to ensure data is not solely available but efficiently shared and reused, promoting innovation, sustainability, and improved quality of urban life.
In these instances, data serves as a catalyst for innovation, enabled by the Strategy's promotion of interoperability among varied data sources and domains. It creates a balanced ecosystem where either public or private sectors have a complementary role, utilizing data while adhering to ethical, privacy, and security standards.

In the realm of data governance, especially within the European context, the categorization of data varies depending on the specific domain or legislative provisions, whereas the General Data Protection Regulation (GDPR) macroscopically refers to personal data[25] in contrast to

23 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en#:~:text=The%20European%20data%20strategy%20aims,businesses%2C%20researchers%20and%20public%20administrations.

24 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32022R0868

25 Article 4.1(a) GDPR: "'personal data' means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online

non-personal data, or the Open Data Directive refers to the concept of open data[26] in contrast to commercial data. Throughout the different data categorizations, semantic overlaps may occur, though it is also possible to define two distinct and opposing concepts: the public and private datum.

Public data refers to information that is openly accessible and can be freely used, modified, and shared by anyone for any purpose. It typically encompasses data generated by public sector entities, making it available for the collective good. On the other hand, private data are identified as information held by individuals or private organizations, often containing sensitive or confidential information protected by privacy laws such as the GDPR or intellectual property rights such as the Sui Generis Directive. The fluidity between these two categories of data is a nuanced process. Private data can transition into the public domain through anonymization or synthesizing processes, where personally identifiable information is "skimmed", ensuring privacy and compliance with regulatory stipulations. Conversely, Public data can assume a private characteristic when it is integrated into proprietary applications or used to derive insights that are then owned by private entities. The GDPR plays a pivotal role in dictating the protocols for such transitions, ensuring data protection and security are upheld, and ethical considerations are integrated into the transformation and utilization of data in its varied forms.

The transition between these categories is nuanced: private data can become public through techniques that ensure privacy and regulatory compliance. Conversely, Public data can assume private characteristics when integrated into proprietary applications or used to generate proprietary insights. The GDPR provides guidelines for these transitions, ensuring privacy, security, and ethical standards.

Therefore, even though we cannot yet calculate the scope of the altruism data initiatives just introduced, it is possible to analyze the rate and culture of making data available in open formats. In particular, the landscape of Open data utilization within public administrations in Italy is unfolding prominently, as depicted by a 2023 survey[27]: a substantial 70% of these administrations assert the provision of open data. Despite this promising inclination, barriers persist, prominently organizational constraints, evidenced by 68% of the respondents, and financial limitations, a challenge for 23%. Legal obliviousness and other factors constituted a minor segment, implicating less than 10% of the administrations.

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identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person;"

[26] Recital 16, Open Data Directive: "Open data as a concept is generally understood to denote data in an open format that can be freely used, re-used and shared by anyone for any purpose."

[27] Banca d'Italia, L'informatizzazione nelle Amministrazioni locali. (2022). https://www.bancaditalia.it/pubblicazioni/tematiche-istituzionali/2022-informatizzazione/VII_Indagine_informatizzazione_nelle_Amministrazioni_locali.pdf

Furthermore, an analysis[28] carried out by the "Agenzia per l'Italia Digitale" (AgID) amplifies this narrative, revealing a strategic shift in data management within Italian public administrations. The emergence of well-articulated Data Strategy plans, focusing on principal formulation and rule establishment for optimized data management and metadata utilization for enhanced data searchability and reuse, is evident. Yet, a significant portion, 27%, of public organizations are engaged in collaborative data ecosystem initiatives. Human-centric challenges, notably culture, and trust, are pivotal impediments, overshadowing even technological barriers. However, for those immersed in such ecosystems, tangible benefits are discernible. An overwhelming majority report enhanced citizen engagement, augmented sustainability initiatives, and fortified resilience against cyber incursions.

Addressing these impediments necessitates concerted efforts in trust cultivation between data stewards and citizens, skill enhancement in data, artificial intelligence, and privacy management, and the resolution of the infrastructure and legal policy deficiencies that currently impede the expansive reutilization of public data.

The continuous transition between private and public data is pivotal in the ongoing evolution of the European data landscape, especially within the context of smart cities and broader data ecosystems. The European Data Strategy and its associated reforms are shaping a dynamic environment where data is not stagnant but constant dynamic state, moving seamlessly and securely between private and public domains (both from a technical and legal standpoint). This fluidity is instrumental in harnessing the full potential of data, ensuring that it is accessible, reusable, and beneficial across a myriad of applications, from enhancing urban living standards to fostering innovation and economic growth. The new legislative frameworks, including the DGA, act as catalysts, accelerating this transition while ensuring it anchors on the bedrock of security, privacy, and ethical considerations.

[28] Agenzia per l'Italia Digitale, La Spesa ICT 2021 nella PA italiana - Principali trend e percorsi in atto. (2021). https://www.agid.gov.it/sites/default/files/repository_files/_la_spesa_ict_2021_nella_pa_italiana_-_principali_trend_e_percorsi_in_atto_final_v.02_2.pdf

Managing the Smart Cities with data

Reprogramming local public services from the demand side

Camilla Jacod

In recent years, the spread of new technologies has led to an increase in both the quantity and quality of data regarding private and public entities and their interactions with the world around them. In the private sector, this so-called fourth industrial revolution[29] has long led companies to adopt innovative solutions to leverage the value of these resources, not just in terms of infrastructure but also in terms of business models. Similarly, the public sector has seen numerous regulatory interventions aimed at adapting administrative organizations to the processes of digitization and datafication[30].
One goal of these efforts is to bridge the traditional gap between governing bodies and citizens, with the ultimate aim of promoting administrative collaboration. In fact, the digitization of certain administrative procedures and the creation of new digital services aim to strengthen citizens' right to access public institutions by making citizen-administration communication more transparent, faster, and more effective[31].

In the Italian context, this first phase of the digitization process has started[32]; with measures such as equipping offices with the necessary infrastructure (e.g., cloud technology), dematerializing payments (PagoPA), and allowing certain documents to be submitted in digital format. However, examples of the application of new technologies to public decision-making for the sustainable management of urban environments remain relatively rare and geographically uneven. These might include systems like sensors and artificial intelligence used to monitor the use of local

[29] The continuous diffusion of increasingly sophisticated and powerful technologies but contained in size and costs. K.SCHWAB, The Fourth Industrial Revolution, World Economic Forum, 2016.
[30] "Datafication" refers to the process by which any information can be translated into data and thus quantified and analyzed, V. MAYER SCHONBERGER, K. CUKIER, Big Data: A Revolution That Will Transform How We Live, Work, and Think, Houghton Mifflin Harcourt, 2013, 103.
[31] For this to be possible, public administration must also take action to prevent the so-called risks of digital divide, which is the inequality among individuals and communities derived from differences in access and ability to use Information and Communication Technologies (ICT)
[32] The Digital Administration Code (Legislative Decree n. 82/2005) regulates the digitization of public administration. Fundamental integrations were made through Legislative Decree n. 235/2010, which introduced the open data into the Italian legal system, thus determining the evolution of the public sector towards Open Government, and Legislative Decree n. 217/2017, which promoted effective digital citizenship's rights; Legislative Decree n. 22/2021 established the Interministerial Committee for Digital Transition (CITD) to coordinate and monitor the implementation of initiatives related to the development and dissemination of emerging technologies such as artificial intelligence, IoT, and blockchain (Art. 8, paragraph 2, letter c); the National Recovery and Resilience Plan - whose drafting, concerning investments and projects for the years 2021/2026, is essential for accessing funds from the so called Next Generation EU (NGEU) - Mission n. 1 is the "Digitization, innovation, competitiveness and culture", with the overall goal of "the country's digital innovation so that a real structural change can be triggered".

transport, traffic, and parking, to improve mobility, or systems that optimize the methods and schedules of urban waste collection and intelligent lighting[33].

Public administrations undoubtedly hold a privileged position in acquiring administrative data on users of local public services and urban data on city infrastructures and services. However, while technical tools have been developed to enable the production and collection of urban data, the biggest challenge lies in the ability of public administrations to use and exploit such data to effectively govern the territory.
Indeed, the data daily produced by the flows of people that make up the urban environment[34] can be strategically leveraged for better service management[35] and planning of medium to long term solutions, thanks to the greater sophistication and quantity of data on real demand in the services market. Focusing on this last element, it becomes clear that in order to plan local public services, one must start from the users and their demands.
When the administration provides a local public service, it agrees to satisfy a public interest to allow the economic and social growth of the governed territory[36]. It is a political administrative choice expressed in a program that identifies the needs of the population, its organization as an economic demand, and results in an obligation on the part of the administration that owns the service to the citizen-users whose interests it represents. Moreover, local public services are characterized by their mandatory provision: they must satisfy the entire demand, meaning also that which would not be met within the normal dynamics of the competitive market due to the lack of economic prerequisites for the creation of a service supply[37].

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[33] A. MASUCCI, *Atto amministrativo informatico. Primi lineamenti di una ricostruzione*, 1989, 42; F. MOROLLO, *Documento elettronico fra* e-government.
[34] To better represent the urban context and public services, the most realistic portrayal of the urban population is a flow comprised of residents, commuters, and tourists who are all potential users of these services. R. CAVALLO PERIN, Beyond the municipality: the city, its rights and its rites, Italian Journal of Public Law, 2013, 2, 307; ID., *La configurazione della cittadinanza amministrativa*, *Diritto amministrativo*, 2004,1, 201.
[35] For example, the company managing the London underground system aimed to increase the percentage of trains arriving at their destination on time from 82% to 90%. Three interacting models were implemented: a) a delay prediction model, using historical data that included characteristics such as train arrival times, location, delay, and time; b) a model to learn patterns in such data to help controllers better understand how the network works and what causes delays; c) a recommendation tool to suggest alternative solutions to controllers. The new system can report delays up to an hour earlier, with 50% greater accuracy than before, and the total delay at all London stations has been reduced by 200 minutes per day. Government Digital Service (GDS) and Office for Artificial Intelligence (OAI), in collaboration with Alan Turing Institute (ATI), 10 June 2019, https://www.gov.uk.
[36] In Italy, the local administrations are listed in the Constitution and include the regions, provinces, metropolitan cities, and municipalities (Article 114). These entities can be defined as associational bodies where the territory is a constitutive element, as the members are the population residing in the territory and the legitimate purposes of the entity are the interests of the resident population. A. ROMANO (Mazzarolli, Pericu, Romano, Roversi Monaco, Scoca), *Diritto amministrativo*, 2005, 24.
[37] A. DE VALLES, *I servizi pubblici*, 1924, 379; G. ZANOBINI, *I servizi pubblici locali, Trattato di diritto amministrativo* (S. Romano), UTET, 1978, 359; MIELE, *Scritti giuridici*, 135; M. NIGRO, *L'edilizia popolare come servizio pubblico (considerazioni generali)*, 1957, 183; R. VILLATA, S. VALAGUZZA, *Pubblici servizi*, 2021; M. DUGATO, *La crisi del concetto di servizio pubblico locale tra apparenza e realtà*, *Diritto amministrativo*, 3, 2020, 511.

Demand data plays a crucial role in shaping the scope of local public services in two main ways. Firstly, it enables to identify which needs are met by services spontaneously provided by the market[38], and which ones require the administration to assume responsibility due to so-called "market failures". This boundary is not fixed, as transparency requirements for the management data of local public services can encourage the supply of new services in a pro-competitive sense, encouraging private initiative for both existing market players and new entrants[39].

Secondly, demand data identify the actual users of local public services, who may not necessarily be permanent residents in the urban territory. This is particularly relevant in today's dynamic cities, where the link between using an urban service and being a citizen is weaker. Restricting the user base to residents only would create a distorted view of the quantity, quality and efficiency of the services needed.

When programming local public services, administrations economically organize the demand by balancing different public interests to determine how to satisfy them. Therefore, the users' claim on the public administration is regulated, including recipient categories, quantity and quality of services, delivery methods and timing (object of the obligation). By doing so, the public administration must justify its choices based on adequacy and reasonableness criteria. All available know-how and data must be used during this preliminary phase, meaning that public administrations must adapt to new technological progresses to make well-informed choices[40]. Whenever the administration's choices are not adequately justified or are disproportionate or unreasonable, the local service program may be considered illegitimate because it fails to achieve its intended purpose.

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[38] The public administration can promote such initiatives through incentive programs, pursuant to art. 118, paragraph 4, of the Constitution. This aspect is also relevant considering the recent reform of the regulation of local public services of economic relevance, which clarifies that the local authority to establish a new service, must first verify that private initiative does not suffice. The decision to establish the service considers the results of a preliminary investigation and can be subjected to public consultation before its adoption (art. 10, Legislative Decree n. 201/2022).

[39] For instance, different transport-related activities can be integrated into an on-demand accessible service, following the concept of mobility as a service. This approach caters to the demand of end-users for flexible transport solutions and encourages competition by offering new forms of shared and collaborative mobility, including shared cars, ride-hailing services, and other types of micromobility.

[40] In Italy, local authorities and other competent public institutions (regulatory authorities for network services, offices of the Prime Minister's presidency for non-network services) collaborate to improve the quality of local public services. Provinces perform support and coordination functions in relation to measures and activities regarding public services and carry out data collection and processing, as well as technical and administrative assistance to local entities in the area (art. 9, Legislative Decree n. 201/2022). Furthermore, the service provider in the service contract has "obligations of information and accountability towards the contracting authority or other entities responsible for monitoring and controlling performance, with reference to effectiveness and efficiency objectives, economic and managerial results, and the achievement of qualitative and quantitative levels". Therefore, all data acquired and generated in the provision of the service must be made available to users, including data on the use of the service by users, in the form of open data, in compliance with guidelines adopted by AgID, after consultation with the Personal Data Protection Authority (art. 24, Legislative Decree n. 201/2022 and art. 50-*quater*, Digital Administration Code).

For instance, when it comes to transportation, the administration needs to ensure not only the economic development of cities and the accessibility of their territory, but also the safety, quality of life, and environmental protection[41]. Therefore, an intelligent and sustainable management of the complexity of the urban environment is necessary, which, by its nature, offers various modes of transportation. Existing technologies allow quantifying the number of people (users) on the move, knowing the time slots and traffic congestion areas, the number and frequency of public transport, the number and location of car/bike sharing services, users' preferences or habits (in terms of destination, route, and means of transportation), etc. The specific information about users' preferences and habits allows administrations to plan the services offered more accurately to the real collective demand and individual demands of users, with an integrated management of services[42], differentiating the services according to effectiveness and efficiency criteria. To plan the services adequately and reasonably with respect to the mobility demand while satisfying the social interest for which it is responsible, the public administration must then define clusters based on origin, destination, time slots, type of demand (systematic for home work/school trips; erratic for leisure/occasional trips), route habits/constraints (e.g., intermediate stops), and diversify the supply services adequately by promoting modal chains on routes, diversifying the cost for the user (travel ticket/subscription/based on usage time), and the type of service based on the means/actors available on the market.

In conclusion, collecting data in an interconnected and integrated way represents a revolutionary opportunity for public administrations to obtain a more detailed and profound knowledge of the target population, their behaviors, needs, and demands. Respecting the criteria of cost-effectiveness, speed, effectiveness, efficiency, and better balance of the interests to which the administrative activity must conform, the administration can learn to strategically exploit those digital technologies and methodologies that are useful for defining public demand, thereby enabling more efficient and adequate programming of public services in continuity with smart city strategies.

[41] European Commission, Green paper: Towards a new culture for urban mobility, 2007.

[42] Meaning a coordinated and synergistic management of diverse public services, with joint planning of activities and a close collaboration among the various entities that oversee public services. Such management is grounded on a comprehensive vision and analysis of interactions among the different services, functioning towards efficiency and sustainability objectives in the administration of public resources.

Promoting Accessibility in European Metros: The Power of Open Data

William Del Negro and Maria Lazzati

European metros serve as vital lifelines of cities, transporting millions of passengers daily. However, the issue of accessibility within metro stations has become a central concern as society increasingly strives to ensure that public transportation is inclusive for all. In this context, Willeasy has conducted an innovative study focusing on the importance of open data and accessibility information for metro stations across Europe.
Considering the number of passengers who use metros daily and annually in some of Europe's major cities, including Lisbon, London, Milan, Rome, and Paris, Willeasy has recognized the urgency of addressing the accessibility challenge. For instance, in London, with 5 million daily passengers and 1.8 billion annually, already ten years ago[43], it was deemed essential to ensure that all people, including those with disabilities or elderly individuals with reduced mobility, can easily use the metro service.

Before we begin, it's important to understand what the GTFS protocol[44] is, invented by Google and used worldwide to provide public transportation information in an open format[45]. The GTFS protocol is a standard used to share data about public transportation, such as buses, trains, and subways, in a structured and easily understandable format. This standard enables app developers and navigation services to access consistent public transportation information from various agencies and cities around the world.
GTFS organizes public transportation data into different files, each containing specific information: Schedule and itinerary files, Stop files, Route files, Calendar files, and more.
Public transportation agencies provide these GTFS data files to Google or other navigation services. Google then integrates this data into its services, such as Google Maps, allowing users to plan their public transportation journeys more effectively.
Practically any public transportation agency can provide data in GTFS format. This includes urban, regional, and national agencies. However, it's essential for agencies to keep their GTFS data up to date to accurately reflect their vehicle schedules and routes.
Public transportation agencies can create and update their GTFS data using specific tools and software. These data can then be sent to Google or uploaded to a shared repository, where apps and navigation services can access them to provide updated information to users.

[43] https://tfl.gov.uk/corporate/about-tfl/what-we-do#on-this-page-1
[44] https://developers.google.com/transit/gtfs/reference
[45] In 2006, TriMet (Portland, Oregon, USA) and Google created the GTFS Schedule data format, which quickly had success world wide, and which has been extended in 2011 with its GTFS Realtime counterpart. https://beyondtransparency.org/part-2/pioneering-open-data-standards-the-gtfs-story/

In summary, the GTFS protocol is a key standard in the world of public transportation, enabling uniform distribution of public transportation information. Transportation agencies provide GTFS data to Google and other services, making travel information more accessible and reliable for all of us[46].
The GTFS protocol provides only limited information about station accessibility. For this reason, London initially and Willeasy later with Lisbon later decided to create an enriched Open Data format with precise and comprehensive data on station accessibility, elevators, escalators, etc. This allows for the development of travel planning solutions that take into account the diverse needs of people.

Case study: London

With over 31 million journeys made every day in London, it is of fundamental importance that people have access to the right travel information to assist them. Almost a decade ago, Transport for London (TfL), under the guidance of its Managing Director, Customers, Communication and Technology, Vernon Everitt, decided to release a significant amount of its data - schedules, service status, and disruptions - in an open format, accessible to anyone and completely free[47]. Vernon Everitt and his team's hope was that partners would then create new products and services and bring them quickly to market, thus extending the reach of TfL's information channels. Vernon Everitt and his team's guiding principle since then has been to make non-personal data openly available unless there is a commercial, technical, or legal reason not to do so.

In 2017, there were over 600 apps powered by TfL data, used by 42 percent of Londoners. What is less understood is the economic value and social benefits of this approach[48].
A research by Deloitte[49] shows that the release of open data by TfL is generating annual economic benefits and savings of up to £130m a year
The release of open data creates a virtuous circle that benefits those who use and manage transport networks in the capital. Open data, which can be freely used, reused, and redistributed by anyone, can support operational improvements, the development of new customer-oriented products and services, increase transparency and innovation, and challenge existing ways of working.

1. TfL provides data about its network through APIs, static data files, and feeds.
2. Companies like Waze, Twitter, Google, Apple, Citymapper, Bus Checker, Bus Times, Mapway, and others, along with numerous academics and professional developers,

46 https://support.google.com/transitpartners/answer/1111481?hl=en&ref_topic=3521043&sjid=6965303984100728579-EU
47 https://odimpact.org/files/case-studies-transport-for-london.pdf
48 https://tfl.gov.uk/info-for/media/press-releases/2017/october/tfl-s-free-open-data-boosts-london-s-economy
49 Assessing the value of TfL's open data and digital partnerships - Deloitte. 2017

collaborate with TfL and use this data to create new customer-oriented products and services, both commercial and non-commercial.
3. TfL network passengers and other road users benefit from these new services and products for a better travel experience in London.
4. Insights derived from external data users can stimulate new thinking within TfL, increase demand for the network, and overall enhance customer satisfaction.

Benefits for TfL Passengers and Road Users

- Time savings for TfL passengers: TfL's open data allows apps to provide real-time transport information, helping passengers plan their journeys more efficiently. This results in greater certainty about when the next bus or train will arrive and saves time. According to available data, this could correspond to savings of between £70 million and £90 million annually.
- Time savings for other road users: The availability of data on roadworks and road accidents helps improve traffic management for private and commercial drivers. Avoiding congestion through this information not only saves time but can also reduce greenhouse gas emissions from blocked traffic.
- Savings from the transition from SMS alerts: The transition from paid services to free services based on open data represents significant savings for passengers, estimated up to £2 million annually. Additionally, new real-time alert services offer an estimated value of use of up to £3 million annually.
- Better travel planning information: Thanks to open data, passengers can plan their journeys more effectively, increasing the use of TfL services. This results in increased travel on the network, with an estimated value of up to £20 million annually.

Benefits for London

- Gross Value Added: Numerous companies, many of them based in London, use TfL data to develop new products and services. This generates revenue, and we estimate that the total Gross Value Added resulting from these uses is between £12 million and £15 million annually, contributing to London's economic growth.
- Creation of high-value-added jobs: The use of TfL's open data directly supports around 500 jobs, many of them in high-productivity sectors. This represents a significant contribution to skilled employment in the city.
- Creation of jobs in the supply chain: Furthermore, the spread of open data has indirectly created another 230 jobs in the supply chain and the overall economy, further contributing to employment.

Benefits for Transport for London

- Savings from not having to develop in-house apps: TfL is harnessing the creativity of over 13,000 registered developers, allowing them to create innovative transport apps and

services. This potentially results in savings for TfL, which no longer needs to develop apps internally or in collaboration with third parties.

- Savings from not having to invest in campaigns and systems: The release of open data provides information directly to passengers, reducing the pressure on support services. Additionally, disseminating this information through open data is significantly more cost-effective than equivalent marketing campaigns, with significant potential return on investment.
- Exploitation of value and savings from partnerships: Collaborations with major data and software organizations allow TfL to acquire additional data, improving analysis and operational efficiency.

In summary, data openness has led to greater customer satisfaction through instant access to accurate information, supported the digital economy of the UK, especially in London, and created new business opportunities through open data. This demonstrates the tangible value of data openness in the public transportation sector.

Social Impact

TfL's open data can also contribute to improving social outcomes, encouraging innovation, and the wider environment. The use of open data can also influence behaviors and position London and the UK to seize new business opportunities.

- **Society**

Promoting a more active lifestyle: Open data can help integrate the first and last mile, encouraging alternative modes of transport such as cycling and walking, with clear health benefits. This supports the goal of promoting healthier streets. Since 2007, the number of people using walking as their primary mode of transport has increased by 13%.

- **Growth and Productivity**

Exploiting new opportunities: The UK and London have already gained a reputation as leaders in open data and the digital economy. Recent research by Tech City found that London's digital economy was worth £30 billion in Gross Value Added (GVA) and supported over 300,000 jobs. Providing open data on transport is a significant foundation for the development of new transport products.
Encourages and facilitates innovation: With the ongoing release of data, TfL can stimulate a growing number of developers to innovate and create a variety of new customer-oriented services that can address social and economic issues (as recently demonstrated by the cycling app challenge).

- **Environment**

Contributes to improved air quality and emissions reduction: By using open data to develop new customer-oriented products that promote a modal shift from private and public vehicles to walking

and cycling, there will be more pedestrians and cyclists. This will contribute to a lower carbon footprint in London and lower particulate emissions, improving air quality.
TfL now has the opportunity to use its leadership in open data to explore new business opportunities and use data more innovatively to enhance the customer experience. These opportunities include releasing additional open data (such as road data), supporting a culture of internal transformation in a data-driven organization, marketing the open data experience, collaborating with developers to identify market gaps and opportunities for new customer-oriented services, especially to improve network accessibility[50]. All of this can be achieved through hackathons, accelerators, blogs, and formal partnerships. Finally, the use of data received from partners in traditionally data-scarce areas can lead to new insights and improve operations (such as real-time traffic monitoring) and enhance the quality and coverage of existing open data through linkage and merging with other datasets.

German study on urban mobility for people with disabilities

In 2020, the #BarrierenBrechen petition highlighted the accessibility challenges faced by people with disabilities in Germany, including access to stores and limited online accessibility. However, the German accessibility legislation has been criticized for its inconsistency.
This study[51] underscores that accessibility in urban travel for people with disabilities remains problematic in many European and North American cities. The use of data is crucial for improving accessibility and promoting equity in mobility.
Two significant projects are Broken Lifts and Elevate Delta. Broken Lifts, an open-source project initiated by the NGO Sozialhelden e.V., provides real-time data on elevators in public transportation in Berlin, enabling people with disabilities to plan routes more effectively, avoiding out-of-service elevators.
Elevate Delta, also promoted by Sozialhelden e.V., aims to integrate elevator data into existing routing applications in German cities. This project seeks to facilitate accessible route planning for a wide range of people and contribute to a more inclusive future urban mobility.
Both of these projects demonstrate the importance of using data to improve accessibility and mobility for people with disabilities, showcasing how technology and real-time information can make a difference in their daily lives.

The open data project in Lisbon

In 2023, Willeasy Srl, through the VoxPop Open Call led by the Lisbon City Council, completed a pilot project to create an Open Data system for metro accessibility[52].
The key phases of this project included:

1. Developing an open-source web application for data collection, management, and sharing;

[50] https://tfl.gov.uk/transport-accessibility/
[51] https://www.tandfonline.com/doi/full/10.1080/17450101.2022.2057810
[52] https://www.willeasy.net/project/en/lisbon-project/

2. Importing existing data in open format into the Willeasy database;
3. On-site data verification and collection of missing data;
4. Making the data available in GTFS format and in CSV format enriched with accessibility data;
5. Developing an app to allow users to report the status of lifts, escalators, and stairlifts.

Through the open.willeasy.app website, you can access information about 50 Lisbon Metro network stations, 112 platforms, 209 entrances/exits, 262 station interior areas, 162 lifts, 1 stairlift, and 421 escalators.
Since the GTFS format does not include detailed accessibility information, an additional format, also open but customized, has been created. This format includes information such as the distance between the train and the platform, the height difference between the platform and the train, elevator dimensions, and the presence of tactile paths.
Approximately 140 million passengers use the Lisbon Metro each year. UNWTO predicts that by 2050, half of the world's population will have some form of disability, and the population is aging rapidly. Planning trips with peace of mind is becoming increasingly essential.

Lisbon has been considered by some sources as a potential "European Silicon Valley" due to the growing interest of tech companies and startups in opening offices or branches in the city. This phenomenon has been partly driven by various factors, including government incentives, a relatively lower cost of living compared to other European cities, a pleasant climate, and a favorable quality of life. The city has been hosting major tech events for several years, such as the Web Summit, which has helped promote its image as a tech hub.
These factors could lead Lisbon to become the second city after London to create a virtuous system based on open data, with a particular focus on accessibility data. The next step that could make Lisbon the first and only city in the world to have a comprehensive accessibility data system would be to extend the dataset to include information about accommodations, restaurants, and tourist-cultural points of interest.

At the time of writing this article, the project is in the validation phase by the Metropolitano de Lisboa company but can be used by users and especially developers from the open.willeasy.app website.

The importance of datasets in projecting and managing Smart cities: a Telco industry example

Silvia Pispico

The concept of data sustainability

Data-driven sectors – and organizations as a result – are among those that grow at a faster pace[53]. However, only a few companies manage to top perform and most of the data they gather is considered to be "dark data". We can describe dark data acquired through different operations but not used for decision-making or to produce other intelligence[54]. According to Professor David Hand of Imperial College of London, dark data "are data you don't have".

Many sectors exceed the pace at which data analysis is performed and most of the time an organization may not be aware that data has been collected. According to an IBM report, up to 90% of data generated never gets used and most companies end up analyzing only 1% of their data[55]. There might be different reasons why such data are not gathered or not used: for example, they might believe that a given data could become useful in the future. This approach is emphasized by the fact that data storage is inexpensive. However, the storage usually entails greater risk-management costs and eventual data breaches, or service disruptions might lead to higher costs and the loss of potential return in profit from data usage[5657].

It is easy to understand why many big data studies focus on the usage of available data that remain stored but are not used. This is the key concept of "data sustainability" hereby presented. A solution, ancillary to smart cities development – but also to many other sectors – is the promotion of "High-performance computing facilities" (HPC), facilities actively involved in reducing dark data from their storages. The HLRS, an HPC based in Stuttgart, Germany, is one of the best examples of HPC facilities in Europe and their work is aimed at diminishing dark data[58].

Coping with these data becomes pivotal in unleashing the unexpressed potential of unused data that might benefit smart-city-oriented decisions. This is the reason why a position tailor-made for managing dark data and general data could be beneficial[59].

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[53] IEEE Transactions on Engineering Management, Understanding and Defining Dark Data for the Manufacturing Industry, IEEE Transactions on Engineering Management (Volume: 70, Issue: 2, February 2023)
[54] https://www.gartner.com/it-glossary/dark-data
[55] Shahzad, M. Ahmad, The big data challenge of transformation for the manufacturing industry, IBM Big Data & Analytics Hub, January 3, 2017
[56] Jing, Li and Qinyuan, Li, Data security and risk assessment in cloud computing, ITM Web of Conferences, January 2018
[57] https://www.cisc.gov.au/critical-infrastructure-centre-subsite/Files/raa-data-storage-or-processing
[58] Schembera, Bjorn and Duran, Juan M., Dark Data as the New Challenge for Big data Science and the Introduction of the Scientific Data Officer, Philosophy and Technology, Springer Journal 33, 93-115 (2020)
[59] *Ibidem*

The peculiarity of this position should take into consideration both the technical responsibilities and privacy responsibilities. Such a role could be ascribed to a position halfway through a Chief Digital Officer and a Privacy Officer. The latter aspect is imperative to cope with the concerns raised by the analysis of the data notion in the GDPR 2016/679[60].

An example of data-sustainability-approach: Data sharing and collaborations with Telco data during the COVID-19 pandemic. A Vodafone case study

This piece of work has stressed out, so far, the process of increasing computation and digitalization that is penetrating the foundations of our cities. The scope of Smart cities, an urban paradigm where digital technologies rationally improve the quality of life of its citizens is becoming highly dependable to a form of data-driven development. Smart cities tackle the increasing challenges of new urban phenomena. In order to better satisfy those new needs rising we need digital infrastructure and competencies to generate, transmit, process, and analyze huge masses of data. Dark data might cause a general slowing of such processes.

In the Mediterranean area, the City of Barcelona provides us with plenty of interesting examples of data usage in Smart cities dynamics. The Spanish city is an example of the implementation of a systematic data-driven solution, where dark data are limited as much as possible[61]. In Barcelona, four main steps of analytical approach are adopted:

1. Review of city data (plans, programs, project descriptions, policy documents, and other secondary data sources).
2. Pattern recognition, to see patterns in seemingly random data that might become dark data.
3. Review of the patterns
4. Report producing to elect relevant data pieces.

As an example, this standard procedure has been adopted in Barcelona for almost a decade and, as a result of its introduction in the so-called Smart waste disposal system – a synergy between BAT (Best Available Technologies), Data gathering, and Smart infrastructures (such as ultrasonic sensors mounted in the waste containers – Barcelona managed to prevent situations of building up, reduce operating and infrastructure costs and improved the state of the environment and quality of life (through reduced exhaust emissions and noise level due to a more efficient vehicle usage).[62]

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[60] GDPR. (2016). Regulation 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). European Parliament and the Council of the European Union. https://eur-lex.europa.eu/eli/reg/2016/679/oj

[61] Bibri, Simon Elias & Krogstie, John, The emerging data-driven Smart City and its innovative applied solutions for sustainability: the cases of London and Barcelona, Energy Informatics 3, Article number: 5 (2020)

[62] Nikitin K, Lantsev N, Nugaev A, Yakovleva A (2016) Data-driven cities: from concept to applied solutions. PricewaterhouseCoopers(PwC)
http://docplayer.net/50140321-From-concept-to-applied-solutions-data-driven-cities.html

The very specific nature of data and the plethora of interconnection points with the telecommunication sector opens up the opportunity to deepen data-oriented *modus operandi* and data-sustainability-oriented practices to explore the often-neglected dark data usage to debate the opportunity of Data sharing and collaborations with the Telco industry.

The COVID-19 pandemic struggle gave us an important example of how once-dark data came into use to curb the pandemic outbreak. Vodafone, one of the most important Telco players in the world, provided masses of anonymized telco data to national Governments and supra-national entities to analyze population-level mobility and help enact efficient actions to limit infections[63].

This is an extraordinary example of how anonymized and aggregated Telco data of cell tower locations, often considered raw dark data, offer a tangible sample of "Smart city in action", where decision-making processes are taken by dint of data analysis.

Other examples of possible usage of the data extracted from telco datasets can be crime monitoring and human behavior mapping[64], or urban mobility management[65].

A Vodafone case study and beyond: data gathering, privacy concerns, and cybersecurity measures

The extension of the Telco Data domain makes it imperative to ensure the highest privacy standards, especially in the European Union where the GDPR regulation 2016/679 is legally binding. Ethical assessments are also conducted in order to boost a trusting relationship between individual customers and Telco providers. Anonymization and aggregation are probably the most effective solutions to use these powerful data sets while preserving users' privacy. These solutions were adopted by Vodafone during the Pandemic outbreak through a "Privacy by design" phase where a Privacy Impact Assessment was conducted[66]. As an example, the types of data to be used were carefully chosen, enhanced encryption techniques were put in place, only aggregated datasets with more than 50 users were used, and pseudonymized random generated IDs were assigned to each user.[67]

These standards boost data-sharing best practices and high-quality, trusted, mechanisms providing security measures, service assurances and, in general, a trusted Telco space where users may feel safe. These pre-requirements are mandatory to drive new opportunities, both for communication service providers and customers. IDS connectors are an example of trusted data

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[63] An in deep explanation of the methodology adopted can be found in Lourenco, P. Rente, Kaur, Gurjeet, Allison, Matthew, Evetts, Terry, Data sharing and collaborations with Telco data during the COVID-19 pandemic: A Vodafone case study, PMC PubMed Central Journal, 22 Oct. 2021

[64] Douglass RW, Ram M, Rideout D and Song D (2015) High resolution population estimates from telecommunications data. EPJ Data Science 4, 10.1140/epjds/s13688-015-0040-6

[65] Steenbruggen J, Borzacchiello MT, Nijkamp P and Scholten H (2013) Data from telecommunication networks for incident management: An exploratory review on transport safety and security. Transport Policy 28, 86–102, 10.1016/j.tranpol.2012.08.006

[66] Lourenco, P. Rente, Kaur, Gurjeet, Allison, Matthew, Evetts, Terry, Data sharing and collaborations with Telco data during the COVID-19 pandemic: A Vodafone case study, PMC PubMed Central Jour-nal, 22 Oct. 2021

[67] *Ibidem*

spaces providing a safe and private environment: a European example is the “Gaia-X initiative”[68]. Gaia-X is an opportunity to unleash Telco Data while promoting a secure exchange and processing of data space, an updated Data governance compliance, and a security-certified digital environment.[6970] Cybersecurity in data-dependent sectors such as those around Smart City thematic areas is a sincere concern: secure planning and design, proactive supply chain risk management, and operational resilience must support privacy and users’ security while protecting ICT (information and communications technologies) and infrastructures as automation in their operations increases: these criteria boost both digital and physical people’s safety while protecting smart services from disruptions.[71]

Conclusions

This paper explored the main advantages of Telco Datasets and how they can help our communities by providing a tangible example. Firstly, we gave a broad definition of Smart city, what it is their main purpose, and why pieces of data are so important in efficiently implementing them. Then, we explored the concept of dark data and why a data-sustainability-oriented approach aimed at limiting this phenomenon is strongly advised. A possible solution is provided. To reinforce this statement, this piece of work tries to provide the Barcelona example of how efficient data gathering might enhance life quality and, in the Vodafone case study, how once-dark data helped curb COVID-19 consequences. In conclusion, this paper outlined the importance of privacy and cybersecurity in data-rich sectors, why they are so interconnected, and what measures can be enacted to assess possible risks.

[68] https://www.data-infrastructure.eu/GAIAX/Navigation/EN/Home/home.html

[69] *Ibidem*

[70] Centro Nazionale IOT e Privacy, Whitepaper: Physical Audience Measuring Technologies and Privacy Concerns

[71] In deep analysis can be found at https://www.cisa.gov/resources-tools/resources/cybersecurity-best-practices-smart-cities, a best practice guidance result of a collaborative effort from CISA, the National Security Agency (NSA), the Federal Bureau of Investigation (FBI), the United Kingdom National Cyber Security Centre (NCSC-UK), the Australian Cybersecurity Centre (ACSC), the Canadian Centre for Cyber Security (CCCS), and the New Zealand National Cyber Security Centre (NCSC-NZ).

How benchmarking might improve the development of product and service within the urban context

Agnese Bianchi and Tommaso Dradi

Why do we need benchmarking

Cities have been transforming into Smart Cities over the last ten years exploiting ICT, IoT and, widely, technology development under all points of view to develop new services and to ensure a better management of classical services. In this process, services are becoming day by day more integrated, efficient and, above all, data producer and data consumer. Data cover a central role since they enable service monitoring, produce information about the city and can support political decisions and daily operation.
This is possible since data about the city and of the city, collected by services, and data about each single service allow to measure KPIs and enable benchmarking procedures.
The continuous process of measuring KPIs and monitoring services and city performance helps to evaluate the maturity of services for each area of the city. Consequently, it is possible to identify gaps with respect to desiderata and support policy makers strategies, which become data driven and may be released with clear and measurable goals.
A clear strategy, defined by the Public Administration, data driven and based on objective and shared rules, can boost an organic growth of city services, also addressing investments on the city and private activities. In fact, making it clear the starting point and the goal, the path and all related activities will be easier identified.
Moreover, when the rules to compute KPIs are standard and shared between different cities, referring to parameters that do not suffer from city specific features (e.g. referring to density of population and not to the absolute number of residents), it is easier to compare the maturity level of same services and topics among cities. In this way, sharing solutions and best practices results easier, also simplifying reuse practice.

How benchmarking might improve the development of product and service within the urban context - Periodic city benchmarking and common frameworks

City benchmarking tools and research are widely spread and are often used to public city rankings. Some of them are listed and shortly described.

- Global Smart City Alliance - Smart Cities Policy Benchmarking Tool
  The Global Smart City Alliance, an organization supported by the World Economic Forum, released this benchmarking tool as a working tool for cities. It has been developed in

cooperation with member cities and it is based on a set of predefined policies about Open Data, Open Contracting, ICT Accessibility, Cyber Resilience, Cyber Accountability Model, Privacy Impact Assessment and Dig Once. The tool helps cities to take an assessment and, consequently, to make a gap analysis. This is considered the starting point to allow cities to verify the maturity level of services, to update strategies and release action plans.

- TM Forum: Smart City Maturity & Benchmark model.

The Smart City Maturity and Benchmark Model has been designed to capture the key aspects of a city's transformation journey to become a smarter city. It accounts many aspects of a city: from the level of engagement for citizens, to its attractiveness for business to the city operation. The model allows a city to quickly assess its strengths and weaknesses in five key dimension areas related to city smartness and to set clear goals as to how it wishes to transform over the next two to five years.

- ICity Rate by ForumPA. It is a smart city ranking released every year by Forum PA. This ranking is the result of the synthesis of many indexes, computed for each sector and summarized to refer to a single dimension or area. In the end, it is strongly summarized since it ends up in a general rank.

These are some experiences. Others may be summed up and explored, but these are enough to observe the missing of a standardized approach. Each of them is similar to the other, but refers to different methods and focuses on different areas.
Cities need either a referring model, standardized and shared among cities, or an internal benchmarking tool, standardized, adopted and officially recognized by the Administration. In this second case, it may be more difficult to compare results between cities, but at least it would be easier to make a self assessment and continuously update gap analysis and operative strategy, also addressing private initiatives and investments in the city.

How benchmarking might improve the development of product and service within the urban context : host a permanent space to discuss the benchmarking results and co-design the future of the city or the land starting with its citizens

Regardless of the benchmarking methodology, the resulting assessment should be made widely available to resident citizens and effort should be made by city's representatives to foster an open discussion with residents as well as with any other stakeholder. But the benchmark results should primarily be observed through the lenses of citizens' needs and local authorities should draw an action plan based on public consultation, before taking in account further corporate or external stakeholders' expectations.
Universities and research bodies have a critical role in connecting the dots between citizens and other stakeholders by identifying emerging needs or hidden obstacles, and this may happen beyond typical mobility and urban planning cases, by embracing also topics like privacy, data protection as well as other culture and society related issues.
This resident-centered process has two essential benefits: on one hand it guarantees that resident citizens could lead the way to a "smart city with a soul", a place which is always relevant

to them even when going through dramatic changes, because there is no such thing as a generic smart city. This does not mean that benchmarking has not to be pursued of course: it is very useful to speak a common language when tackling common problems across cities and lands.
On the other hand, it fosters local economies by creating the case for customised solutions or customised deployment of common solutions and widespread technologies, thus leading to increased effectiveness of any smart city initiative. Any other private body, by easily obtaining a clear picture about the most relevant items of the city's plan will likely be able to provide solutions that best fit that smart city environment.

Design and redesign of new products and services based on smart cities data

Giuseppe Ciniero

Smart cities have emerged as a central theme for enhancing the quality of life and promoting sustainable development in urban areas. The collection and analysis of urban data enable a better understanding of city dynamics and the identification of innovative solutions to address environmental, social, and economic challenges. In this context, the redesign and development of new data-driven products and services for smart cities play a crucial role in ensuring increased efficiency, sustainability, and inclusion.

Characteristics of the emerging market for smart city products and services

The market in which new products and services for smart cities are positioned discloses enormous growth potential and a fundamental innovative footprint. This market is characterized by a series of peculiarities that makes it unique and yet to be fully explored, offering opportunities and challenges for businesses, institutions, and citizens.

The increasing urbanization and the need to address the environmental, social, and economic challenges associated with this trend are accelerating the demand for smart city products and services. The smart city market is anticipated to continue growing at a steady pace in the coming years, with an increase in investments from governments, businesses, and international financial institutions. This presents a huge opportunity for companies operating in this sector, as well as for startups and innovators seeking to enter this emerging market.

What differentiates Smart City products/services from B2B/B2C products/services?

The creation of products and services for B2B (business-to-business), B2C (business-to-consumer), and Smart City markets presents a series of significant differences in terms of needs, expectations, and modes of development and marketing of proposed solutions. We will now explore the main differences among these three types of markets, focusing on the specificities and challenges associated with each of them.

a. B2B and B2C: common features and differences

While B2B and B2C markets share some similarities, they present substantial differences in the creation of products and services. Both markets aim to meet customer needs, but the nature of these needs and the way they are addressed vary considerably.

- **Customer needs:** in the B2B market, customer needs are often more specific and technical, related to particular sectors or production processes. In the B2C market,

customer needs are more diverse and constantly evolving, influenced by emotional, social, or cultural factors.

- **Decision-making process:** in B2B, the decision-making process involves various stakeholders within the organization and requires more in-depth evaluations of the impact of proposed solutions on the business. In B2C, purchasing decisions are often quicker and based on the attractiveness, accessibility, and user experience of the product or service.
- **Relationships between customers and suppliers:** in the B2B market, relationships tend to be more stable and long-lasting, based on trust and the ability to provide solutions that adapt to the ever-evolving needs of businesses. In B2C, relationships are more focused on individual purchases, with the emphasis on the immediate satisfaction of customer needs.

b. Smart City: a unique and challenging market

The Smart City market presents distinctive characteristics that set it apart from traditional B2B and B2C markets, creating an intersection between these two worlds and offering unique opportunities and challenges:

- **Involvement of multiple stakeholders:** Smart City products and services must take into account the needs of a wide range of stakeholders, including citizens, businesses, public administrations, and non-governmental organizations. This complexity requires a holistic and collaborative approach in the creation and implementation of solutions.
- **Integration and interoperability:** unlike B2B and B2C markets, where products and services can be designed to function independently or within specific sectors, Smart City solutions require extensive integration and interoperability among various platforms, technologies, and services. This implies the need to establish common standards and facilitate communication and data exchange among different systems and actors involved.
- **Sustainability and social responsibility:** in the Smart City market, environmental sustainability and social responsibility take on a prominent role in creating products and services. Unlike B2B and B2C markets, where these considerations can be secondary, in the context of Smart Cities, attention to sustainability and social inclusion is crucial for ensuring the success and acceptance of proposed solutions.
- **Regulation and governance:** the creation of Smart City products and services requires greater attention to regulatory and governance issues, as implemented solutions must comply with local and international regulations concerning privacy, security, and sustainability. This aspect adds another layer of complexity compared to B2B and B2C markets and necessitates careful planning and coordination among various stakeholders involved.
- **Innovation and technological development:** Smart Cities represent fertile ground for innovation and the development of new technologies, solutions, and business models. In this context, businesses and innovators must be able to anticipate and exploit emerging opportunities, working collaboratively and adapting rapidly to market transformations.

In summary, the Smart City market presents a series of challenges and peculiarities that differentiate it from traditional B2B and B2C markets. The creation of products and services for this market requires a holistic, inclusive, and sustainable approach, taking into account the needs of a broad range of stakeholders and fostering integration and interoperability among diverse technologies and services. Through collaboration, innovation, and attention to regulatory and social responsibility issues, it is possible to contribute to the development of more inclusive, resilient, and sustainable Smart Cities.

Designing new products and services for Smart Cities

The design of new products and services based on smart city data requires a holistic and collaborative approach that involves various stakeholders at different stages of the process. A co-design model can be used to structure this process, promoting active collaboration among different stakeholders, including designers, manufacturers, citizens, industry experts, and representatives of public administrations, with the aim of developing innovative and sustainable solutions that meet the needs of all actors involved.

The use of co-design methodologies allows for the integration of knowledge, skills, and perspectives from each stakeholder from the early stages of the development process, fostering an understanding of the needs and expectations of end-users and the creation of products and services that truly reflect their requirements. Furthermore, the direct involvement of various actors facilitates the sharing of responsibilities and the definition of common objectives, contributing to a sense of belonging and commitment to the project, which can ultimately promote the full adoption and utilization of the solution.

Description of a co-design process for the development of new products and services

Assuming we have the opportunity to bring various stakeholders to the table, a challenge that is far from simple in the contexts characterizing Smart Cities, we could divide the process into 4 main phases:

1. Identification of needs and definition of objectives

In this phase, it is crucial to involve stakeholders in defining the needs and objectives of the new products and services. Through meetings, workshops, and surveys, it is possible to gather opinions and expectations from citizens, businesses, and institutions, and integrate them with urban data analysis to identify the main priorities and challenges. The objectives defined in this phase must be clear, measurable, and aligned with the interests and needs of the involved stakeholders.

2. Ideation and prototyping

Once the needs have been identified and the objectives defined, stakeholders work together to generate ideas and develop innovative solutions. In this phase, it is important to promote creativity and experimentation through the use of co-design methods and tools, such as

brainstorming, mind mapping, and rapid prototyping. Direct involvement of end-users and practical experimentation with prototypes allow testing the effectiveness of the proposed solutions and gathering valuable feedback for product or service improvement.

3. Development and validation

After collecting feedback and refining the prototypes, it is necessary to develop and validate the new products and services. In this phase, it is important to involve technical experts and researchers to ensure that the solutions are based on solid scientific principles and are capable of operating effectively in the urban context. Validation may include laboratory tests, field trials, and impact analysis, which allow verifying the effectiveness of the solutions and identifying any issues or areas for improvement.

4. Implementation and monitoring

The final phase of the process involves the implementation and monitoring of the new products and services in the urban context. In this phase, it is crucial to involve institutions and companies responsible for the management and maintenance of urban infrastructure and services, to ensure effective integration of the developed solutions. Moreover, it is important to establish monitoring and evaluation mechanisms that allow measuring the impact of the new products and services on the quality of life, environment, and urban economy. Monitoring may include performance indicators, real-time data analysis, and user satisfaction surveys, which allow identifying any issues or areas for improvement and adapting the solutions to the needs and expectations of the involved stakeholders.

Stakeholders to involve in the co-design process

To ensure an effective and inclusive co-design process, it is crucial to involve a variety of stakeholders with different skills, experiences, and interests. Some of the key stakeholders to involve include:

- **Citizens**: the end-users of urban products and services, whose needs and expectations must be at the center of the co-design process.
- **Businesses** and start-ups: key players in the development and commercialization of new products and services, who can contribute with their technical and business expertise.
- **Public institutions**: responsible for the planning, regulation, and financing of urban infrastructure and services, who can facilitate the implementation of the developed solutions.
- **Researchers** and **universities**: experts in the field of science and technology, who can support the innovation and validation of the proposed solutions.
- **Non-governmental organizations** (NGOs) and **citizen associations**: representatives of local communities and specific interests, who can contribute to defining needs and objectives and ensuring an inclusive and participatory approach.

In general, by adopting a co-design approach that involves various stakeholders in the different phases of the process, it is possible to ensure that the developed solutions adhere to the needs and expectations of end-users and are capable of generating a positive impact in the urban context. However, the success of these initiatives will depend on the ability to overcome challenges related to data access and quality, collaboration among different actors, professional training, and privacy protection. With a joint commitment from all involved stakeholders, smart cities can become a reference model for a more sustainable and inclusive future.

Data: the enabler to achieve new milestones

Data, understood as raw, quantitative, or qualitative information collected and recorded through various sources and technologies, represents one of the fundamental elements in creating new products and services for Smart Cities, acting as an enabler for the reaching of previously unimaginable milestones. The availability of an increasing amount and quality of data, derived from a wide range of sources such as IoT sensors, mobile devices, social media platforms, and environmental monitoring systems, has revolutionized the way cities and businesses can design and implement innovative solutions to address urban challenges.

Firstly, the collection and analysis of data allow for an in-depth understanding of the needs, behaviors, and preferences of end-users, contributing to the creation of tailor-made products and services for different communities and urban contexts. For example, mobility data analysis can help to design more efficient and sustainable transportation systems, while energy data analysis can guide the development of solutions for optimizing consumption and renewable energy production. Furthermore, sharing and integrating data across different systems and actors can facilitate the creation of holistic and interconnected services that consider interactions between various sectors and aspects of urban life. For example, combining data related to waste management, mobility, and energy efficiency can enable the development of integrated strategies to reduce greenhouse gas emissions and improve air quality in cities.

The availability of real-time data and the ability to process it quickly through advanced technologies, such as artificial intelligence and machine learning, also allow the creation of more responsive and adaptable products and services to urban dynamics. This can result in solutions capable of predicting and responding to user needs in real-time, improving the efficiency and resilience of urban infrastructures.

Lastly, access to a wide range of data provides new opportunities for innovation and experimentation in the field of Smart Cities. Thanks to the unprecedented availability of data, innovators can explore new approaches, business models, and technological solutions, paving the way for products and services that could revolutionize the way we live and work in urban areas.

In summary, data is a fundamental enabler in creating new products and services for Smart Cities, allowing the achievement of new milestones through a better understanding of user needs, integration and interoperability between systems, responsiveness and adaptability of proposed solutions, and opening new frontiers in innovation and experimentation. The increasing amount

and quality of available data offer enormous potential for developing solutions capable of addressing urban challenges more effectively, sustainably, and inclusively, contributing to improving the quality of life in cities and creating more resilient and prosperous urban environments.

To fully exploit the potential of data in the context of Smart Cities, it is crucial to develop policies and strategies that promote sharing, accessibility, and interoperability of data among different stakeholders involved, while ensuring privacy protection and information security. Additionally, it is important to invest in training and developing specific skills for data analysis and interpretation, to support the growth of an ecosystem of innovators and professionals capable of driving the transformation of cities into smarter and more sustainable realities.

Only through a holistic, collaborative, and data-driven approach can we foster the creation of products and services that meet the needs of urban communities and contribute to achieving the goal of Smart Cities: improving the quality of life for citizens, reducing environmental impact, and creating economic and social growth opportunities for all inhabitants.

The scalability challenge

In the world of smart cities, the main challenge is scalability. How can a data-based product or service for a smart city be designed to grow and adapt to the ever-changing needs of cities? Scalability is crucial to ensure that the developed solutions can be adopted by a wide range of urban contexts, regardless of their size, demographic characteristics, or infrastructure.

To address the scalability challenge, it is important to consider several key factors in the design and development process of data-based products and services for smart cities. Firstly, it is essential to adopt a modular and flexible approach, which allows for the easy addition, removal, or modification of components and features based on the specific needs of each urban context. This also implies the use of open and interoperable standards, which facilitate integration between different platforms, systems, and devices. Furthermore, it is important to invest in the training and adaptability of the human resources involved in the management and implementation of data-based products and services for smart cities. This will ensure that solutions can be easily adapted and scaled to the diverse needs of cities and communities.

Another crucial aspect for ensuring scalability is adopting a data-driven approach, which allows for constant monitoring of product and service performance and making improvements and optimizations based on feedback and collected information. This requires a robust and scalable data infrastructure that can support the collection, analysis, and sharing of large amounts of data from various sources and in different formats.

Finally, it is essential to actively involve local stakeholders, such as public administrations, businesses, and citizens, in the development and implementation process of data-based smart city solutions. Collaboration between these actors will allow for the sharing of knowledge, resources, and best practices, facilitating the adoption and dissemination of solutions at both local and global levels. By addressing these factors, smart city solutions can become more

scalable and adaptable, ensuring that they can effectively address the diverse needs and challenges of urban contexts worldwide.

Conclusion

In conclusion, this chapter titled "Redesign and design of new products and services based on smart cities data" has explored the critical importance of urban data and its role in redefining and developing innovative products and services in the context of Smart Cities. We discussed the challenges and opportunities offered by the increasing availability of high-quality data and the evolution of technologies for their collection, analysis, and sharing.

Through the analysis of the different stages of the product and service development process, we highlighted the importance of a co-design approach that actively involves stakeholders, including end-users, industry experts, public administrations, and other relevant actors. This approach allows for the integration of knowledge and expertise from each stakeholder, promoting the creation of effective, sustainable, and tailored solutions for urban communities' needs.

Moreover, we examined the peculiarities of the Smart City market, highlighting the differences compared to traditional B2B and B2C markets and stressing the importance of developing specific strategies and business models for this context.

Finally, this chapter has underscored how data enablement and the increasing interconnection between urban sectors and systems open new frontiers for innovation and experimentation in the field of Smart Cities. Through sharing, integrating, and effectively utilizing data, it is possible to develop products and services that adequately address urban challenges, improve the quality of life in cities, and promote economic and social growth.

The future of Smart Cities depends on our ability to fully harness the potential of data and develop products and services that respond to the evolving needs of urban communities. Adopting a collaborative and data-driven approach, combined with investment in research, innovation, and training, is crucial to guide the transformation of cities into more intelligent, sustainable, and inclusive realities

Technologies for the urban data collection, sharing and reuse

Data collection technologies for smart cities

Tommaso Dradi and Agnese Bianci

The vision: Digital Urban Ecosystem as a service to enable the development of new services

The Urban Digital Ecosystem is a public service offered by the Municipality of Milan. It allows the sharing in real-time of data about city services, between users and with standard methods, through defined and accessible application interfaces. The service is regulated with a set of policies which define the legal framework and it is offered via a digital platform.
The Urban Digital Ecosystem aims at reducing barriers and costs to access dynamic data shared by public and private bodies operating across the city's boundaries, both by creating a single place to establish multilateral agreements as well as by promoting technical and semantic standards for data.
The birth of the Urban Digital Ecosystem within Enterprise Architecture in the Municipality was established with the Municipal Council Resolution n° 620/2020 having as its object "Approval of the guidelines for the adoption of the Enterprise Architecture model of the Municipality of Milan and for the governance of the Urban Digital Ecosystem".
The Resolution recognizes that it is necessary for the "public entity" to define a set of rules to encourage the sharing of data and services among all entities operating in the city with standard and interoperable protocols. It is expected that this would boost the development of an innovative and inclusive smart city, where data produced by the city's public spaces are valorised and, if made accessible and usable, can be considered common goods with economic and research value. Moreover, the Municipality would have access to a lot of information about services operated by other entities, supporting the Administration's governance choices. The last point, even if in undirect way, is a benefit for citizens who enjoy better public services.
The reference legislation is the following.
At European level:

- European Directive 2013/37/EU
- EU Directive 2019/1024 of the European Parliament and of the Council
- Regulation 2022/868 of the European Parliament (Data Governance Act)

At the national level:

- Legislative Decree n° 200/2021
- Three-year plan for IT in public administration 2022-2024

In the Municipality of Milan

- Council Resolution 620/2020 – already mentioned
- Council Resolution 1475/2020 with consequent Implementation Resolution DD 2021/9756 on Open Data

The Urban Digital Ecosystem has tackled the challenge of leveraging shared Data Spaces on a city-wide scale since the early phases of policy draft (2020). This is why the project is already compliant with the principles drafted in the Data Governance Act: the Milan Council role is very close to that of a “data intermediary” depicted by the regulation, and will be largely based on voluntarily data contributed by public and private bodies under the “data altruism” paradigm.

The service: terms and conditions and membership agreement

As introduced, the Urban Digital Ecosystem is a public service that allows members to publish dynamic information related to the services they manage or view information published by other entities. The service is enabled by an IT platform for publishing and reading information, effectively an API Manager, that is managed by the Municipality of Milan free of charge for members. The platform itself and, at same way, the service are regulated by some rules which set many aspects as: the methods of membership, of information sharing, the methods of integration with the platform, the usage licenses for data, the calling methods, the SLAs, the aspects related to privacy, ...
Each member must accept the rules of the Ecosystem in order to use the service.
Moreover, each provider (i.e. the member who wants to share data about its service with other members) is required to fulfill a “Membership Agreement” and submit it to the Municipality of Milan. The “Membership Agreement” is a paper where are defined some features for each single service published. Main features regulated in this document are those related to service levels (latency, throttling policies, ...) and those related to the opening level for each single service.
The opening level for each service must be regulated because the service provides that each single API published may be available for different categories of users at different levels of opening: it may be in an open format, therefore for all members, only for some categories of members (e.g. for universities, but not for other companies) or for the Municipality of Milan. The access level is defined by the data provider during the publication phase. The provider can also decide to assign different levels of access for the same service: some information about that service may be available for all members and other information about that same service may be available only for a category of users. From this two key facts:

- Users are profiled during their access only to make possible the match
- Providers can decide to share information with other members in a non discretional way, in fact each API must be accessible for categories of users and not for a single one (i.e.: if it is open to universities, then all the universities will have access to it).

The project is nowadays developing and transforming from a Proof of Concept to a real public service, also leveraging on some agreements and collaboration activities with Associations and Societies based in Milan and offering services on the city

Synthetic Data for Enhanced Urban Data Sharing

Daniele Panfilo

Introduction

Urban data analysis is crucial in achieving sustainable development goals. It may for instance match energy supply and demand across time and geography, avoiding dissipation[72]. Governments can further leverage this in urban design and subsidy allocation. Likewise, companies can use analytic insight when choosing facility locations. Recent advances in Artificial Intelligence (AI), optimize energy supplies[73]; bus routes[74]; and more.

Unfortunately, these applications require vast amounts of data. Such data are often unavailable due to privacy restrictions. When available, they tend to contain information gaps, or underrepresent specific social segments. In consequence, urban information cannot flow across departments and organizations, hampering analysis.

Synthetic data, a novel paradigm in data completion and protection, overcomes these obstacles. A revolutionary approach to reconciling data privacy and utility, it occurs in seminal documents: the European Union's AI Act and Data Governance Act; and the United State's National Strategy to Advance Privacy-Preserving Data Sharing and Analytics. This paper introduces synthetic data technology and quality assurance. The merits of synthetic data are then illustrated in the context of smart cities.

Synthetic Data and its benefits

Synthetic data are not gathered through empirical means. Instead, they are artificial, and constructed by algorithms. Thus, a record in a synthetic dataset cannot be linked to any real data

[72] Keirstead, J., Jennings, M. and Sivakumar, A., (2012). A Review of Urban Energy System Models: Approaches, challenges and opportunities. *Renewable and Sustainable Energy Reviews* 16(6), pp. 3847 – 3866, ISSN: 1364 - 0321.

[73] J.R. Duflou et al., (2016). Impact Reduction Potential by Usage Anticipation under Comfort Trade-Off Conditions. *CIRP Annals* 65(1), pp. 33 – 36. ISSN: 0007-8506.

[74] Aktas, D., Sörensen, K. and Vansteenwegen, P., (2022). A Demand-Responsive Public Bus System with Short-Cut Trips. *Proceedings of the 2022 Conference on Advanced Systems in Public Transport (CASPT 2022)*.

subject. Advanced AI methods[75] can generate synthetic data with an unassailable degree of realism. Analysis of such synthetic data leads to all the insight that analysis of a real dataset would. Furthermore, as the data is artificial, its analysis does not breach real citizens' trust. Synthetic data can securely and reliably substitute real data in smart city projects. It can enable urban data sharing and analysis at scale.
Furthermore, synthetic data can augment real data when information gaps hinder analysis. This prevents inaccuracies and bias in results and AI models. For example, a difference in response rates between more and less affluent urban districts may lead to unfair AI systems. Due to data availability, such systems may favor affluent areas in infrastructure design. Inflating underrepresented samples through synthetic data removes such unfairness.

Synthetic Data Technology

A small thought experiment illustrates how synthetic data can be realistic. Suppose one wants to create artificial data with the properties of a real population. They did research and have documented the population's properties. For example, they know that the female-male ratio of the population is equal. Furthermore, they know that roughly one in six people have blue eyes, while the others have brown eyes.

To create the data of an artificial person, they now do a small experiment: first, they flip a coin. If it lands on heads, they mark it down "female". If it lands on tails, they mark down "male". Next, they roll a die. If it lands on the face with six eyes (a chance of 1/6), they mark down "blue eyes". If it lands on any other face (1, 2, 3, 4 or 5, a chance of 5/6), they mark down "brown eyes". Repeating this experiment many times gives a synthetic population with realistic properties.

Generative AI operates in a similar, though more sophisticated fashion. In the thought experiment, the experimenter has advanced prior knowledge about the population. Generative AI requires no prior knowledge: patterns are directly inferred from the data. These patterns are far beyond human comprehension, hence the synthetic data is hyper-realistic. Anomalies, dependencies, and hidden patterns are all replicated directly and effortlessly.

Synthetic Data Quality Assurance

Synthetic data has to meet two conditions:

1. it should not disclose sensitive information of the real data it emulates ("*privacy*");
2. it should preserve the analytic value of said real data ("*utility*").

[75] D. Panfilo et al., (2023). A deep learning-based pipeline for the generation of synthetic tabular data. *IEEE Access*, Vol. 11, pp. 1–1, 2023.

Scientific measures[76,77,78,79] show how well these conditions are satisfied.

A privacy assessment method gaining popularity is the use of deliberate privacy attacks[80]. These are attempts to retrieve personal sensitive information from a synthetic dataset, as depicted in Figure 1. Suppose deliberate attacks cannot recover information about real individuals. Then the synthetic dataset offers a superb degree of protection. In practice, attack efficacy against synthetic datasets is negligible[81].

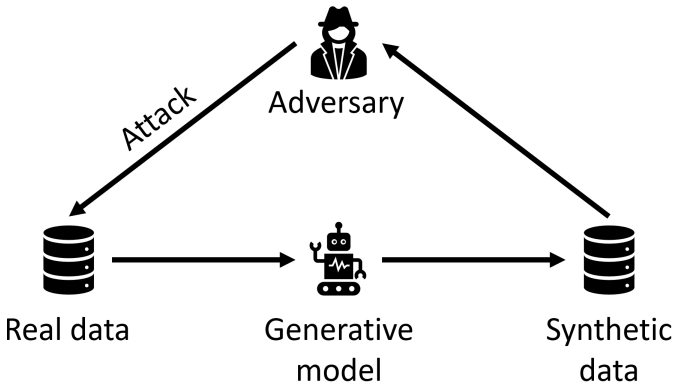

Figure 1. Conducting deliberate attacks to measure synthetic data privacy. The adversary tries to reidentify real data subjects based on the available synthetic data.

There are multiple ways to assess the analytic utility of synthetic datasets. For each attribute, the behavior of synthetic data should mimic that of real data. This is easily verified, as illustrated in Figure 2 for the attribute age. Synthetic data should also capture the dependencies between attributes. Comparisons of real and synthetic correlations reveal how well such dependencies are preserved. The performance of AI models trained on real data and trained on synthetic data is also compared to measure analytic utility.

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[76] E. Cristofaro (2020) An overview of privacy in machine learning. 2005.08679

[77] M. Hittmeir, A. Ekelhart, and R. Mayer, (2019). Utility and Privacy Assessments of Synthetic Data for Regression Tasks. *2019 IEEE International Conference on Big Data*.

[78] M. Hernandez et al., (2022). Synthetic Data Generation for Tabular Health Records: A Systematic Review. *Neurocomputing* 493, pp. 28-45.

[79] B. van Breugel and M. van der Schaar, (2023). *Beyond privacy: Navigating the opportunities and challenges of synthetic data*.

[80] See, e.g. M. Giomi et al., (2022). *A unified framework for quantifying privacy risk in synthetic data*.

[81]See, e.g., the "hide-and-seek privacy challenge", in which contestants were challenged to attack synthetic datasets. They typically could not infer any statistically significant amount of sensitive information about real data subjects: J. Jordon et al. (2021). Hide-and-seek privacy challenge: Synthetic data generation vs. patient re-identification. In: *Proceedings of the NeurIPS 2020 Competition and Demonstration Track* (H. J. Escalante and K. Hofmann, eds.), vol. 133 of Proceedings of Machine Learning Research, pp. 206–215, PMLR, 12 2021

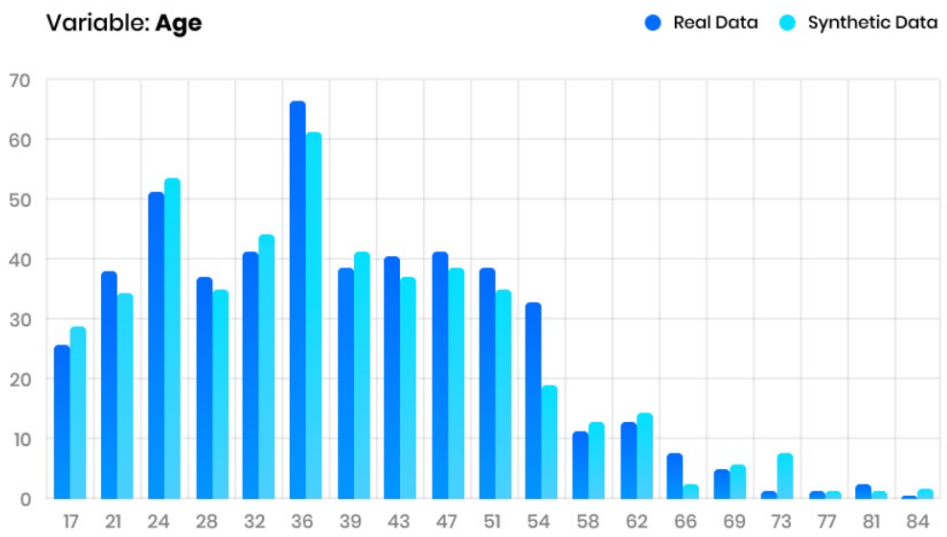


Figure 2. Utility is preserved: the overall distribution of the synthetic data closely resembles that of the real data.

Synthetic Data for Smart Cities: a use case

Problem. The local government of a city wants to increase the efficiency of its road network. To do so, they want to impose demand-dependent tolls on a selection of roads. *Congestion pricing* encourages travellers to disperse over the network, reducing their travel expenditures. Appropriately chosen tolls minimize travel times, costs, and energy consumption[82,83].
Unfortunately, determining optimal tolls involves the processing of citizens' travel demands. Such data details at what moments particular citizens are at particular locations. While the local government collects this information, it is highly sensitive. Privacy guidelines prohibit its exchange to external consultants. This hinders analytics service providers from designing optimal tolling strategies.

Solution. Generative AI methods construct *synthetic traveller profiles*. Such synthetic data do not pertain to real travellers. Yet, they accurately capture the travel demand on the city's road network. The local government shares these synthetic traveller profiles with the external consultant. The consultant applies network optimization tools directly to the synthetic data. This process culminates in cost-effective, time-efficient optimal toll design.

Value added. Synthetic data allows the consultant to work directly with realistic information. This translates into tolling strategies dispersing traffic of very high quality. By contrast, legacy

[82] F. Ahmad et al., (2023). Game theory applications in traffic management: A review of authority-based travel modelling. *Travel Behaviour and Society*, vol. 32.
[83] K. Staňková and A. Boudewijn, (2015). *Stackelberg and Inverse Stackelberg Road Pricing Games: State of the Art and Future Research*.

approaches use mathematical models rather than a data-driven approach. These are prone to inaccuracies and human bias.

Besides quality improvements, synthetic data offers cost and lead-time reductions. Synthetic data is directly available to the consultant. This allows them to efficiently run their optimization methods and come to promising conclusions. By contrast, legacy model building involves numerous stakeholders discussions. This latter process is time consuming and costly.

Conclusion

We outlined the importance of synthetic data for smart city initiatives. Privacy restrictions, bias, and data gaps hinder the use of real data for these purposes. Synthetic data overcomes these challenges by offering a complete, nuanced, and privacy-respectful alternative.

Synthetic data is artificial, constructed by algorithms rather than empirical data gathering. As such, a synthetic data record does not pertain to any real individual. Through generative AI, synthetic data preserves the realism needed for data-driven innovation. It can substitute or improve real data in smart city projects. This results in more safety, accuracy, and fairness in AI systems. Scientific methods can measure both privacy protection and realism. This allows for the construction of synthetic data that does not compromise either goal.

Finally, we presented a practical use case for synthetic data in smart cities. Optimal toll design is an approach to minimizing congestion in a road network. Unfortunately, local governments depend on external consulting firms for the involved analytics. Real traveler profiles are confidential and cannot be disclosed to the consultants. Synthetic data helps derive toll designs outperforming those of state-of-the-art mathematical models. Moreover, these can be delivered rapidly and cost-effectively.

Synthetic data technology will revolutionize urban data analysis: it overcomes privacy concerns, completes information, and removes implicit bias.

Sharing mobility data for redesigning public services

Emanuele Strano

Introduction

At the heart of the Smart City is the individual, the fulcrum of this ecosystem. The way in which citizens move is what most influences the urban environment, therefore mobility data becomes the fundamental element for intelligent city planning.

If moving is a primary need, the task of technology is to help people do it in a simple, safe and efficient way. People are constantly on the move for work, study and recreation related reasons and other daily activities. Effectively managing these flows of people and vehicles is essential for planning cities, improving people's quality of life, and addressing pressing challenges such as urban air pollution and growing traffic congestion.

Digital technologies have revolutionized the collection and processing of mobility data. Through GPS devices, mobile phones, traffic sensors and social media, it is possible to obtain detailed information on the movements of people and vehicles and thus have a valuable overview of traffic flows inside and outside inhabited centres, travel behaviour, and user transport preferences.

With a view of building a true Smart City, whose primary objective must be the improvement of the quality of life of citizens, it is essential to anticipate the symbiotic integration of four closely interconnected layers:

- **Infrastructures and Networks**: represent the fundamental layer that includes all technologies enabling connectivity, from broadband connections to 5G.
- **Sensors and IoT**: the second layer consists of the ecosystem of devices that use connected services to transmit information (such as sensors for collecting mobility data).
- **Service Platform**: the third level is the management operations centre, which constitutes the platform for processing and distributing information to the various parties through a communication network. In addition, this layer facilitates the aggregation and analysis of data from previous layers.
- **Applications and Services**: this level includes web and mobile applications and services that create added value for citizens and institutions. These applications represent the point of contact between public bodies, their services, and citizens.

Collecting, analysing, and understanding mobility data is crucial for planning transport, optimizing public services, and developing sustainable mobility solutions. These data, integrated into

Artificial Intelligence and Data Intelligence systems, are the constituent elements of a true Smart City.

Types of data

In the context of Smart Cities, there are different types of data related to mobility.

- **GPS data**: detected by satellite tracking devices such as cell phones or vehicle tracking systems, they provide information on the location and path of people or vehicles.
- **Mobile telephony data**: collected by telephone companies, these data allow to understand traffic flows, people movements, and population density in specific urban areas.
- **Public transport data**: provided by transport companies, these data include information on journeys, arrival or departure times and use of stations, useful for optimizing public transport services.
- **Electronic ticketing data**: they record information on passenger movements, making it possible to analyse flows and improve the efficiency of transport services.
- **Traffic sensor data**: collected from ground sensors or monitoring cameras, these data provide information on traffic speeds, road congestion, and help improve infrastructure planning.
- **Social media data:** coming from posts on platforms such as Twitter or Instagram, they offer indirect information on people's mobility and travel trends.
- **Data from surveys**: they are collected to obtain first-hand insights into people's mobility behaviour, including transportation preferences and travel habits.

Data collection and sharing: the Blimp Case

The effective development of a Smart City revolves around the central role of individuals within the urban ecosystem. The way citizens move within a city significantly impacts its dynamics, making mobility data a cornerstone of intelligent urban planning.

In pursuit of a true Smart City, Blimp has contributed by facilitating the development and testing of solutions rooted in Artificial Intelligence by supplying precise mobility data derived from various sources with the aim to support urban development and planning.

The goal is to enable the creation of applications that optimize various aspects of the Smart City, such as:

- **The optimization of Municipal services** and therefore a reduction in costs, for example through public lighting based on real flows of passers-by.
- **Improving the quality of existing services**, for example by predicting the impact of changes to road networks or adapting safety measures based on attendance at public events.

- **The creation of new services for citizens** using the data collected, for example with applications that manage public car parks in real time or communications to citizens in relation to events and warnings.

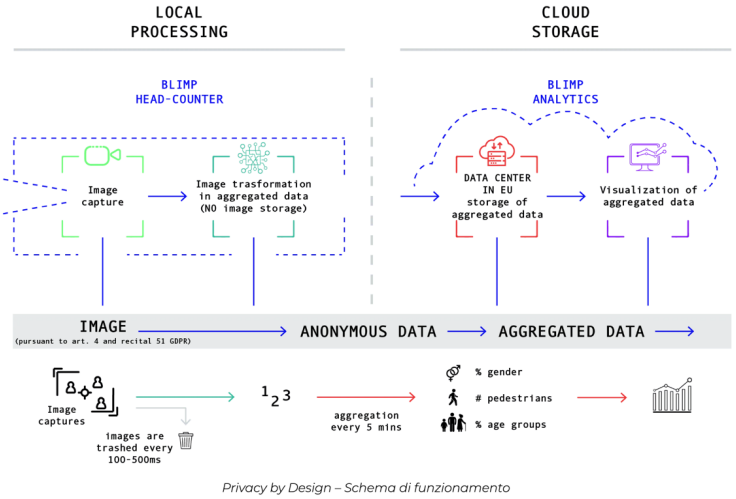
Blimp's solution consists of two elements: the Head-Counters, which are artificial intelligence sensors installed in the field for the acquisition of anonymous and aggregated data on pedestrian and vehicular flows; and the cloud platform that collects Head-Counter data, integrating it with third-party data (such as mobile phone, GPS and public transport data), and subsequently displays it on the dashboard.

Blimp's technology adheres to the “Privacy by Design” principle, ensuring the protection of personal data: the Head-Counter sensors can process images in an interval of instants ranging from 100 to 500 milliseconds. During this time, a series of proprietary algorithms process the photographs inside the volatile memory (RAM) to extrapolate the numerical parameters. Once the extrapolation has taken place, the Device irreversibly erases the image.

Through its own Head-Counter sensors and the acquisition of data from third parties (such as telco and mobile companies), this technology makes it possible to monitor the influx of people who move on foot within public spaces, preventing situations of excessive gatherings or anomalous flows. This is achieved through the analysis of the number of pedestrians, their directionality, and the time spent in the monitored areas, predicting any dangerous situations and reporting them in real-time as soon as they occur.

Furthermore, it is possible to analyse traffic conditions in real time, monitoring vehicle flows in main junctions even outside urban centres based on parameters such as the number of vehicles in transit, their classification (cars, motorcycles, trucks, buses, etc.), their directionality, the speed and danger index, and any prohibited uses, such as driving against traffic or parking on the sidewalk.

The reliability of the technology has been validated under various conditions, indoors and outdoors, with different distances, weather, and lighting conditions, demonstrating reliability with metrics accuracy ranging from 91.5% to 99.9%, depending on environmental conditions.



Privacy by Design – Schema di funzionamento

Figure 1 The image analysis and acquisition system developed by Blimp is able to take photographs that are then processed by a calculation unit inside the meter to obtain relevant information excluding any identifying element, therefore remaining anonymised and numerical. More details can be found at the following link.

Sharing at the center of the ideal Smart City

In Smart Cities, each entity (or stakeholder) collects data to pursue its own specific purposes. For example, public transport companies are interested in optimizing services during peak hours, while waste management companies are interested in improving the efficiency of their vehicle fleets. Although the purposes may vary, some essential aspects require particular attention: the protection of privacy, as well as the choice of the right technology to integrate the data collected, in addition to the quality and level of detail of this data.

In this context, grouping the goals of the various stakeholders could prove to be an effective solution for reducing the costs associated with data collection (infrastructure, management and maintenance) and at the same time improving the urban environment. If the Public Administration were able to divide the investment costs among stakeholders, this sharing would allow each party to benefit and, more importantly, it would have a positive impact on the lives of citizens.

The heart of data collection in a Smart City is always, and in any case, the centrality of people, and privacy is both a fundamental element for the citizen and a priority for the Public Administration.

Data regarding the movement of citizens is therefore produced and collected for their own benefit. Transparency in using data therefore helps to build trust between the Public Administration and citizens, making the process of building a Smart City shared and participatory. The protection of

personal data becomes a commitment to ensure an efficient and safe urban environment for everyone.

In summary, if all the parties involved share the focus on citizens' quality of life and collaborate in the collection and use of data, a smart and sustainable city can truly be built. A city that reflects the needs and desires of those who live there. A Smart City that makes data an element for progress and collective well-being.

Conclusion

In building a concrete and sustainable Smart City, the Public Administration would be responsible for the ownership of the data, which should be shared, according to appropriate logics, with the stakeholders who have contributed to the investment of the various technological layers for the collection of that data.

The ideal goal of Smart Cities applications is to optimize the Municipality's investments in citizen services through the sharing of infrastructure and data engaging in joint projects where infrastructure and sensors are backed by players from the advertising world. This synergy allows to obtain useful metrics for the business of partners, who see an increase in revenues through innovative business models.

At the same time, the same infrastructure could also prove to be extremely useful for the Public Administration, which would take advantage of the territorial data to implement strategies aimed at improving the city.

The same principle could be applied to other contexts such as, for example, brands that want to measure the performance of shop windows or the local police that want to monitor key areas with video surveillance systems. Even in these cases, there is the opportunity to enrich the data relating to mobility by sharing the infrastructure and the related costs.

In practice, technology becomes a strategic resource for various stakeholders, each with specific purposes regarding the collection and analysis of data. The result is an overall enhancement of services, to the benefit of the entire community.

Collaboration between the various stakeholders thus proves to be a winning opportunity for all interested parties, creating a unique synergy that makes it possible to build an efficient, sustainable, and innovative Smart City.

Sustainable Waste Management in Smart Cities: A Data-Driven Approach with Xworks

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Electra Coutsoftides

Introduction

Waste management is one of the most significant challenges that smart cities face today. With the rise in urbanisation and population density, traditional waste management practices such as landfills and incineration have become unsustainable and environmentally hazardous. To tackle these challenges, the use of data has become increasingly crucial in waste management. Xworks is a company that is leveraging data to help smart cities achieve their sustainability goals by tracking waste digitally and promoting transparency in waste management.

Challenges in Waste Management:

Smart cities are characterised by high population density and limited resources, making waste management a significant challenge. The increasing amount of waste generated in cities puts a significant strain on traditional waste disposal methods such as landfills and incinerators. Improper waste disposal can also pose health hazards, particularly in developing countries where waste is often dumped in open landfills. To address these challenges, smart cities need to adopt sustainable waste management practices.

Importance of Data in Waste Management:

In the current age of digitalization, data is a valuable asset that can help businesses and cities optimise their waste management operations. By leveraging data, it is possible to identify inefficiencies and develop strategies for improvement. Data-driven approaches can also help reduce costs and improve efficiency in waste management operations.
Data is playing a vital role in waste management by providing insights into waste generation patterns and identifying opportunities for waste reduction and recycling. Data-driven approaches can also optimise waste management operations, reducing costs and improving efficiency. By tracking waste digitally, cities can gain a better understanding of waste generation patterns and make informed decisions about waste management strategies. This is where Xworks comes in, being at the forefront of this movement, collecting real-time data on waste generation, transportation, and disposal.

The Role of Xworks:

Xworks is playing a vital role in collecting data to help cities achieve their sustainability goals. Their platform collects real-time data on waste generation, transportation, and disposal, allowing

cities to track waste across the entire value chain. With this data, Xworks can identify areas for improvement and help businesses and cities develop strategies to reduce waste and improve sustainability practices. Xworks' platform also promotes transparency and accountability in waste management, providing real-time data on waste flows and ensuring compliance with regulations.By leveraging the power of data, Xworks is helping smart cities achieve their sustainability goals.
Waste management is a critical issue in smart cities, but data-driven approaches offer a promising solution. Xworks is one company leading the way in data collection and sharing, helping cities and businesses achieve their sustainability goals by tracking waste digitally and promoting transparency in waste management. Xworks is at the forefront of this movement. By leveraging the power of data, we can create a more sustainable future for our planet.

The Current State of Waste Management:

- **Global waste growth projections by the World Bank:**

The world is facing a growing waste crisis. According to the World Bank, global waste generation is projected to increase by 70% between 2016 and 2050, with an estimated 3.4 billion tonnes of waste produced annually by 2050. This trend is particularly pronounced in developing countries, where urbanization and population growth are contributing to an increase in waste generation.

- **Average daily waste generation in developed countries:**

In developed countries, the average daily waste generation per capita is around 2 kg, with the United States generating around 239 million tonnes of waste per year. While traditional waste disposal methods such as landfills and incineration have been the go-to solutions for managing waste, they are not sustainable in the long term.

- **Strain on landfills and incinerators:**

Landfills and incinerators are facing increasing strain as waste volumes continue to grow. Landfills take up valuable land resources, and incineration produces harmful emissions that contribute to air pollution and climate change. Improper waste disposal can also lead to health hazards, particularly in developing countries where waste is often dumped in open landfills.

- **Health hazards of improper waste disposal:**

In addition to the environmental and health hazards, the cost of waste management is also a significant burden on governments and communities. The traditional approach of disposing of waste in landfills and incinerators is costly, and the fees associated with waste disposal can quickly add up.

The current state of waste management is unsustainable and presents a significant challenge for smart cities. To address this challenge, innovative and sustainable waste management practices are required. One such approach is data-driven waste management, which can optimise waste management operations, reduce costs, and improve sustainability practices.

The Changing Regulatory Landscape

- **Introduction of waste management regulations in different countries:**

As the world becomes more environmentally conscious, governments around the world are introducing waste management regulations to reduce the negative impact of waste on the environment. These regulations are designed to promote sustainable waste management practices and encourage the use of innovative technologies that reduce waste and increase recycling.

- **EU's target to recycle 55% of municipal waste by 2030:**

In the European Union (EU), the Waste Framework Directive sets out the legal framework for waste management in member states. The EU has set an ambitious target to recycle 55% of municipal waste by 2030, which is a significant increase from the current recycling rate of around 44%. This target is designed to reduce the amount of waste that ends up in landfills and incinerators and encourage the use of sustainable waste management practices.

- **UK's commitment to net-zero emissions by 2050:**

In the United Kingdom (UK), waste management regulations are guided by the UK Waste Strategy, which sets out the government's approach to waste management. The UK has also committed to achieving net-zero emissions by 2050, which will require significant changes to waste management practices. This commitment has led to increased investment in sustainable waste management technologies and innovative approaches to waste reduction and recycling.

- **US states' laws on electronic waste recycling:**

In the United States, individual states have introduced laws to promote waste reduction and recycling, particularly in the area of electronic waste. For example, California has implemented the Electronic Waste Recycling Act, which requires retailers to provide consumers with free and convenient options for recycling electronic waste. This law has helped to divert significant amounts of electronic waste from landfills and promote the reuse of valuable materials.

As the regulatory landscape continues to evolve, waste management companies must adapt to comply with new regulations and meet sustainability targets. Data-driven waste management is an effective approach to achieve compliance and improve sustainability practices. Xworks plays an important role in this process, collecting data across the entire waste management value chain to understand where improvements can be made to achieve sustainability goals. This data can then be shared with businesses and authority bodies to create lasting change and promote a more sustainable future.

Waste management in smart cities requires a data-driven approach to promote sustainability and improve operational efficiency. By collecting and analysing real-time data, waste management

companies can identify waste generation patterns and opportunities for waste reduction and recycling. This information can then be used to optimise waste management practices and reduce the negative impact of waste on the environment.

The Need For Data

- **Importance of data in identifying waste generation patterns:**

Data is essential to identify trends in waste generation, and it allows waste management companies to develop effective waste management strategies. For example, by analysing data on waste generation rates, companies can identify areas where waste reduction efforts are needed, such as in households or commercial buildings. This approach allows waste management companies to target their efforts more effectively and achieve better results.

- **Opportunities for waste reduction and recycling:**

Effective waste management requires a comprehensive understanding of the waste generation patterns, waste reduction opportunities, and recycling capabilities of a given region. The importance of data in waste management cannot be overstated. The availability of data on waste generation, recycling, and disposal allows waste management companies to identify trends and develop effective strategies to reduce waste and promote sustainability.

- **Use of data-driven approaches for waste management optimization:**

One key aspect of waste management that requires data is waste trading and recycling. Waste trading refers to the buying and selling of waste materials between companies, while waste recycling involves transforming waste materials into new products. In both cases, it is critical to track the waste from the supply side through the value chain to where it will be recycled. This allows waste management companies to ensure that not too many hands are involved, and that the waste is being sent to a legitimate recycling facility.

Xworks' role in collecting real-time waste data:

Xworks plays a critical role in this process by collecting real-time waste data. By using advanced technologies, Xworks can track waste materials from their source to their final destination. This enables waste management companies to understand where the waste is going and ensure that it is being recycled properly. In addition, Xworks can track the recycled materials back to the consumer, providing a full picture of what happens to waste materials after they are discarded.
By collecting and analysing data on waste trading and recycling, waste management companies can identify opportunities for waste reduction and recycling, and optimise their waste management practices. This not only promotes sustainability but also reduces the negative impact of waste on the environment.
The collection of data on waste trading and recycling is essential to effective waste management in smart cities. By using data-driven approaches to track waste materials from their source to their

final destination, waste management companies can ensure that waste is being recycled properly and promote a more sustainable future.

Data is critical to effective waste management in smart cities. By using data-driven approaches to identify waste generation patterns and optimise waste management practices, waste management companies can reduce costs, improve sustainability, and promote a more sustainable future. Xworks plays a key role in this process by collecting real-time waste data and enabling waste management companies to optimise their practices.

Transparency Changing The Waste Management Landscape

- **Benefits of transparency in waste management:**

Transparency is a crucial element in the waste management industry which is now taking centre stage, and it is helping to promote more sustainable waste management practices. By providing real-time data on waste being traded, transported, disposed, and recycled, Xworks is playing a critical role in promoting transparency and accountability in waste management.

- **Use of digital technologies to track waste from generation to disposal and/or recycling**

The benefits of transparency in waste management are numerous. It helps to build trust between waste management companies, their clients, and the public, while also promoting compliance with regulations and standards. Digital technologies like Xworks' platform are transforming waste management by enabling real-time tracking of waste throughout the value chain.

- **Promoting transparency and accountability in waste management:**

Xworks' platform provides real-time data on waste generation, transportation, disposal, and recycling. This data allows waste management companies to track waste at every stage of the process, ensuring that it is handled properly and sustainably. By providing a clear and concise view of waste management practices, the platform also helps to identify areas for improvement and promote more sustainable waste management practices.
In addition to promoting transparency, Xworks' platform also facilitates accountability. By tracking waste materials, waste management companies can identify the parties responsible for waste generation, transportation, disposal, and recycling. This helps to promote responsible waste management practices, and also ensures that waste is handled in an environmentally friendly manner.
Transparency is changing the waste management landscape in smart cities. Digital technologies, such as Xworks' platform, enable waste management companies to track waste from generation to disposal, promoting transparency and accountability. By providing real-time data on waste generation, transportation, and disposal, the platform also facilitates more sustainable waste management practices. Ultimately, transparency and accountability are essential components of effective waste management and promote a more sustainable future for our planet.

The Role of Xworks

- **Xworks' platform for data collection across the entire waste management value chain:**

As waste management continues to be a critical aspect of creating sustainable smart cities, the need for real-time data collection across the entire waste management value chain is becoming increasingly crucial. Xworks is at the forefront of providing a comprehensive platform for collecting this data.

- **Real-time waste data for optimizing operations and identifying areas for improvement:**

Xworks' platform is designed to collect real-time data on waste being traded, transported, disposed, and recycled. This data provides valuable insights for optimising operations and identifying areas for improvement. By using Xworks' data-driven approach, waste companies and businesses can identify the most efficient and sustainable methods for managing waste.

- **Demonstrating compliance with regulations through data-driven approaches:**

Furthermore, Xworks' platform is also essential for demonstrating compliance with regulations. Governments worldwide have introduced regulations that make it mandatory for waste management companies to track waste digitally. With Xworks, companies can ensure compliance by tracking waste from the point of generation through to disposal or recycling.

- **Xworks' platform for promoting transparency and accountability in waste management:**

Xworks' platform also promotes transparency and accountability in waste management. By providing real-time data on waste generation, transportation, and disposal, Xworks helps waste companies to be transparent about their operations. This transparency not only builds trust with customers but also helps to improve the overall image of the waste management industry.

Xworks' platform is essential for waste companies and businesses to achieve their sustainability goals. By providing real-time data across the entire waste management value chain, Xworks is helping to optimise operations, comply with regulations, and promote transparency and accountability while incentivising good behaviour reducing carbon and plastic footprints.

Sharing Data To Create Lasting Change

- **Importance of sharing data in achieving sustainability goals:**

Sharing data is critical to achieving sustainability goals, as it allows businesses and authorities to identify areas for improvement and develop more effective waste management practices. Xworks'

platform for data collection and real-time monitoring of waste generation, transportation, and disposal provides a wealth of valuable data that can be shared with various stakeholders to create lasting change.

- **Xworks' platform for sharing waste data with businesses and authority bodies:**

By sharing this data with businesses, they can identify areas where waste can be reduced, recycling can be improved, and sustainability practices can be enhanced. This can lead to significant cost savings and a more positive reputation for the business.

Authority bodies can also use Xworks' platform to promote transparency and accountability in waste management. By having access to real-time data on waste being generated, traded, transported, disposed and or recycled, they can develop policies and regulations that encourage sustainable practices and ensure compliance with environmental regulations.

- **Identifying areas for waste reduction and improving sustainability practices:**

Sharing data also facilitates collaboration between different stakeholders in the waste management industry. By working together and sharing data, businesses and authority bodies can create a more circular economy and reduce waste. They can identify opportunities for collaboration, such as joint recycling initiatives or sharing waste transportation infrastructure, that can lead to cost savings and reduce the environmental impact of waste management.

Xworks' platform makes it easy to share data securely and efficiently. The platform provides comprehensive data management tools that allow users to share data in real-time with selected stakeholders. This ensures that the right people have access to the right data, improving collaboration and decision-making.

- **Developing regulations and policies for promoting sustainability:**

Sharing data is essential to creating lasting change in waste management. Xworks' platform for data collection and real-time monitoring, combined with its tools for data management and sharing, provides a valuable resource for businesses and authority bodies looking to improve their sustainability practices. By working together and sharing data, we can create a more sustainable future for our planet.

Conclusion

Recap of waste management challenges in smart cities:

Waste management is a significant challenge for smart cities around the world, and it is crucial to address this challenge to achieve sustainability goals. Data plays a vital role in identifying waste generation patterns, opportunities for reduction and recycling, and waste management optimization. With its platform for data collection across the entire waste management value chain, Xworks provides real-time waste data for optimizing operations, demonstrating compliance

with regulations, promoting transparency and accountability, and identifying areas for improvement.

Importance of data in addressing these challenges:

Moreover, sharing data is essential in achieving sustainability goals. Xworks' platform for sharing waste data with businesses and authority bodies is an important step towards developing regulations and policies for promoting sustainability. By understanding where the waste is going and how it is being managed, stakeholders can identify areas for waste reduction and improve sustainability practices.

Xworks' role in collecting and sharing real-time waste data to achieve sustainability goals:

Xworks' real-time data collection and sharing platform are key tools in addressing waste management challenges in smart cities and achieving sustainability goals. It is important for businesses, authority bodies, and other stakeholders to work together and utilize data to promote sustainable waste management practices.

Air quality data communication to citizens

Elisa Leone and Andrea Bassi

Introduction

Air pollution is a serious issue affecting millions of people worldwide. It can cause a range of health problems, including respiratory issues and heart disease. In order to address this problem, it is crucial to have accurate and up-to-date data on air quality from innovative technologies in cities as a first step to then being able to take action[84].
Wiseair is an innovative startup with the mission to guide policy and decision-makers in the identification, implementation and monitoring of policies and measures that have a concrete and quantifiable impact on air quality in cities. In doing so, engagement and involvement of citizens through education and data sharing empowers local communities to have a wider comprehension of the phenomenon and a clearer path towards air quality defence and promotion.

Good air quality data

Promoting an environmental excellence - the use case of Campomarino (Molise, Italy)

Air quality data has demonstrated to be fundamental in contexts where the population is fully aware of breathing good air and wants to promote it as a standard of a good quality of life. To do so, reliable and local data is the main tool used to disseminate information and to seek national certifications.
This is the case of Campomarino, a seaside town where certifying high standards of life quality is important for the local Administration in order to promote the territory towards locals and tourists through certification and well-grounded awareness but also to educate the population about the importance of defending such a valuable asset.

The collaboration with said administration had the primary objective of verifying whether or not the belief of having a good air quality was well-founded and could be data-supported. A year of continuous data collection revealed ideal conditions also in usually-critical months for air pollution (autumn and winter months in which weather conditions and heating systems negatively impact air quality).
It was then possible, figures in hand, to promote such environmental excellence. Actions put in place by the administration by leveraging Wiseair data and reports on air quality include:

[84] As advised by C40 members in the dedicated case study on best practices on air quality management "Sensing Change: How cities are using new sensing technologies to achieve air quality goals", available at this page

continuous sharing of information, charts and periodic elaboration of data using official website and social media channels, integration of the air quality monitoring service in the Bandiera Blu certification module in order to prove continuous improvement and commitment in enhancing the territory life quality, and, finally, running an annual educational and informational event with citizens and local tourist promotion agencies to convey the importance of promoting but also maintaining and defending the status of the air.

Responding to citizens doubts towards air quality - the use case of Carsoli (Abruzzo, Italy)

Citizens' concerns on air quality are, firstly, understandable, and secondly, usually the main need behind administrations' adoption of a complete service with which giving answers to citizens' doubts.
In the case of Carsoli, trustworthy data on local air quality represented the conjunction ring between local Administration and population, giving them a new possibility to communicate and join forces based on evidence.
The first point of contact allowing alignment and confrontation between the two were data shared on the app and the promotion of the odour nuisance reporting feature as a means to direct and better manage citizens' preoccupied instances.
By using the app to not only verify air quality conditions but to also notify odour nuisance, citizens could feel empowered while actively contributing to the understanding of air pollution phenomena on their territory. Users' reports are, indeed, constantly checked by Wiseair experts to verify whether or not they are linked to increased particulate matter concentrations and whether or not citizens have a reason to be worried for their health.
Up to now, data and tools (such as reports) put at disposal by Wiseair, contributed to make citizens reconsider their negative assumptions on local air quality since figures resulted as extremely positive throughout the year and odour reporting never corresponded to high PM2.5 or PM10 concentrations on the territory.

Neutral - bad air quality data, examples in the Po Valley

As previously explained, citizens' concerns on their health are among the main drivers behind the adoption of Wiseair air-quality monitoring service.
Municipalities from the Po Valley, well-known as one of the most critical areas in Europe for air pollution[85], very often encounter the need to share local AQ data with citizens but also to be the initiators and sponsors of initiatives aimed at reducing internal emissions and educating citizens to correctly read data

Skepticism-handling through listening and education - the use case of Nonantola (Emilia-Romagna, Italy)

[85] As stated in the "Europe's air quality status" 2023 briefing from the European Environmental Agency, available at this link

The population of Nonantola knows about the critical conditions of air quality and puts pressure on the local administrators to take action and safeguard citizens' health. One of the main objectives of Wiseair collaboration with this municipality was to educate citizens and, only then, catalyse all of their energies towards initiatives aimed at reducing internal emissions.
The primary focus of the educational chapter, carried out with in-person educative meetings with Wiseair experts and well-structured data-sharing on the municipality's website, was to make people understand the concept and extent of background pollution and the importance and effects of weather conditions and morphology of the territory, so to be able, in the end, to have a complete picture of the factors impacting air quality.
Right now we are still working to make citizens realise their action space on internal emissions and appreciate and support the administration's intent on reducing them (e.g. investing on infrastructures for a softer mobility), while being aware of not being able to solve the problem of air pollution in the Po Valley alone.

Interventions and positive citizens engagement - the use case of Gambolò (Lombardy, Italy)

Making citizens feel safeguarded and well-informed about air quality conditions in their area, so as to convey the importance of a local-distributed air-quality monitoring system was the main purpose of the collaboration with the administration of Gambolò.
All data and report sharing activities (such as press releases and website updates) had the aim of sharing data and details as unambiguously as possible and to make citizens build trust towards the service and start collaborating with the administration once they came to the initiative step.
In their case, as in many others in northern Italy, the initiative was focused on supporting citizens in leveraging national grants[86] to improve the efficiency of their heating systems (detected as the main source of internal emissions in the territory)[87].

Technical data communications

How to treat highly technical subjects with non-specialist stakeholders - the use case of Castano Primo (Lombardy, Italy)

Air quality data from locally distributed sensors results particularly useful when unforeseen events that could threaten citizens' health occur. A critical example arises when a wildfire occurs and citizens are not only informed about it but can also see the smoke column from their homes. At this point, administrators feel the duty to analyse and comprehend the event to manage the crisis, but also to provide themselves with data-based information to be shared with citizens and answer their worries.

[86] Such as the Conto Termico Nazionale, 2023 allocated to cover a certain percentage of privates' expenses towards energy efficiency operations on buildings
[87] The initiative was implemented during a dedicated event and through the delivery of a dedicated informative flyer, available at this link

On March 29th, 2023, the area of Novara was affected by a major wildfire at a chemical manufacturing plant. Governmental instruments[88] are normally used onsite for assessing the impact of such events (e.g. the dispersion of pollutants in air, land and water) and were used also in this case to reassure the absence of dangerous consequences on citizens' health.
Castano Primo, a client municipality near the city of Novara, asked Wiseair for a specific analysis aimed at spotting eventual negative impacts of the wildfire on the air quality of their area both on the day of the event and during the subsequent days[89].

[88] High-precision sensors provided by regional environmental agencies (ARPA) that are both used in fixed infrastructures on the national territory and in ad-hoc temporary measurement campaigns [6] The analysis was presented to the local administration and then shared with citizens directly by the mayor. The analysis is available at this link
[89] The analysis was presented to the local administration and then shared with citizens directly by the mayor. The analysis is available at this link.

The collection and management of satellite data for the development of smart city projects: a case study

Gaetano Volpe and Mauro Manente

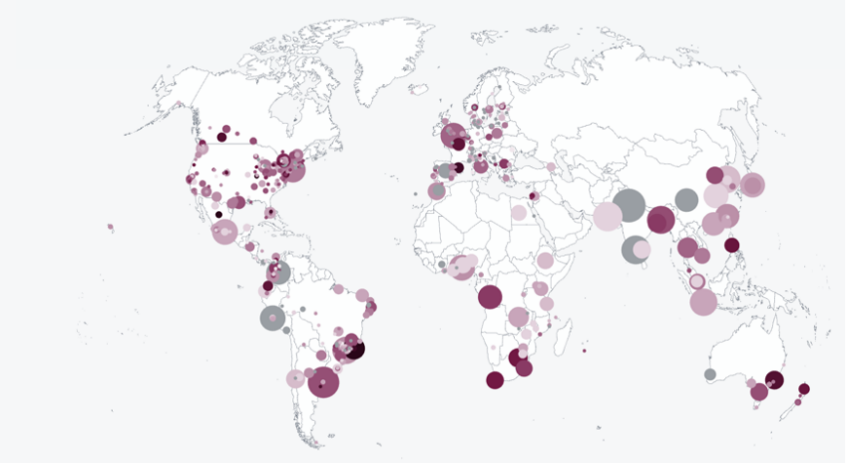
Territorial changes, whether natural or artificial, can have a strong negative impact on land, buildings, critical infrastructures, and the natural environment in terms of both territorial sustainability and resilience dynamics. Smart Cities and Smart Communities increasingly require the study and implementation of technological systems (integrated and with high connectivity) that contribute to constantly improving the performance of the urban ecosystem without neglecting the aspects of territorial analysis, sustainability, resilience (understood at 360 degrees, also regarding climate scenarios and therefore to specific adaptation needs) and attention to the citizen and in general to the individual.

Cities all over the planet are now exposed to uncontrollable risks due to the constant impact of climate change. To this first problem, we must add that we live in a rapidly urbanising world. In the next 30 years, some 70 million people will move to urban areas yearly. By 2050, two-thirds of the global population will live in cities. It is, therefore, necessary to plan concrete actions to mitigate the impacts of climate change and provide tools to design sustainable, resilient and inclusive cities to protect citizens (especially those in the weakest groups) and infrastructure and reduce the economic impact of possible damages generated by uncontrolled climate events. Smart Cities and Smart Communities increasingly require the study and implementation of technological systems (integrated and cognitive) capable of offering new tools that can support the improvement of urban ecosystem performance without neglecting the aspects of territorial analysis, sustainability, resilience (understood at 360 degrees, also regarding climate scenarios and therefore to specific adaptation needs) and attention to the citizen and in general to the individual.

Many cities developed specific 'smart' technological infrastructures to identify the impact of climate on urban areas and to collect data that could be useful to locate climate stressors and, in some cases, to integrate them with other sources (e.g. citizens, government institutions, industry, the scientific community, etc.) according to an approach that is presented as the 'quintuple helix model'. All this implies an enormous effort, often replicated in each city, to collect data and create artificial intelligence models to extract indicators related to climate and land use and thus develop predictive models, also considering that not all cities are able to collect and manage the enormous amount of data produced by the sensors present on the territory and the information mentioned above sources. Based on these premises, it is clear that the use of remote sensing techniques, in particular, the use of satellite images in combination with algorithms for large-scale spatial analysis, could make this easier, faster and more effective and improve knowledge of urban environments, according to a paradigm of 'learn from the past, monitor the present and design a sustainable city of the future'.

In a CDP survey (cdp.net https://www.cdp.net/en/research/global-reports/cities-at-risk), cities globally were asked to make an analysis of potential climate risks and their expected severity. By processing the responses, a global map of risks that may impact cities was constructed, calculating a 'hazard score', calculated by multiplying the number of risks reported by their severity (Least severe = 1, Severe = 2, Extremely severe = 3). This analysis allowed both an understanding of the risks cities face and their ability to analyse and measure risk.
The analysis conducted by CDP shows that the five main risks cities face are:

- flash/surface floods
- heat waves
- rain storms
- days of extreme heat
- droughts.



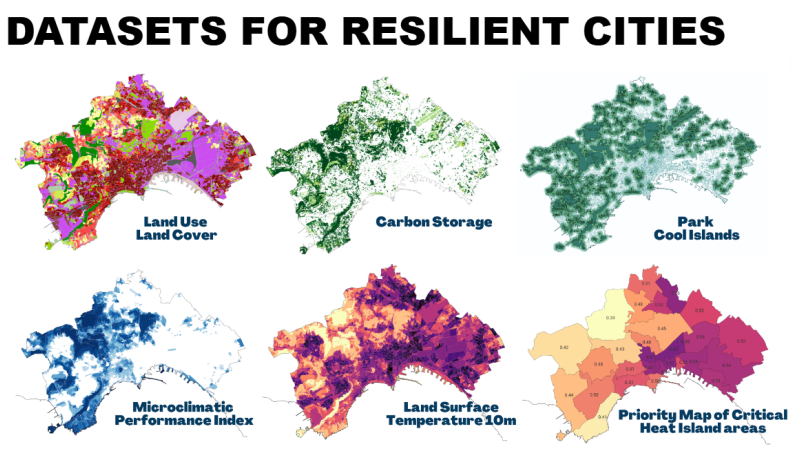
Cities are already feeling the impact of these hazards, and 42% of the reported hazards are expected to manifest themselves in the short term. Since the majority (60%) of these hazards are reported with a medium or high probability, it is clear that cities are aware that there is a very high risk associated with climate change, and this impact will be increasing in the coming years.
For this reason, demand is developing for technological solutions that can help decision-makers find a model for clear risk analysis, identification of priority areas on which to act, and tools that can provide decision support in the mitigation actions to be put in place, especially using Nature-Based Solutions.

Satellite remote sensing brings an invaluable dimension to our quest for comprehensive urban landscape insights. This sophisticated technology, capable of capturing a wealth of data from Earth's vantage point in space, augments our understanding of complex urban ecosystems in myriad ways.
These technologies provide us with a clear view of cities, enabling us to analyze urban sprawl, land use patterns, and the expansion of infrastructure. This perspective extends our comprehension of how cities evolve over time, essential for effective urban planning and development.
Remote sensing data offers a deeper comprehension of environmental factors within urban areas. We can monitor changes in green spaces, tree cover, and overall vegetation health. This data is vital for addressing urban heat island effects, enhancing air quality, and promoting urban

greenery, all of which contribute to healthier and more sustainable cities and at the same time elevating the quality of life of citizens.
The fusion of satellite remote sensing information with urban analysis is a powerful synergy that propels our ability to create more livable, resilient, and sustainable cities. It's not just about collecting data; it's about gaining profound insights that inform better decisions and actions for urban environments, thus enriching our quality of life. Satellite remote sensing isn't merely a technology; it's a catalyst for urban transformation and progress.

Urbalytics

In the implementation of sustainability-oriented urban design and planning policies, it is necessary to have an in-depth knowledge of the relevant urban scenario and its evolution over time. It is not enough to identify current risks; but it is necessary to understand the main trends from which these risks originate. This information and the data constituting it are very difficult to identify, encountering difficulties in accessing data, the presence of fragmented and inconsistent data, and even the total unavailability of the data sought.
Latitudo40, in order to support data-driven decision-making in the urban environment, has created an innovative Urban Data Analytics platform, which is configured with an environmental operating system capable of supporting all actors involved in the urban planning process in understanding risks, identifying priorities for action and intervention, identifying KPIs for improvement, and 'ex-post' quality control of mitigation actions.
Urbalytics is Latitudo 40's innovative, integrated platform, designed to acquire and process satellite data using cutting-edge artificial intelligence algorithms.
Urbalytics leverages satellite technology to capture high-resolution imagery, providing a detailed view of urban landscapes. From identifying land use patterns and vegetation cover to monitoring changes over time. At its core, Urbalytics functions as a digital sentinel, offering urban planners, policymakers, and city administrators an unprecedented window into the complex and dynamic world of urban landscapes.e, it offers a holistic understanding of urban environments.



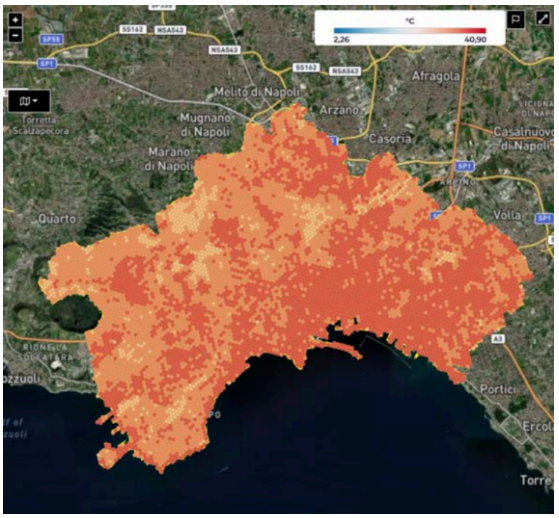
Urbalytic's motto is "Learn from the Past, monitor the Present and make the best decisions for the Future".
Our vision is to create an easily accessible and visualisable platform for policy-makers, urban planners, public administrators and other stakeholders involved in the sector of urban planning and urban regeneration. Thanks to Urbalytics, the users can easily visualise the layers of data that provide critical insights into various aspects of urban

environments, including land use, tree cover density, soil temperature, and more. Not only that, the platform gives access to the history and trends of these data layers, allowing users to track changes and developments in urban environments over time. Moreover, Urbalytics offers the flexibility to customise the platform to specific urban challenges and goals. Whether it's optimising green spaces, improving transportation infrastructure, or enhancing disaster resilience, users can tailor Urbalytics to their unique needs.

Available Information Layers

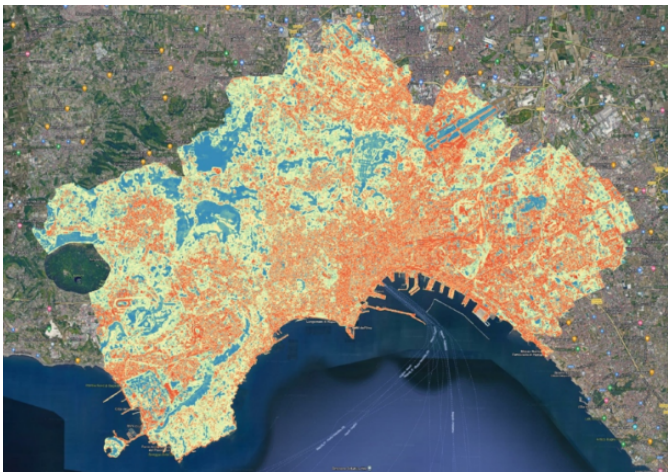
- **High Spatial Resolution Land Surface Temperature map (LST 10m)**

The layer is obtained by applying Latitudo 40 proprietary machine learning algorithms to Copernicus Sentinel 2 images in order to obtain a land surface temperature map for use in studying the Urban Heat Islands phenomenon. The map has a ground spatial resolution of 10m and is provided at a frequency of no less than one survey per week (in the absence of clouds).



- **Surface Urban Heat Island (SUHI)**

These maps intend to show the occurrence of the Surface Urban Heat Island (SUHI) effect on the city's territory. This layer describes the average LST difference observed over a specific period (at least monthly), between each map location (10m pixel resolution) and a reference temperature value, in order to display and assess the intensity of the SUHI.

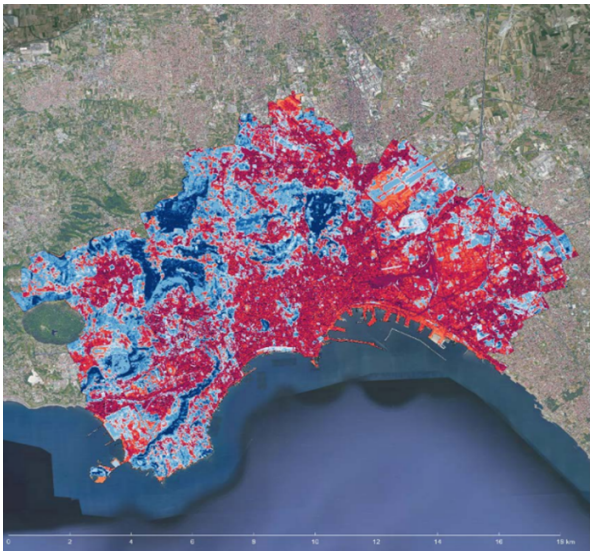


The automatic workflow that Latitudo 40 created to generate SUHI maps foresees, as a first step, taking advantage of the LST 10m maps generated starting from Sentinel 2 images. The first step to compute the SUHI maps consists in performing a temporal average of the LST at 10m spatial resolution.

Afterwards, a reference temperature value is chosen by performing statistical analysis of LST values over the Area of Interest, in order to reduce possible contribution of residual negative/positive LST peaks. For each month a SUHI value is computed by subtracting the reference LST value to the monthly averaged LST of the considered map's pixel.

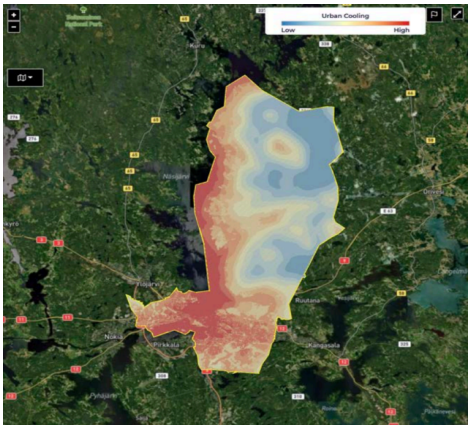
- **UHI Vulnerable Areas**

The identification of the most vulnerable areas to UHI is one of the most important elements in providing with clear evidence of what the city's critical issues are in this respect, how they have changed over time, and how any changes (whether planned or unplanned) have contributed to a change (positive or negative) in these critical issues in specific areas of the city. With the specific aim of providing users with an information layer for the identification of areas of the city vulnerable to the UHI phenomenon, Latitudo 40 created a geospatial data fusion workflow that combines several information (Albedo, Pervious Surfaces, Green Infrastructures, Built-up fraction layer), assigning three intensity classes (Low, Medium, High) to the values contained therein, and subsequently superimposing them (a geospatial sum) until arriving at the creation of a single layer with twelve intensity levels (the combination of the increase factors) which, normalised, identifies the areas of impact (vulnerability of the locations) of the UHI within the city in a particularly accurate manner.



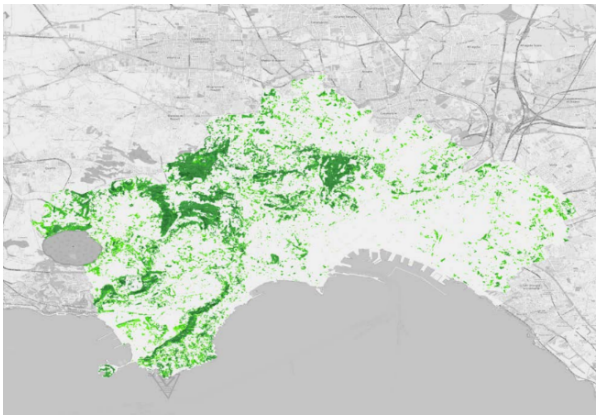
- **Urban Cooling Index**

The layer shows the areas of the city that are most prone to heat island phenomena. The Urban Cooling Index is obtained by means of the InVEST urban cooling model, which calculates a heat mitigation index based on shade, evapotranspiration and albedo, as well as distance from cooling islands (e.g., parks). The index is usually used to estimate a reduction in temperature by vegetation. The map has a ground spatial resolution of 10m and is usually provided once a year in the warmest month for the specific area of interest.



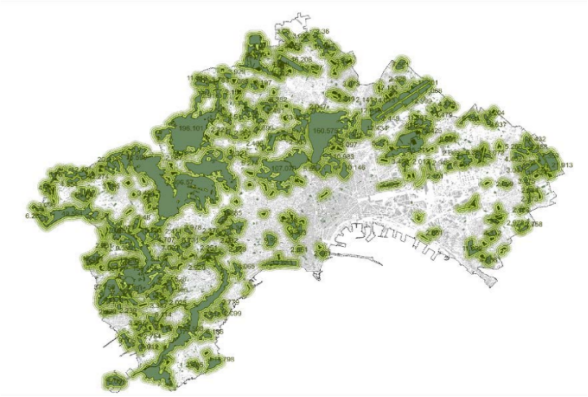
- **Tree Cover Density**

The high level of detail provided by the products obtained by applying the super-resolution algorithm to Sentinel 2 images in the R,G,B and NIR bands allows the application of further processing steps aimed at extracting information layers that can be used independently or in combination with other data to analyse urban environments.

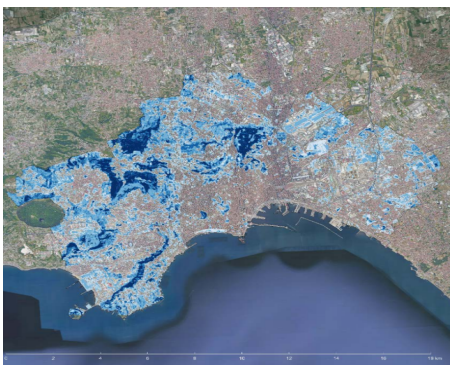


In this way is possible to obtain data which delineates with high precision the city areas with the presence of green (including tree-lined avenues) and which, by virtue of the intensity trends of the vegetation indices and the identification of the tree canopies (tree cover density), allows to carry out further analyses on the microclimatic performance of the green area.

- **Urban Cool Island Assessment**



A Park Cooling Effect (PCE) map is provided, i.e. a representation of the cooling effects that a park (understood as green infrastructure) has in the surrounding area. This effect is obtained because the natural elements of urban parks (e.g. vegetation, trees and water bodies) enjoy a reduction in surface temperature in their internal area through shading and evapotranspiration and, through convection and air diffusion, the cold air thus generated is conveyed to the surrounding areas, resulting in a cooling effect whose intensity and extent are a function of a range of specific factors such as the size of the park and the complexity of its geometry.
etc.). The Urban Cool Island layer fulfils exactly the purpose of assessing the PCE of urban parks or, more generally, of existing green infrastructure larger than one hectare, and is calculated as a function of the increase in LST in the area surrounding the park and of the dominant influencing elements;

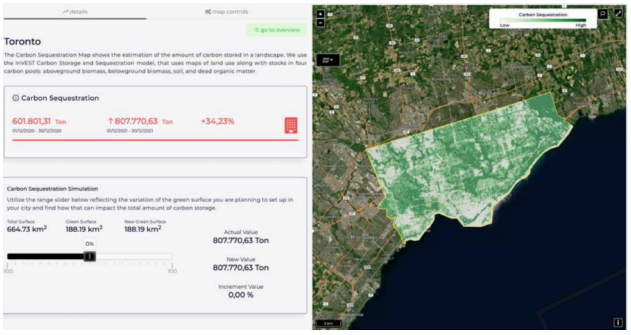


- **Microclimatic Performance of Urban Vegetation**

This information layer was created to satisfy the evaluation need to identify areas to be subjected to urban planning

intervention for the mitigation of UHI through the application of Nature Based Solutions. The layer is constructed through a mechanism of assigning different microclimatic performance levels (High, Medium, Low and Impervious, low perviousness, high perviousness) as a function of the values present in layers obtained from a subclassification of the green infrastructure product (tree cover density, green areas, bare soil) and in the pervious surfaces, which are subsequently superimposed to form a single information layer.

- **Carbon Sequestration**

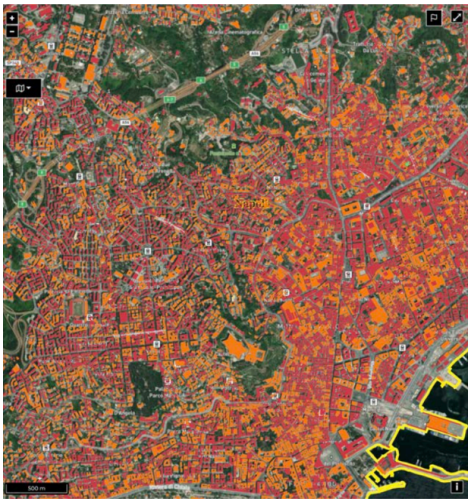


The layer shows the ability of the city's green infrastructure to absorb CO2. The layer is calculated from a very high- resolution land cover map to which the estimated surface biomass, subsurface biomass, soil characteristics and estimated dead organic matter are added in the application of the specific proprietary machine learning model;

- **Albedo**

Surface albedo in rural and urban environments is one of the most influential parameters in assessing the effects of solar radiation on the earth's surface. The study of UHI and, above all, of the effects of any mitigation actions taken cannot disregard an assessment of albedo.

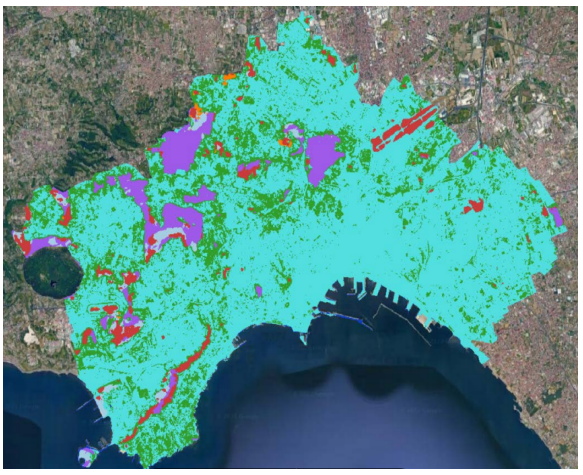
- **Roof Reflectivity**

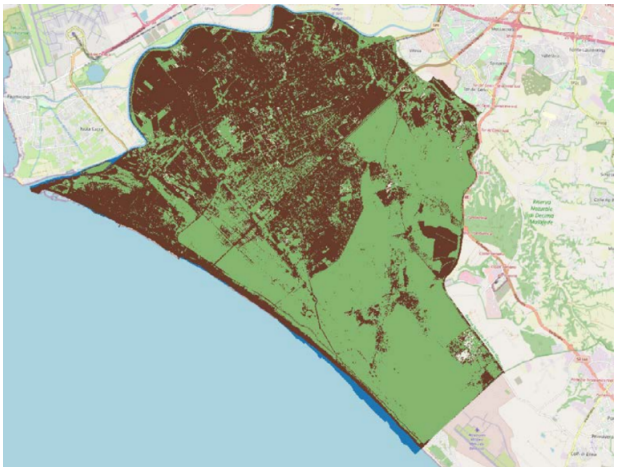


The layer provides an indication of the ability of roofs to reflect sunlight on a scale ranging from very poor to very good. Through this layer it is possible to obtain one of the many variables that determine the thermal performance of a building. The map has a ground spatial resolution of 10m and is usually provided once a year in the hottest month for the specific area of interest.

- **Land Cover/Land Use Map (Areas with Vegetation, Urbanized Areas, Water Bodies)**

The layer provides the representation of the land use map according to a basic three-class representation. The map has a ground spatial resolution of 10m and is usually provided once a year for the specific area of interest.
Created using our super resolution algorithm that allows to obtain an image with a 1m spatial resolution starting from a standard Copernicus Sentinel 2 image (10m GSD), provides high level details on greenery classes.





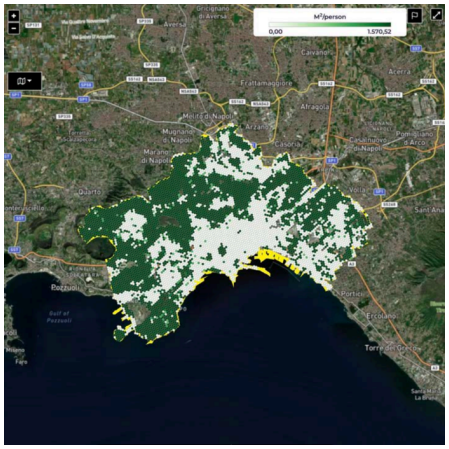
- **Pervious Surfaces**

Continuous mapping and monitoring of pervious and impervious surfaces are crucial activities to support sustainable urban management strategies and plan effective actions for environmental change. Having a constantly updated mapping of pervious and impervious surfaces represents an enormous added value for those in charge of urban planning, as these maps are an essential indicator for assessing urbanisation and environmental quality. Furthermore, with the aim of providing useful products for the ex post evaluation of UHI mitigation interventions (with Nature Based Solutions) using geospatial analysis this type of layer should always be included;

- **Built-up fraction**

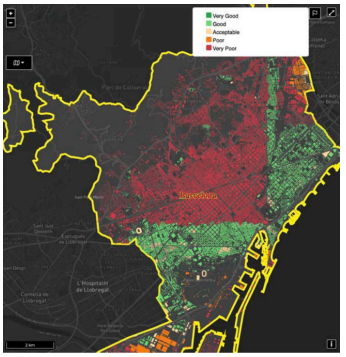
Following an approach very similar to that used for the generation of the green infrastructure information layer from the Sentinel 2 images following the application of the super-resolution algorithm, the layer dedicated to the identification of urban areas with a high density of buildings are produced. In this case the classification process is focused on the recognition of buildings but not on the definition of their footprint, obtaining within the scene a series of clusters that are used for the identification of one of the factors with the greatest impact on the UHI phenomenon;ù

- **Vegetation per Person**



Using data fusion between population distribution and land use class classified as green area, a layer representing geospatial analysis of green availability per individual inhabitant is obtained;

- **Urban Tree Provision**



The layer represents the implementation of the 3-30-300 rule that focuses on the key contribution that urban green infrastructure (parks, trees, forests, gardens, etc.) makes to the health and well-being of citizens, as well as the adaptation to climate change. The rule provides the necessary support for planning the extension of urban green infrastructure. The rule of thumb provides clear criteria for the minimum urban tree allocation in our urban communities:

- 3 trees per household

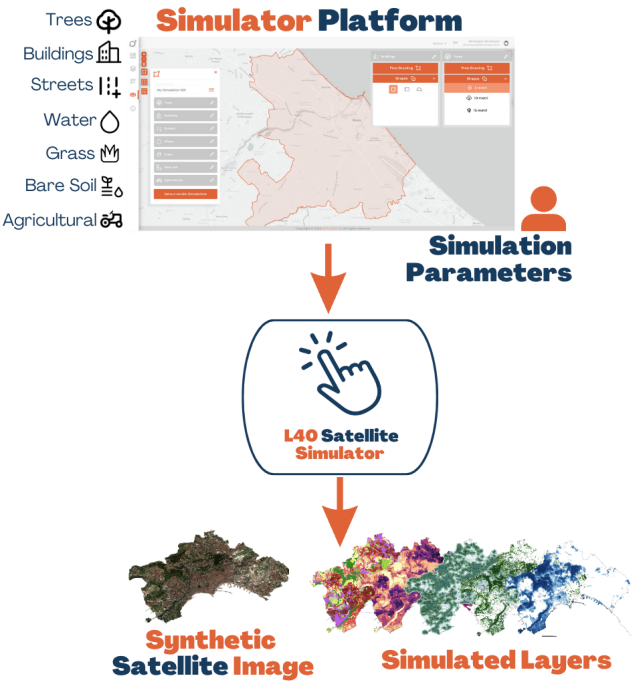
- 30 percent tree cover in each neighbourhood
- 300 meters from the nearest public park or green space

Every city is unique, and so are its challenges. Urban planners can tailor Urbalytics to meet their city's specific needs, whether it's steering toward sustainable development, bolstering disaster resilience, or optimizing infrastructure deployment.
As urbanization continues to accelerate, the role of innovative technologies like Urbalytics becomes increasingly significant. Urbalytics rises to this challenge by transforming data into actionable intelligence. In doing so, it goes beyond resource optimization; it becomes a catalyst for improving the quality of urban life. By leveraging Urbalytics, urban planners and decision-makers aren't just managing cities; they're shaping urban experiences that are more sustainable, resilient, and prosperous for all.

Urbalytics Simulator

The Urbalytics Simulator, powered by our AI, serves as a pivotal tool for urban planning professionals, policymakers, and municipal and local administrators to explore different strategies for urban development and evaluate their potential consequences. It leverages the remarkable capabilities of artificial intelligence to offer a fresh perspective on urban development. Fundamentally, the simulator capitalises on artificial intelligence to provide a data-centric view of urban development.

The aim of the Simulator is to give urban planners, companies and public administrators powerful tools in order to achieve their policy-related objectives.
The Simulation Designer is a user-friendly web interface where users can upload or draw scenarios to be simulated. Seven classes will be supported in this first version (Trees, Buildings, Streets, Water, Grass, Bare Soil, Agricultural). Tools to draw scenarios easily and immediately (guided drawing, pre-set scenarios) will be introduced.



The processes behind the development of the tool are summarised below:

- **Data Collection**: We start by gathering a vast dataset of high-quality multispectral images. These images come from high-resolution satellites

and cover different types of areas, from urban to rural. This diverse dataset ensures that our model can handle various urban planning scenarios.

- **Training the GAN Network**: The Generative Adversarial Networks model is trained on the prepared dataset through a fully automated process. The generative network learns to produce synthetic satellite images that are increasingly similar to real ones, while the discriminative network improves its ability to distinguish between them. The GAN model will output optical high-resolution synthetic satellite images to guide the multispectral machine-learning model generator.
- **Simulation of multispectral features for the reference city**: Once the GAN model is trained, an additional machine learning model is used to simulate the multispectral features for the reference city. This model is trained over the city itself, ensuring a high level of fidelity through the use of historical Sentinel-2 images.
- **Synthetic satellite image generation**: The urban simulator uses the trained generative network and simulation model to generate synthetic satellite images from vector files describing different urban planning scenarios.

This generation process includes assessing the impact of proposed changes on key performance indicators (KPIs), like tree cover density, traffic management, land use land cover and many others. These algorithms enable customers to simulate changes on the urban landscape, in order to optimise green spaces, improve the urban planning process, help to make cost-effective decision making, and to monitor the improvement potential of urban landscapes. This modelling process isn't just theoretical; it's a dynamic tool aimed at optimising green spaces, streamlining urban planning processes, enabling cost-effective decision-making, and continuously gauging the potential for enhancing urban landscapes.

The Urbalytics Simulator represents an innovative approach to urban development, where AI precision intersects with pragmatic urban planning, sustainability considerations, and data-driven decision-making. It redefines urban development by fostering efficiency, livability, and environmental responsibility.

Case study: project AI4Copernicus in Naples and Milan

The UrbAlytics experiment, from the 4th Open Call of the Horizon AI4Copernicus project, aims at demonstrating the possibility of applying machine/deep learning algorithms on Sentinel 2 images to estimate the Land Surface Temperature and, combining such information with land cover maps and meteorological data, to provide a clear indication of the urban areas affected by the Urban Heat Island effect, of the temporal evolution of this phenomenon and, finally, to suggest a selection of Nature-Based Solutions for climate adaptation and mitigation. The experiment analyses the territories of two Italian cities, Naples and Milan.

Presenting AWS: defining the value of the Cloud

Laurent Foucauld and Syrine Souissi

Cloud computing has now become the new normal for both the private and the public sector; it has driven a major shift among organizations of all types to adopt scalable, cost-efficient cloud infrastructure. Cloud computing is the on-demand delivery of IT resources over the Internet with pay-as-you-go pricing. Instead of buying, owning, and maintaining physical data centers and servers, organizations can access technology services, such as computing power, storage, and databases, on an as-needed basis from a cloud provider like Amazon Web Services (AWS). This allows for greater speed and flexibility than was ever thought possible, and it is ushering in a new era of productivity and innovation.

Cloud computing to accelerate public sector digital transformation

Government, education, nonprofit, and healthcare organizations around the world face unique challenges to accomplish complex missions with limited resources. Public sector leaders overwhelmingly turn to the power and speed of cloud computing when they want to serve citizens more effectively, accelerate innovation and digital transformation, and put more of their time and resources into their core missions. Public sector organizations are notably looking to improve operations, deliver better services to citizens, increase productivity of their teams, and become more resilient. With millions of active monthly customers and over 100,000 partners across 150 countries, providers such as Amazon Web Services leverage the network effect to offer the world's most extensive cloud infrastructure, boasting 99 availability zones in 31 geographic regions. AWS' cloud platform is the most comprehensive and widely adopted, providing over 200 fully featured services in compute, storage, analytics, machine learning, and IoT. All of this is backed by a deep set of cloud security tools with 300 security, compliance, and governance services and features. All 117 AWS services that store customer data come with built-in encryption capabilities.

Helping cities become data-driven with a data strategy and AWS services

Public sector organizations across the globe want to make better and faster decisions. This can be possible by putting data at the center of every decision-making process. For cities more specifically, a more detailed understanding of citizen ambitions and requirements creates a better citizen experience. While data is abundant and growing rapidly, just producing and storing this data doesn't automatically create value. As cities accumulate a significant amount of data, much of that data lives in different silos. Data silos can require different platforms, different management, different security, and different authorization approaches. All of this increases the operational risk and the operational cost – and can make it difficult to analyze data holistically.

Also, these systems are typically not built for exponential growth of event data like log files, click stream data, and machine-generated data from internet of things (IoT) devices. To overcome these challenges, organizations are shifting towards becoming more data-driven and develop their own modern data strategies

There are five key areas to consider to build a modern data strategy:

1. **Data product mindset** – This means adopting a product-oriented mindset versus a platform-oriented one that is typically seen in traditional data strategies. Product orientation means that we design and create data-enabled offerings that consider business and technical requirements in order to solve business problems and positively affect the citizen experience. AWS offers a variety of services that empower organizations to develop and deploy data products effectively.
2. **Business and technology ownership** – Owners of traditional data strategies tend to be technology leaders. A modern data strategy is owned by both the business and technology leaders jointly. Integrating business and technology in this way reflects the importance of data.
3. **Agility** – Modern data strategy is agile, building and refining data products in an iterative process of testing, experimenting, and learning to inform the next revisions. In a traditional data strategy, teams first gather all the requirements known upfront and spend time building the foundation before delivering tangible business value to the stakeholders. In a modern data strategy, the iterative, agile approach can reduce time to value and deliver incremental foundation.
4. **Governance** – According to modern data-driven practices, organizations federate or distribute governance to balance nonnegotiable security, privacy, and regulation concerns with the need to innovate. In a more traditional strategy, teams may create organizational constructs where everything must be tightly controlled by a centralized team, restricting innovative developments for one team's needs.
5. **Technology** – Purpose-built data stores and analytics services that are based on business needs allow organizations to build cloud-based platforms that are scalable and resilient. In contrast, a traditional data strategy can often take a one-size-fits-all approach to data store and analytics services, regardless of the actual need. The scalability limitations of on-premises environments can slow down agility and innovation.

In alignment with these principles, AWS offers several solutions to empower organizations in their data strategies:

- **AWS Data Exchange**: As a comprehensive data marketplace, AWS Data Exchange hosts a vast array of third-party data sets. It simplifies the process of accessing and integrating external data into your data lakes, applications, analytics, and machine learning models.
- **AWS Clean Rooms**: This service streamlines secure data collaboration by creating protected environments for analysis without the need to share sensitive data externally. It aligns with the principles of data access control and encryption, supporting secure collaboration.

- **Amazon DataZone**: This data management service enables organizations to catalog, discover, govern, share, and analyze data across AWS services. It promotes data discoverability, access governance, and seamless data sharing.

AWS Garnet Framework: The Garnet Framework, formerly known as Smart Territory Framework (STF), is a set of tools and standardized modules offered by AWS that can be utilized to build and operate sustainable and effective solutions, in line with global industry standards and based on the open-source offering of the FIWARE ecosystem. Garnet Framework combines the benefits of standardization with the power of cloud computing to support the development and integration of smart and efficient solutions across multiple domains such as Smart Cities, Campuses and Regions; Energy and Utilities; Agriculture; Smart Building; and Manufacturing. It was developed to help organizations to solve the three main challenges that prevented them from collecting data and gaining the insights needed to innovate and provide efficient services that improve the lives of their residents: breaking down data silos, enabling platform interoperability, and decoupling data producers from data consumers. The framework is open source and available on GitHub, and was designed to be very easy to deploy. With only two lines of command and half an hour, any organization can start building their smart and interoperable solutions at scale using the Garnet Framework.

Adopting a standard-based approach with the FIWARE Foundation

The market needs to run scalable and interoperable platforms to connect heterogeneous sources. This brought AWS to engage and support the FIWARE ecosystem in 2020 and then join the FIWARE Foundation to develop a joint roadmap that will allow AWS to achieve long-term business goals, while also creating new open-source solutions using open standards, standardized APIs and data models.
The FIWARE Foundation's mission is to build an open, sustainable ecosystem around open software platform standards that ease the development of Smart Solutions in multiple sectors. With members of the FIWARE Community, the FIWARE Foundation is contributing to the creation of open standards when they do not exist and solving how open standards can be integrated based on the experience gained through the implementation of open source components.
Open standards implemented in FIWARE have become de-facto for the development of smart cities worldwide, and their adoption is growing in other domains (agri-food, manufacturing, ports, water, energy, etc.). In this respect, FIWARE has gained a great reputation for moving from vision to execution and making things happen.

Using FIWARE technologies, organizations have been able to break down their internal information silos and exploit data for better decision-making and further automation of processes. Thanks to this digital transformation they can evolve into smart organizations. Connecting to data spaces is the next natural step in this transformation journey. A data space can be defined as a decentralized data ecosystem built around commonly agreed building blocks enabling an effective and trusted sharing of data among participants. They allow organizations to exploit data

and data services from third parties as well as provide data services to other organizations, thus becoming active participants of multi-side markets driving the materialization of a data economy.
FIWARE is contributing to making data spaces happen by actively contributing to the identification and integration of standards for data spaces, implementing components that help to materialize data spaces, and contributing to relevant initiatives. Here, it is worth highlighting the creation of the Data Spaces Business Alliance (DSBA) that FIWARE Foundation launched together with BDVA, Gaia-X and IDSA. The DSBA has produced technical recommendations that are becoming a reference in the domain of data spaces.
Moreover, FIWARE has released the first version of a FIWARE Data Space Connector that integrates modules implementing the most relevant DSBA technical recommendations, namely:

- An Authentication module based on W3C standards (DIDs, Verifiable Credentials) implementing interfaces to Trust Services through EBSI APIs (DID-Registry, Trusted Issuers Registry), and supporting the new generation of OIDC protocols (SIOPv2, OIDC4VCI, OIDC4VP).
- An Authorization module implementing ABAC (Attribute Based Access Control) using claims of Verifiable Credentials as attributes.
- A Contract Negotiation module implementing TM Forum Open APIs through which organizations can publish their data product offerings in data spaces, and manage the steps linked to acquisition of rights to use those products by potential customers.

This FIWARE Data Space Connector is designed to easily integrate with the FIWARE Context Broker technology to enable an effective exchange of digital twin data using the NGSI-LD API standard and relying on an inventory of more than 1200 common data models in 13 domains and 7 languages under the Smart Data Models initiative. It will evolve with additional modules implementing data resources publication using DCAT standards or supporting negotiation of policies specified in ODRL, in line with IDS Dataspace protocols.
The FIWARE Foundation is building collaborations around the use of FIWARE Data Space Components. As an example, it is worth mentioning the i4Trust collaboration program with iSHARE targeted to show how the combination of the FIWARE Data Space Connector technology with iSHARE Satellite services and a legal scheme for trust can provide a solid foundation for the creation of data spaces aligned with DSBA Technical Converge recommendations.
With all of this, FIWARE is positioned as a key implementer of data spaces technology by bringing its well-proven standards and technologies in data interoperability and its recent developments about trust, identity and authorization, all combined under the FIWARE Data Space Connector.

Minimum Viable Data Spaces with AWS

AWS also plays a pivotal role in championing the adoption of data spaces. AWS acknowledges the potential of data spaces in facilitating data sharing among diverse stakeholders, allowing both public and private organizations to unlock value from shared data. The AWS cloud acts as a

central enabler for data spaces, offering powerful computing and analytics capabilities. This empowers organizations to extract valuable insights from shared data, perfectly aligning with their objectives.
When it comes to sharing data at the city-level, data spaces offer diverse possibilities. For instance, they can be harnessed to optimize energy distribution and consumption by merging data from smart meters, renewable energy sources, and power grids. This leads to enhanced demand-response, improved management of peak loads, and heightened energy efficiency. Another valuable urban application of data spaces involves enhancing disaster preparedness, response, and addressing climate change challenges. Through seamless integration of weather, climate, and extreme weather data into smart city infrastructures, cities can significantly enhance their ability to anticipate and respond to extreme events, safeguarding critical infrastructure and resident safety. These data-driven insights also support climate change adaptation efforts, enabling informed decisions on urban planning, infrastructure development, and resource allocation.
However, realizing these objectives hinges on robust data strategies that foster sharing, first within organizations (intra-organizational data sharing), and then across organizations (inter-organizational data sharing).
To facilitate data sharing within organizations, such as cities, one effective approach is to leverage the Garnet Framework. This open-source platform simplifies the creation and operation of interoperable systems. This framework adheres to global industry standards and is compatible with the open-source tools provided by the FIWARE ecosystem. By implementing the Garnet Framework and harnessing FIWARE's open-source technologies, cities can dismantle data barriers and promote data sharing within their own organizations.
Regarding inter-organizational data sharing, organizations can experiment with Minimum Viable Data Spaces (MVDS). MVDS involves deploying a small-scale data space based on FIWARE components. MVDS serves as a cost-effective method for organizations to experience the benefits of a data space with minimal time and financial investment. It not only allows organizations to experiment with various data space technologies but also enables them to explore different data governance approaches. This includes establishing trust, identity, and access management policies to facilitate safe and secure data sharing on a larger scale.

The building blocks of FIWARE data space technology are well-suited for creating MVDS. These modular building blocks can be easily integrated with existing solutions and can accommodate the addition of new features over time. Initially, MVDS focuses on ensuring data interoperability and establishing data sovereignty and trust using the FIWARE data space framework. Participants in MVDS can deploy these framework building blocks on AWS and integrate them with AWS Garnet. Cities can also use the FIWARE Data Space Connector to expand their applications and securely share data with other organizations.

Ulrich Ahle, CEO, FIWARE Foundation: "'Using cloud services for the operation of mission critical IT systems is a standard in the manufacturing industry. Also, the public area and the domain of Smart Cities is now identifying the flexibility and massive cost advantages of

cloud-based services. AWS is making the next step by combining such cloud services with their FIWARE-based Garnet Framework for the benefit of the customers in cities and regions."

Examples of implementation of the Garnet Framework

Naxos Smart Island, Greece: An illustration of how a standard-based approach can foster the development of innovative solutions can be found in the Naxos Smart Island Project. This project focuses on enhancing mobility, primary healthcare, and the transport of goods. Powered by the AWS Cloud, it utilizes cutting-edge technology to 'smarten' existing infrastructure, including tourist ports, the energy grid, and water management systems. The Naxos Smart Island project is built around the AWS Garnet Framework, which seamlessly integrates AWS services with global industry standards and open-source offerings from the FIWARE ecosystem. This framework ensures the maximum benefit for Naxos citizens by enabling secure and straightforward sharing of non-personally identifiable information (PII) data among government departments and external organizations[90].

City of Heidelberg, Germany: The City of Heidelberg is a great example that illustrates the ease of use and the pace of innovation that enables the Garnet Framework. Within a week, the city of Heidelberg deployed the framework, integrated an existing system for monitoring the road traffic, and built a dashboard to visualize the data and extract insights. They are now able to easily link the road traffic with the air quality and understand how these two interact[91].

Sebastian Warkentin, CEO Digital-Agentur, Heidelberg: “We started to use the AWS Garnet Framework, and we were amazed to find an open platform where we could easily integrate existing applications and solutions, create new data spaces and use cases on a fast pace.”

[90] Learn more: https://aws.amazon.com/blogs/publicsector/smart-island-how-aws-cloud-powering-social-economic-environmental-improvements-greece/

[91] Learn more: https://www.youtube.com/watch?v=plGnF0Wl3Lg