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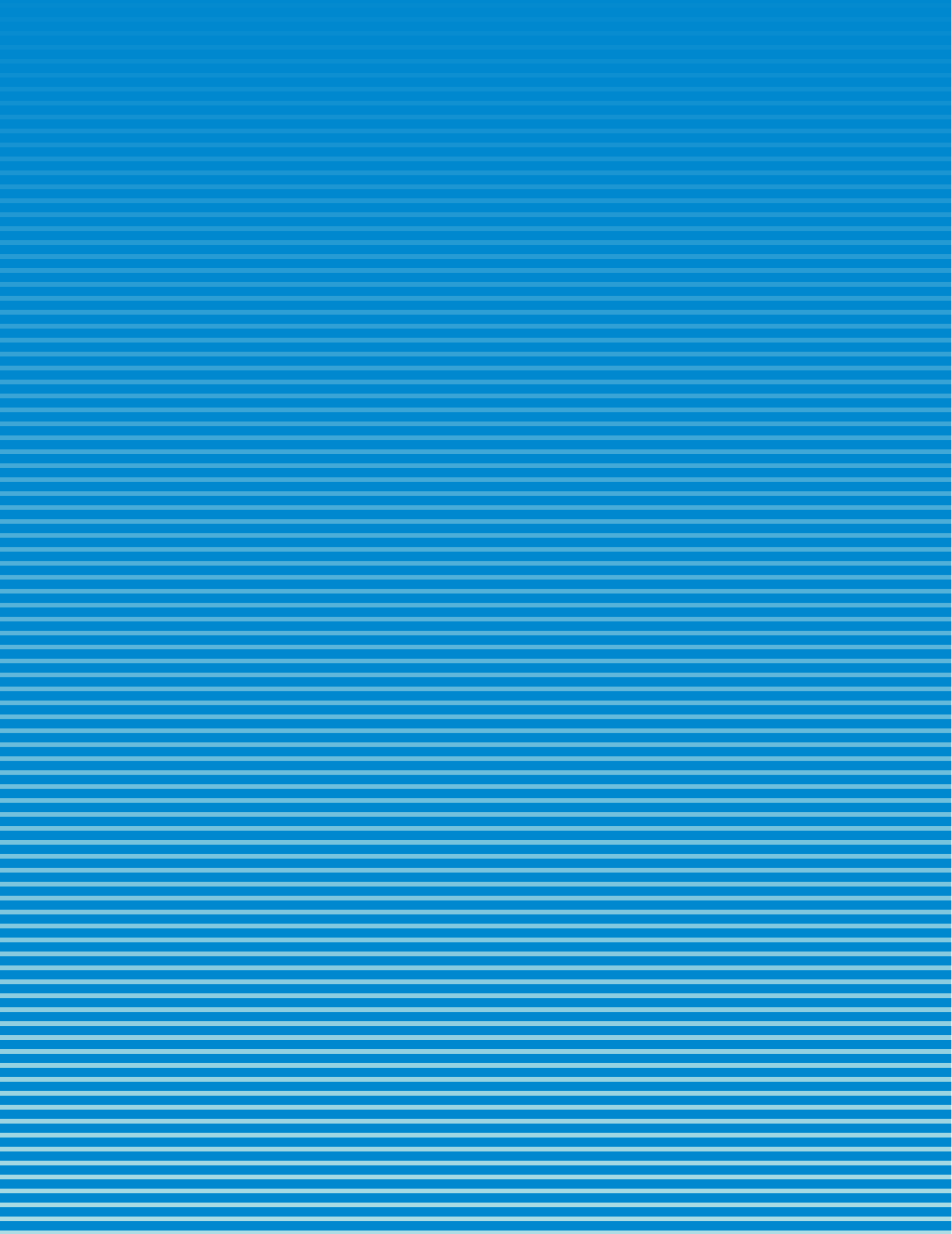
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BIG DATA

FOR SUSTAINABLE URBAN DEVELOPMENT

Creating evidence-based
urban public policies





BIG DATA

**FOR SUSTAINABLE
URBAN DEVELOPMENT**

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Creating evidence-based
urban public policies

2021





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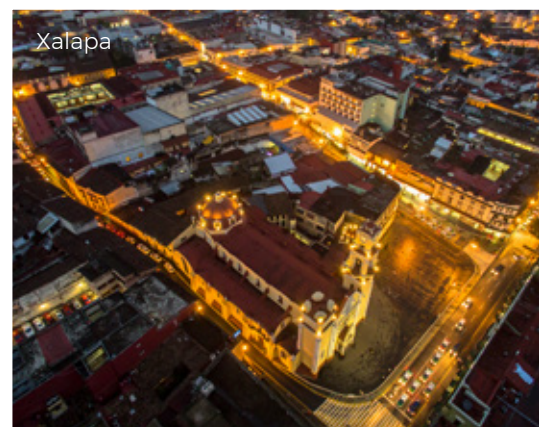
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Innovation, partnerships and knowledge dissemination to continuously improve multisector response capacity



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While we continue dealing with the impacts of the pandemic in each country, we also have a great opportunity to think about the type of recovery we want for Latin America and the Caribbean region, which is the most urbanized in the world.

At IDB, Vision 2025 (our guide to support these countries on this journey) includes sustainability as the transversal route in our activities, projects, and initiatives, and it is permeated with axes such as job creation, digital transformation and faster adoption of new technologies, in addition to acting proactively to improve the institutional capacity of both our public and private customers.

We believe in increasing productivity based on the dissemination of instruments that allow for achieving increased effectiveness and efficiency by leveraging partnerships and continuously improving our multisector response capacity, innovation, and knowledge expansion.

Seeking to keep up with the dynamism of these transformations and provide the cities in that region with tools for coping with major urban challenges, we have supported a diversity of initiatives to transform cities' traditional administration into smart administration, thereby including them in the promising world of smart cities. This will allow our urban life to continue to grow in a sustainable and efficient manner.

The rapid digital transformation process, combined with the increasing use of connected devices, such as sensors, cameras, and smartphones, has generated huge amounts of data, or big data. On the one hand, this data offers great opportunities to improve planning and life in

cities, but on the other hand, it poses significant challenges to public administrators, who often need to enhance and strengthen their local capabilities in order to handle and analyze challenges in a manner that enables converting this data into useful knowledge to support decision making and bring effective improvements to citizens' day-to-day lives.

The good news is that excellent experiments on the use of big data for sustainable urban development have been taking place in our region, and in order to better understand and disseminate these practices, the Inter-American Development Bank (IDB), in collaboration with Fundação Getulio Vargas and within the scope of the Regional Public Goods initiative, developed an innovative knowledge product. This was done in the cities of Miraflores, Montevideo, Quito, São Paulo, and Xalapa, and generated rather positive results and reflections. Additionally it inspired the production of this publication.

On the following pages, you will find conceptual models and practical examples of massive data use in different sectors of these cities. The experiences, lessons learned and recommendations will hopefully help other cities that are seeking to enhance the use of big data in order to improve urban management and the design of public policies, promoting quality of life and reducing inequalities in urban territories.

Tatiana Gallego Lizón

Chief of Housing and Urban Development Division
Climate Change and Sustainable Development Sector
Inter-American Development Bank



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Science, technology, innovation and public policies: the benefits of partnerships between academia and public administration

The benefits to society generated by cooperation between academia and the government agencies in charge of preparing and implementing public policies are already globally recognized. The accelerated advance of technological innovations has made significant transformations in society. In an environment of rapid and frequent changes, politicians and public administrators are pressured to solve ever more complex challenges in ever shorter time intervals. Within this context, scientific evidence produced by academia becomes a powerful instrument available to those in charge of designing and evaluating public policies.

A necessary condition for developing a research project whose results can be used in the design of public policies that highly impact the wellbeing of a municipality is that researchers and government representatives work in an interactive and very close manner. Those in charge of preparing and implementing public policies should be engaged from the first stage of structuring the project proposal, i.e., in formulating research questions. With the purpose of defining the challenges that would be addressed, discussions with the representatives of the municipalities of Montevideo, Quito, Xalapa, Miraflores and São Paulo have been conducted. These discussions were organized by Fundação Getúlio Vargas researchers and began at the inception of the Big Data for Sustainable Urban Development project. In fact, the project research questions reflect the challenges associated with sustainable urban development faced by public policy administrators in the partner municipalities.

Internally, FGV organized a multidisciplinary team of researchers, including competencies in the sectors of Public Administration, Law, Public Policy Evaluation, and Data Science. This interdisciplinary team was in charge of producing recommendations capable of contributing to solve complex and intersectional issues presented by the municipal managers.

Continuous interaction between FGV researchers and public agents of all five cities participating during the project development allowed for the application of several of these recommendations, especially those regarding data publication and use in implementing improvements in the public policies existing in municipalities participating in the project.

On the pages of this book, you can find a summary of the results achieved by this innovative project developed by FGV in partnership with the IDB, which could potentially benefit other cities in Latin America and the Caribbean.

Goret Pereira Paulo

Director

Applied Knowledge and Research Network

Fundação Getulio Vargas



Museu de Arte de São Paulo



EXECUTIVE SUMMARY



The growing digitization that affects and challenges our entire society can also create opportunities to improve people's quality of life. In addition to potentially facilitating several aspects of our daily routine, transforming economic activities and revolutionizing entire sectors, cities can be planned in a more efficient and sustainable manner by cocreating modern digital technologies in policies focused on urban development.

Today, 55% of the world population live in urban areas, a proportion which is predicted to increase to 68% by 2050.¹ The Latin America and the Caribbean (LAC) region has the world's second highest population share—80% of its inhabitants—living in urban areas. Planning, managing and governing cities in that area in an efficient and transparent manner poses enormous challenges.

The process of urbanization of countries in that region occurred in a rapid and disorderly manner, exerting pressure on important areas, such as urban mobility, basic sanitation, supply of drinking water, air quality, disaster response, safety, health, education, housing, and the environment. Nowadays, thanks to digitization, an unprecedented amount of data can be collected in cities through the monitoring and recording of a wide range of connected devices and sensors, which can serve as key input for governments to face issues involving these topics.

Digital technologies bring a significant increase in data flows, as well as the capacity to process them for purposes of planning, monitoring and assessing urban policies intended to cocreate innovative solutions in a synergetic process between academia, government, and companies.

¹ United Nations. 2019. *World Urbanization Prospects – 2018 Revision*. New York: United Nations. Available at: <https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf>. Accessed on: April 3, 2021.

This is what characterizes the so-called smart cities when directing innovative products composed of said data and technologies in order to provide better living conditions for people.

Buildings, vehicles, infrastructure and manufactured products can supply information about the world around us, providing a wealth of raw information on life in our cities. The objective of this article is to inspire and help public administrators extract value from this big data through urban policies. The proposal here is to present in a practical and comprehensive manner the necessary elements to formulate and manage data-driven public policies, considering the specificities of the local scenario.

What have the administrators of Latin American cities been doing to transform data into relevant information to improve people's quality of life? What would be the necessary requirements for a city to start using its dispersed, disorganized data to understand public issues and offer better services to its citizens?

Considering as a reference the Big Data for Sustainable Urban Development project,² which was financed by the Inter-American Development Bank (IDB) and developed by Fundação Getulio Vargas, this book addresses the most important aspects in using big data to improve the life quality of citizens while optimizing resources, reducing costs, anticipating, mitigating and even preventing crises, changing processes, providing feedback to city planning and public policies, changing dynamics in the provision of public services, transforming problems into creative solutions, adding value to the installed infrastructure, and generating improvements in performance indicators.

Five cities with distinct realities participated in the Big Data for Sustainable Urban Development project—Miraflores (a District of Lima, Peru), Montevideo (Uruguay), Quito (Ecuador), São Paulo (Brazil), and Xalapa (Mexico)—helping identify the main challenges in formulating and implementing said data-based policies. The participation of the cities also helped to identify strategies to achieve this objective, and the benefits that can be generated. The knowledge built as a result of

**BUILDINGS, VEHICLES,
INFRASTRUCTURE AND
MANUFACTURED PRODUCTS
CAN SUPPLY INFORMATION
ABOUT THE WORLD AROUND US**

² Available at: <https://www.iadb.org/en/project/RG-T3095>. Accessed on: April 3, 2021

the work performed with these cities enabled the preparation of this document, which contains recommendations and good practices for the public administrators interested in the development of data-driven public policies.

Several data use cases in the decision-making process are reported. It's evident that, when considered as a background for the urban challenges that we currently face—and which we will face in the near future by reason of the effects on digital transformation caused by the COVID-19 pandemic—massive data processing and proper intersecting of the public authorities' databases, or even of data provided by third parties, could significantly contribute to smart and modern management, which presents broad, participative, and effective solutions.

MASSIVE DATA PROCESSING
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AND EFFECTIVE SOLUTIONS

The objective of this book is to present in a simple and attractive manner the path to be taken by the cities that seek a new municipal management model, inspiring them to use massive data in a productive manner for the development of more effective public policies for their citizens.

This edition is divided into five chapters in addition to this executive summary. Chapter 1 contextualizes the topic and primary concepts around the use of big data by the public administration. In it, we show how cities in different parts of the world use smart technology to collect and process data in order to improve their operations and service provisions for their citizens, thus becoming an inspiration for countries in the LAC region.

Chapters 2 and 3 introduce the Big Data for Sustainable Urban Development project, its methodology and the diagnosis of the participating cities, considering technological and legal conditions. They also consider the detailed mapping of services, data, and information already available in each one of the cities.

Chapter 4 analyzes the practical results of the project, such as the creation of an online platform to store, disseminate and distribute available open data among the cities, in an integrated manner, to the



Quito's modern district

general public. It also provides reference applications, which can be replicated in other cities in that region. Additionally it presents the process of cocreating the prototypes developed to address mobility and environmental topics in the cities participating in the project, and emphasizes the importance of the players' interactive participation—government, academia, and the consulting firms engaged—in creating and developing solutions according to the reality and needs of each individual city.

The last chapter presents recommendations of actions for migration from a traditional city model to that of a smart, i.e., data-driven, city. In the form of item checklists to be considered, the recommendations take into account factors such as preparation and approval of a specific data policy; establishment of partnerships for pilot data analytics projects; creation of a data analytics team through an administrative act; creation of public-private partnerships for collecting and handling data; and formation of a management team. Based on these necessary conditions, the book lists recommendations for the formulation and implementation of innovation policies, emphasizing input mapping and qualification, problem diagnosis, validation of solu-



Government palace and cathedral,
Xalapa

tions in conjunction with public administrators, and the importance of monitoring and assessment for the continuous improvement of the prototyped solutions.

Finally, we can't forget the event that placed new and extraordinary pressure on city administrators and imposed the need for increased efficiency and nimbleness in the decision-making process. COVID-19 turned work relationships in a new and different direction—both institutional and personal, as well as those of the society as a whole. In light of an unprecedented threat, the priorities of the different governmental spheres worldwide have turned towards fighting the pandemic and seeking measures to prevent and control the infections generated thereby. This book will also address this topic, illustrating these solutions through the use of massive data by the municipalities.

At the end of the reading, it is noted that the journey to government modernization and transparency fundamentally requires evolving from the traditional management model to a smart urban management model, which is driven by data and the cocreation of products in partnership with academia and companies, combining technologies, people, and processes in an innovative manner. This change will allow for a transformation process that enables integrating data, knowledge

and all information collected, thus shifting to a new integrated urban planning model.

LAC is a rather heterogeneous region, and each city can identify their own strategies and solutions that are more appropriate to their reality. This edition emphasizes the need to identify at least the proposed pillars—which include institutional/public policy, legal/regulatory, and technological/data science aspects—as well as to prepare and implement a solid plan around them.

Enjoy the reading!



Miraflores microcenter

City Hall's collection



1.



OPPORTUNITIES AND CHALLENGES OF BIG-DATA- BASED URBAN POLICIES

Data is nearly everywhere and in large amounts. Much of what we do in our daily life produces data. In 2018, it was estimated that each inhabitant of the planet would generate an average of approximately 2 megabytes of data per second in 2020.³ And this was a conservative estimate, as it did not include the digital acceleration imposed by the COVID-19 pandemic and the fact that every new digital technology exponentially increases data flows.

Commonly referred to as big data, this generation of abundant use of data has transformed several sectors of the society and impacted the decision-making processes of several players, including in public administration.

The complex challenges experienced on a daily basis in cities are also abundant and demand evidence-based urban policies that can be revealed by data. This data, which undergoes a process of cocreation and is based on advanced technologies capable of processing them, may create new solutions for problems experienced in municipalities. Properly taken advantage of and analyzed within the scope of public policies, it may then help improve decision-making processes, urban planning, and the feasibility of truly smart cities. Smart cities are defined by the IDB as those cities that place people in the center of development, incorporate information and communications technologies in urban management, and use these elements as tools that encourage the formation of an efficient government, which would include collaborative planning and citizen participation.⁴

When including, for instance, sensors in urban infrastructure and creating new data sources—including data generated by citizens

3 Domo. 2018. "Data Never Sleeps 6.0". American Fork, USA: Domo. Available at: <https://www.domo.com/learn/data-never-sleeps-6#/>. Accessed on: April 3, 2021. In 2019, Domo itself warned that these data could be undersized and stopped attempting to make this estimate.

4 Bouskela, M., Casseb, M., Bassi, S., De Luca, C. e Facchina, M. 2016. *The Road toward Smart Cities – Migrating from Traditional City Management to the Smart City*. Washington, D.C.: IDB. Available at: <https://publications.iadb.org/publications/english/document/The-Road-toward-Smart-Cities-Migrating-from-Traditional-City-Management-to-the-Smart-City.pdf>. Accessed on: July 23, 2021

themselves through their mobile devices—formulators of urban policies that include favorable regulatory-institutional and technological environments capable of working this data can add it to innovative environments and therefore minimize problems, reduce costs, and improve the public's quality of life. However, it should be kept in mind that the sensors cannot be an end in themselves. For a sensor to genuinely help increase the “intelligence” of a city, it is necessary to think that it can help solve problems.

A study conducted by the United Nations (UN) points out that, in 2050, 70% of the global population (more than 6 billion people) will be living in cities.⁵ Although the urbanization rates in virtually all countries in South America are already above this level, this is still a sign of a trend. To manage and improve its operation, it is necessary to understand the factors affecting people's daily lives. In this sense, it becomes more evident that it is critical to provide decision-makers with increased analytical capacity by using data, which has become an ever more important input to the implementation, monitoring, and assessment of public policies.

There are many examples of how municipal governments can enhance the use of data to transform the way they see cities and offer better services to citizens by responding to their demands.

In 2020, we noted a significant increase in the generation of data, the analysis of which supported the decision-making process and formulation of public policies to respond to the sanitary emergency caused by the COVID-19 pandemic.⁶ At the start of the pandemic, data from cell phone sensors enabled several cities to find social distancing rates. During the quarantine phases, georeferenced data enabled the departments of health to not only understand the evolution of the pandemic, but also identify the places of its highest concentration. Over time, all data regarding head-of-household mothers and the elderly allowed administrators to establish support strategies focused on these communities. These are examples of how data analysis generated by the urban environment and the public can help public administrators act to minimize—and even correct—the several issues

DATA MAY THEN HELP
IMPROVE DECISION-MAKING
PROCESSES, URBAN PLANNING,
AND THE FEASIBILITY OF
TRULY SMART CITIES

5 ONU prevê que cidades abriguem 70% da população mundial até 2050. *ONU News*. Feb. 19, 2019. Available at: <https://news.un.org/pt/story/2019/02/1660701>. Accessed on: April 6, 2021.

6 Please refer to “COVID-19 — Practical big data applications and lessons for public administration”, on page 119 of this publication.

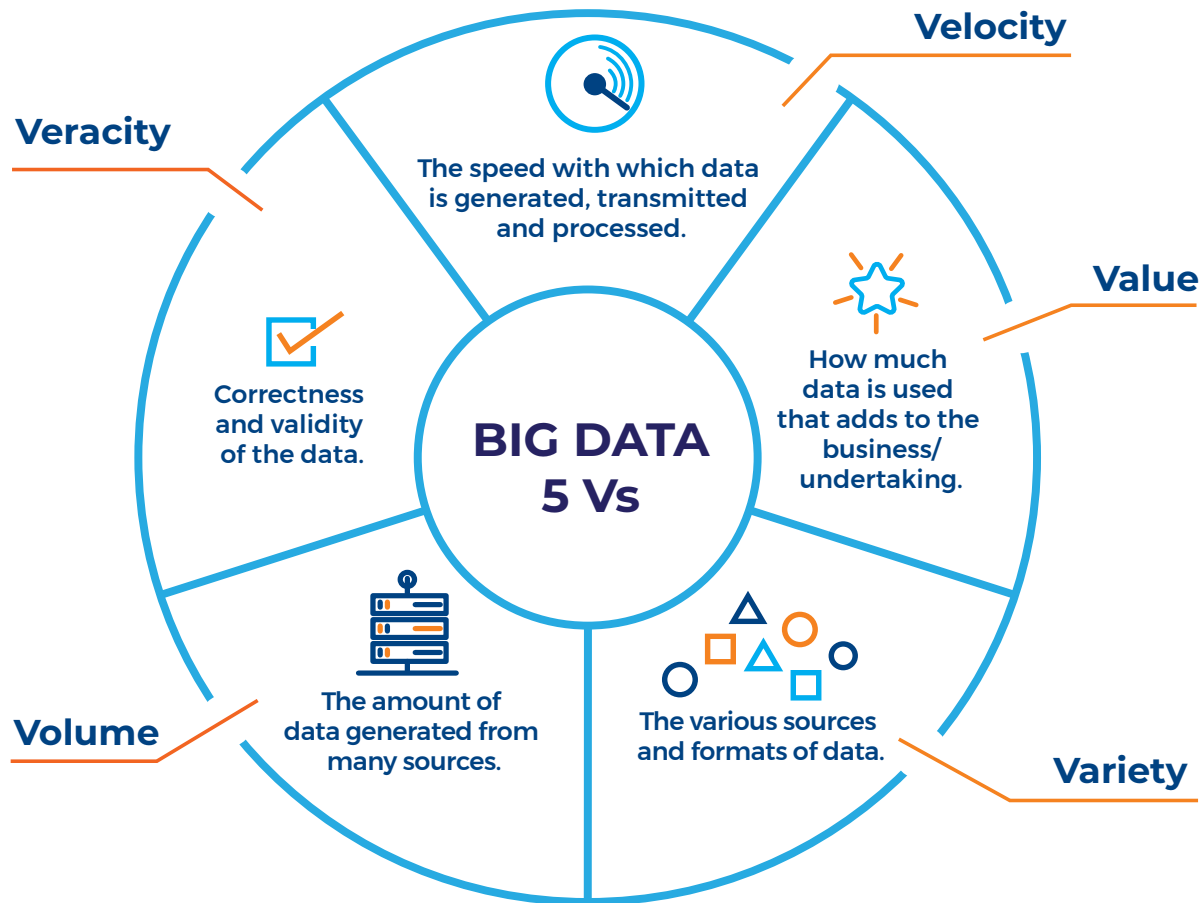
**BIG DATA GAINED
MORE RELEVANCE
IN THE EARLY 2000s****What is big data?**

Data collection is an old practice, but the concept of big data gained more relevance in the early 2000s, when Doug Lancy, an analyst from the consulting firm Gartner, articulated a definition based on three characteristics known as the 3Vs⁷ in data management: volume, velocity, and variety.

Volume is defined as the high amount of data generated from a diversity of sources, such as financial transactions, smart equipment using the internet of things (IoT), industrial systems, sensors, and social networks, among others. Velocity is associated with the speed at which data is generated, transmitted, and handled. Variety concerns several different sources (applications, social networks, sensors, devices) and data formats, from structured data (such as numerical data in traditional databases) to non-structured data (text documents, video, audio, e-mails, and financial operations).

Some theoreticians⁸ consider value—i.e., creation of value when applying data handling techniques—as being the fourth V in big data; and veracity would be the fifth V. If the data collected is not true, or if its quality cannot be measured, the entire analysis will be compromised. The necessary effort to extract value from data and the risks posed by inappropriate handling must be considered at all times and in all situations. In fact, a myth was created that simply the possibility of collecting a large volume of data would generate intelligence for cities. This is the same type of error as believing that supply creates demand itself (even though this is true in specific conditions and for a definite period). The process of creating value from data requires talent, which is the scarcest “asset” in the information era.

In order to use data and compare it with other sources, we must validate its representativeness. In addition, there is a need for an



intense effort in structuring, cleaning and handling data so that it can be used in implementing more dynamic management models. This factor is typically ignored by public agencies.

Simple data opening generates a potential, but if we wish this potential to be democratized, it is necessary to clean this data. Otherwise, only companies capable of incorporating the data loading and cleaning process can benefit from this opening.

7 Lancy, D. 2001. "3D Data Management: Controlling Data Volume, Velocity, and Variety". *Application Delivery Strategies*. Stamford, USA: Meta Group. The article was written when Lancy worked at the Meta Group, which was subsequently acquired by the Gartner Group. Available at: <https://studylib.net/doc/8647594/3d-data-management--controlling-data-volume--velocity--an>. Accessed on: April 3, 2021.

8 Ge, M., Bangui, H. e Buhnova, B. 2018. "Big Data for Internet of Things: A Survey". *Future Generation Computer Systems*, 87: 601-614. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0167739X17316953>. Accessed on: April 3, 2021.

that affect the daily life of citizens. This experience shows that it was not necessary to add any sensor to the technological park of cities. Virtually any citizen over 15 years of age has a mobile phone now. Strategies to create incentives for people to share these sensors with the public sector are at the core of a smart city, which does not need to spend its money from a tight budget acquiring sensors, but rather, increasing knowledge.

Several other different initiatives may benefit from correct data utilization, such as carbon emission reduction, urban mobility, and a safe, sustainable and cost-effective infrastructure management. The predictive analysis of traffic and transportation patterns may reduce traffic congestion and improve the efficiency of public transportation services. City resources for public safety and social assistance, among other essential services, may be directed in a more effective manner through updated information.

Quito's Old Town



The use of big data in public administration

The use of data has become more important in the decision-making process in both the private and the public sectors, but governments still have a long way to go for the effective use of big data in public policies to become a reality capable of benefiting the society as a whole.

Extensive use of data that is currently available to public administrators can create public value in several dimensions, provided one knows how to analyze and use it in public asset cocreation programs and processes.⁹ Its effective use, however, depends on its availability in proper use conditions, which in some cases implies hiring cloud services, a task which is still difficult for Latin American cities. Nonetheless, this is not merely about difficulties in developing applications to improve public services, but rather about a difficulty that precedes those. Some agreements are entered into so that the service supplier can maintain control over the data from its origin, which prevents the open innovation process that could lead to effective development of innovation in the supply of public services.

In many cities worldwide, real-time data collected from sensors and other devices is helping, for instance, to optimize connections between different modes of transportation in order to achieve shorter travel times, reduce operation costs, and increase convenience through information services optimized for the users.

The Chinese city of Hangzhou implemented the City Brain platform, created by the company Alibaba, in order to forecast traffic flows and detect accidents as a part of its expanded traffic management system.¹⁰

Kansas City, in the US state of Missouri, has been using big data and IoT analytics to save billions of dollars in expenses associated with a smart sewer system management project.¹¹

Dublin, in Ireland, is part of a group of Mastercard partner cities in the City Possible¹² project. Insights generated from the pattern of

9 Projects such as the Sharing Cities program, financed by the European Union, are exploiting the use of data in a sustainable energy management system that optimizes energy production and consumption at a community level. Learn more at: <http://www.sharingcities.eu/>. Accessed on: July 23, 2021.

10 Learn more at: <https://damo.alibaba.com/labs/city-brain>. Accessed on: July 23, 2021

11 The Kansas City smart city project started in 2015. Today, the city is fiercely proud of its smart sewer network. Learn more at: <https://www.kcsmartsewer.us/home-smartsewer>. Accessed on: July 23, 2021.

12 City Possible is a partnership and cocreation initiative that brings together cities, companies and communities with the purpose of identifying common challenges and developing joint solutions that promote inclusive and sustainable urban development. Dublin developed a holistic city planning approach using data and perceptions to drive evidence-based urban development. Learn more at: <https://citypossible.com/driving-evidence-based-urban-development-in-dublin>. Accessed on: July 23, 2021.

expenses by residents and visitors of the Irish city are being used by local administration to better understand the economy in Dublin and compare it with that of the entire country, thus enabling the creation of more assertive strategies for the economic development of the city. Finally, the Spanish city of Barcelona uses GPS¹³ sensors to improve emergency medical services. Traffic lights detect ambulances and change their route so that they can drive on the roads as fast as possible without creating dangerous situations for other users.

Application of big data in different sectors

In cities, data sources are everywhere: in smartphones, computers, environmental sensors, cameras, websites, social networks, GPS, etc. There are plenty of ways to store, organize, analyze and obtain insights from this data in order to help decision-makers plan improvements in services provided and make public administration more transparent, open, and democratic.

Nevertheless, using this analytical intelligence to build better life conditions in cities is contingent upon a process to frame urban policies through which different tools are used and which develop strategies and engagement forms that appropriately respond to challenges in different sectors: finance, water, electricity, mobility, and health, among others. Technological platforms can be cocreated within the scope of these policies, with the support of artificial intelligence (AI) resources to improve life in cities, such as reduction in the commuting time between home and work; street, house, and building monitoring; electricity and water consumption management; improved access to public services; issuance of alerts on changes in air quality; and preparation for emergency situations. The following are some practical examples of this new approach.

Urban cleaning

Within the context of the city of Montevideo, public safety is managed by the Ministry of the Interior of Uruguay, which provides an infrastructure of security chambers in several points of the city.

¹³ The Ambulancia Conectada 5G project further expanded this IoT application in the city of Barcelona. Learn more at: <https://5gbarcelona.org/es/pilotos/ambulancia-conectada-5g/>. Accessed on: July 23, 2021.

The Intendancy of Montevideo and the ministry entered into an agreement that ensured mutual access to the camera images by both the city and the ministry itself. As a result, the amount of equipment available increased, enabling surveillance of previously inaccessible points of the city. The intendancy took advantage of this fact to improve the already existing public cleaning system and introduced new ways to use the cameras.¹⁴

In a pilot project, data generated by the cameras was used to impose fines for violations in waste management. The Cleaning Monitoring Center uses the cameras to monitor street containers and locations used as illegal dumps. Images of the equipment are submitted to the City Operation Center, where they are stored and analyzed. In a pilot plan implemented in December 2018 in two districts, the intendancy added a camera system to special groups of policemen who patrol the area 24 hours a day.

Urban planning

Many cities in Latin America and the Caribbean (LAC) face the challenge of rapid informal urban growth, which prevents them from providing basic services to their citizens and ensuring sustainable urban development. Today, drones, artificial intelligence and machine learning provide key information for cities to better understand informal growth patterns and improve urban management.

In Brazil, a pilot project in Manaus¹⁵ financed by the IDB Cities Laboratory¹⁶ revealed the exponential growth of an informal community, with a 130% increase in housing units in the occupied area within five weeks. Originally, the city only had two satellite images of this area, taken in 2010 and 2016, without any shadow of the informal occupation. The use of drones and big data analyses helped the city address, plan and even develop predictive measures to cope with the uncontrolled growth of informal settlements. Between 2000 and 2010, the city population increased by 2.51% per year, as compared to a 1.95% growth for the state, with a relevant growth caused by the illegal land occupation identified in the experiment conducted.

USING THIS ANALYTICAL
INTELLIGENCE TO BUILD BETTER
LIFE CONDITIONS IN CITIES IS
CONTINGENT UPON A PROCESS
TO FRAME URBAN POLICIES

14 López Reilly, A. "Policía accede a cámaras de la IMM". *El País*. Madrid, Spain, June 29, 2018. Available at: <https://www.elpais.com.uy/informacion/sociedad/policia-accede-cameras-imm.html>. Accessed on: April 3, 2021.

15 Bouskela, M. e Elnir, H. 2019. "Monitoring Informal Settlement Growth in Manaus, Brazil with drones". *Ciudades Sostenibles*. Washington, D.C.: IDB. Available at: <https://blogs.iadb.org/ciudades-sostenibles/en/monitoring-informal-settlement-growth-in-manaus-brazil-with-drones/>. Accessed on: April 3, 2021.

16 Available at: <https://www.iadb.org/en/urban-development-and-housing/idb-cities-lab>. Accessed on: April 3, 2021.

Big data applications in different sectors of public management of cities

Public health

The immense volume of information collected from public and private databases, social networks and applications can be transformed into benefits such as early diagnosis, preventive care and epidemic control. In Brazil, for example, Info Dengue alert system brings together epidemiological, meteorological and social media data to monitor the transmission of arbovirus and inform the competent bodies.

Urban cleaning

Real-time monitoring of cleaning, collection and inspection teams; waste management and treatment; waste reduction and process optimization. These are some of the benefits of using big data in urban cleaning management. A pilot project in Montevideo monitors street containers and places used as illegal garbage dumps with security cameras.

Tourism

The creation of "tourism observatories", whereby strategic data for planning and decision-making in the sector are collected and disseminated, is a way to promote tourism as an activity for the economic and social development of cities. In Montevideo, information from secondary sources has been incorporated, such as national surveys, many of which are also available to citizens and tourists.

Urban planning

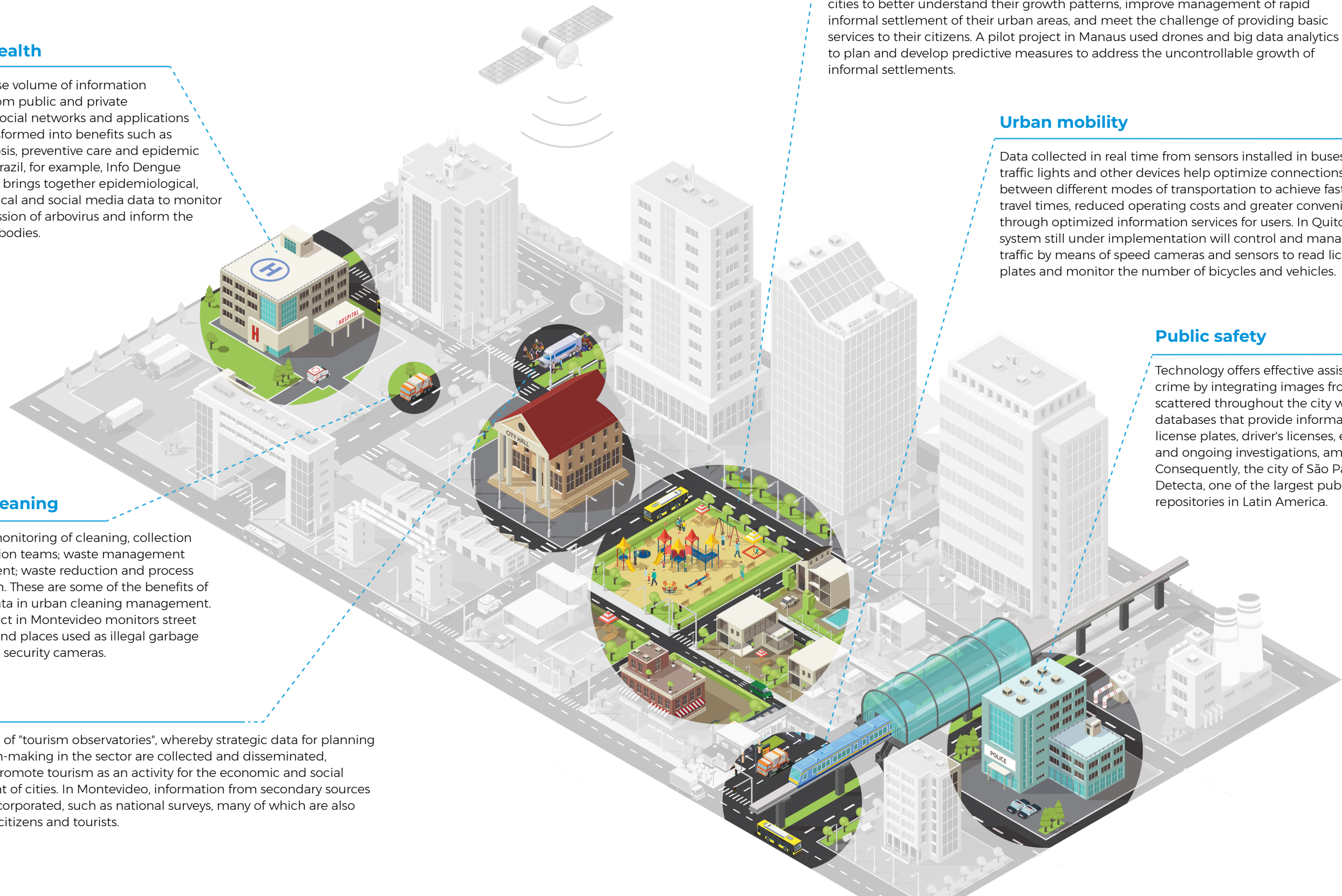
Artificial intelligence and machine learning solutions provide crucial information for cities to better understand their growth patterns, improve management of rapid informal settlement of their urban areas, and meet the challenge of providing basic services to their citizens. A pilot project in Manaus used drones and big data analytics to plan and develop predictive measures to address the uncontrollable growth of informal settlements.

Urban mobility

Data collected in real time from sensors installed in buses, trains, traffic lights and other devices help optimize connections between different modes of transportation to achieve faster travel times, reduced operating costs and greater convenience through optimized information services for users. In Quito, a system still under implementation will control and manage traffic by means of speed cameras and sensors to read license plates and monitor the number of bicycles and vehicles.

Public safety

Technology offers effective assistance in fighting crime by integrating images from cameras scattered throughout the city with public databases that provide information such as license plates, driver's licenses, emergency calls and ongoing investigations, among others. Consequently, the city of São Paulo created Detecta, one of the largest public security data repositories in Latin America.



DATA COLLECTED
IN REAL TIME [...] IS HELPING OPTIMIZE
CONNECTIONS BETWEEN
DIFFERENT MODES
OF TRANSPORTATION

Urban mobility

One of the major challenges faced by the city of Quito, in Ecuador, is to reorganize its bus lines due to the advent of the metro and to advance towards an integrated transportation system. To solve the issue, the city has analyzed data on people's displacement habits collected by cell phones.

In addition, the Orquestador de la Movilidad system, announced in 2019, is expected to help ease heavy traffic, which is considered one of the most congested in Latin America. Through the interconnection of different platforms, the system will monitor road safety, smart mobility and the economic sustainability of land transportation, traffic and road safety. In order to do so, it will be equipped with air quality and traffic flow sensors, speed cameras, license plate readers, vehicle and pedestrian controllers, etc.

In general, local transportation departments have taken the lead in the adoption of big data analyses. Data collected in real time from sensors and other devices is helping optimize connections between different modes of transportation in order to achieve shorter travel times, reduce operation costs and increase convenience through information services optimized for the users.

Public health

One of the most emblematic examples of data use in health management is Info Dengue (<https://info.dengue.mat.br/>), a public alert system for online monitoring of arbovirus risk by regions, which has been operating for four years in Brazilian cities. The system provides continuous analyses through weekly reports disclosed via e-mail, which reduces the health authorities' response time for 2,122 municipalities in the states of Ceará, Espírito Santo, Maranhão, Minas Gerais, Paraná, Rio Grande do Sul, Rio de Janeiro, Santa Catarina, and São Paulo.

Info Dengue issues alerts to the health surveillance departments, which therefore can more quickly mobilize preventive health programs.

Through a set of mathematical and statistical models, Info Dengue gathers epidemiological, meteorological and social media data, indicating the areas with the highest arbovirus transmission rates and providing information to the relevant agencies. Epidemiological data is obtained through information provided by the municipal and state departments of Health; all meteorological information is produced by the National Center for Natural Disaster Monitoring and Alerts (Cemaden), and the reports or mentions of the diseases in social networks are analyzed with the aid of the Dengue Observatory at the Federal University of Minas Gerais (UFMG).

When the project started in Rio de Janeiro, in 2013, it helped the city achieve a 98% reduction in dengue cases from one year to the next.¹⁷ The number of notifications of dengue cases dropped from 1,294 per 100,000 inhabitants to only 41.7 per 100,000 inhabitants, while other cities at the same latitude achieved as much as 3,000 cases per 100,000 inhabitants.

At the beginning, many players were involved, each with their own specializations and projects, such as the Department of Health, the Department of Education, and the Department of Conservation. The use of data in an intersectional manner between the agencies, in line with the highest levels of municipal administration, was crucial for the success of the city administration's strategy. Historical records of dengue cases, as well as their georeferencing (geographical location) and overlapping with official data on districts, schools and hospitals, among others, were used over nearly four years.

Tourism

To consolidate the city of Montevideo in Uruguay as a smart tourism destination, a strategy was devised by its Tourism Department in mid-2018. The local administration developed a strategic management tool that seeks to know the state of affairs and the evolution of the tourism system. The so-called Tourism Observatory generates and discloses tourism information and market intelligence to guide the decision-making process of the

¹⁷ Data from PENSA – Sala de Ideias, a group that existed between 2013 and 2016, comprising data scientists and public servants with knowledge on data analytics, and which carried out projects using data from a diversity of sources and data-oriented analysis methods to design projects and public policies.

public sector, as well as of companies and professionals, promoting tourism as a strategic activity for economic and social development.

To this end, big data techniques were applied to analyze new sources of information and better understand the environment, providing aid in qualitative surveys on the behavior of the main tourism segments and markets. Information from secondary sources generated by other institutions, such as national surveys, were also incorporated. Much of this information is available to citizens and tourists on the Descubrí Montevideo portal (www.descubrimontevideo.uy), which is also a tourism open data platform for operators and key players in this sector. Relevant information is available on the destination, such as the different visitor profiles and segments, levels of satisfaction, tourism mobility, opinions on hotels and attractions, and air capacity, among others.

Public safety

In 2014, the state of São Paulo created one of the largest data repositories on public safety in LAC. In practice, Detecta is a crime prevention and investigation system that promotes integration

Costa Verde cliffs,
Miraflores



between databases and cameras from a diversity of institutions in order to monitor specific areas, vehicles and suspicious individuals, helping the police fight crimes across the São Paulo territory. To enable this, data from the Digital Police Registry (RDO), from the Institute of Identification (IIRGD), from the Military Police Operating System and from the Criminal Photo System (Fotocrim) was used. Vehicle data and the National Driver's License (CNH) of the State Traffic Department (Detran) were also utilized.

In total, 56 municipalities in São Paulo established a partnership in order to integrate Detecta. Over the past years, governments of other cities and states demonstrated interest in the platform integration and information sharing.

São Paulo was inspired by the city of New York, where, in August 2012, the Police Department, in partnership with Microsoft, announced the launch of the Domain Awareness System (DAS)¹⁸ as part of the Lower Manhattan Security Initiative.¹⁹ Connected to thousands of cameras scattered throughout the city, the system has access to data to at least 2 billion license plate readings, millions of subpoenas,

18 Learn more at: <https://www.informs.org/Impact/O.R.-Analytics-Success-Stories/NYPD-Domain-Awareness-System-DAS>. Accessed on: June 2, 2021.

19 Learn more at: <https://www.nyclu.org/en/cases/nyclu-v-new-york-city-police-department-seeking-access-information-lower-manhattan-security>. Accessed on: April 3, 2021



millions of calls to the police, millions of prisons and warrants. Its operation is based on the tracking of police targets and supports prevention against terrorist acts.

Collaboration, integration and sharing

As seen in this chapter, the use of massive data may generate administrative savings, improve processes, service provision and formulation, implementation, monitoring and assessment of public policies, making them smarter, more responsible, and more responsive to the feedback of citizens. To achieve better results, it is important that public administration entities are open to collaboration with civil society, academic and corporate communities, and with other government spheres.

The city of Chicago, for instance, worked with data from Allstate Insurance over four years to create a predictive model that helped guide food safety inspections.²⁰ Another example demonstrating this type of collaboration is the Rural Routes project,²¹ which was recently announced by the government of São Paulo state, the objective of which is to map 60,000 kilometers of rural routes, enabling the creation of digital addresses for 2 million people living in areas not displayed on location services such as Waze and Google Maps. The digital address of the properties will be provided with the use of a technology referred to as plus codes, which converts latitude and longitude coordinates obtained by satellite into codes that are similar to postal codes.

This cooperative logic is also reflected in urban big data and data maturity models, such as that developed by IDB²² and the Reference Analytical Framework used in the Big Data for Sustainable Urban Development project, presented in chapter 2 hereof. IDB's model considers the use of big data in public policies works as an ecosystem. The effective, ethical and equitable use of massive data is achieved through the creation of a community of users, use culture and data sharing mechanisms, implementation of open innovation practices, expansion of society's participation in identifying issues, agglutination of technical capacity to obtain valuable insights and regular reassessments to provide sustainability to performance assessment and change



Marcos Mattos CET SP

Vila Madalena subway station and bus terminal, São Paulo

20 Available at: <https://github.com/Chicago/food-inspections-evaluation>. Accessed on: April 3, 2021.

21 Learn more at: <https://www.al.sp.gov.br/repositorio/legislacao/decreto/2020/decreto-65183-17.09.2020.html>. Accessed on: April 3, 2021.

22 Available at: https://publications.iadb.org/publications/english/document/Big_Urban_Data_A_Strategic_Guide_for_Cities.pdf. Accessed on: 7 July, 2021.

processes. The Reference Analytical Framework also reflects cooperative logic, especially by addressing other topics regarding transparency and participation, and culture and society, which foster citizen engagement. It is also crucial to consider the use of data in public administration as a common asset. Data sharing and integration must be facilitated whenever possible. Sharing data by ensuring citizen privacy is one of the major challenges faced during the process to develop a big data project.

Governments must also be capable of managing changes and have the ability to adapt processes, systems and practices in order to place big data in a position to serve as an input by governments.

It should be stressed that data and technology alone do not create better cities. Unanalyzed databases produce no benefits. It is crucial to have public policies based on data and technology, but this needs to be done using a synergistic and interactive process between the governments elected to solve the problems of the society, the academia—which scientifically raises and tests hypotheses to better signify this issue—and the companies—which produce data, products and services that could also cause socioeconomic impacts.

SHARING DATA BY
ENSURING CITIZEN
PRIVACY IS ONE OF THE
MAJOR CHALLENGES

The main challenges

The use of data as input for decisions made by public administration is not a trivial topic and must be done cautiously and strategically. It should be done by forming and qualifying teams, structuring data and making the necessary adaptations for the information to be used in a responsible, planned, transparent, ethical and inclusive manner, respecting privacy and confidentiality, and attempting to better serve the public interest. In practice, it is possible to divide the challenges into three major pillars:

Pillar 1: technological/data science

Pillar 1 concerns the definition and implementation of the necessary technological structure to capture and process large data volumes.

This includes aspects that are both external (connectivity, digital inclusion, existence of an ecosystem that already uses data comprised of players external to the public administration) and internal (existence of a team responsible for data-based projects, availability of computer infrastructure, selection process, and maintenance of qualified personnel, among others) to the administration.

The main issues faced by cities in having unified platforms are budget and personnel limitations, and the need for standardizing and integrating databases in order to generate quality information. The trend is the centralization of bases from different areas of government activity, such as mobility, safety and energy, as this facilitates the analysis of problems and the preparation of performance indicators for the formulation of more effective solutions.

For instance, a big data solution must be scalable for it to be in line with this concept. Traditional data servers cannot offer this type of solution, i.e., a cloud solution is necessary. Most municipalities in Latin America are not even prepared to obtain cloud services yet. Their teams are not qualified to handle this technology. Additionally the purchase system of the Latin American public sector cannot deal with a service for which the amount to be obtained beforehand is unknown.

Pillar 2: legal/regulatory

The legal and regulatory challenges of cities in regards to data use are relevant to render data use feasible in city planning. There are both external (national standards regarding transparency and open data, privacy protection, and ways of hiring personnel and technology) and internal aspects of municipal administrations (local standards that define the attributions of the data teams, their freedom to act and independence, and the viability of establishing partnerships with external players). Many municipal administrations lack clear standards that could be of help in adopting policies to use citizens' data.

Pillar 3: institutional/public policies

After overcoming the barriers in creating the legal-regulatory and technological conditions described above, the challenges to ensure increased social inclusion and generate more comprehensive benefits through a public policy involve factors such as: mobilizing necessary inputs, fostering interaction of different players in innovative environments. Government, academia and companies working synergistically are especially responsible for cocreating a logical model of urban policies based on innovation systems.



Xalapa's Symphonic Orchestra, Tlaqná auditorium

2.



BIG DATA FOR URBAN DEVELOPMENT — IN SEARCH OF A SUSTAINABLE MODEL

With the purpose of identifying key aspects for the successful implementation of big data use in fostering sustainable urban development, Fundação Getulio Vargas, in partnership with the Inter-American Development Bank (IDB), carried out the Big Data for Sustainable Urban Development project, which included participation from five Latin American cities: Miraflores (a district of Lima, Peru), Montevideo (Uruguay), Quito (Ecuador), São Paulo (Brazil), and Xalapa (Mexico). Based on analyses of the experiences developed by these cities, a discussion was initiated on necessary ways to cocreate sustainable urban policies capable of mitigating the complex problems experienced in cities in Latin America and the Caribbean (LAC), considering the technological and legal-political-regulatory conditions collaboratively laid down by local governments, academicians, and companies. The challenges common to all five cities can, therefore, serve as a benchmark to other cities in that region.

The starting point was the diagnosis made of the technological and regulatory conditions of each city, and a detailed mapping of the open data and information available in each one of them. The diagnosis considered their systematization and listing in order for them to serve as inputs for the public policies to be implemented.

Concurrently, a CKAN (comprehensive knowledge archive network) platform was conceived.²³ Referred to as Dataurbe, its objective is to store, diffuse and distribute open data available among cities. A manual for administrators was also produced in order to identify factors to be considered in implementing the regulatory

²³ CKAN is a data cataloging web application developed by Open Knowledge.

data opening policy.²⁴ Additionally, a bill/decreree was developed, aimed at creating big data management teams in each city.

Representatives appointed by the cities comprised the project Steering Committee, which was the scope of dialogue and strategic inquiry of the work performed with FGV. The Regional Meetings held in São Paulo and Miraflores in May and December 2019, respectively, and via webinar in January 2021 due to the COVID-19 pandemic, allowed for interaction between the representatives of the cities. On those occasions, speeches, case presentations, round tables, and dynamics were held, enabling productive discussions with the purpose of reaching common goals with respect to the elements to be addressed within the scope of the project.

The dimensions of the Reference Analytical Framework

All participating cities seek better and increased utilization of data collection, analysis, and use. For a previous assessment of the maturity level of each one of them, FGV researchers proposed the creation of a methodology based on a comparison case study of the partner cities: the Reference Analytical Framework. This could serve as a basis for other cities in diagnosing their own maturity level in data use.

The Reference Analytical Framework comprises four dimensions: Technology; Data Protection and Security; Transparency and Participation; and Culture and Society.

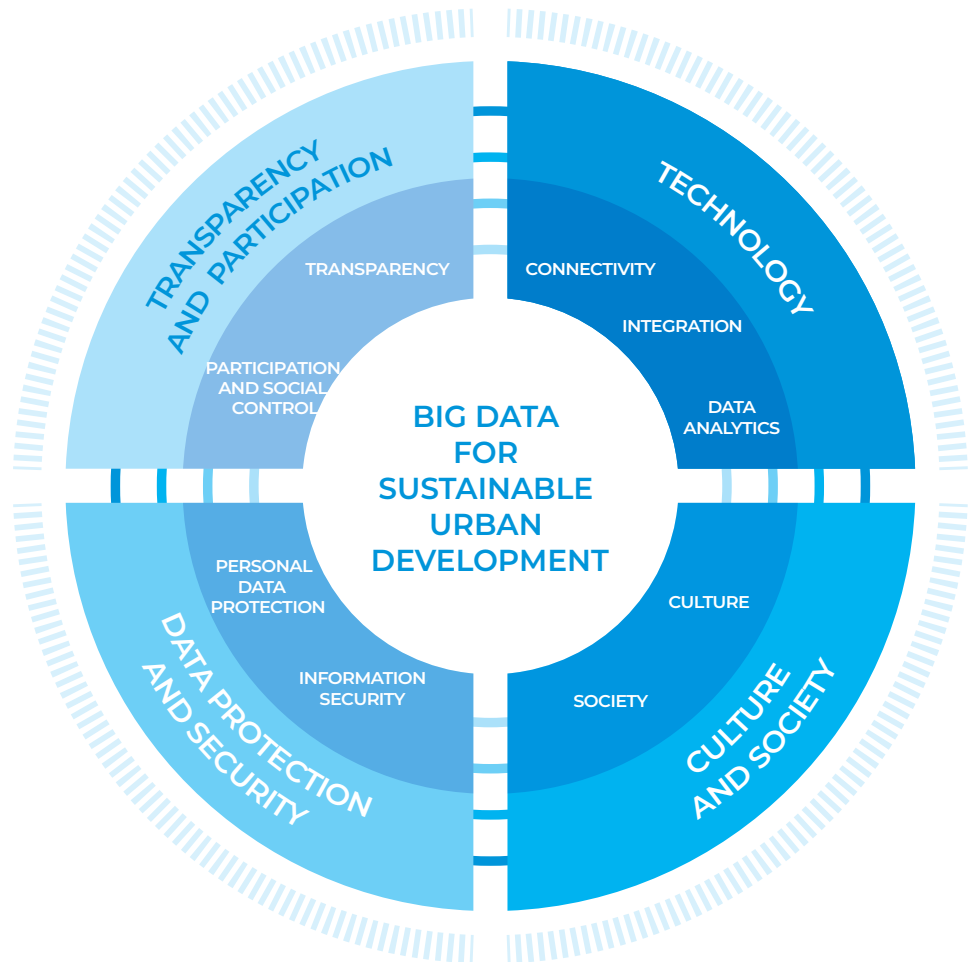
Technology

The Technology dimension seeks to identify the existence of political-regulatory frameworks that foster the adoption of technological and digital tools that enable better data use for the development of smart cities by cocreating solutions in open innovation urban policies. It comprises three subdimensions: Connectivity; Integration; and Data Analytics.

BASED ON ANALYSIS OF THE EXPERIENCES DEVELOPED BY THESE CITIES, A DISCUSSION WAS INITIATED ON NECESSARY WAYS TO COCREATE SUSTAINABLE URBAN POLICIES CAPABLE OF MITIGATING THE COMPLEX PROBLEMS EXPERIENCED IN CITIES IN LATIN AMERICA AND THE CARIBBEAN

24 Available at: http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29694/tr_5_-_produto_5_-_manual_final_revisado_web.pdf?sequence=1&isAllowed=y. Accessed on: April 3, 2021..

Reference Analytical Framework



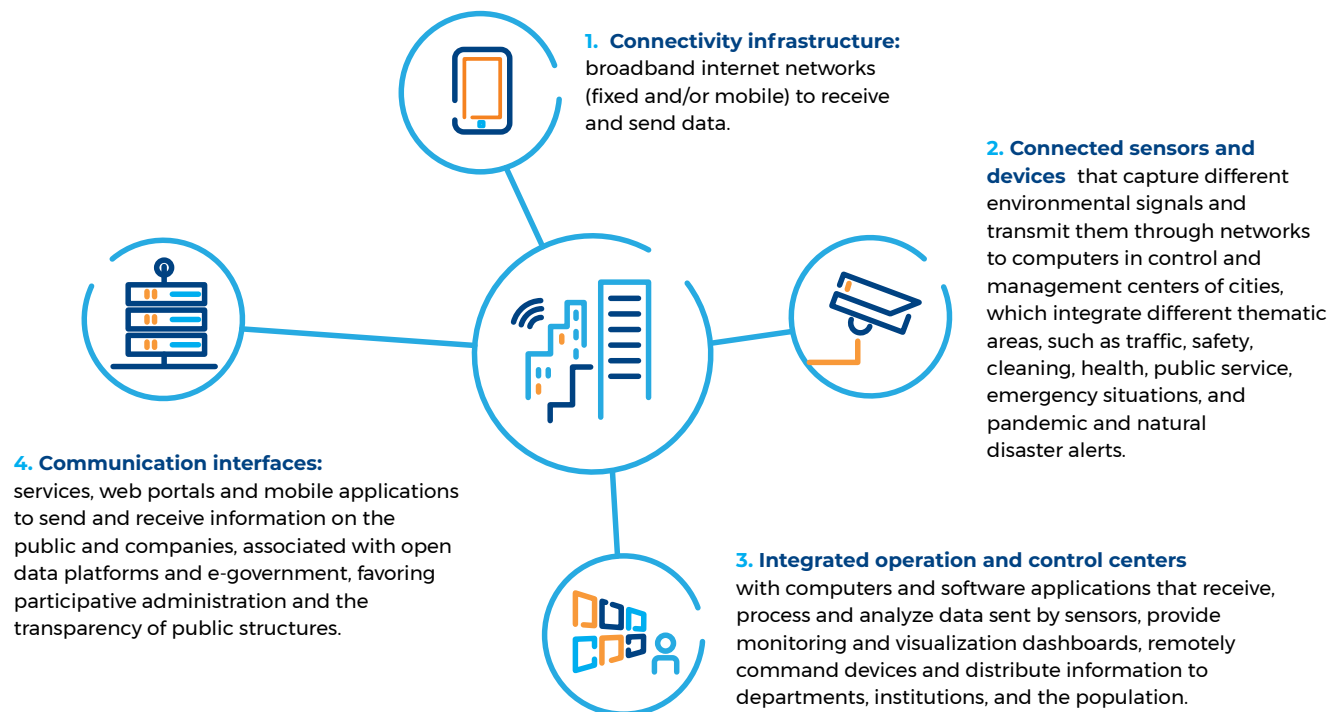
The Connectivity subdimension maps existing regulation to improve internet connection and speed up access by citizens to the digital service platforms offered by the municipality.

The Integration subdimension analyzes regulatory frameworks that ensure standards and interoperability between the municipality's different databases and systems. The goal here is to integrate data into a platform in the medium or long run.

The Data Analytics subdimension checks the stimuli for collection, storage, organization, analysis and data use that will help the administrator make quicker and smarter decisions.

It should be stressed that the Technology dimension used, as a basis, the four technological components considered basic for a smart city according to the IDB study.²⁵

Basic technological components for a smart city



These components connect to one another. For instance, the Connectivity subdimension includes elements from the connectivity infrastructure and communication interface components due to the importance of smartphones and broadband internet connections for the generation of data by citizens in the use of public services or private partners of the public administration. Integration and Data Analytics subdimensions include elements such as connected devices and sensors, as well as integrated control operation centers. Networks of sensors capture a gigantic amount of data (big data), which, when submitted to a predictive analysis in real time, allow for quick decision-making, and in a preventive manner.

25 Bouskela, M., Casseb, M., Bassi, S., De Luca, C. e Facchina, M. 2016. *The Road toward Smart Cities — Migrating from Traditional City Management to the Smart City*. Washington, D.C.: IDB. Available at: <https://publications.iadb.org/publications/english/document/The-Road-toward-Smart-Cities-Migrating-from-Traditional-City-Management-to-the-Smart-City.pdf>. Accessed on: July 23, 2021.

Data Protection and Security

The Data Protection and Security dimension analyzes the governance of all information collected from the perspective of the impact that it could cause on the fundamental rights of those living in the cities. The political-regulatory frameworks associated with two subdimensions will be assessed, namely: Personal Data Protection and Information Security.

The Personal Data Protection subdimension considers the existence of laws to protect citizen data at all governmental levels, including a jurisprudence dedicated to the big data topic.

The Information Security subdimension checks for frameworks established for the adoption of data use standards in public entities and agencies, such as ISO 27001. It covers all types of organizations (for instance, business ventures, governmental agencies, and non-profit organizations). This standard specifies the requirements to establish, implement, operate, monitor, critically analyze, maintain, and enhance an Information Security Management System (SGSI) documented within the context of the organization's global business risks. It specifies requirements for the implementation of customized security controls for the individual needs of organizations or their stakeholders.

Transparency and Participation

The Transparency and Participation dimension unfolds into both the Transparency and the Participation and Social Control subdimensions.

In regards to the topic of Transparency, regulatory instruments established are verified in order to give guidance on how citizens access data and how it is used in decision-making processes. This subdimension also deals with the regulation of open data platforms, the citizens' participative administration, and public administration transparency, all of which consist of elements dealt with in the communication interfaces technological component.

The Participation and Social Control subdimension deals with regulation that enables society to control proper data use on the part of municipal administrators and the feasibility of establishing a space for dialogue and discussion between citizens and government—and between the citizens themselves—on the formulation of policies and regulations regarding data use in city administration.

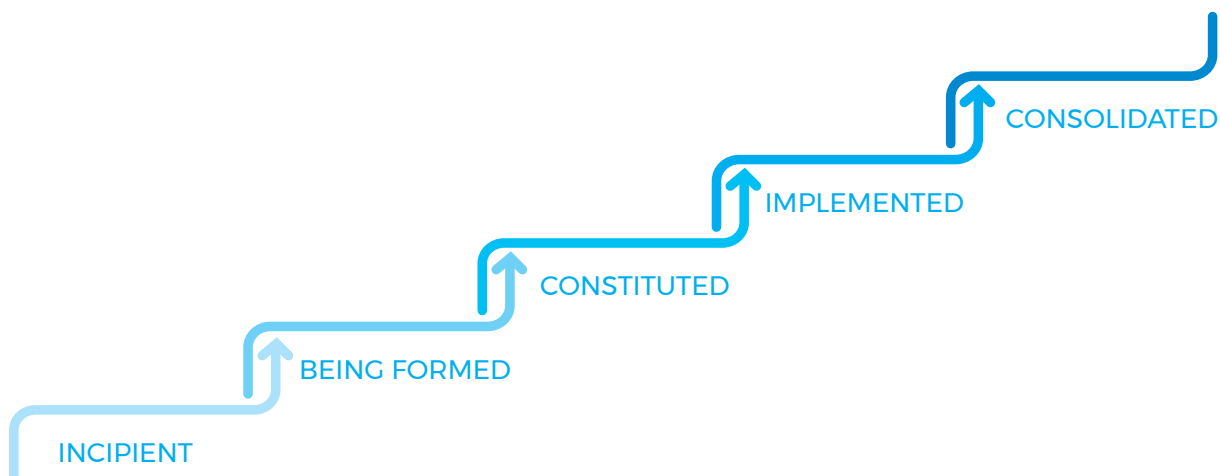
Culture and Society

The last dimension, Culture and Society, identifies the political-regulatory frameworks that foster engagement of citizens through their active participation in digital platforms. This participation includes contributions to technological innovations for data use and analysis, with the purpose of solving problems and improving city administration.

The maturity level of each dimension

To qualify the degree of development of each dimension in a city and allow for identification of urban big data challenges and the follow-up of their evolution, FGV researchers have established five maturity levels: 1 (Incipient); 2 (Being Formed); 3 (Constituted); 4 (Implemented); and 5 (Consolidated).

Maturity level



The Incipient level represents that moment at which the actions are nothing but good intentions. There are no regulatory frameworks. No more than an embryonic discussion.

At the Being Formed level, there already are regulatory-institutional projects on data use, as well as some isolated public policies.

At the Constituted level, public policies are yet to be improved, particularly with respect to their coordination.

The Implemented level means that the defined objectives are close to being achieved, although they still require some adjustments.

Finally, the Consolidated level is the highest stage, at which public policies related to the regulatory frameworks of the five dimensions are in effect and their implementation seeks continuous improvement of public administration and city life.

It should be stressed that, as national policies and standards impact the formulation of local public policies, the interruption of regulatory frameworks was not restricted to local analysis. For instance, in most cases, the regulatory frameworks of Transparency and Personal Data Protection have their origin in national legislation, but have a crucial bearing on the formulation of local public policies.

To learn more

Learn more about each dimension and subdimension of the Reference Regulatory Framework on page 23 of the *Regulatory Report Containing List and Criticism of the Legislation for the Use of Public and Private Data in the Cities of São Paulo, Montevideo, Quito, Xalapa, and Miraflores* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29691/tr_1_producto_4_informe_final_es_site.pdf?sequence=1&isAllowed=y).

The analysis of the five cities

According to the *State of Latin American and the Caribbean Cities report*,²⁶ produced by the United Nations Human Settlement Programme (UN-HABITAT), the urban population in LAC will reach 89% in 2050. The Southern Cone,²⁷ of which two cities contemplated in the project are a part of, currently have its highest proportion of population living in cities (85%), followed by the Andean countries and Mexico, where the fifth city, Xalapa, is located. Therefore, for the countries taken into consideration, the expected change in degree of urbanization is irrelevant: a 4% increase in 30 years. Nonetheless, even when considering a minimum rural-urban migration rate, this does not mean that these cities have undergone an orderly growth.

One of the consequences of disorderly growth of cities in that region is the fact that they face ever more complex issues and more innovative solutions to eliminate them. Urban management and the development of effective public policies within a dynamic context such as this are challenges that have been provoking discussions and reflections in the most diverse sectors of society. Add to them the enormous challenge of replicating, within this context, solutions based on digital technologies that other cities in the world seek to implement due to the significant heterogeneity of the municipalities in that region in terms of their physical, geographical, economic, institutional and social characteristics. Said heterogeneity is also permeated with political and cultural challenges.

This leads us to believe that the best strategy for each region can only be well defined when backed by innovative evidence-based urban policies subject to monitoring and constant assessment. Urban policies that access and mobilize open data and available technological resources in a process to cocreate solutions that are actually capable of eliminating previously diagnosed complex issues. Without it, the mere transposition of successful strategies from one place to the other could easily fail.

THE BEST STRATEGY FOR EACH
REGION CAN ONLY BE WELL
DEFINED WHEN BACKED BY
INNOVATIVE EVIDENCE-BASED
URBAN POLICIES SUBJECT
TO MONITORING AND
CONSTANT ASSESSMENT

²⁶ Available at: <https://unicrio.org.br/onu-lanca-relatorio-sobre-cidades-latino-americanas/>. Accessed on: April 3, 2021.

²⁷ Brazil, Argentina, Paraguay, Uruguay, and Chile.



City Hall's collection

Playa La Estrella, Miraflores

The implementation of innovative, evidence-based urban policies is not trivial and concerns not only the availability of financial and technological resources, political matters, and a municipal governance capable of hearing, understanding and prioritizing the demands of citizens. It also concerns the conditions that pre-existed in cities for massive data collection and handling; the adoption of a transparency model that demonstrates the public purpose of data use; the implementation of good data use and information security practices; the establishment of good communication conditions and interaction between governments and citizens; the construction of a regulatory-institutional structure; and particularly the capacity to mobilize all these resources and cocreate truly innovative solutions. But none of this will have the capacity to generate effective innovation if it does not start from a good question that seeks to provide a response to a substantial urban public policy problem.

Many aspects are yet to be developed in most cities, such as the identification of an administrative and ideal management structure, a proper regulation to allow data use by administrators without posing a risk to the intimacy and private life of their citizens, and the maintenance of a democratic model. Once these steps have been guaranteed, it will be possible to identify the potential private and academic partners that, in synergy with cities, will model, test and develop solutions that will translate into actual value for society, as they will be focused on the problems. Pilot solutions have been proposed within the scope of the project and will be detailed in chapter 4. In the next chapter we will learn about what is already being done in each city.

To learn more +

All information used in the diagnosis outlined through the Reference Analytical Framework was obtained from primary sources collected by means of interviews conducted either remotely or onsite. Information was also collected from secondary sources available on the governmental web pages of all five cities analyzed and their respective national governments.

Details on this work, as well as on the legal-regulatory structure, the jurisprudence and governance analyses, availability of open data, and the recommendations on what must be done in order to identify and increase the maturity level of each one of the five cities can be found in the following documents: *Regulatory Report Containing List and Criticism of the Legislation for the Use of Public and Private Data in the Cities of São Paulo, Montevideo, Quito, Xalapa, and Miraflores* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29691/tr_1_producto_4_informe_final_es_site.pdf?sequence=1&isAllowed=y), *Technical Report Containing List and Diagnosis of the Public and Private Data Available in the Cities of São Paulo, Montevideo, Quito, Xalapa, and Miraflores* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29692/tr_2_producto_4_-_reporte_final_web.pdf?sequence=1&isAllowed=y), *Draft Bill/Decree for the Creation of Big Data Management Teams in Each City* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29693/tr_4_-_producto_4_-_reporte_final_-_web.pdf?sequence=1&isAllowed=y) and a *Manual for Administrators on the Identification of the Factors to Be Considered in Implementing the Regulatory Open Data Policy* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29694/tr_5_-_producto_5_-_manual_final_revisado_web.pdf?sequence=2&isAllowed=y), all prepared by FGV.



Cayambe volcano, Quito

3.



THE HISTORY OF THE FIVE CITIES — PRACTICES AND MODELS ANALYZED



Faro de La Marina (Parque El Faro), Miraflores

TECHNOLOGY

Connectivity

LEVEL 4: IMPLEMENTED

Integration

LEVEL 1: INCIPIENT

Data Analytics

LEVEL 1: INCIPIENT

DATA PROTECTION AND SECURITY

Personal Data Protection

LEVEL 3: CONSTITUTED

Information Security

LEVEL 3: CONSTITUTED

TRANSPARENCY AND PARTICIPATION

Transparency

LEVEL 2: BEING FORMED

Participation and Social Control

LEVEL 2: BEING FORMED

CULTURE AND SOCIETY

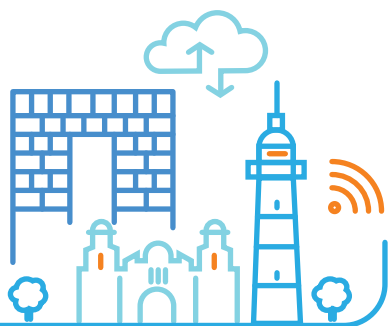
Culture and Society

LEVEL 3: CONSTITUTED

MIRAFLORES (A DISTRICT OF LIMA, PERU)

Miraflores is certainly one of the most famous and wealthiest of the 42 districts of Lima, the capital of Peru. Twenty years ago, technology was included in the agenda of the Peruvian public administration and has been allowing advances in the environment, urban transportation, infrastructure and citizenship. The guidelines of a digital government, however, were only established in 2011, when the national digital transformation project coordinated by the Special e-Government Commission started being implemented.

An example of how Miraflores has sought to advance in data use to improve public administration is the purchase of a database from Telefónica in order to analyze the flow of people (origin-destination matrix). Another example is their partnership with Waze, as a participant of the Connected Cities Program (<https://www.waze.com/en/ccp/>), which is the app's global program to support the development of big data tools that facilitate the decision-making process in urban mobility, including the management of traffic congestion points. A further example is the Ecohogares platform (<https://www.miraflores.gob.pe/los-servicios/ambiental/ecohogares/>):



it is active on the city online portal and allows citizens to include their water and electricity consumption data and obtain discounts if they manage to reduce consumption of these resources.

Within the scope of urban transportation, an effort is being made to develop a system to automate district traffic lights, which combines cameras, optical fiber, data centers, information management, and integration with the police and the fire department.

Since the citizens of Miraflores live in a high-income district, they are among the most connected people in the country. According to the National Household Survey, 81% of the residences in Miraflores have access to the internet, which is above the 76.2% country average from 2020. The average internet penetration rate in Peru is estimated to be 64.4% (September 2020), according to the ERESTEL study, conducted by Supervisory Body of Private Investment in Telecommunications (Osiptel). It is not by chance that the Connectivity subdimension was the highest ranked in relation to the district, with maturity level 4 (Implemented).

Peru has been relying on a framework for the construction of a national optical fiber network and the incentive to using broadband since 2011, when the guidelines for a digital government were established with the purpose of increasing the levels of transparency; with open data in all agencies, except those protected by the national Personal Data Protection Law (2011); with access to public information through an Open Data Portal; with citizen participation in administration thanks to mechanisms that facilitate collaboration; and with development of digital government.

The Data Protection and Information Security subdimensions are at maturity level 3 (Constituted), anchored to what is available in the national government legislation. Based on national law, Miraflores adopted a Privacy and Personal Data Protection Policy, which basically protects personal data collected when users access services from the public administration portal.



Miraflores bike lane



Palacio Municipal, Miraflores

The Personal Data Protection Law determines the need for implementing technical security measures of personal data protection, such as access control, traceability, backup management and conservation, in addition to the need for alignment with ISO 27001. In 2013, the Data Protection Authority published an Information Security Guideline with the purpose of guiding the applicable technical measures to ensure personal data protection, which is applicable to public or private administration databases.

The Transparency subdimension is at maturity level 2 (Being Formed). The detailed regulatory transparency and information access framework is national, and Miraflores relies on the National Open Data Platform (<https://www.datosabiertos.gob.pe/>), which enables citizens to participate in budget-related matters. For the future, the district believes in the vision of a smart city with policies for the integration of services that encourage citizens to further contribute to municipal administration.

The last dimension, Culture and Society, is at maturity level 3 (Constituted). The Miraflores District Urban Plan 2016-2026 seeks to create a smart city, including service integrating policies, and invites its citizens to contribute to this. The plan uses digital platforms for e-mail marketing campaigns, an open data portal, and a web system,

(the Internet-based Neighborhood Care System — SAVE). The application allows users to provide information to city administration on the cleaning, lighting problems, poor public road and sidewalk conditions, as well as to pay taxes and follow up the status of their requests. It is estimated that, since 2013, more than 160,000 people have accessed the platform.

In 2016, Miraflores was awarded for its citizen involvement by the Inter-American Association of Telecommunications Companies (ASIET) and by the e-Government Initiative for digital inclusion achieved through the SAVE application.

According to information obtained from district administrators, it is believed that the creation of a big data team is a long-term project, while in the short and medium term an effort will be made to consolidate the open data policy and formulate public policies based on the analysis of public data.

In as far as the availability of public and private data is concerned, the district already has the so-called National Open Data Platform—containing information available to the public in the form of predefined dashboards and thematic tabs—and the Geographic Information System (SIG), which consists of a database that allows for handling, analyzing and plating all forms of special data for a set of objectives.

TWENTY YEARS AGO,
TECHNOLOGY WAS INCLUDED
IN THE AGENDA OF THE
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IN THE ENVIRONMENT,
URBAN TRANSPORTATION,
INFRASTRUCTURE AND
CITIZENSHIP

TECHNOLOGY

Connectivity

LEVEL 5: CONSOLIDATED

Integration

LEVEL 3: CONSTITUTED

Data Analytics

LEVEL 3: CONSTITUTED

DATA PROTECTION AND SECURITY

Personal Data Protection

LEVEL 5: CONSOLIDATED

Information Security

LEVEL 4: IMPLEMENTED

TRANSPARENCY AND PARTICIPATION

Transparency

LEVEL 4: IMPLEMENTED

Participation and Social Control

LEVEL 4: IMPLEMENTED

CULTURE AND SOCIETY

Culture and Society

LEVEL 4: IMPLEMENTED

MONTEVIDEO, URUGUAY

The policy for a smart Montevideo started in 2015, when their public administration proposed to work towards converting their city to a smart city. Since then, the municipality started holding annual smart cities meetings and participating in international events with the purpose of providing visibility to its projects, benchmarking, and attempts to obtain financing.

The local administration established a policy to improve public services, citizen participation and organization of processes and projects prepared by the Intendancy of Montevideo. This policy impacts the fields of mobility, environmental development, and human and financial resources. The local administration also created the Department of Intelligent Sustainable Development, which now hosts the telecommunications units, IoT (internet of things), data analytics, and the platform for smart cities. It should be stressed that Montevideo had long worked on digital inclusion, personal data protection, open data, and citizen participation.

In addition to municipal efforts, the Electronic Government Agency and Information and Knowledge Society (AGESIC) prepares regulatory



frameworks and technical capacities that facilitate the implementation of intelligent solutions in Montevideo.

The most important project implemented under the Intelligent Montevideo seal was in public transportation. With 1,400 buses operated by four private companies, it is incumbent upon the municipality to regulate and organize itineraries and schedules. Through a GPS system, the same ticket (STM card) vending machines analyze all data and allow for real-time tracking of buses. The *Cómo Ir* application (<https://m.montevideo.gub.uy/comoir/>) was made available to passengers and locates buses, their routes, and their arrival times at the bus stop. During the COVID-19 pandemic, the origin-destination-movement matrix helped the public administration restrict the number of passengers per vehicle (no more than 40).

The city also relies on a Mobility Management Center (CGM) that uses data collected with cameras in real time, counts the number of vehicles, their speed and time in traffic on the city's main roads. The project is being expanded and should soon include 400 cross-roads with smart traffic lights capable of calculating the time of each phase as a function of traffic volume. In 2017, data showed a 67% reduction in severe and fatal accidents as compared to the average for the same period between 2013 and 2015. Montevideo is also part of Waze's aforementioned Connected Cities Program, which allows partner cities to use big data development tools in order to share the management of mobility in the most varied aspects.

The Intendancy of Montevideo also developed the *Cercanía Digital* platform (<https://montevideo.gub.uy/areas-tematicas/servicios-digitales/desarrollo-sostenible-e-inteligente/cercania-digital>), which has become a tool used to monitor the opinion of the population on social networks. When planning to perform an action that impacts citizens, the municipality uses a heat map to check what people think and talk about, preparing a feelings analysis. The platform also centralizes information from the main administration areas and departmental services so as to provide a quick response to citizens.

The city stands out in the Data Protection and Security dimension, with one of the most advanced levels of maturity. Since 2008, Uruguay has had a Personal Data Protection Law, and the national Regulatory and Personal Data Control Unit (URCDP) inspects its local application.

As far as the Information Security subdimension (maturity level 4, Implemented) is concerned, the Intendancy of Montevideo has something called an Information Security Superintendence, a department in charge of protecting and making data available and ensuring the necessary technological infrastructure. It implements data protection and security policies and ensures alignment in relation to the National Data Protection Law and the country's Cybersecurity Framework.

In 2018, AGESIC published a new version of the Cybersecurity Framework, which provides support material including good international practices for the application of information security measures across the national territory. The 65 requirements include: incident and risk management, operations security, and security governance. The framework also developed a model that allows for identification of its maturity level and definition of improvement actions.

The Connectivity subdimension is also consolidated (maturity level 5), as a result of several national and local actions that allowed the



population to connect to smartphones and have residential internet connection. In 2016, a covenant was executed, which provides Wi-Fi connection on public roads for free, as well as connection for the performance of public services such as operation of traffic lights, cameras, and a sensor system for the Montevideo Mobility Management Center (CGM).

Among the cities participating in the Big Data for Sustainable Urban Development project, Montevideo is the only to conduct detailed studies on the use of smartphones and on how its citizens access public online services. In a survey conducted in 2016 by AGESIC and the National Statistics Institute (INE) of Uruguay, 83% of homes had internet access. The number of Montevideo residents accessing the network via smartphones soared from 27% to 74%, a 174% jump within three years; 45% of users surfed government web pages seeking information on regulations and process status. Another 21% were already making online payments. More than half of Montevideo's population was familiar with using the internet for topics associated with public services.

Another project led by AGESIC is a high-speed network that allows for interconnection between different bodies and the Uruguayan government interoperability platform, the e-Government Platform (PGE).

Panoramic view of Montevideo



THE NUMBER OF MONTEVIDEO
RESIDENTS ACCESSING THE
NETWORK VIA SMARTPHONES
SOARED FROM 27% TO 74% [...]
WITHIN THREE YEARS

As far as Integration subdimension is concerned, Montevideo is at maturity level 3 (Constituted), following the national government guideline through a decree that regulates information sharing and interoperability agreements by the country's public entities. The city has already started several projects for the integration of its databases and is developing a platform to integrate services and launch a center in charge of the task.

AGESIC is currently working on connecting to other municipalities. A practical example is ID Uruguay (<https://mi.iduruguay.gub.uy/>), which consists of a personal identification system that works as a single identity card. The Intendancy of Montevideo uses ID Uruguay. With it, a person can create a single account for access to public services.

The Data Analytics subdimension is at maturity level 3 (Constituted), because the municipality has an institutional and regulatory organization, a single unit in charge and also competences for data collection, storage, organization, analysis, and use. In 2018 Montevideo developed the Urban Mobility Observatory, the first in Latin America, which provides quality inputs for those who make decisions on public policies regarding urban mobility, thus helping to transparently provide information to citizens.

In the Transparency and Participation dimension, a picture of the city shows maturity level 4 (Implemented). For years, Uruguay has been moving towards data transparency and an open government, which resulted in the Open Data Portal initiative. Laws establish which information must mandatorily be published on the web pages of public bodies and which may be requested electronically. Montevideo has 61 open databases on this portal, containing a diversity of topics, such as education, transportation and infrastructure, which can be accessed in different formats.

In the Participation and Social Control subdimension (maturity level 4, Implemented), Montevideo presents the Open Data and Services from Internet of Things Sensors in order to develop collaborative technology solutions in transportation, cleaning, and environmental quality.

The project encourages public participation and has already implemented 30% of their suggestions.

The Culture and Society dimension is also at maturity level 4 (Implemented), with projects that encourage civic engagement, such as Montevideo Decide. In 2018, the Digital Citizen Engagement Program won the Digital Transformation Award, at the Smart City Expo. The program manages services provided by the city in real time (mobility, water, sanitation, and environmental areas) with information collected from IoT devices in collaboration with citizens.

Montevideo Decide platform enables digital participation by citizens in discussions with public administration and allows them to propose projects in order to improve city services.

Regarding open data availability, the Intendancy of Montevideo has its data registered in a catalog maintained by a national entity (Uruguay's Open Data Catalog). In addition, it maintains a geographic information system, in which it is possible to download databases containing georeferenced information.

Mobility, environment and urban development are the segments containing the largest amount of available data. In the education segment there is only aggregated data for the entire city, which does not allow for territorial analyses. There are no registered bases in the health segment, which is the fundamental topic for the human and social development dimension.



Montevideo's Old Town



Iglesia de San Francisco, Quito

TECHNOLOGY**Connectivity****LEVEL 5:** CONSOLIDATED**Integration****LEVEL 4:** IMPLEMENTED**Data Analytics****LEVEL 4:** IMPLEMENTED**DATA PROTECTION
AND SECURITY****Personal Data
Protection****LEVEL 2:** BEING FORMED**Information Security****LEVEL 2:** BEING FORMED**TRANSPARENCY AND
PARTICIPATION****Transparency****LEVEL 4:** IMPLEMENTED**Participation
and Social Control****LEVEL 4:** IMPLEMENTED**CULTURE AND SOCIETY****Culture and Society****LEVEL 3:** CONSTITUTED

QUITO, ECUADOR

The letter of intent to become a smart city was launched with the Metropolitan Plan for Development and Territorial Organization (2015-2025). The intent was to have a more open, global and inclusive city. At this point Quito had already been preparing itself with investments in sustainability and technological infrastructure, particularly with respect to the increase in connectivity and the development of information and communications technologies (ICT) tools.

Ordenanza 101, approved in 2016, is the local regulation that governs information management in the municipality. It creates a metropolitan information management system, the intention of which is to administer, process and manage all statistical information generated in different agencies. Ordenanza 184, released in 2017, brought about the concept of open government: a new way to govern in which innovation and collaboration walk hand in hand. Since the implementation of a smart city requires a long process, this legal framework enabled continuity of the work performed in previous municipal governments, with information and data governance. This allowed the city, with the available theoretical bases and tools, to take a leap in terms of big data.

An example of this was the partnership established with the IDB and Telefónica in 2017. Referred to as Luca Transit, it combines anonymous mobile data with artificial intelligence technologies and big data analytics in order to understand the behavior and movement of future metro users through their cell phones (origin-destination). The objective is to generate heat maps of the distribution of people throughout the city. Once the metro starts operation—expected for 2022—movement flows around the stations, the number of passengers per line, and the time they stay in the system, among others, will be determined.

The main project in Quito is the Orquestador de la Movilidad project. It is still being implemented and its challenge will be to improve the traffic of one of the most congested cities in LAC. Through the interconnection of different platforms, the system will control and manage traffic by using speed cameras and sensors for reading license plates, checking the number of bicycles and vehicles, etc. To ensure the model is comprehensive and sustainable, there are guidelines to encourage the use of bicycles, including electric ones. Interconnecting all systems, the Orquestador project will make a general map available, in real time, of urban mobility in the district.

The Municipality of the Metropolitan District of Quito (MDMQ) has also already developed big data projects to help citizens regulate purchases of residential and commercial real estate. It is quite common that lands in a risk zone or industrial allotments are sold, which means fines and difficulties in obtaining licenses for those buying them. Geoportal (<http://www.geoportaligm.gob.ec/portal/>), on the open government web page, publishes information that must be known before any purchase: maps to discover and locate lands and real estate properties, as well as usage and zoning rules. However, the portion of the population that has no access to the internet and/or laptops/smartphones faces difficulties obtaining this information. However, Quito's city administration has been insisting on the Get Informed before Buying campaign, disclosed on social networks, professional associations, etc. The public platform is used often, totaling approximately 100,000 visits per month.

Through its proximity to universities, Quito's city administration has encouraged the training of employees and citizens on the use of data made available on the Open Government Platform. In the Metropolitan Information System, it is possible to find geographic and administrative data about the city. It is formed by district indicators that support both administrative and statistical records.

In the future, the City of Quito intends to reform Ordenanza 101, expanding the powers of the metropolitan information management system and its financial, human and technological resources. It is understood that, with more information and further governance, it will be possible to have unstructured databases. The *Draft Bill/Decree for the Creation of Big Data Management Teams in Each City*,²⁸ developed within the scope of the Big Data for Sustainable Urban Development project, contributed much to the reform proposals for Ordenanza 101.

Accelerating the works for the Orquestador project as fast as possible and generating new big data solutions are among the city's top priorities. During the preparation of the Big Data for Sustainable Urban Development project, a major governance structuring plan was in progress in consonance with Quito's 2040 Vision.

In 2018, the Municipality of the Metropolitan District of Quito (MDMQ) established its vision for 2040 and concluded that, to value its history and culture, its main challenges were to become more open, inclusive, global, competitive and environmentally responsible.

The Metropolitan Plan for Development and Territorial Organization of the Municipality of Quito, in effect until 2025, already includes concern about the environment, urban mobility, district revitalization, improved housing conditions, and increased citizen participation in decision-making processes. All of this is being coupled with an increase in the use of digital technologies, participative dialogue, and the optimization of social networks.

28 Available at: http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29693/tr_4_-_produto_4_-_relatorio_final_-_web.pdf?sequence=2&isAllowed=y. Accessed on: April 4, 2021.

In the general analysis of the dimensions, Quito's most significant development is in Technology, which is already consolidated, with

emphasis on the Connectivity subdimension (maturity level 5, Consolidated). With 2.2 million inhabitants, 80% of the municipality's residences already had internet connection in 2016 and 75% of the residents had a mobile device.

The municipality developed a diversity of initiatives to work on the construction, maintenance and improvement of smart city tools. The Quito te Conecta program, for instance, has more than 500 free Wi-Fi network points scattered throughout the city's public spaces. Online tools were made available to establish a dialogue with the residents on the provision of public services (virtual assistant, online chat, and contact center), in addition to the Portal de Servicios Municipales (<https://pam.quito.gob.ec/PAM/Inicio.aspx>) to facilitate the submission of suggestions and complaints.

The city also benefits from the existence of national public policies in Ecuador in the telecommunications sector, which foster actions such as implementation of a fixed access network, mobile access network coverage, digital inclusion and literacy, the promotion of supply and demand of information and communications technologies products and services. The 2018-2021 Society and Knowledge Plan, for instance, encourages the formation of digital territories and smart cities. It includes the Emerging Technologies for Sustainable Development Program, with emphasis on mobility and transportation systems policies.

In the Integration subdimension (maturity level 4, Implemented), data governance is coordinated by the General Department of Planning, which, through the Metropolitan Information Management Board, implements the Metropolitan Information System, which consists of a set of institutions, technological means, and data management procedures available to municipal entities. This information is published on an internet portal, in observance of the open government strategic pillars: transparency, participation, and collaboration.

The Open Government Portal (<http://gobiernoabierto.quito.gob.ec/>) also contains documents on the manner in which services must be



Plaza Chica, Quito

provided to public administration. There is, for instance, the Methodology of Service Provision and Process-Based Management.

In 2014, the government of Ecuador took on the commitment of developing a standard to regulate and standardize the preparation and publication of the central administration's public information and open data. The Open Data Public Policy Guide was disclosed. It was incumbent upon the Ministry of Telecommunications and the Ecuador Government Information Society, in partnership with the Organization of American States (OAS) and the IDB, to develop a National Open Data Policy.

Quito has implemented several transparency policies based on national laws and makes information available on the Open Government Portal. This information includes the functional organic structure, monthly compensation of work positions, annual managed budget information, and results of audits, among others. The Metropolitan Information System makes municipality statistics, indicators, metadata, and geographic information available. On the Open Government Portal, it is possible to find management reports, main projects in progress, and interactive maps on land use and occupation plans.

Quito's modern district



Ecuador has a Personal Data Protection Draft Bill, which was prepared through a participative process led by the National Department of Public Data Records. At the municipal level, Quito has a regulatory framework for personal data protection, and addresses information security in a specific Municipal Code chapter.

Citizen participation was institutionalized through ordinances that promote and regulate the Metropolitan System of Citizen Participation and Social Control. The General Department of Territorial Coordination and Citizen Participation coordinates and promotes active participation mechanisms—including for rural residents—which are widely utilized by the population: citizen meetings; metropolitan planning council; advisory councils; public hearings; pre-legislative inquiries; participative budget; and popular councils. The mechanisms are centralized in the Open Government Portal. Quito Participa (http://gobiernoabierto.QUITO.gob.ec/?page_id=7775) includes public assemblies, participatory budgeting, and prior consultation in the formulation of legislation, among others.

The electronic platform Quito Decide (<http://www.decide.QUITO.gob.ec/>) encourages the active participation of citizens, who can propose projects, vote on proposals, participate in discussions to approve a municipal rule, participate in workshops, and volunteer for projects, among other initiatives.

The municipality also has a platform for data sharing of users' water footprints (direct and indirect freshwater consumption by each individual) and carbon footprints (direct and indirect greenhouse gas emission by each individual), which is available on the Department of Environment web page. Depending on what people do and the space where they are, they can use a calculator to measure, record and compare their carbon footprint.

Data available on the territory is mostly recorded on the Open Government Portal, but it is also possible to find information about the municipality on 14 other internet pages of different public agencies, primarily those in the federal sphere.

IN 2014, THE GOVERNMENT OF ECUADOR TOOK ON THE COMMITMENT OF DEVELOPING A STANDARD TO REGULATE AND STANDARDIZE THE PREPARATION AND PUBLICATION OF THE CENTRAL ADMINISTRATION'S PUBLIC INFORMATION AND OPEN DATA

TECHNOLOGY

Connectivity

LEVEL 4: IMPLEMENTED

Integration

LEVEL 4: IMPLEMENTED

Data Analytics

LEVEL 4: IMPLEMENTED

DATA PROTECTION AND SECURITY

Personal Data Protection

LEVEL 3: CONSTITUTED

Information Security

LEVEL 4: IMPLEMENTED

TRANSPARENCY AND PARTICIPATION

Transparency

LEVEL 4: IMPLEMENTED

Participation

LEVEL 4: IMPLEMENTED

CULTURE AND SOCIETY

Culture and Society

LEVEL 4: IMPLEMENTED

SÃO PAULO, BRASIL

Over the past decade, the municipal governments of São Paulo have been investing time and resources in new administration models in order to solve the city's problems and increase the quality of life of its residents. This effort has led the largest metropolis in Latin America to lead the Connected Smart Cities Ranking 2020,²⁹ which collected data and information on all Brazilian municipalities with more than 50,000 inhabitants, totaling 673 cities, among which 48 have over 500,000 inhabitants, 274 of them have 100,000 to 500,000 inhabitants, and 349 have 50 to 100,000 inhabitants.

The strong commitment of São Paulo's digital government is to improve the efficiency of the municipal network of services by increasing interaction with the citizens. One of the main projects, started in January 2015, is the implementation of the Electronic Information System (SEI). It consists of a 100% web platform comprising modules and functionalities to promote administrative efficiency, eliminating paper as a physical support for institutional documents through the digitization and management of documents and cases in different public administration departments.

29 Available at: <https://ranking.connectedsmartcities.com.br/resultados.php>. Accessed on: April 7, 2021.



SEI allows for knowledge sharing with updates and notification of new events in real time.

In June 2019, the City of São Paulo achieved a 99% rate of electronic cases in all its departments, agencies, and entities. Currently, according to data from the 100% SEI Electronic Process portal (<https://processoeletronico.prefeitura.sp.gov.br>), 2.5 million electronic cases (among 906 types of cases) have already been processed, representing a savings of as much as BRL 4 million and eliminating the consumption of 86 million sheets of paper.³⁰

SP156 (<https://sp156.prefeitura.sp.gov.br/portal/servicos>), for instance, is a portal on which citizens make their requests electronically and satisfy many of their demands to public administration. The portal has already been implemented and the Municipal Department of Innovation and Technology (SMIT) is in charge of data governance. In 2019, the portal achieved an average of 27,000 daily hits.³¹

As far as urban mobility is concerned, from time to time, city administration collects data on the origin-destination (OD) of metro

30 Available at: <https://processoeletronico.prefeitura.sp.gov.br>. Accessed on: April 7, 2021.

31 City of São Paulo. "Prefeitura de São Paulo moderniza portal SP156 e agiliza registro de pedidos". April 30, 2019. Available at: <http://www.capital.sp.gov.br/noticia/prefeitura-de-sao-paulo-moderniza-portal-sp156-e-agiliza-registro-de-pedidos>. Accessed on: June 2, 2021.

São Paulo's bike lane



users in order to design displacement patterns and habits. This data includes citizen mobility indicators on routes inside and outside of the São Paulo Metropolitan Area (RMSP), including the use of different modes of transportation (car, bus, bicycle, train, motorcycle, metro, and foot) and routes (from where to where) in order to identify displacement patterns. The latest OD Survey took place between 2017 and 2018 and included data from Traffic Engineering Company (CET) and on the location of metropolitan buses (GPS).³²

Currently, CET accesses data (accidents, traffic jams, slow traffic, broken traffic lights, holes, and road defects, among others) from a diversity of sources, such as Waze (a partnership formalized in 2017, the first in the world), Institute of Forensic Medicine (IML), SP156 radar information, etc. Said information is used in traffic management, in the definition of road safety measures and policies, and in real-time follow-up of occurrences. Thanks to information extracted from CET databases and passed on to other city agencies, it is possible to improve service provision indicators.

Another initiative of open government is Pátio Digital (<http://patiodigital.prefeitura.sp.gov.br/>), of the Municipal Department of Education, which gathers data on waiting time for vacancies in daycare centers, registrations, and educational performance (IDEB). The Prato Aberto platform (<https://pratoaberto.sme.prefeitura.sp.gov.br/>) in its own right allows for checking menus in municipal schools.

For the future, the main challenges to be faced by city administration will be team training, new internal resources, and data anonymization. By law, the city is required to open all data, but much of it is aggregate, which hinders anonymization and does not ensure its security, which would lead to crossing it with other information and therefore disclosing people's identity.

Making one of the largest metropolitan areas in Latin America and the world smarter is certainly a great challenge for administrators. It is necessary to implement innovative solutions and make more open data available, in real time, detailing the operation of public services

³² Available at: <http://www.metro.sp.gov.br/pesquisa-od/index.aspx>. Accessed on: April 7, 2021.

and the daily lives of citizens. But this is not enough. To continue improving the public's quality of life, without wasting resources and money, an organizational transformation is required, which not only acquires solutions, but also empowers the government with the processes and skills necessary for the proper use of these technologies. Additionally it enables society itself to reap the rewards of digital transformation.

The latest TIC Domicílios survey on internet use in Brazil in 2019, disclosed in May 2020, points out that 71% of Brazilian residences have access to the internet and that 74% of the population has access to it. More than half (58%) access it exclusively via cell phones. In the Southeast region, the percentage of residents and individual users grew to 75%.³³ An unprecedented study conducted by Seade in partnership with Cetic.br/NIC.br estimates that 77% of São Paulo population has access to the internet.³⁴ According to SMIT, the free connection network of the Wi-Fi Livre SP program (<https://wifilivre.sp.gov.br/>) had 800 points in late 2020; covered 550,000 users and expected to increase the number of points to 1,000 in 2021.³⁵

The 130 Telecentros (<https://telecentro.prefeitura.sp.gov.br/>) created in 2001 are part of another digital inclusion initiative in São Paulo intended for the population in socially vulnerable areas. Covering an average of 164,000 people per month, they make computers and other electronic devices available. More than 75% of users use Telecentros to look for jobs and take vocational courses.

Information and Communication Technology Company of the City of São Paulo (Prodam) plays a crucial role in integrating databases generated by different agencies and entities in São Paulo. Between 1992 and 2004, thanks to Prodam, city administration consolidated public service systems, developed the Citizen Database—to assist low-income families—and installed a municipal communication network and an open system for processing and communicating distributed data—the Municipal Information Technology Network (RMI). At this time São Paulo discontinued the centralized model that existed up until that point.

SÃO PAULO INTEGRATED SYSTEMS THAT ENABLED ACCESS TO, AND EXTRACTION OF, PUBLIC DATA FOR DEVELOPING SOLUTIONS AND APPLICATIONS

³³ Available at: https://cetic.br/media/analises/tic_domicilios_2019_coletiva_imprensa.pdf. Accessed on: April 7, 2021.

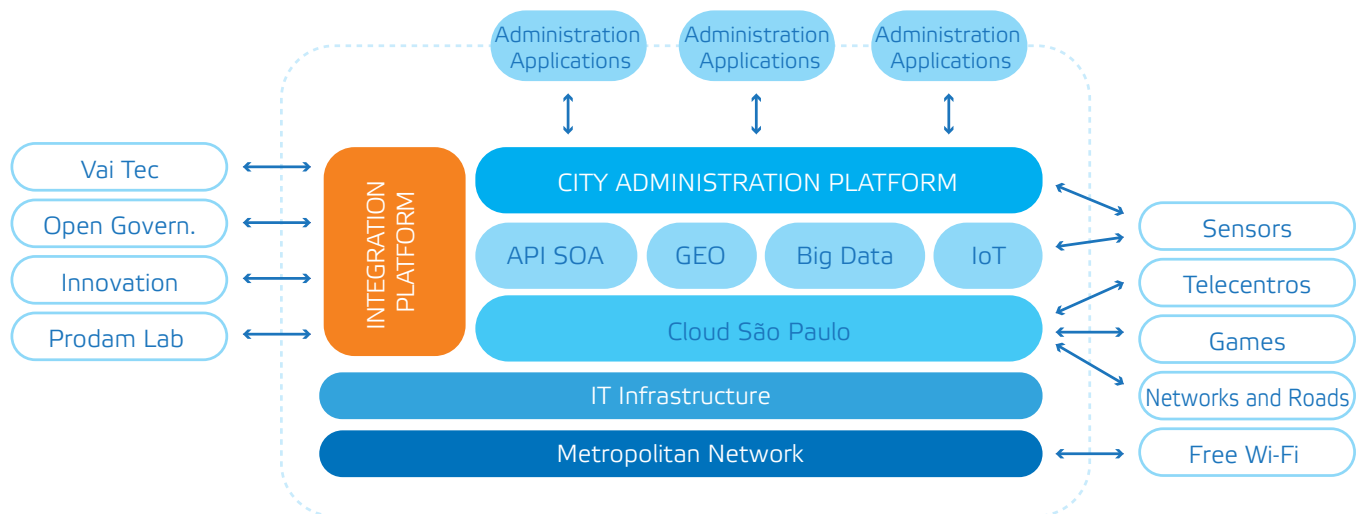
³⁴ Available at: https://www.seade.gov.br/produtos2/midia/2020/07/Cetic_produto01_7ago.pdf. Accessed on: June 3, 2021.

³⁵ Available at: <https://www.abranet.org.br/Noticias/Mambo-WiFi-substitui-Google-Station-no-projeto-WiFi-Livre-em-Sao-Paulo-3174.html>. Accessed on: April 7, 2021.

Over the subsequent years, Prodam developed a cloud computing solution, the so-called Cloud São Paulo, combining its own data centers and servers with controlled services provided by the private sector. The objective was to host part of their municipal data in the cloud through a service provided by the city itself.

To provide increased interaction with the user, Prodam integrated systems that enabled access to, and extraction of, public data for developing solutions and applications. The following graphic summarizes Prodam's modernization efforts in developing integrative systems and increased interaction between local public administration and society.

Prodam's technological structure



Source: Prodam

The municipality has also already developed complex and integrated systems associated with urban mobility with GeoSampa (geosampa.prefeitura.sp.gov.br/PaginasPublicas/_SBC.aspx) and the Monitoring and Integrated Management System (SMGI). The former is a solution that allows for planning public policies with more than 150 layers of georeferenced data in a single digital map. The latter, which is also georeferenced, issues warnings to agencies responding to floods, fallen

trees, and landslides. SMGI has two projects: SMGI-CET, in charge of urban mobility, set up by Traffic Engineering Company (CET), and SMGI-SGZ, which analyzes data for monitoring municipal janitorial services.

Another case of database integration for traffic and transportation policies is MobiLab (<http://mobilab.prefeitura.sp.gov.br/>), São Paulo's mobility innovation laboratory. It combines data from the Municipal Department of Mobility and Transports, CET and São Paulo Transporte S.A. (SPTrans) with the objective of developing solutions to improve urban mobility, such as the applications Ponto Certo (for payment of a single ticket, which allows for the purchase of credits via Facebook), Zona Azul (paid rotating street parking), Moovit, and Cadê o Ônibus (which estimate the arrival time of public transportation vehicles).

São Paulo also relies on the Municipal Database Catalog (CMBD), which combines databases from different regional indirect administration agencies, departments, and regional city administrations. It is possible to identify the person in charge of each base, his/her location, and how to access them.

After developing complex integrated systems, Prodam invested in the use of big data and IoT, based on data generated by sensors scattered throughout the city for predictive analytics and planning. Thanks to that, it was possible, for instance, to anticipate and act on dengue outbreaks. The probability of anticipating the occurrence of dengue outbreaks three weeks in advance and with an 85% assertion was revealed in 2013 and 2016. Data of all agencies involved generated a dynamic map of the city administrative regions and enabled more effective responses in the fight against *Aedes aegypti* mosquito.

Another example of the use of big data in São Paulo is in the field of security. The software Detecta, developed by Microsoft and the São Paulo state government, processes a massive amount of police information for issuing crime alerts. Although public security is a responsibility of state governments, Detecta relied on the cooperation of city administrations for using the infrastructure of the cities in São Paulo. In the case of the state's capital, this cooperation gave rise to



Liberdade district, São Paulo

the City Câmeras project (<https://www.citycameras.prefeitura.sp.gov.br/>), the objective of which is to help public administration detect, prevent and react to emergency situations. The plan here is to have more than 10,000 cameras installed in the city of São Paulo over the next four years.

As far as the Transparency and Participation dimension is concerned, São Paulo is at maturity level 4 and meets the necessary checklist for a smart city: it has a regulatory open data framework; it is easy to request public information; and data from different bases is available in different formats.

The Open Data Portal (http://dados.prefeitura.sp.gov.br/pt_PT/) combines 181 datasets from 75 municipal public agencies and entities into a friendly format. CMBD aggregates all databases produced by municipal district administrations and agencies, totaling 591 information bases, including metadata. Both are examples of active transparency when the government advances data publication. If a citizen cannot find the desired database, they may request it through the SIC.SP portal (<http://www.sic.sp.gov.br/>).

Bela Vista district, São Paulo



As far as the Participation and Social Control subdimension (maturity level 4) is concerned, São Paulo records public internet and open data inquiry cases. The Office of the City Comptroller (CGM) implements the Information Access Law and is responsible for organizing social control and participation mechanisms in the formulation of public policies. There are municipal councils, public hearings and inquiries, and citizen service channels.

The city has transparency and open data initiatives, as well as an area in CGM with the institutional mission to build this policy. In 2019, through the Municipal Department of Innovation and Technology (SMIT), this policy was expanded through the launch of the City of São Paulo's APIs Library, APILIB (<https://apilib.prefeitura.sp.gov.br/store>). This initiative fostered the creation of services and applications based on access to public databases in a practical, organized and integrated manner, as well as ensured active participation of civil society organizations, start-ups, academia and the third sector in city administration.

In the previous year, 2018, a diagnosis was made of the information security situation inside city agencies, which was an initiative by the Municipal Information and Communication Technology Governance Policy (PMGTIC). The results showed that only 20% of the public administration agencies had an information security policy in place.

It should be mentioned that, although the city has a high degree of maturity in terms of open data according to the methodology adopted in the study, this does not mean that it has achieved the upper limit of development, and therefore, there is plenty of room for it to improve and evolve in this area. In addition, this is an assessment of data availability at a certain moment in time that reflects some prerequisites that help enable implementation of data-based policies, other than data use in effective terms.



TECHNOLOGY

Connectivity

LEVEL 4: IMPLEMENTED

Integration

LEVEL 1: INCIPIENT

Data Analytics

LEVEL 1: INCIPIENT

DATA PROTECTION AND SECURITY

Personal Data Protection

LEVEL 4: IMPLEMENTED

Information Security

LEVEL 3: CONSTITUTED

TRANSPARENCY AND PARTICIPATION

Transparency

LEVEL 3: CONSTITUTED

Participation and Social Control

LEVEL 2: BEING FORMED

CULTURE AND SOCIETY

Culture and Society

LEVEL 2: BEING FORMED

XALAPA, MEXICO

Xalapa is one of the most unequal metropolitan areas in Mexico: according to Datamexico.org data, in 2015, 33.9% of the population lived in medium poverty and 3.64% in extreme poverty.³⁶ The UN Habitat 2018 report indicates that 32.2% of the population has an income of less than two minimum wages.³⁷ Strategically located 916 km from the US border, in the state of Veracruz, the municipality is one of the country's main entry and exit points thanks to the Port of Veracruz, which makes it a center for the creation of public jobs. Xalapa is also included in IDB's Emerging and Sustainable Cities (ESC) program and received support from the bank for the Sustainable Xalapa Action Plan.³⁸

The Metropolitan Area of Xalapa (which includes the municipalities of Banderilla, Coatepec, Emiliano Zapata, Xalapa, Jilotepec, Rafael Lucio, and Tlalnelhuayocan) has 738,516 inhabitants, of which 488,531 live in the municipality of Xalapa.³⁹ The area faces all challenges typically faced by a developing municipality in Latin America. The government drew up the Municipal Development Plan for 2018-2021, which includes measures for its transformation into a smart and sustainable city. The work started in 2014 and involved the sectors of



infrastructure, housing, health, education, public services, social security, safety, mobility, transports, and digital democratization.

The strategic axes of the development plan include reduction in inequalities, care for the environment, open government, urban safety, and economic development. However, it underwent some governance adjustments as well as a critical assessment of the results obtained to date, by both the previous government (2014-2017), which started implementing the open government, and the current government. In fact, since 2012, the municipal administration has been working to convince the Municipal Council of the importance of proper handling of data generated by the numerous different sectors of public administration, both to put them at the service of administration, as well as the population.

The first project implemented sought to bring technology and citizens together: 30 containers with computers, printers and free internet access were placed in strategic points of the city. A total of 17 free internet access points are in operation in several different areas of the municipality, and the goal is to achieve 30 points by the end of 2021. As many as 15 community management centers scattered across the city were created, where citizens access the internet and use IT equipment at no cost. Free Wi-Fi and IT equipment are also made available at nine municipal libraries. The Xalapa Innovation Lab (LABIX) was opened in December 2017 and its objective is to be a public space for experimenting with new technologies and to be a coworking space for collaborative work. The city relies on an open data portal for access to local information and services (<https://ayuntamiento.xalapa.gob.mx/>), including data for tourists, biddings, employment exchange, Xalapa Bikeway routes, and cultural information. Projects in operation include the Telephone Care Center of the City of Xalapa (<https://catax.xalapa.gob.mx/>), a digital platform in which the population can report problems involving public services via the internet, and which has been generating data for the city, and the Open Data Platform (<http://datosabiertos.xalapa.gob.mx>), which has the objective of ensuring transparency of municipal data. In addition, the municipality relies on the Cartografía



Olmec head at Museo de Antropología de Xalapa

36 Available at: <https://datamexico.org/en/profile/geo/xalapa>. Accessed on: 8 abr. 2021.

37 Available at: http://70.35.196.242/onuhabitatmexico/cpi/2015/30087_Xalapa.pdf. Accessed on: 8 abr. 2021.

38 Available at: https://issuu.com/ciudadesemergentesysostenibles/docs/xalapa_sostenible. Accessed on: May 12, 2021

39 SEDESOL, CONAPO, INEGI. Delimitación de las zonas metropolitanas de México. 2010-2012; y Censo General de Población y Vivienda 2020, INEGI

Xalapa project (<https://cartografia.xalapa.gob.mx>), which integrates geographic information.

The Mapatón Ciudadano.Org application (<https://www.mapaton.org/>) is a successful case in urban mobility initiatives. In light of the fact that only a limited amount of data on public transportation routes was available and that much of the available data was not yet open, in 2016 a group of citizens and civil organizations started compiling information based on data collected by their cell phone GPS while driving. Today, only one among several transportation companies operating in the municipality collects information via the GPS installed in their vehicles, but it does not make it available to the public. This is only one security tool that attempts to inhibit vehicle theft and route detours.

A work group has been recently created to assess the possibility of a collaboration agreement with Waze. The idea is to disclose previous information on the construction projects to be performed in the city. This agreement must be formalized in municipal regulatory frameworks so as to ensure continuity of the measure in future administrations.

The internet rate of penetration is 77%, according to the National Survey of Information Technology Availability and Usage in Households 2018, conducted by the National Institute of Statistics and Geography (INEGI).⁴⁰ Most residences (69%) are connected to the internet; and 90% of the population has cell phones with network connection.

One of the national digital literacy initiatives of the Mexican government, the Punto México Conectado project (<https://www.gob.mx/epn/es/articulos/punto-mexico-conectado-142554>), created user centers in areas with a high poverty rate. Between 2012 and 2018, the residents of selected areas were offered programming language, innovation and entrepreneurship courses. As of 2019, the digital strategy, referred to as Internet para Todos (Internet for All), was modified with the purpose of ensuring the right to access to TIC, including broadband connections.

⁴⁰ Available at: <https://www.inegi.org.mx/programas/dutih/2018/#Microdatos>.
Accessed on: April 4, 2021.

Since 2014, the IDB has been working with the municipality of Xalapa in the development of mobility and environmental projects.

An e-Government Sub-Administration under the direction of the Open Government Directorate as well as a study group intended to coordinate databases were established.

The National Institute of Transparency, Information Access and Personal Data Protection (INAI) is one of the most active authorities in Latin America in protecting the personal data of Mexican citizens. In addition, the agency ensures the right to access public information.

The Mexican legal framework in this field is wide and distributed across all government branches. Therefore, the Personal Data Protection subdimension can be considered implemented. Up until 2017, Mexico had a Personal Data Protection Federal Law only applicable to private parties. Thereafter, the General Personal Data Protection Law started including governmental entities and agencies. In addition, since 2015, the country has relied on the General Law of Transparency and Access to Public Information.

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NETWORK CONNECTION

La Araucaria, Xalapa





City Hall's collection

Callejón del Diamante, Xalapa

At the state level, Veracruz, where Xalapa is located, published the Transparency and Public Information Access Law and the General Law for the Protection of Personal Data in Possession of Obligated Subjects. There is also the Veracruz Institute of Information Access and Personal Data Protection (IVAI), an authority in charge of ensuring and safeguarding the right to internet access and protecting personal data.

The municipality itself relies on the Transparency Coordination Operation Regulation, which defends the right to public information access. It also protects personal and confidential data in government possession.

As far as information safety is concerned, Xalapa currently follows the policies and guidelines established at the federal and state levels, although it has already set out a municipal framework approved in 2021.

The Mexican government approved the National Cybersecurity Strategy, but this policy is limited in scope. The Mexican General Personal Data Protection Law includes a chapter dedicated to information security measures. At the state level, the law requires public entities to safeguard personal data and to implement rules in order to ensure information security.

In the state of Veracruz, Law No. 875 on Transparency and Public Information Access is noteworthy. There is a local open data policy with information on the municipal web page. Other data is available on the National Transparency Platform, through the Infomex Veracruz System (<https://infomexveracruz.org.mx/infomexveracruz/default.aspx>). Xalapa has established the Open City Regulation, which determines the bases for technical standardization and publication of governmental data.

Assessed by the Citizen Collective for Transparent Municipalities (CIMTRA), which consists of a group of civil organizations that encourages and assesses the transparency of local governments, Xalapa came in at number four in the national ranking of top capitals in 2019. In the CIMTRA COVID-19 2020 assessment, specifically created to identify and assess information provided to citizens within the context of sanitary

emergencies, Xalapa came in at number two in the national ranking. On the other hand, the 2020 Index of Municipal Transparency and Availability of Tax Information, an instrument created by the civil association ARegional to proceed with the actions of the local governments with the purpose of providing transparency to the performance of their administration, the municipality of Xalapa came in at number twelve, a significant improvement compared to its ranking the previous year.

The Participation and Social Control subdimension is classified as maturity level 2 (Being Formed). Xalapa has state and local regulatory frameworks that encourage social participation in the decision-making process. The Municipal Development Plan for 2018-2021 included public collaboration. The document highlights the importance of smartphones and the internet in improving the supply of public services. Another recent example was the approval of the Citizen Participation and Open Government Law of the State of Veracruz, which establishes tools and technologies that allow for the organization and participation of residents in procedures, roles, and decisions.

It should also be stressed that the City Open Sessions were approved in Xalapa, in which any citizen can participate and express their opinion on the topics addressed (<https://ayuntamiento.xalapa.gob.mx/web/cabildo/cabildo-abierto>). The sessions are broadcast live, and citizens can inquire about any information regarding them on the web page (<https://ayuntamiento.xalapa.gob.mx/web/cabildo/sesiones-cabildo>).

Basílica del Voto Nacional, Quito



4.



URBAN INNOVATION POLICIES — PRACTICAL APPLICATIONS

Complex urban issues require innovative solutions. These solutions, in turn, depend on technologically advanced inputs and proper legal-regulatory-institutional conditions. To transform inputs into the expected results, it is necessary to formulate urban policies based on science, technology, and innovation—as well as on evidence provided by big data, in a constant cocreation process between governments, academia, and companies. However, first of all, it is necessary to understand the problem that needs to be solved. Thousands of cities worldwide have access to the necessary inputs, though only a few managed to fundamentally change the quality of their public services, as they were based on data as an end rather than a means. The most common mistake is to believe that “data is the new oil”, as though the mere existence of the resource alone could guarantee wealth.

The possibility of conducting analyses and handling large data volumes pressured urban public policy formulators to incorporate ever more advanced technologies into their work. As seen in the previous chapters, real-time monitoring and prediction systems based on unconventional data analytics offer cities the possibility of predicting and understanding the occurrence of urban phenomena with increasing details and precision—and in real time when necessary.

However, advanced technologies and big data are not magic pills that automatically generate better cities. Said resources, side by side with open data policies and the creation of an appropriate regulatory environment, are necessary, albeit insufficient, conditions to face the challenges of urban management. In addition to the need for



asking a question that guides the objectives, which is the basis for any public policy that makes sense, it is crucial to mobilize resources in a cocreation process capable of:

Paseo de Los Lagos, Xalapa

- diagnosing the problem to be solved and ensuring the minimum necessary conditions;
- building hypotheses, modeling, implementing, monitoring and measuring the impact of possible solutions;
- prototyping and creating the social value translated into the mitigation of the problem diagnosed.

Public and private actions alone might generate insufficient initiatives when governments cannot offer innovative solutions and, at the

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same time, companies, distanced from the problem and hypotheses tested by academia, partially solve the problems in the same measure as the technological solutions they can create. Technologies developed to be used by public administrators are often decontextualized from local realities and/or are not coherent with public policy logic, as a well-structured causal relation between inputs, actions and results is inexistent. When this occurs, the opportunity to solve public issues and generate social and economic development through smart urban policies is missed.

Correcting this route was the main objective of the Big Data for Sustainable Urban Development project. In it, it was possible to work on a logic of innovative urban policies in which the administrators of the cities of Miraflores, Montevideo, Quito, São Paulo and Xalapa, the FGV researchers and consultants mapped inputs and necessary conditions in conjunction. By doing so they understood better the common issues that could be solved and, based on the existing conditions, cocreated open digital platforms prototyped in an innovative environment built on cloud computing.

The result was the development of replicable and scalable pilot models that mobilized big data and advanced technologies in order to mitigate complex problems common to these cities based on the knowledge of both the data ecosystem existing in each one of them and their regulatory frameworks, for the cities to access and use the data.

The process to cocreate platforms

The process to develop platforms, as well as other interventions, requires transformation of ideas into products by mobilizing specific inputs. However, when it comes to innovative processes, this transformation does not always take place in a linear manner. It doesn't automatically generate knowledge from academia which then overflows to outside companies that create solutions to be used by governments in the future.

Projects with these characteristics require partnership and interaction from the players involved at many moments, but especially at the stage of platform development. The process is inspired by the Triple Helix theory,⁴¹ an innovation model in which the three primary institutional spheres (university/academia, private sector, and government) interact to promote development through innovation and entrepreneurship. The primary mission of innovation is to solve complex social problems, which tend to shine through the poorly planned urban fabric in cities in Latin America and the Caribbean (LAC).

This result comes from a logical concatenation started with an answer to the main question: what problems can be tackled by public policies using big data? Using this as a base, it is possible to execute a path that transforms inputs into actions, actions into products, and products into results that will ultimately impact the situation-problem initially diagnosed.

Logical model structure



Inputs consist of understanding the necessary conditions (i.e., legal, regulatory, institutional, and technological) to solve the problem identified. Activities reflect onto joint actions and processes that mobilize inputs to mitigate problems. Products indicate the platforms that can be built. Next, the results stage is intended to answer how resources, actions, platforms and the cocreation process help cities solve the problem diagnosed, generating positive impacts with the intervention of the policy formulated.

For each stage of this process, it is necessary to structure specific questions and methodologies, following the example of the content in the methodology table applied to each problem:

41 Etzkowitz, H. e Zhou, C. 2017. "Hélice Triplíce: inovação e empreendedorismo universidade-indústria-governo". *Estudos Avançados*, 31(90): 23-48. Available at: <https://doi.org/10.1590/s0103-40142017.3190003>. Accessed on: April 4, 2021.

Methodology applied to each problem

Unity	Analysis	Methodology
Problem	Which problems require big-data-based urban policies for their solution?	<i>Design thinking</i> with representatives of the cities.
Inputs	Which technological, regulatory environments and data exist and are necessary to generate solutions for the problems diagnosed?	Inquiry to files for the survey of legal-regulatory-institutional conditions and analysis of data quality. Platform CKAN.
Activities	Which joint actions consisting of input mobilization will mitigate the urban problems diagnosed?	Interviews, observation of the platform cocreation process in conjunction with city technicians and administrators.
Products	Which technological platform can be built to mitigate the problems diagnosed?	Prototyping of the technological model.
Results	How can resources, actions, platforms and cocreation processes help cities solve problems?	Interviews on satisfaction with the services provided in the cities.
Impacts	Was the expected positive effect demonstrated?	Impact assessment methodologies to assess the need to correct the policy.

In this table, it is possible to see in a generic manner the initial logic conceived for this project. However, as mentioned before, the innovative process logic might not be linear, but systemic and interactive, and its formulation, implementation, monitoring and assessment occur on a continuous basis.

During the project, we learned that some solutions occur in a more fluid manner, such as in the case of the transparency and air pollution platforms detailed in the next section of the book. Fluidity is improved because the local context interferes very little with the model built, and because of this it can be quickly replicated in other realities.

In the case of the platforms associated with planning and public administration, such as that of public transportation and congestion, each city started with different inputs and different realities, both in terms of data quality and the specific problems of each region. Therefore, it was necessary to reassess the logical process, perform a new activity to create solutions in conjunction with each city separately, and carry out new product validation. At that moment, the integration between administrators, companies and academia was essential to resume development of the platforms. The dialogue and cocreation process in these platforms was one of the main lessons learned in this project. An attempt to propose said solutions “from bottom to top” would be destined to fail.

Where to start from?

In order to materialize the urban policy in these terms, we conducted initial mapping studies on the cities’ regulation and data quality. This initial analysis allowed us to visualize the degree of maturity of open data, the processing capacity, the needs for improvement, the creation of necessary conditions to develop public policies using data, and the possibilities for more immediate actions per departments and sectors.

The primary concern was to focus on the qualification of public and private data existing in the cities and the creation of a standardized storage platform. In the case of the project that inspired this publication, the targeted cities have access to the Dataurbe portal, in which documents, decrees and information regarding many fields—mobility, lighting, transportation, and the environment—are available and can be either consumed by a diversity of technologies or inquired by the citizens.

THE DATA MAPPED AND
THE OPINION ON THEIR STATUS
WERE THE STARTING POINT TO
FORMULATE SPECIFIC POLICIES
COCREATED BY THE CITIES

By mapping the cities, data was extracted, which potentially allowed for the conduction of public policy analyses using these tools, with an aim at solving problems in fields such as mobility, education, health, and the environment. In addition, within the scope of the project, it was possible to view opportunities to use data and external tools available to the public—using Waze, for example, which is present in all five cities.

The data mapped and the opinion on their status were the starting point to formulate specific policies cocreated by the cities, FGV and the companies engaged. Without this input mobilization process, ideals cannot transform into the necessary results to improve the quality of life in cities. This change requires cocreation of products—the result of the policy formulated—which, in the future, could impact municipalities' urban reality.

Within the context of the project, it was sought, to the extent possible, to automatize the importation of data already existing in cities. This is so because the idea is to have information available without generating additional time costs to cities. This is another point in which cocreation played a crucial role. For those cities without a data distribution platform, the platform represented an unequivocal gain and could be directly implemented. In the case of cities that already have an open data distribution and analytics platform, integration becomes crucial for the city to effectively use the tool. For this to occur, the platform must be created jointly by the city and developers.

One of the relevant adaptations took place in the case of São Paulo, with the incorporation of data from GeoSampa to Dataurbe. Considering that São Paulo already had an open data distribution platform, requiring that another platform be fed with the same data is not only an inefficient strategy, but could probably lead to the abandonment of the platform created for this purpose. This automatization was presented to city technicians as an opportunity for using a similar technique to link GeoSampa data to the municipality's other CKAN platforms. The interaction with the São Paulo city technicians indicated that Dataurbe could in fact add value to the municipality. GeoSampa allows for the extraction of the full database, which requires knowledge of data

processing that is not common in society. It also allows for specific pre-defined tabulations. With Dataurbe, it is possible to create customized tables without the need to deeply know data processing, as well as freeing the user from the need to create processing capacity.

The use of technology is not the end in itself. To be smart, a city must be capable of using technology to eliminate problems and then monitor and assess its impacts. Only then will it be possible to improve and scale other initiatives by using and crossing data within the scope of other cities. Public innovation policies will only be effective if the products resulting from them effectively solve the problems experienced by society.

The stage before this cocreation process consists of analyzing and shaping possible evidence-based public policies that reveal the capacity to mitigate the problems mapped in design thinking sessions. The decision on feasible solutions within the scope of the project must be made in conjunction with municipal administrators and developed based on several different established conversations. By the same token, the subsequent solution cocreation and development process requires a joint effort on the part of the administrators and municipal technicians, the team of researchers and the data engineering companies involved in the policy formulation, implementation, monitoring and assessment process.

Practical experience

Following the example of what occurred after the II Regional Meeting of the Big Data Project for Sustainable Urban Development in 2019, it is recommended to perform design thinking sessions with representatives of cities, where the challenges faced by the municipalities are addressed from the point of view of their administrators and the priority areas that are subject to being dealt with in the policy. This experience has led to a proposal for four platform concepts, which were of interest to cities in general, and could be enabled considering the resources and within the time associated with the project. Interaction with cities ultimately defined specific usabilities that met both the data limitation and the most specific demands of the cities.



Avenida 9 de Julho, São Paulo

Below is a summary of the four-platform concept:

1. Transparency – Created from data in standard format, with capacity for simple visualization and tabulation by the citizens and ease of adding information and indicators for the administrators to develop urban projects of public interest. The portal created provides open data currently existing in cities and already organized on CKAN. For São Paulo, collaborating with city administration, it was defined that the data would be integrated with its current system (GeoSampa). Therefore, São Paulo's open data is fed from its original platform. A special model of this product makes it possible to feed the system with data from municipal projects already in progress, inspired by the platform developed for Montevideo with this functionality.

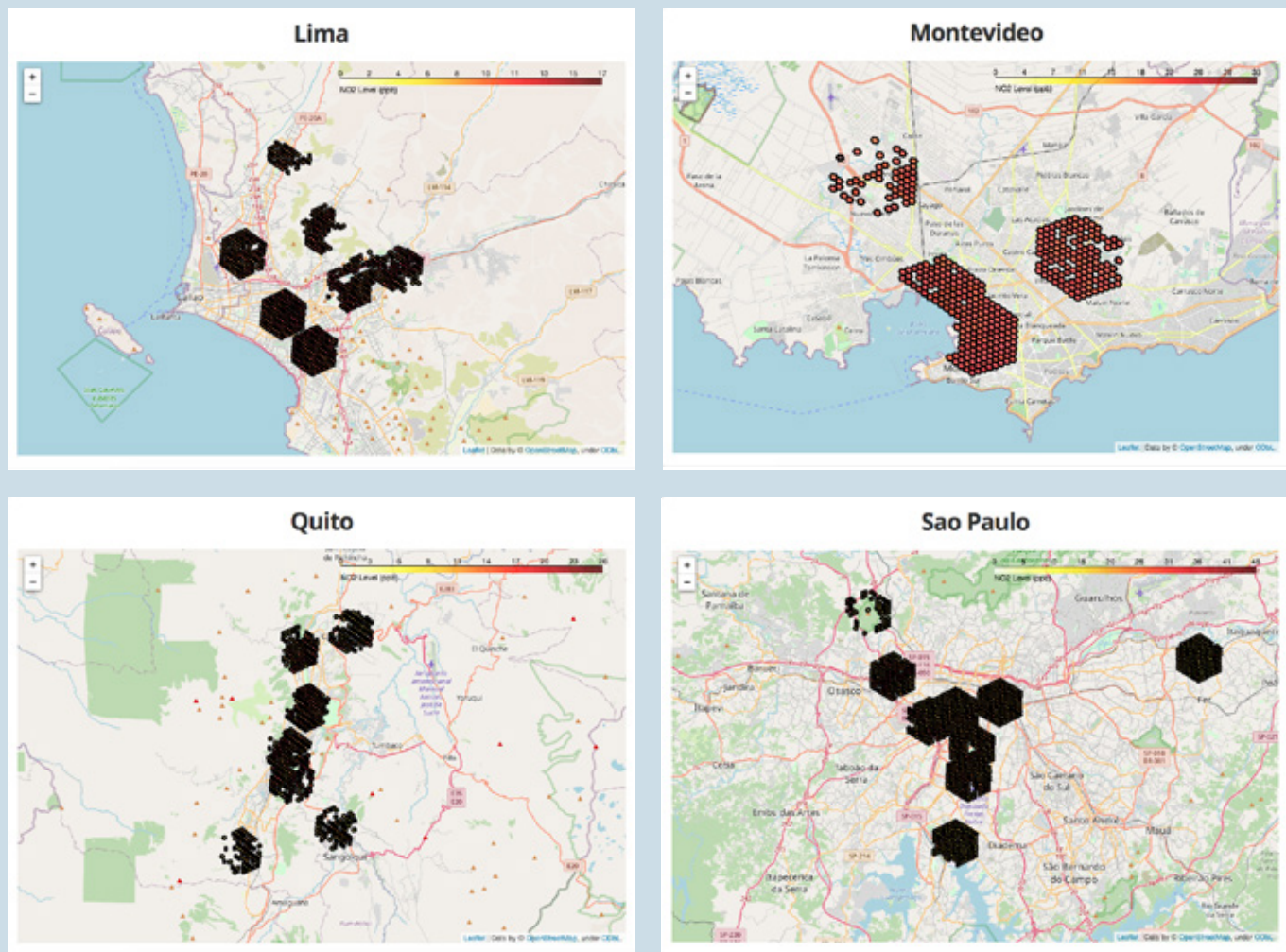
2. Air pollution estimates – Since pollution is a recurring problem in large cities worldwide and results in respiratory diseases and a reduction in life expectancy, the solution chosen uses Waze inputs in combination with Open Street Maps, using open data, to put together a pollutant emission estimate model. In cities where sensors collect emission data, it is possible to implement a machine learning system to improve predictive models in large urban areas. In our case, learning will be provided to the City of São Paulo and subsequently used in other cities participating in the project. In addition to enabling observation of locations that are more subject to atmospheric pollution in the city, the tool allows for the monitoring of pollution levels over time, and potentially serves to issue emergency alerts for the municipality to take any measure to protect citizens.

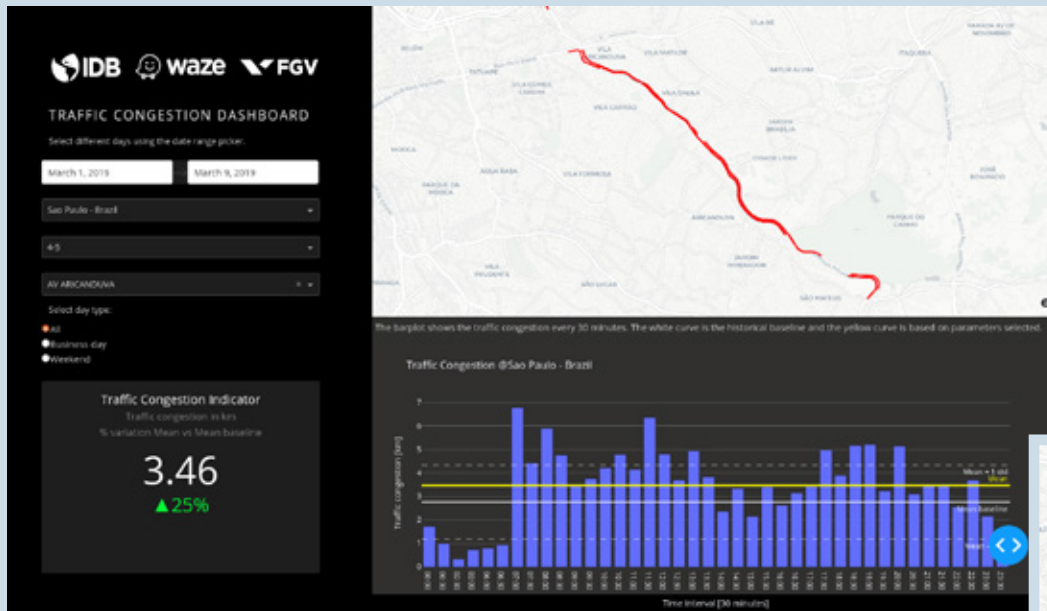
3. Support to public transportation – To support public transportation, the use of data from the departments of transportation and mobility was recommended for generating visualizations and tabulations with average waiting times by region and bus route travel times, among other analyses. Some cities already relied on data in GTFS (general transit feed specification) format, whereas others did not. Additionally, some cities depended on data in real time, while others relied on data only in a static manner. Therefore, both open data and information provided by the administrators to achieve different functionalities

were used respecting the key concept of appropriating technological advancements to improve the use of public transportation.

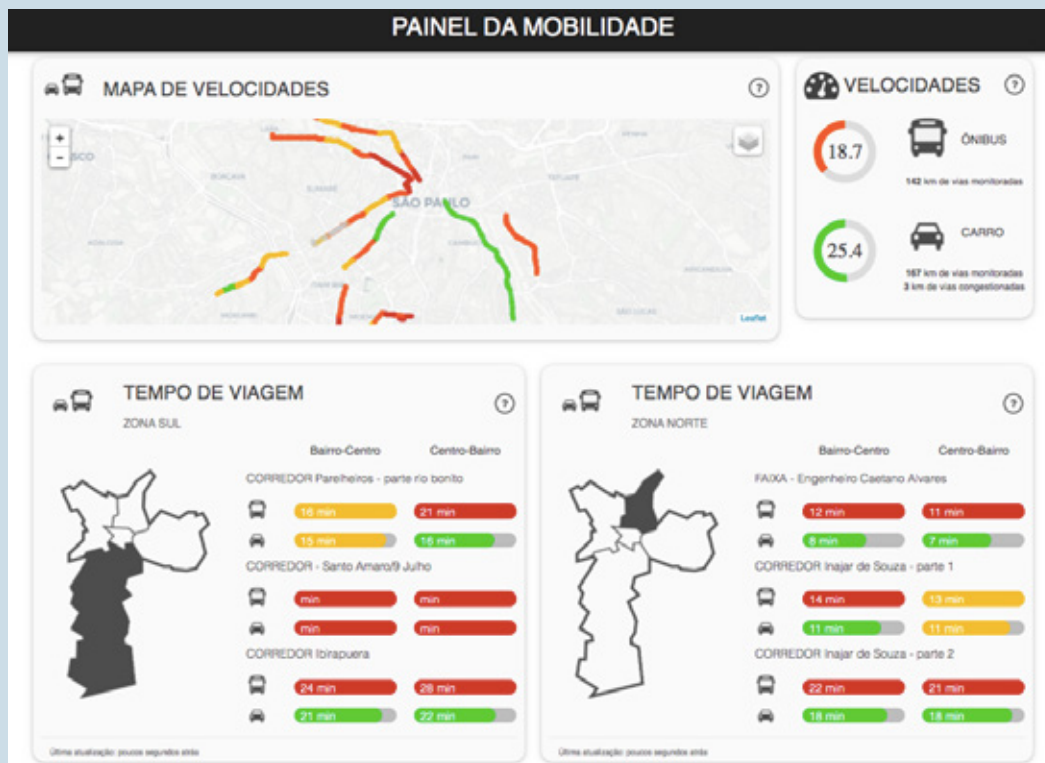
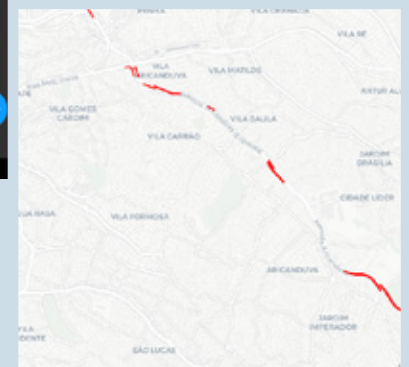
4. Traffic support — Two prototypes were created by leveraging Waze data in each city. The first one was intended to be used by administrators for analyzing congestion; and the second, to issue accident alerts through an indicator of abrupt change in the speed of vehicles and in the Waze feed. These bases could help collect information on accidents, their characteristics and visualization in real time, as well as to issue alerts for traffic and health officials so that they would be able to quickly reach the location, for instance. In those cities with structured accident data it is also possible to have the machine “learn” in order

Visualization of the tool that allows the monitoring of pollution levels.





Congestion index panel from Waze data.

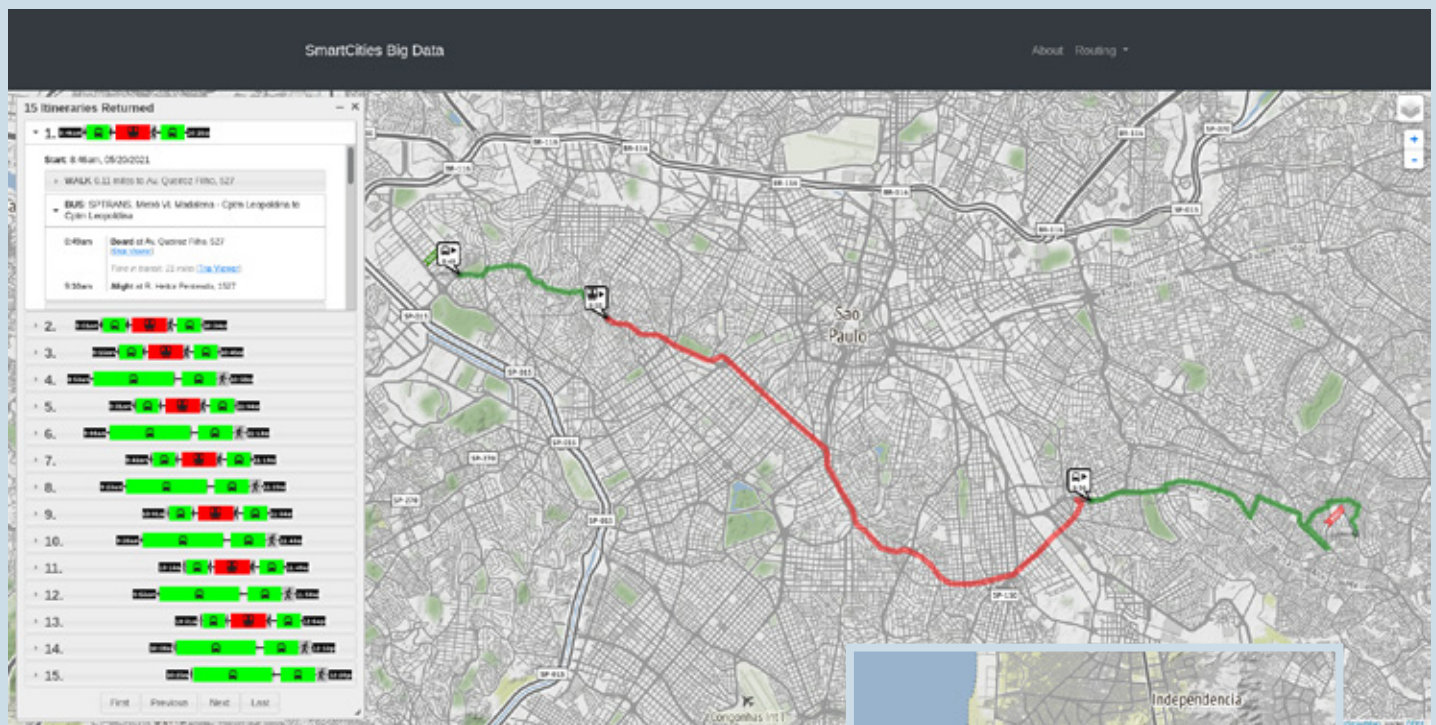


Visualization generated by the tool that compares travel time between buses and cars.
Left, image of São Paulo.
Below, image of Montevideo.

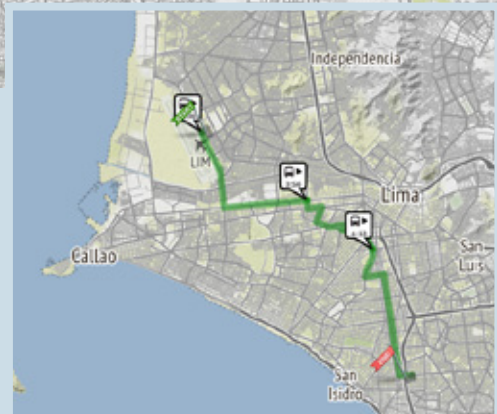


to improve the tool. In this case, we will prepare machine learning for São Paulo and use it in other cities.

Platforms 1 and 2 were cocreated based on two meetings held with the cities, while platforms 3 and 4 required further deepening and adaptations based on the reality of each city. Despite the significant common challenges to exchange ideas and experiences, it was determined that transportation and traffic solutions depended on the specific needs of the administrators and technicians of each municipality, as well as the circumstances of each city. In this sense, the product associated with traffic support was adapted. This adaptation process illustrates quite well the value of making innovations based on a cocreation process.



Visualization of routing generated from GTFS data using the Open Trip Planner (OTP). One of the most common uses of GTFS data is the possibility of plotting transportation system routes, as visualized in the figures.



Xalapa and Miraflores are yet to have their GTFS consolidated, and therefore, the initial idea of generating visualizations in real time was not possible. Although Xalapa had already developed a first sketch with a mapatona, its structure did not allow for the development of a solution based on this product, as expected. In the best-case scenario, in both these cities, we have access to what is referred to as static GTFS, while the solution initially designed requires a dynamic GTFS. For both cities, the solution was the consolidation of a static GTFS with the possibility of a routing tool for bus transportation.

The geolocation of vehicles available to create a visualization that compared the speeds of buses in corridors and cars on the same road was used for Montevideo, Quito, and São Paulo. Waze data was used in this product to measure the speed of cars, and data from the GPS installed in buses was used for the speed of buses. The reason for this application is the fact that the administrators of these cities think users are not aware of the advantages of bus corridors during peak hours and that coming up with a technological solution combining this data could produce the necessary evidence for future planning of these cities. The value of this product for the city consists of educating the population on the importance of prioritizing collective modes of transportation and encouraging mode migration. However, the application created is founded on the idea of changing the behavior of individuals towards a more sustainable city based on technological advances.

As far as traffic is concerned, two solutions were proposed, again meeting the needs of the cities with Waze data, for the following purposes: congestion analytics and accident detection.

With respect to congestion analytics, some cities have been using Waze data for certain applications, particularly to monitor the volume of congestion. São Paulo is one of them. Before Waze, data was “manually” collected by CET. Nearly 40 agents observed the CET cameras scattered throughout the city and classified the roads in terms of the flow. The number of kilometers of roads classified as “slow” was then summed up in order to obtain the slow traffic index.

São Paulo has migrated to Waze and with it verifies the total number of roads in about 800 kilometers originally monitored by cameras essentially using the same classification. Although, to a certain extent, the process dispenses with the use of agents, it is still quite manual. In addition, it maintains the 800 kilometers while it would be possible to increase coverage considering that it no longer depends on cameras. Therefore, this application would enhance data use and allow for an increase in the scope of coverage.

For other cities that still do not use Waze for measuring congestion, this indicator could be an interesting option. Here we have direct interaction between economists and data scientists in order to create the most appropriate indicator. Using Waze data since 2018 makes it possible to go back in time and create a historical series, including for purposes of comparison with previous indicators, if any.

In the accident detection product, the idea consists of not only leveraging the fact that an accident almost always causes an abrupt change in the flow of vehicles, but also of attempting to associate the piece of data on the change in the flow with the probability that an accident could have occurred.

Data on cities, when available, as well as Waze feed data, may serve as a basis for the system to learn when speed change patterns most likely indicate an accident. Occasionally, it could be possible to indicate the seriousness of the accident. This would be a significant advance and a contribution potentially replicable in many cities worldwide.

In addition to speed data, we also have accident notifications by users on the Waze feed. As is the case with some cities in the project (notably São Paulo) there is also a base of accidents with victims formed with data on hospitalization, police report and Forensic Medicine Institute (IML) data. This base is rather detailed, and it is possible to induce the seriousness of a fatal accident with victims.

Finally, training workshops were offered to the team, in which a manual on use of all applications created was made available and a

series of webinars were held to train public administrators on using the platforms. In addition, the developed prototypes were used as an example of the potential of open innovation in improving the supply of public services in the cities participating in the project.

It should be stressed that, originally, it was imagined that the primary demand in this part of the project would be for data processing and storage capacity. Nonetheless, when we started implementing the prototypes, we noted that most demand is for “intelligence”, i.e., for the development of prototypes, rather than for servers capable of ensuring storage and processing capacity. As discussed above, an innovative project requires scheduling and open data capabilities. The cloud enables these capabilities through a data lake (a repository of raw, structured and unstructured data) or a data warehouse (a repository of filtered and structured data that has already been processed for a specific purpose). Therefore, cities must migrate from the concept of data center to that of data lake, which is at a somewhat embryonic stage in Latin American cities.

Obelisco, São Paulo



Smart urban policies

Smart cities depend on urban innovation policies, preferably open, the logic of which incorporates their systemic innovation process. They depend on previous conditions, such as open data policies and a careful governance plan, in addition to specific inputs, including big data and cloud technologies capable of processing them. However, these are only the necessary conditions. Based on them, it is necessary to structure actions to be carried out by the innovation system created by academia, government and companies, among other civil society institutions interested in the topics to be addressed.

The prototypes to be developed within the scope of the Big Data for Sustainable Urban Development project took into account time, level of open data maturity, regulatory structure, and needs and priorities of cities. They are examples of initiatives that can be developed within the project term and which illustrate: types of data usage (large or small volumes) to improve their disclosure and transparency; machine learning and shaping to obtain information on public matters that foster discussions and actions of future policies. Examples would include assessments of air pollution and prototypes that help administrators make more precise decisions. The road traveled for this project, from beginning to end, included the development of the prototypes consisting of a process of cocreation at several levels, including analysis of the current circumstances (diagnosis), regulatory structure, and mapping. These steps were essential to understand the level of institutional advancement at which each one of the five cities was, and what the recommended steps would be for them to improve their legislation. In addition to the survey, the interaction between the legal advisors and the cities through interviews was crucial. It was this work that rendered the data policy feasible and enabled the proposal for creation of a management team and other relevant factors in the implementation of regulatory open data policies.

As far as the existing data ecosystem is concerned, the performance of detailed work involving the survey of bases and qualification by areas made it possible to understand the level at which each city was.

SMART CITIES DEPEND ON
URBAN INNOVATION POLICIES,
PREFERABLY OPEN, THE LOGIC
OF WHICH INCORPORATES THEIR
SYSTEMIC INNOVATION PROCESS

Its results were equally crucial for the forwarding of both recommendations and the preliminary identification of technological application opportunities in public administration, according to data availability in areas of urban policy.

The development step of the platforms was divided into the stage of problem identification centered on the shaping of urban policies that would be shaped, considering their primary fields of activity and the challenges common to cities. This includes a design thinking exercise; the stage of assessment of potential solutions with a general proposal for a platform; and the stage of validation with cities.

The latter stage consisted of holding discussions with representatives and technicians of each city, concerning applicable and workable specifications, and solutions according to the particular conditions of the city, the resources, and the time available. The validation stage required active participation and engagement of FGV researchers, the administrators and technicians of the municipalities, and the data engineering company. This interaction enabled development of a different solution for each municipality—albeit in a common area for all—based on its needs, challenges, and institutional and technological environment.

The final result achieved by the project consisted of the deliverance of different technological prototypes to face the common problems experienced by the partner cities. These are products cocreated in an innovative system based on preestablished conditions. They do not represent the main result expected from the public policies formulated. The final result must consist of the capacity of cities, based on these products, to eliminate the problems diagnosed; and of the change caused by intervention of the public policy implemented. Monitoring and assessing the actual impact of these products and making the necessary corrections are efforts that go beyond this project. At any rate, the main objective was achieved: to create the necessary conditions for the prototypes, such as those given here as an example, to be cocreated according to the logic of the desired urban policy in order to improve the quality of life of its citizens.

THE ROAD TRAVELED
FOR THIS PROJECT,
FROM BEGINNING TO END,
INCLUDED THE DEVELOPMENT
OF THE PROTOTYPES CONSISTING
OF A PROCESS OF COCREATION
AT SEVERAL LEVELS

However, this mission will only be fully achieved if, based on this study, other prototypes are created and many complex problems, such as the current ones, experienced due to the COVID-19 pandemic, are eliminated, and also if this way of approaching complex matters through big data processing in the jointly architected urban policy cycle is replicated in many other cities, especially those located in Latin America. Even if the functionalities of these prototypes are effectively useful for cities, our objective was to demonstrate that it is possible to create innovation with modest expenditures provided a relevant question is asked. This question must be jointly answered by the government itself, academia, and the private sector. The focus is placed on the process, and not on the result. But, for didactic effect, the result is also highly relevant.

uito Turístico
king Tour



mación Turística



o del Carnaval



Montevideo's Old Town

5.



RECOMMENDATIONS AND CONCLUSIONS FOR A CITY ORIENTED TO EVIDENCE-BASED PUBLIC POLICIES

To manage and also improve the functioning of cities, it is necessary to know its problems well and seek innovative solutions based on the mobilization of existing resources, such as the massive amount of data produced on a daily basis at its several different levels of operation. However, said solutions will be innovative when cocreated by government (and its several secretariats and departments), academia, and companies, in an environment that favors constant interaction between these players in search for the best way to solve urban problems by safely handling and using this data.

As seen in this book, cities usually generate a large amount of data—and will generate much more in the near post-pandemic future, when it is expected that society will have further enhanced available digital tools. The implementation of plans to organize legal, institutional, technological and data governance infrastructure in this scenario will provide enormous potential to eliminate complex problems with ever more innovative solutions cocreated in well devised urban policies. Understanding data allows for shaping a number of urban policies, in addition to improving many aspects regarding the quality of local management, thus generating instruments to provide feedback to a more integrated urban plan in the future.

In order to do so, cities must have the necessary institutional and technological conditions for the complex problems experienced by society to be mitigated through data, as well as capacity for them to be mobilized in the sense of cocreating new solutions in a process of intense interaction. This needs to occur between the governments elected to solve the problems, academia, which generates knowledge

of them, and companies capable of producing technological solutions based on existing inputs. This way, results can mean better and more inclusive cities that apply their inputs in an effective manner and implement a series of actions, which must start with the definition of an urban policy based on data-produced evidence. These cities will then proceed with the cocreation of innovative products, which are oriented to a final consistent result in solving the problem diagnosed.

In the Big Data for Sustainable Urban Development project, this path was taken based on the experience acquired in the work performed with the municipalities analyzed. As a result, some recommendations were identified throughout the project, and the best practices are summarized as follows.

Policy on data use by public administration

Before starting to shape an evidence-based urban policy, cities must expend efforts to create the necessary crucial conditions in order to enable innovative products that positively impact the quality of life of citizens. These conditions comprise the policy on data use by public administration. This includes its preparation and approval, the establishment of strategic partnerships, the creation of a qualified team, and in the case of open data, a specific policy in this sense.

1. Preparation and approval of a data policy

The local government must prepare and approve a data policy and publish this data on a single automated platform that is regularly fed by new data generated by the administration. All data must be made available in formats that can easily allow for an analysis by internal players, and possibly, external players, in compliance with personal data protection rules.

In this process, it is also recommended to make an initial diagnosis that maps and assesses the following items:

- applicable institutional and regulatory frameworks associated with data handling and use;

- forms of governance previously designed;
- available technology and infrastructure;
- privacy and security;
- publication stages;
- data maintenance;
- big data culture.

With the diagnosis at hand, it is recommended to prepare a regulatory instrument that accommodates the above topics in a legal-regulatory environment that enables the desired urban policies.

2. Establishment of partnerships for pilot data analytics projects

The local government must establish partnerships with external players (academia, civil society, and/or the private initiative) to analyze government data made available on specific platforms. The objective here is to seek correlations between different fields by combining different bases and promoting experiments. This enables the municipality to start projects that seek an extensive data analysis through partnerships that allow for access to data generated by private and/or public administrations. In addition, it can assure involvement by civil society in the process, which is also a recommended step, not only to confer increased legitimacy, but also to ensure responsibility for rules regarding data security, privacy, and ownership.

3. Creation of a data analytics and management team through an administrative act

A team specializing in data analytics and management must be created through a regulatory instrument approved by the local legislative power. This regulatory instrument must provide for



mechanisms to coordinate the team, its responsibilities and roles. This must encompass the formulation of a local big data policy and alignment with other innovation projects, among others. In addition, human and financial resources must be planned. The team must have a multidisciplinary profile, including public policy formulators and administrators, in addition to technical professionals dedicated to data analytics. Such multidisciplinary is necessary for most strategic roles, as well as roles regarding communication and coordination with other public entities and agencies, and for dialogue and establishment of partnerships with private players.

Parque María Reiche, Miraflores

It is equally recommended to redesign the administration of cities in order to combine efforts and diversified knowledge, such as architecture, urban planning, engineering, information and communications technologies (ICT), health, education, and the environment, among others. Considering this, the first step on the path to the creation of a smarter city should be to structure the team that will use the leader's vision as a map of the project.

All connections between the different players must be clear to the administrator, who must ensure that all players have a common objective. The multidisciplinary team, in turn, is the project engine as it ensures its progress towards the desired direction and records the lessons learned along the way. This team must consist of representatives

of each department with sufficient technical knowledge and management capacity for making strategic and operational decisions.⁴²

Before implementing a big data team in each city, it is recommended to check if the city:

- already relies on an advanced open data policy;
- has data analytics projects that seek correlations, which can be done through partnerships with the private sector, academia, and civil society;
- is in a position to allocate part of the team in charge of the technological innovation of the city in order to analyze data through a simple administrative act;
- is in a position to establish sophisticated public-private partnerships for access to data generated by companies and has control mechanisms in place involving civil society;
- has the political and financial conditions to create a team dedicated to management of big data, especially in those cases in which the approval of a legal standard by the local legislative power is sought.

Once the above conditions have been met, it is recommended that the standard to create a big data management team provides coordination mechanisms, its responsibilities and roles, the formulation of a data policy, and alignment with other innovative projects, as well as human and financial resources.

It is also recommended that the team manager has a channel for direct communication or direct link with the mayor's office, and that he/she works in conjunction with other departments, particularly those in charge of the city's strategic planning and the ICT. He/she must be the point of contact with city administration for any topics regarding analysis of data by other departments or external players.

42 Bouskela, M., Casseb, M., Bassi, S., De Luca, C. e Facchina, M. 2016. *The Road toward Smart Cities – Migrating from Traditional City Management to the Smart City*. Washington, D.C.: IDB. Available at: <https://publications.iadb.org/publications/english/document/The-Road-toward-Smart-Cities-Migrating-from-Traditional-City-Management-to-the-Smart-City.pdf>. Accessed on: July 23, 2021

It should be stressed that the role of the team manager should not be confused with the responsibilities of the chief information officer (CIO), who is responsible for proper operation and security of the information technology infrastructure used in data collection and sharing. Although the technological component is crucial for data analytics, it is recommended that big data analysis and management be the responsibility of a specific professional, who will have separate functions from those of the CIO.

4. Open data

Further care should be taken when it comes to open data. First, it is recommended to create an inventory. Database inventories are full catalogs containing the detailed description of public information generated within the scope of a city. The importance of making a data inventory is associated with the large amount of information produced within the scope of cities and the difficulty faced in organizing and structuring this information with the purpose of making it usable and reusable. After selecting data, the entities must establish the bases to be published. This stage consists of the analysis of which data, when open, could cause a greater impact, and thus, be established as a priority.

The choice of formats conferred to data is of paramount importance, to the extent that it enables leveraging a variety of uses. In other words, the provision of data in a diversity of formats provides users with increased accessibility and facilitates their reading by machines. It should be stressed that the need for proper formatting is not only a technical requirement for opening data, but above all, an open data principle. Therefore, it is important to establish an “open format” for the set of data.

Ultimately, the use of metadata must be analyzed. In other words, data contextualization, so as to allow them to be sufficiently discovered or reused by third parties in addition to publishers. Most specifically, metadata provides additional information with the purpose of providing greater understanding of the meaning of data and their

To learn more



The details on requirements for the creation of a team dedicated to big data management in cities can be found in the document *Draft Bill/Decree for the Creation of Big Data Management Teams in Each City* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29693/tr_4_-_produto_4_-_relatorio_final_-_web.pdf?sequence=1&isAllowed=y), prepared by FGV.

structure. This information consists of license terms and rights, details on the organization that generated the data, quality of the data, data access methods, and updating, among others.

It is also absolutely necessary that administrators adopt data maintenance measures. First it is crucial that all data published is always updated. This involves careful synchronization of publications with the frequency of updates to increase the confidence of data consumers and encourage reutilization. Data disposal is also relevant.

To learn more



The details of each one of the pillars and of the diagnosis can be found in the document *Manual, for Administrators, of Identification of the Factors to Be Considered in Implementing the Regulatory Open Data Policy* (http://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/29694/tr_5_-_produto_5_-_manual_final_revisado_web.pdf?sequence=2&isAllowed=y), prepared by FGV.

Formulation and implementation of innovation policies

After establishing the necessary conditions above, the next step for shaping evidence-based urban policies produced by big data analysis and processing is to mobilize these inputs in an innovative system capable of transforming them into efficient products targeted for solving complex problems experienced by society.

To do so, the following steps are recommended, which are taken from the project that inspired this book. In it, solutions were prototyped in a cocreation process, the primary objective of which was to illustrate the process and set the bases for the future shaping of policies of this magnitude based on the technological infrastructure created and the manual produced.

1. Input mapping

Firstly, it is necessary to make a careful selection and analysis of both public and private data that are available in cities, as mentioned above. The detailed analysis must involve their quality and consumption capacity, as well as the identification of opportunities to create public value, through urban policies driven by innovation, equality, and development, in order to solve problems of public interest.

Subsequently, it is necessary to make an effort of systematization and categorization by theme associated, in this case, with the development of sustainable urban policies such as social and human development, urban development and economic development, as well as mobility and the environment. Within the scope of the project, structured open data common to participating cities were mapped for purposes of comparison and strengthening of relevant evidence in order to validate the efficacy of the public policies shaped in the project.

2. Development of the Online Data Registration, Validation, and Disposition Environment tool (AOCD)

The next relevant step in the policy building process is to use an online platform for data ratification, cataloging, and management. By using it, a diversity of information can be stored, disclosed and distributed in an accessible manner both by the general public and by innovative systems for the development of a number of prototypes within the scope of urban policies on open innovation.

In this project, a platform referred to as Dataurbe was created, which aggregates open data from all five participating cities in a single repository. It is possible to approach the datasets in two different manners: either by the selected city or by the type of data to be accessed, such as education, mobility, health, safety, or the environment. Developed in CKAN,⁴³ an open-source platform maintained by Open Knowledge, the AOCD automatically captures the cities' dataset on a regular basis through a synchronization resource of the tool, which enables maintaining all updated data.

⁴³ Available at: <https://ckan.org>. Accessed on: April 5, 2021..

The choice of an open-source tool—regardless of which one—is intended to provide transparency to the entire AOCD development and maintenance process, especially since it is also about publicizing of open data. In addition, the creation of platforms such as this is an example for cities that still do not have an open platform to publish their data.

3. Diagnosis of the complex public problem that is the target of the innovation policy

After creating the basic infrastructure and mapping the public and private data available, the next step is to understand the problems surrounding the entire logic of the policy to be formulated. This is a stage of important active participation by public administrators of the cities and the members of the government elected to respond to the complex problems, the solutions of which are of public interest.

At this stage, it is recommended to hold design thinking sessions, applying methodologies such as the human centered design (HCD), which aims to place people's needs at the center of development, thus promoting empathy and experimentation and combining analytics and intuition. The core idea here is to place the user as close as possible to the solution development process.

Within the scope of the project, the participants from cities must be encouraged to interact with each other and with academic specialists in multiple disciplines, in addition to a diversity of other interested players from organized civil society and the private sector. These players are responsible for formulating public policy in conjunction with the cities. The intention here is to map common problems that can be corrected by public policies based on the data available by answering the following question: "How can mapped data promote local development for common problems in cities?". This provocative question allows for specifying the demands in terms of products expected as a result of the project, as well as requires a joint processing of the results found in order to consolidate the causal relations of the policy that will lead inputs

ONE OF THE MAIN LESSONS
LEARNED FROM THIS
PROJECT WAS THE INCLUSION
OF SOLUTIONS THAT WOULD
BE PROTOTYPED

to the final results expected, consistent with the solution of the problems mapped.

4. Cocreation and validation of solutions in conjunction with the technical body

While public policy managers and decision-makers have a clear view of the problems to be faced, the solutions must be created in conjunction with a technical body, which has a more realistic experience with the feasible technical conditions and needs. In this sense, one of the main lessons learned from this project was the inclusion of solutions that would be prototyped, as these are the professionals who will enable successful solutions in the long run.

This product cocreation stage also depends on the quality of the inputs, the existence of previous conditions in each city, and particularly, the availability of sufficient data to be consumed and processed. The combination of inputs that will generate prototypes also depends on the degree of interaction and synergy between: governments, which, in the name of public interest, seek solutions for urban problems experienced in cities; academia, which prepares questions in order to better diagnose problems and builds solutions for their hypotheses; and companies, which develop the solutions that will be effective if they actually face, in whole or in part, the urban problems verified.

5. Protocol for monitoring and assessing the impact of the solution

Since the final result expected is not the prototyped product itself but the mitigation of the problem diagnosed with these products, it is crucial that the policy implemented has these results monitored and assessed in order to eventually observe the real impact of the policy shaped and possibly correct any failures. If necessary, the entire process will be restarted from the creation phase.

The great importance of monitoring, assessing, and feeding the entire urban development and planning process for the learning cycle in a

smart city cannot be overemphasized. The measurable results of each small project, along with positive publicity and engagement of citizens will drive future projects.

The use of indicators and transparency in data publicity are powerful allies in the face of public opinion and the partners involved. It is necessary to create a participation and communication strategy for the project and show the progress made, as well as demonstrating the project is working and the service provision is improving, impacting people's life and making visible changes in the dynamics of cities.

This result can only be achieved if, in addition to ensuring continuous interaction of the players, the urban policy implementation logic is also capable of creating the necessary conditions to enable collaborative action in an innovative system, and if the latter allows for cocreation of products as a result of the process.

Final considerations

The use of big data is extremely important for effectively planning cities, though not sufficient to improve the quality of life of their citizens. The same applies to the isolated actions of government, academia, and companies. The process of data-based innovation requires this data to be associated with urban policies so that innovative products are actually directed toward building cities that provide a better quality of life and are more efficient, productive, and resilient.

As seen throughout this book, the efficient operationalization of a data environment in local governments is not only a technological challenge. There is also a series of preexisting conditions and local specificities of legal, political, technological, and human nature to be faced.

In this sense, it is important that relevant experiences in public innovation policies focused on massive data use—and their results and limitations—are reported in order to contribute to fostering and improving the discussion on this ever more important topic.

In addition to providing methodological and technical contributions, the work performed by FGV with the support of the IDB, as well as by advisors with the five Latin American cities, also provided practical lessons learned from the cocreation process. The difference between the cities—regarding the size of each one of them and their experience using data in public policies—was translated into challenges addressed in conjunction so as to allow for the creation of prototypes intended to solve urban issues pointed out by municipalities themselves.

As a legacy, it is expected that this project will be the seed for other cities to also follow the path presented in this book, by replicating the pilot model of massive data governance in order to reach a new administrative model through evidence-based public policies and using big data with transparency and efficiency for sustainable urban development. We believe that, instead of merely hiring “off-the-shelf” solutions, the five cities involved in this project should progressively start their process by asking questions that guide said hiring. Based on these questions, hopefully the five cities will foster development in a cocreation environment that involves companies and academia at every step of the process.



Quito's public transportation during COVID-19 pandemic



APPENDIX: COVID-19 — PRACTICAL BIG DATA APPLICATIONS AND LESSONS FOR PUBLIC ADMINISTRATION

The rapid unfolding of the crisis caused by the new coronavirus pandemic represented a historical challenge to the world and the nations of Latin America and the Caribbean (LAC). In some countries—such as Brazil,⁴⁴ Ecuador, and Uruguay⁴⁵—the epidemiological curve increased significantly during certain periods, requiring quick responses on the part of public administration.

In addition to risks posed to health, the pandemic aggravated chronic socioeconomic issues in that region,⁴⁶ impacting millions of people. Although it is difficult to foresee the impact in the medium and long run, it is clear that the complexity of the issues arising from the pandemic for cities in that area required and will continue to require the development of quick and innovative solutions to overcome the effects of COVID-19 at the social, sanitary, economic, and tax levels.

To effectively face the situation, the response and recovery efforts started to be guided by evidence-based policies. And in this sense the appropriate use of big data showed to be imperative.

In all four corners of the world—including the cities in that region—it was possible to note, for instance, a significant increase in the generation of epidemiologic monitoring and mobility data, which support decisions made by public administrators and the definition of public policies to respond to sanitary emergencies. In some municipalities, such as Medellín and Quito, the analysis of data generated by digital technologies at the hands of citizens and the public administration itself made it possible to anticipate the behavior of the infection curve, thus allowing for a better response on the part of public administration.

44 Fariniuk, T. M. D., “Smart cities e pandemia: tecnologias digitais na gestão pública de cidades brasileiras”. *Revista de Administração Pública*, (54) 4, Jul./Aug. 2020. Available at: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-76122020000400860&tlng=pt. Accessed on: April 4, 2021.

45 Ministry of Health of Uruguay. Available at: <https://www.gub.uy/ministerio-salud-publica/coronavirus>. Accessed on: June 2, 2021.

46 Libertun, N. 2021. “Cuatro desafíos que nuestras ciudades pueden superar”. Washington, D.C.: IDB. Available at: <https://blogs.iadb.org/ciudades-sostenibles/es/cuatro-desafios-que-nuestras-ciudades-pueden-superar/>. Accessed on: April 4, 2021.

In other municipalities, although it was impossible to anticipate cases, public health data was still based on the *a posteriori* response to mitigate the consequences. Above all, this data helped integrate the efforts⁴⁷ of several different public agents to mitigate the harmful effects on the economy, education, etc.

Right at the start of the pandemic, for instance, thanks to data collected from cell phone sensors, it was possible to find out the social distancing rates in several cities, such as Quito⁴⁸ and São Paulo. During the quarantine phases, georeferenced data enabled the departments of health to not only understand the evolution of the pandemic, but also identify the places where it was concentrated. Over time, all data regarding head-of-household mothers and the elderly allowed the administrators to establish support strategies focused on these communities.

Most of these initiatives relied on cooperation between different public agencies, civil entities, and private companies. The first country affected by COVID-19, China, for instance, received assistance from the private sector in the fight against the disease. Alibaba, one of the giants in the technology sector, created Alipay Health Code,⁴⁹ which consists of a big data analysis tool that provides a color code for the level of contamination risk by the new coronavirus (green, yellow, or red, from the lowest to the highest level of caution). The system was tested in the city of Hangzhou, in Eastern China. Data collected included cell phone geolocation and facial identification with body temperature measurement, among other resources that helped anticipate the local government's strategic actions.

The use of tools such as GPS and/or cell phone triangulation was also crucial to understand the levels of adoption (or non adoption) of the social distancing practices by parts of society, since according to the World Health Organization (WHO) reducing people's movement in social settings is one of the primary measures in preventing higher rates of contamination. The cities of Recife, Rio de Janeiro and São Paulo,⁵⁰ in Brazil, relied on mobile monitoring based on data provided by telephone companies and startups with geolocation solutions. In

47 Fariniuk, T. M. D., "Smart cities e pandemia: tecnologias digitais na gestão pública de cidades brasileiras". *Revista de Administração Pública*, (54) 4, Jul./Aug. 2020. Available at: https://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-76122020000400860&tlng=pt. Accessed on: April 4, 2021

48 Mintel presenta en Quito plataforma COVID-19 para mapear la emergencia. *El Comercio*. April 13, 2020. Available at: <https://www.elcomercio.com/actualidad/michelena-alban-yunda-plataforma-covid19.html>. Accessed on: April 22, 2021.

49 The first time the application was mentioned in the West was in an article by the New York Times on the use of digital technologies in the fight against coronavirus in China. Available at: <https://www.nytimes.com/2020/03/01/business/china-coronavirus-surveillance.html>. Accessed on: April 4, 2021.

50 Questions and answers about Intelligent Monitoring and Information System (SIMI-SP). Available at: https://www.ipt.br/download.php?filename=1932-FAQ_SIMI.pdf. Accessed on: April 22, 2021.

Colombia, Medellín launched a georeferencing strategy to better plan the distribution of health services in the city.

The Inter-American Development Bank (IDB) made the People Mobility Map available to countries in LAC⁵¹ a benchmark application that has been using georeferenced and anonymous data from cell phones. To facilitate its use, the results were also included in a new section on urban mobility of the IDB Coronavirus Impact Dashboard.⁵²

It should be stressed that the adoption of new technologies for different types of monitoring has been a trend among large cities, though not uniformly.⁵³ In the case of COVID-19, the implications of the use of citizen tracing in the fight against its rapid dissemination are still unclear in many countries. Using citizen data to improve the understanding about the spread of the virus and the management of disease fighting processes represents a new type of interaction between governments, private initiative and citizens for access and use of personal data for public good. The COVID-19 pandemic offers the chance to reflect on a series of pending data governance questions and act on them.

All existing regional data protection laws, such as the Brazilian General Data Protection Law of 2018, the Mexican Data Protection Law of 2010 and the Colombian Habeas Data Law of 2012 depend on the consent of the user to allow most types of personal data collection and use. These regulations contain extensive exceptions for national emergencies and data collected for public purposes. Exemptions for public emergencies are necessarily contingent upon responsible authorities to define the limits of what an emergency is—and what is acceptable or not when it comes to using and managing personal data volumes.

In South Korea, for instance, the city of Seoul⁵⁴ implemented the Digital Health Program, combining big data, artificial intelligence, blockchain, telemedicine, and consumption electronics. For years, the Korean government has worked in close collaboration with the private sector to encourage hospitals and health companies to use the data they collect to help develop medications for fatal diseases, including infectious diseases.

51 Available at: <https://www.iadb.org/en/research-and-data/mobility-covid>. Accessed on: April 4, 2021.

52 Available at: <https://www.iadb.org/en/topics-effectiveness-improving-lives/coronavirus-impact-dashboard>. Accessed on: April 4, 2021.

53 Lu, H. P., Chen, C. S. e Yu, H. 2019. "Technology Roadmap for Building a Smart City: An Exploring Study on Methodology". *ScienceDirect*, 03/13/19. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0167739X18304011>. Accessed on: April 22, 2021

54 Tursunov, R. "How Digital Health is Helping South Korea Win against COVID-19". *Intralink*, 05/13/20. Available at: <https://www.intralinkgroup.com/en-GB/Media/Blog/May-2020/How-digital-health-is-helping-South-Korea-win>. Accessed on: April 22, 2021.

With the COVID-19 pandemic, the data privacy regulations⁵⁵ were loosened in Seoul, and the Korean government started using citizen data for epidemiological surveillance and the implementation of contamination tests. Ultimately, big data became one of the most important tools in the fight against the virus in South Korea. As noted by Bloomberg: “No one is using big data as effectively as South Korea to combat the coronavirus, even if it gets a little personal”.⁵⁶

Another important big data analysis front within the context of a sanitary emergency has been public transportation,⁵⁷ a major ally in preventing and mitigating the effects of the outbreak. The cities of Curitiba,⁵⁸ Buenos Aires, Bogotá, Medellín and Quito are using an artificial intelligence tool developed by the IDB (Distancia2)⁵⁹ which uses video cameras already installed in bus and train stations to measure the distance between people in those locations. The system includes a control panel that provides useful data for decision-making. In the event of agglomerations, it is possible to issue alerts for people to keep a safe distance from each other. The same system could be used by public transportation managers for measuring peak hours and reformulating the number of vehicles available, for instance. In addition, hospitals and automated health systems were and continue to be crucial in following up the occupation and availability of beds, medication consumption, and human resource allocation (physicians, nurses, etc.).

Finally, several data collection and analysis efforts have been and continue to be expended to measure the impact of the closing of educational institutions,⁶⁰ traveling restrictions,⁶¹ commerce-related measures,⁶² etc. It is expected that all evidence will be used to re-plan cities with the hope of resuming and driving economic activity.⁶³ Another reason would be to have a more detailed look over these indicators which could reveal blatant inequalities.

Given the economic and social inequalities in Latin America, the effects of the pandemic will disproportionately affect the vulnerable medium-income segments of the population. This will lead to an increase in informal employment and child labor, as the most

55 BBC. “Coronavirus Privacy: Are South Korea’s Alerts Too Revealing?”. 03/05/20. London: BBC. Available at: <https://www.bbc.com/news/world-asia-51733145>. Accessed on: May 12 2021.

56 Anjani Trivedi. “Want to Know if COVID-19 Was There before You?”. Bloomberg, 03/05/20. Available at: <https://www.bloomberg.com/opinion/articles/2020-03-05/coronavirus-koreans-know-where-it-was-helping-contain-outbreak>. Accessed on: 22 abr. 2021.

57 The IDB and Moovit conducted a research to understand how COVID-19 was affecting public transportation users in nine cities in Latin America. Available at: <https://www.iadb.org/pt/noticias/transporte-publico-segue-indispensavel-mesmo-na-pandemia>. Accessed on: April 4, 2021.

58 Mobilize Brasil. “Sistema monitora distanciamento no transporte”. Nov. 23, 2020. São Paulo: Mobilize Brasil. Available at: <https://www.mobilize.org.br/noticias/12409/sistema-monitora-distanciamento-no-transporte-publico.html>. Accessed on: May 12, 2021.

59 Available at: <https://code.iadb.org/en/tools/distancia2>. Accessed on: April 4, 2021

60 Learn more at: “Education: From Disruption to Recovery”. Available at: <https://en.unesco.org/covid19/educationresponse>. Accessed on: April 4, 2021.

61 Learn more at: <https://www.iata.org/en/programs/safety/health/diseases>. Accessed on: April 4, 2021.

62 World Trade Organization. “COVID-19: Measures Affecting Trade in Goods”. 02/01/20. Geneva: WTO. Available at: https://www.wto.org/english/tratop_e/covid19_e/trade_related_goods_measure_e.htm. Accessed on: April 4, 2021.

63 United Nations Conference on Trade and Development. “Productive Capacities Index Helps Countries Build Economic Resilience”. 02/08/21. New York: UNCTAD. Available at: <https://unctad.org/news/productive-capacities-index-helps-countries-build-economic-resilience>. Accessed on: June 2, 2021

vulnerable families will depend on them to survive. Poverty in that region had already increased between 2014 and 2018, and effects of the pandemic will probably increase poverty and extreme poverty rates.

Numbers do not lie: the crisis does not affect all in the same way. A survey conducted by the IDB in 17 countries in LAC shows that many people have lost their jobs, businesses, etc.⁶⁴ The situation was much more serious in the most vulnerable families. Among those who stated that before the crisis their income was lower than a minimum wage (which corresponds to approximately the lower tenth percentile), 59% report that at least one of their family members lost his/her job during the pandemic and 43% of those who ran a business reported that they had to close it. Those who received income equivalent to more than six minimum wages (which corresponds to approximately the higher tenth percentile) report job loss in 15% of the families and businesses closing down by 21%.

COVID-19 impacted afro-descendent women who support their families disproportionately. Inclusive policies must be urgently devised in partnership with the public and private sectors in order to maintain and expand these advances. The selection of economic activities that would benefit can be based on data of economic sectors (contribution to employment and GDP), on the characteristics of the activities (facility areas and other conditions that enable implementing social distancing alternatives in interaction with users), etc.

The mapping of social projects showed to be useful in providing financial aid to those who most needed it. The IDB approved a transaction of USD 1 billion to the government of Brazil in order to strengthen the country's capacity of emergency response to the vulnerable populations and the workers registered on applications provided by the government. Nearly 475,000 families and 1 million workers will benefit from this.⁶⁵ The registration data provided was crossed with several government databases in order to avoid fraud. The program sought to contribute to preserving the levels of income and employment for the people affected by the pandemic in the immediate period and during crisis recovery.

64 Altamirano Montoya, A., Azuara Herrera, O., González, S. 2020. "¿Cómo impactará la COVID-19 al empleo?" Washington, D.C.: IDB. Available at: <http://dx.doi.org/10.18235/0002301>. Accessed on: April 4, 2021.

65 Inter-American Development Bank. "BID asigna USD 1.000 millones para apoyar poblaciones vulnerables y trabajadores en Brasil". Aug. 13, 2020. Washington, D.C.: IDB. Available at: <https://www.iadb.org/es/noticias/bid-asigna-us-1000-millones-para-apoyar-poblaciones-vulnerables-y-trabajadores-en-brasil>. Accessed on: April 4, 2021.

In addition to all this, big data resources were also and continue to be rather useful in Latin America in the fight against corruption. The use of e-procurement platforms and open contracts in that region generated larger and better data that can be extracted to detect and prevent irregularities, as reported by the World Economic Forum.⁶⁶ The data on government purchases and contracts became more open, thus allowing for increased scrutiny by oversight agencies and the public in general, including civitechs and govtechs, and technology-and data-based startups that seek to create social impact and improvement in public administration.

Ecuador, for instance, improved the quality and availability of 30 datasets that, when crossed, allow for detecting corruption risks. In Colombia, the Department of Transparency of the presidency sought to develop a data lake that gathered and crossed datasets from different sources in order to identify corruption risks in real time, not only in public purchases, but also in the licensing or generation of regulations. This applies to the actions taken by federal governments, as well as to state and municipal governments.

In summary, big data helped and continues to help not only to understand the crisis, but also to create a new and perhaps better social and economic environment. All it takes is to know how to use it. Unfortunately, in many cities in that region the promise of data revolution remains unfulfilled. Quite frequently—be it due to lack of technical capacity, rooted interests, or simply for the impetus of the status quo—the extraordinary amount of data currently available exerts little impact on the political process. It is more than time to change this scenario.

66 World Economic Forum. "Why Data Is Latin America's Best Weapon Against COVID-19 Corruption". Aug. 28, 2020. Geneva: WEF. Available at: <https://www.weforum.org/agenda/2020/08/why-data-is-latin-americas-best-weapon-in-the-fight-against-covid-19-corruption/>. Accessed on: April 22, 2021.

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La Virgen del Panecillo, Quito

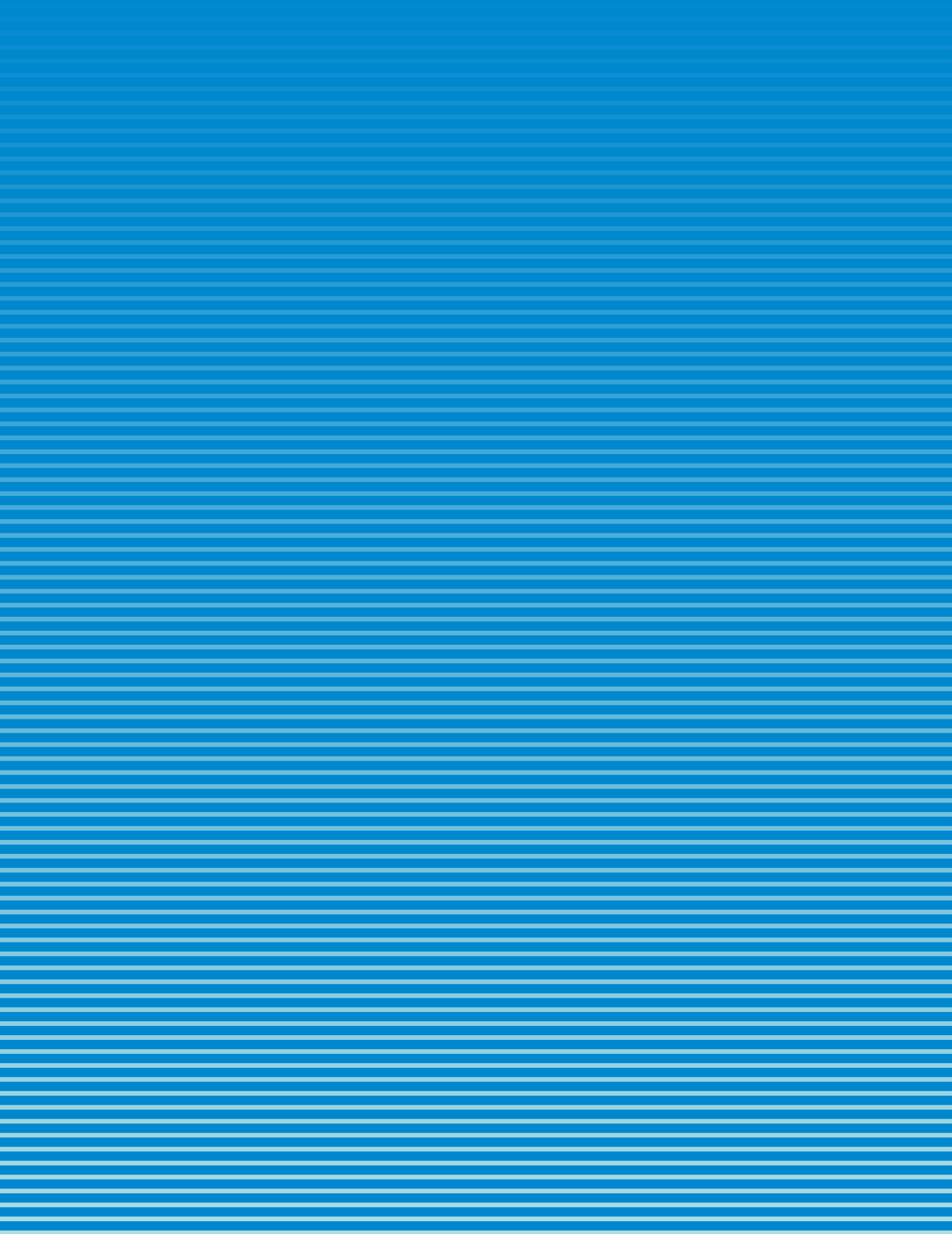


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