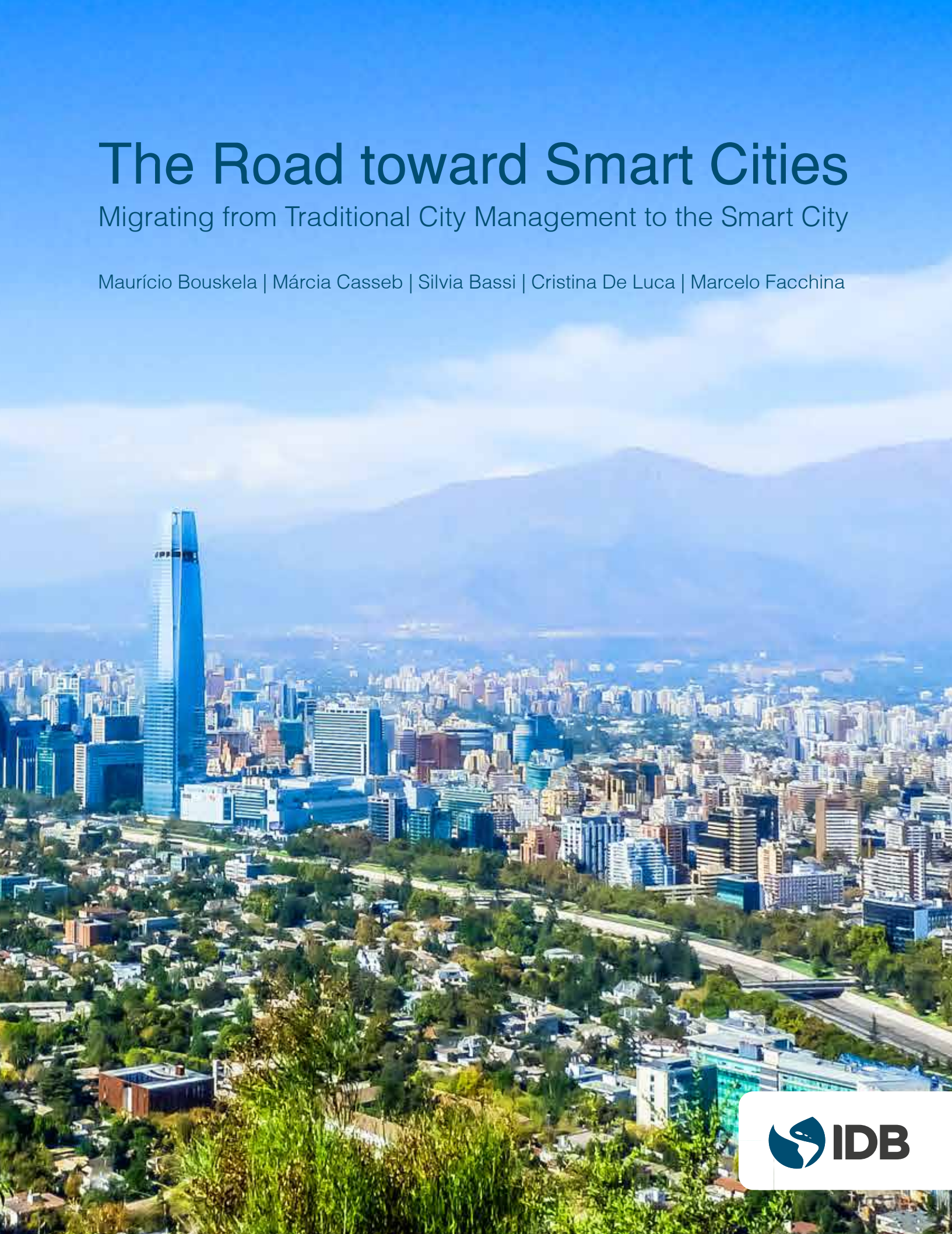
The Road toward Smart Cities

Migrating from Traditional City Management to the Smart City

Maurício Bouskela | Márcia Casseb | Silvia Bassi | Cristina De Luca | Marcelo Facchina



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IDB

RAMÓN ZAMORA

Implementation requires leadership and vision

The cities of Latin America and the Caribbean (LAC) are the protagonists of one of the most significant processes of population growth ever experienced in the planet, with major implications for the sustainability, quality of life, and competitiveness of the region. Addressing these challenges requires an evolution in governance and decision-making, as well as a more efficient use of our cities' resources, in order to undertake a smart approach to management.

As a result of the increasingly wider use of Information and Communication Technologies (ICT) in LAC, these have become a key ally of smart management. However, the use of technologies should be understood as a means and not an end in itself. In the words of Enrique V. Iglesias, former President of the Inter-American Development Bank (1988-2005), "It is not enough to have smart cities; smart citizens are also necessary."

People play a very important role as beneficiaries of and participants in city transformations. This role is evident in the active use of mobile devices and applications that increasingly facilitate monitoring and collaboration in the context of the transformative actions undertaken by city leaders. Therefore, the Inter-American

Development Bank (IDB) conceptualizes a Smart City in much broader terms, referring to those cities that put human beings at the center of development and planning, ensuring a sustainable and long-term vision for Smart Cities.

This vision is part of the comprehensive development model that we are promoting in the region with the Emerging and Sustainable Cities Initiative (ESCI). Based on our experience with ESCI, we believe that the implementation of a Smart City is a complex task that requires great leadership and vision, and brings multiple benefits to both leaders and citizens, encouraging public-private cooperation and promoting local competitiveness. Currently, more than 10 cities in the IDB's Sustainable Cities Network already have feasibility studies concerning smart management issues.

This Guide is a valuable contribution to the body of literature on smart urban management and seeks to share best practices on how cities can successfully migrate from traditional management to smart management. We hope this tool will be useful to our mayors, managers, consultants, entrepreneurs, planners, and their teams, in addition to serving as a vehicle for a long-term dialogue between the IDB and their cities.

BID

Ellis J. Juan
Division Chief
Housing and Urban
Development Division
Inter-American
Development Bank

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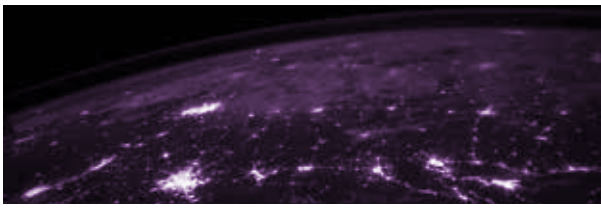
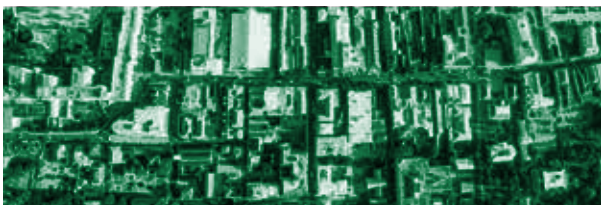




PASO AU YEUNG

Hong Kong, China

Smart Cities

executive summary

In Search of the Smart City

According to the UN, in 2050, **70%** of the global population (over six billion people) will be living in cities

We live in the convergence of two important phenomena in the history of humanity: the acceleration of global urbanization and the digital revolution. A United Nations (UN) study points out that, for the first time in history, more than half of the population on the planet (54.6 percent or 3.6 billion people) lives in cities. The study shows that by 2050, city dwellers will account for more than 70 percent of the world's population (over six billion) – 64.1 percent of the people in developing countries and 85.9 percent of the population in the developed world will be living in urban areas.

After North America, where 82 percent of the population is already living in cities, the region formed by Latin America and the Caribbean (LAC) is the second most populous in the world, with 80 percent of its population living in urban areas.[1] This urbanization phenomenon has accelerated in the second half of the twentieth century; in 1950, only 42 percent of the region's population lived in cities.

Planning, managing, and governing cities in a sustainable way, by maximizing economic opportunities and minimizing environmental damage, are major challenges that virtually all countries will be facing in this new century. Public funds need to be better targeted and natural resources need to be explored consciously and responsibly.

All urban areas present challenges to be overcome. Large cities and metropolitan areas, in turn, are increasingly seen as complex systems with connections between their different environments and individuals. Hence, the growing importance of both urban planning and the development of dynamic decision-making mechanisms, which take into account growth and the inclusion of citizen participation processes.

Managing and improving cities requires knowing what happens within them, in their different regions. This is only possible with changes in government structures and in the communication and participation processes of the different actors responsible for managing them.

[1] United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).

Therefore, transforming "traditional cities" into Smart Cities is an increasingly important demand, in addition to an opportunity for governments and citizens in LAC. With the emergence of digital technology, the Internet, and mobile technologies, this transformation is becoming more viable each day.

In general, a smart and sustainable city is an innovative city that uses Information and Communication Technologies (ICT) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, and environmental aspects.[2] In addition, it is attractive to citizens, entrepreneurs, and workers, and generates a safer space with better services and an innovative environment that encourages creative solutions, thus creating jobs and reducing inequality. As a result, it promotes a virtuous cycle that not only produces economic and social well-being, but also secures the sustainable use of its resources in order to ensure quality of life in the long run.

In 2050,
64.1%
of people in developing countries will be living in urban areas

Smart Cities use connectivity, sensors distributed throughout the environment, and computerized smart management systems to solve immediate problems, organize complex urban settings, and create responses that are both innovative and in line with the needs of their citizens. To ensure this efficient and sustainable management, Smart City technologies integrate and analyze large amounts of data captured from multiple sources to prevent, mitigate, and even foresee crises. These mechanisms enable the providing of services, alerts, and information to citizens in a proactive manner.

Although important, technology is just a tool that must be coupled with the planning and management process. The use of ICT should generate changes in practices, incorporate feedback into planning, change the dynamics in the provision of public services, turn problems into creative solutions, add value to the existing infrastructure, and improve performance indicators. That is, the process of making a city smarter produces effective and measurable results that can be monitored by residents as well as by those visiting the city. However, cities become smart only when they are able to address their complex challenges holistically. In this regard, they should go beyond technology and make use of assets and information at the local level

[2] International Telecommunication Union (Focus Groups on Smart Sustainable Cities, 2014).

to prepare a development strategy that addresses environmental, urban, social, and economic aspects. How can this variety of elements be combined into a plan that is at the same time solid, integrated, and comprehensive?

The Emerging and Sustainable Cities Initiative (ESCI)[3] is a program from the Interamerican Development Bank (IDB) that started in 2011 and focused on supporting medium-sized cities in LAC in order to address their sustainability challenges in the short, medium, and long run. ESCI operates in cities with populations between 100,000 and two million, which have experienced economic and demographic growth above their countries' average. The methodology is based on three dimensions of sustainability – environmental, urban, and fiscal/governance – and seeks to provide an integrated and comprehensive development strategy.

Expanding the use of technology to improve the management of cities and the provision of services is a relevant line of work under the Initiative.

[3] http://www.iadb.org/en/topics/emerging-and-sustainable-cities/responding-to-urban-development-challenges-in-emerging-cities,6690.html

RAMÓN ZAMORA

Nassau, Bahamas

Building Smart Cities should be part of a broader development agenda and is very important for meeting the urban challenges of the region. The application of the ESCI methodology in more than 60 cities in the region has evidenced a lack of understanding and knowledge in the public sector of how to combine technology and management to improve people's lives.

This document is meant to assist in that understanding by presenting concepts, examples, and guidance to transform "traditional" city management models into "smart" management models. The purpose of offering ideas about infrastructure requirements, the impacts of technology use on the provision of public services, and the benefits brought by coordinated city management is to generate more structured knowledge for the cities and facilitate the incorporation of Smart City interventions in the region.

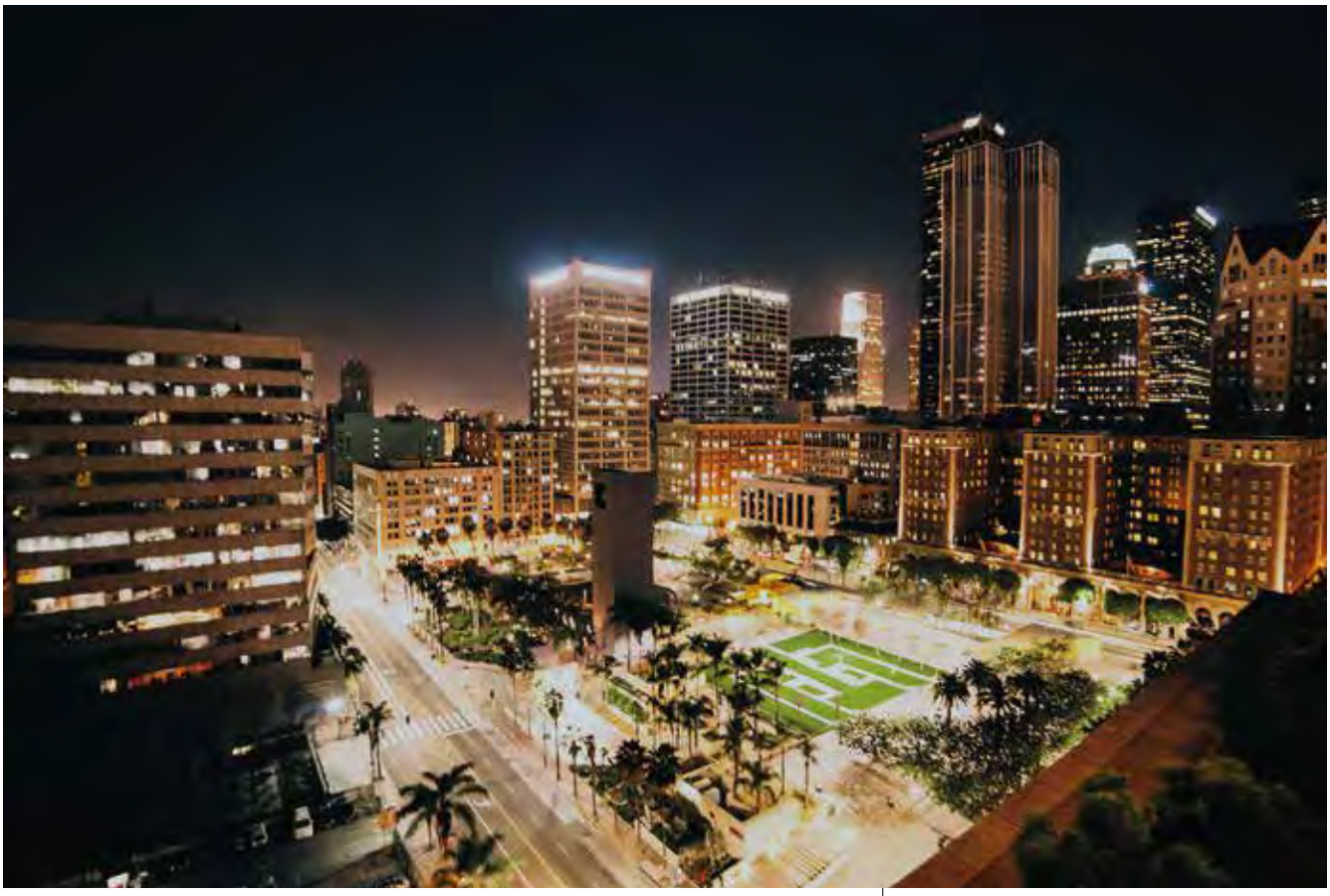
Planning, managing, and governing cities in a sustainable way, by maximizing economic opportunities and minimizing environmental damage, are challenges that virtually all countries will be facing this century

The Smart City concept stems from the viewpoint that technology is a key factor for cities to follow the pace of transformation of society and meet the expectations and needs of the population. Moreover, this concept has proven to be essential in the process of making urban centers more efficient and in offering good quality of life and resource management through increasingly participatory processes. However, thinking about Smart Cities without taking into account the urban, social, and environmental aspects of urban centers would mean missing the ultimate purpose of the development of cities: to improve the quality of life of people. Therefore, to be considered smart, a city must incorporate aspects related to improved governance, planning, infrastructure, and how this is reflected in human and social capital. Only when these elements are taken together, cities become effectively smart and capable of promoting sustainable and integrated development that is part of the virtuous cycle mentioned earlier.

A Smart City places people at the center of development, incorporates Information and Communication Technologies into urban management, and uses these elements as tools to stimulate the design of an effective government that includes collaborative planning and citizen participation. By promoting integrated and sustainable development, Smart Cities become more innovative, competitive, attractive, and resilient, thus improving lives.

The transformation and modernization of city management yields a host

JAY MANTRI



Los Angeles, United States

of concrete and positive results, with efficiency gains through the integration of different areas (mobility, traffic, safety/security, surveillance, water, energy, risk management, etc.). By working collaboratively, managers share quality information in order to provide better services to the population. In summary, a Smart City:

- generates integration that provides governments with necessary, transparent information for better decision making and budget management;
- optimizes the allocation of resources and helps to reduce unnecessary spending;
- enables better customer service to users and improves the image of public agencies, thereby raising the level of satisfaction of the population;
- generates common procedures that improve government efficiency;
- allows for greater involvement of citizens and civil society in the administration through the use of technological tools that help monitor public services by informing and interacting with the municipality in order to address concrete problems;

- produces performance indicators that help measure, benchmark, and improve public policy.

The purpose of this Guide is to present, in a practical and comprehensive manner, the basic Smart City concepts and principles, as well as the elements necessary for their formation. These involve the use of technologies and processes, mechanisms that seek greater government efficiency, increased business productivity, and incentives for an innovative environment, taking into account the specificities of the LAC context. In the Guide, we show how cities in different parts of the world use smart technology to improve their operations and the provision of services to citizens, thus becoming an inspiration to our region.

In summary, the purpose of this Guide is to present, in a practical and comprehensive manner, the basic Smart City concepts and principles, as well as the elements necessary for their formation

The Guide is divided into four sections. The **first section** (Chapters 1 and 2) addresses the major challenges in the current management of urban centers and explains in detail what a Smart City is and its benefits for citizens and managers, in addition to the impacts of technology use in the quality of life of its population.

The **second section** (Chapters 3 and 4) shows the Smart City architecture from the standpoint of the main technologies that comprise it, and provides a list of potential applications for the technology. The **third section** (Chapter 5) presents the cities that have already begun the transition from traditional management to a Smart City scenario. Readers will find practical examples of projects in different sectors and applications.

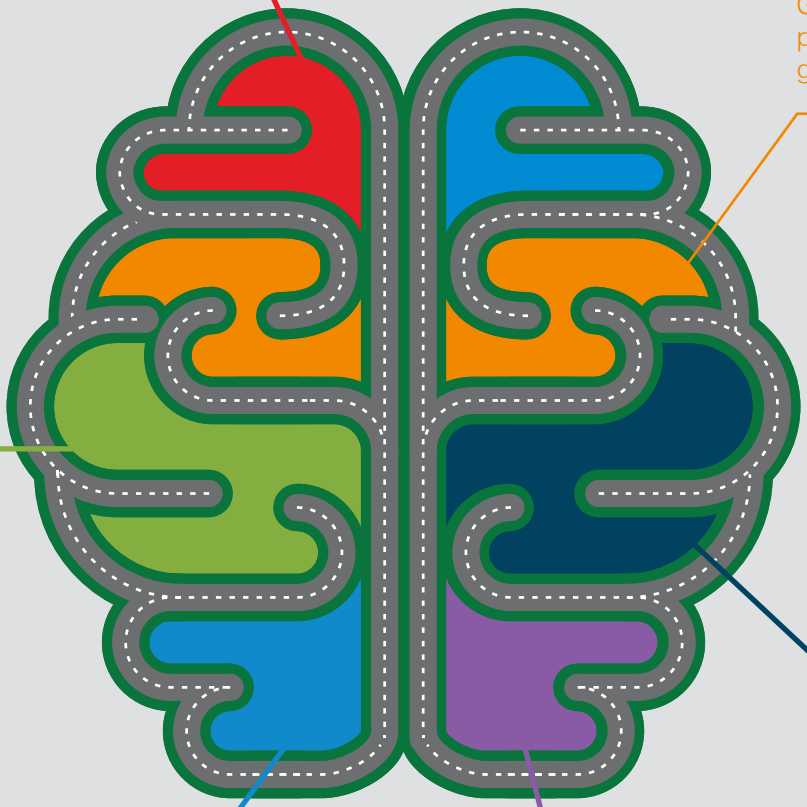
Finally, the **fourth section** (Chapters 6, 7, and 8) offers a suggested route for migrating from a traditional city to a Smart City model and a checklist of items to consider, taking into account the importance of collaboration, integration, and synergies between areas. In addition, the role of the IDB in this context is also discussed.

This Guide is intended to provide a foundation for discussing the Smart City scenario. By presenting practical examples and success stories that reflect the reality of many cities around the world, we hope it can function as an inspiration and a reference for mayors, managers, consultants, entrepreneurs, planners, and their teams; and that it can serve as a starting point for the discussion of future action plans.

IN SUMMARY, A SMART CITY

Generates integration that supplies the government with necessary and transparent information

Generates common procedures that improve government efficiency



Optimizes the allocation of resources

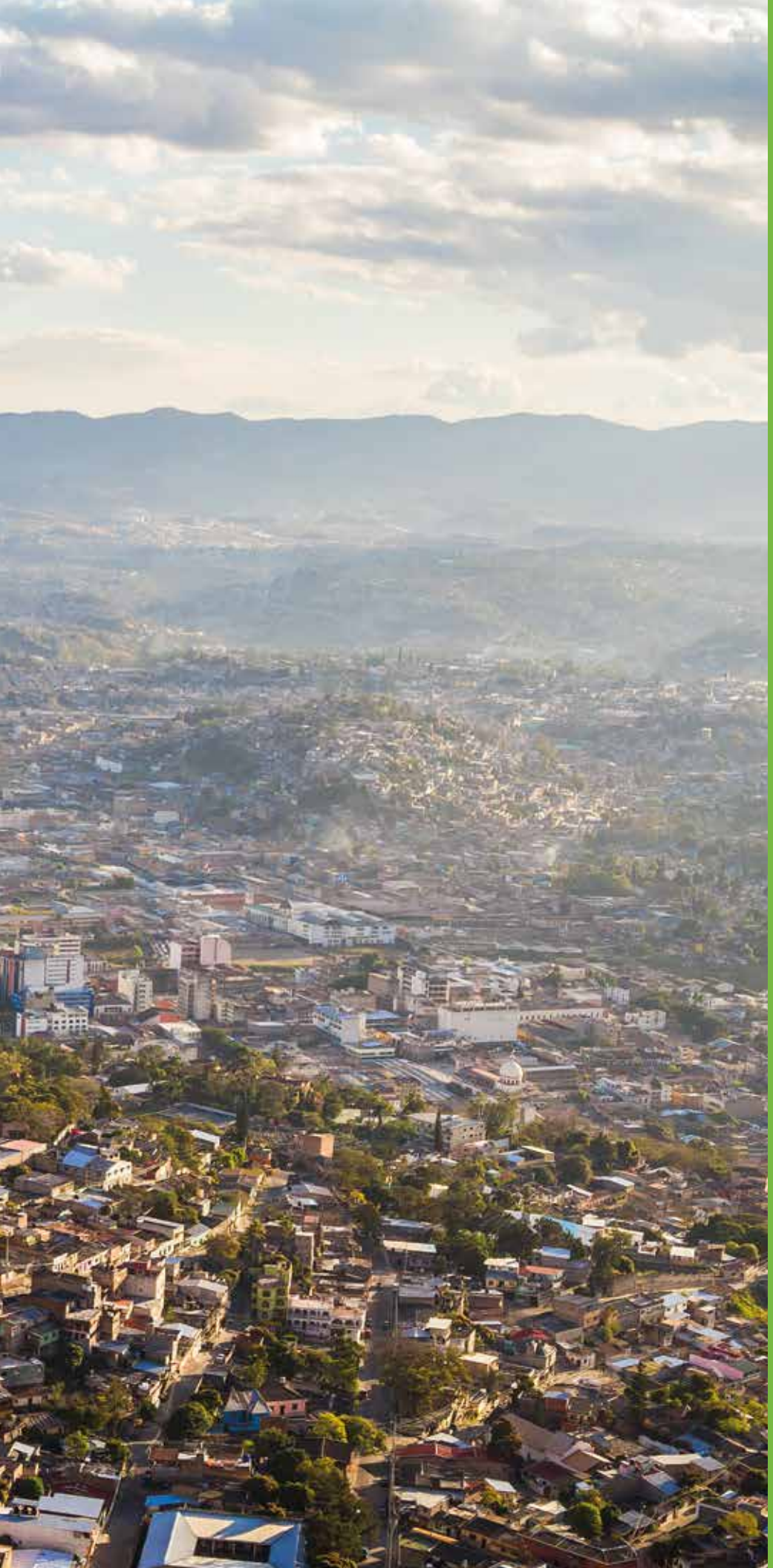
Ensures greater involvement of civil society in public administration

Has a high level of satisfaction of residents

Produces performance indicators that help measure, benchmark, and improve public policy

RAMON ZAMORA

Tegucigalpa, Honduras



Smart Cities

chapter 1

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90%
In 2050, of the LAC population will be concentrated in urban areas

Zaragoza, Spain

The great urban challenges

High urban concentration brings to cities and countries a number of challenges regarding meeting the needs of growing populations, starting with basic items such as infrastructure, sanitation, transportation, energy, housing, safety/security, jobs, health, and education, as well as other equally fundamental ones like communication and leisure. Keeping the city working in a sustainable and integrated manner is certainly one of the great challenges of the 21st century.

The highly complex urban structure, which in the past was attributed to megacities alone, changes with the new demographics, as megacities have a slower rate of population growth when compared to relatively smaller urban centers. This is especially true in developing countries, where medium-sized cities are growing rapidly and their population is increasing. The Latin America and Caribbean (LAC) region ranks second on the planet in terms of urbanization, having increased its urban population density from 42 percent in 1950 to 80 percent in 2014, and moving toward an estimated 90 percent in 2050.[4] The region's cities account for 70 percent of gross domestic product (GDP). Around the world, cities occupy only 2 percent of the space, but use 60 to 80 percent of energy and generate 75 percent of carbon emissions. In the region, medium-sized cities already concentrate 188.8 million people, or 36 percent of the population.

The accelerated growth observed in medium-sized cities can affect both sustainability and the quality of life of the population, reproducing the dynamics of growth with low urban and environmental quality that has affected megacities in the region. The rapid, uncontrolled urbanization the region has experienced since the 1970s continues to put pressure on important issues such as urban mobility, drinking water supply, adequate solutions for

The rapid and disorganized urbanization of LAC countries puts pressure on important issues such as urban mobility, basic sanitation, drinking water supply, air pollution, response to disasters, safety and security, health, and education

[4] United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).

basic sanitation, air pollution, and disaster response, as well as on the provision of education, health, and public safety services.

Currently, LAC cities continue to face problems in providing services to the population. This is directly related to their fiscal capacity; low revenues and high spending at the local level result in reduced budgets for investment and high dependence on transfers from other spheres of government. This mismatch between demand and government responsiveness leads to the recurrence of the aforementioned problems in the region's urban centers. These issues are aggravated by the structural and procedural problems of governments, which are often divided into silos with low interaction between sectors, and the use of obsolete systems without proper integration.

The goal of the ESCI is to help LAC governments face public management challenges without giving up urban, fiscal, and environmental sustainability

The **IDB's Emerging and Sustainable Cities Initiative (ESCI)** was born from the need to meet these challenges found in most LAC cities using an intersectoral approach. The ESCI seeks to support the local governments of emerging cities – i.e., those with a population between 100,000 and 2 million, and economic and population growth above the average of their countries – in facing the great challenges of the cities by reflecting on different topics grouped into three dimensions:

Environmental sustainability and climate change: Covers issues related to the use of physical space and its impact on the environment, as well as the ability of cities to anticipate and respond quickly to natural disasters. For example, high population density has a direct impact on air pollution and water levels as well as on solid waste generation and disposal and energy consumption, which, in turn, impact the environment and climate.

Urban sustainability: Is directly related to the issues of city occupancy and the ability of local governments to optimize this occupancy and distribute urban services equally. This dimension includes housing supply, safety, transportation and mobility, broadband connectivity networks, education, health, energy, employability, and economic efficiency.

Fiscal sustainability and governance: Includes issues related to the government and its ability to communicate with the population; the exis-

AN URBANIZED WORLD

Legend

Rural

Urban

LEG

Country or continent
Urban population (%)
Urban population (millions of people)

Latin America and Caribbean

More than 75% of urbanization

Rural

Urban

URU ARG CHI VEN BRA BAH MEX DOM PEI COL

Uruguay	Argentina	Chile	Venezuela	Brazil	Bahamas	Mexico	Dominican R.	Peru	Colombia
95%	92%	89%	89%	85%	83%	79%	78%	78%	76%
3.25M	38.29M	15.88M	27.44M	172.60M	0.32M	97.77M	8.22M	24.09M	37.26M

Between 50 and 75% of urbanization

Rural

Urban

CRC BOL NCA ESA SUR PAN ECU HON PAR HAI JAM GUA

Costa Rica	Bolivia	Nicaragua	El Salvador	Suriname	Panama	Ecuador	Honduras	Paraguay	Haiti	Jamaica	Guatemala
75%	68%	66%	66%	66%	65%	64%	64%	59%	57%	55%	51%
3.74M	7.40M	3.61M	4.23M	0.35M	2.60M	10.50M	4.47M	4.10M	6.01M	1.50M	8.11M

Less than 50% of urbanization

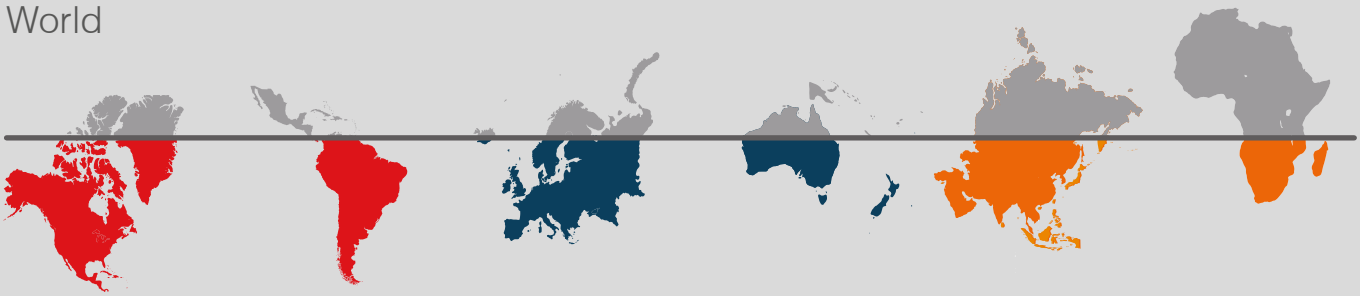
Rural

Urban

BIZ BAR GUY TTO

Belize	Barbados	Guyana	Trinidad and Tobago
44%	32%	28%	9%
0.15M	0.19M	0.23M	0.12M

World

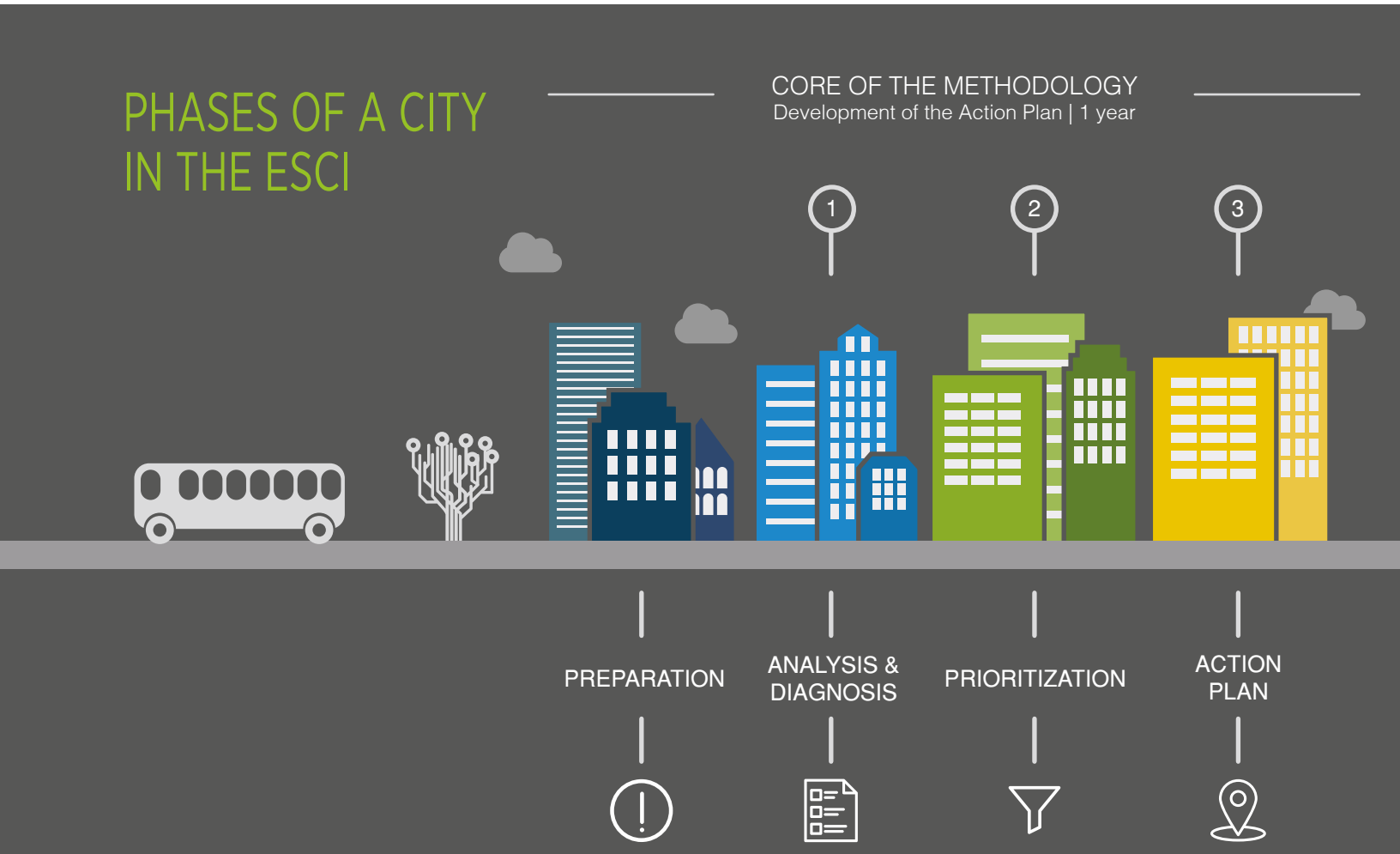


North America	Latin America and Caribbean	Europe	Oceania	Asia	Africa
81%	80%	73%	71%	48%	40%
291.86M	495.86M	545.38M	27.47M	2064.21M	455.34M

Source: World Urbanization Prospects, 2014. Revision United Nations, Department of Economics and Social Affairs

tence of transparent information mechanisms regarding administration, finance, and public debt; the ability to collect from the population the data needed to act according to the real needs of the city, thus creating a participatory management mechanism; and the design of instruments that ensure efficiency in urban management.

This methodology is divided into five phases: Phase 1: Diagnosis; Phase 2: Prioritization; Phase 3: Development of the Action Plan; Phase 4: Pre-investment; and Phase 5: Monitoring. It identifies the main sustainability challenges facing medium-sized and emerging cities through an analysis of indicators, prioritizes the most critical issues by applying filters, and proposes a series of actions compiled into an Action Plan, which includes a short–, medium–, and long-term investment plan, outlining a route to sustainability.



A common aspect in many municipal governments is the fact that they operate based on departments, which often behave like islands within the administrative structure. This division of tasks generates inefficiencies, has little collaborative content, duplicates efforts and resources, increases costs, reduces productivity, undermines the smooth flow of information, and, more importantly, hinders the work of governments to provide satisfactory services and proper quality of life to the population. These difficulties are not restricted to any one government area; on the contrary, they affect the entire administration.

Understanding the data generated by the urban environment and the population – collected by sensors, digital devices, and communication centers – enables solving a number of problems that affect the daily lives of citizens and undermine the efficiency and resilience of cities on a va-

PREFEITURA MUNICIPAL DE FLORIANÓPOLIS

riety of issues. These sources of concern are, among others, time spent commuting to work; public-safety systems; monitoring of streets, houses, and buildings; energy and water management; and access to public services, including alerts on air quality and emergency preparedness situations. Furthermore, analysis of the collected data allows cities to improve a number of aspects related to the quality of local management, as it provides quality and periodic information, assisting in the monitoring of ongoing actions and generating instruments to foster a better-integrated plan in the future.

Technology, when considered against the backdrop of the urban chal-

Florianopolis, Brazil

lenges we face today and will certainly face in the near future, is a strong ally to promote the sustainability of cities. In this sense, the process of transforming traditional city management models into smart models is central to achieving the sustainability of urban centers in the medium and long term. However, although recent, the term Smart City is already the subject of a wide variety of definitions, not always aligned with the fair and balanced development of urban centers. For this reason, this Guide seeks to clarify what is understood as Smart Cities and how they can help overcome the challenges mentioned above. The next chapter tries to define, clearly and objectively, the actual meaning of Smart City and its components.

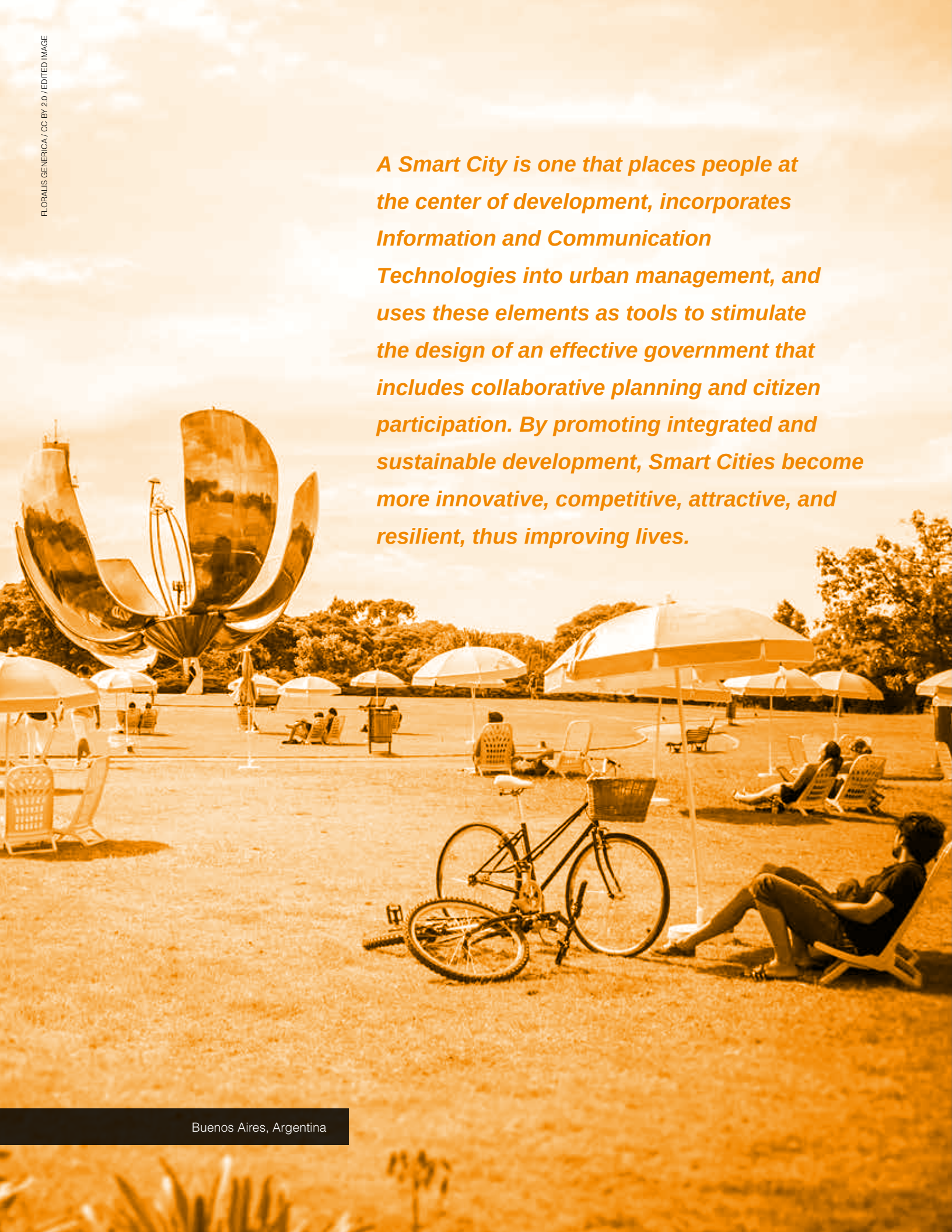
SERGIO MORENO

Panama City, Panama

Smart Cities

chapter 2

A Smart City is one that places people at the center of development, incorporates Information and Communication Technologies into urban management, and uses these elements as tools to stimulate the design of an effective government that includes collaborative planning and citizen participation. By promoting integrated and sustainable development, Smart Cities become more innovative, competitive, attractive, and resilient, thus improving lives.



Buenos Aires, Argentina

What is, in fact, a Smart City?

"Smart Cities are where technology comes alive." This statement by Peter Sany, CEO of TM Forum,[5] is a good starting point to understand the scope of the term Smart City. Smart Cities do not use technology alone to computerize their activities or departments. In a Smart City, technology connects citizens and businesses to the city and to each other, thus eliminating islands of information and reducing negative impacts through the smart allocation of resources.

In Smart Cities, citizens benefit from better public services and are active participants in public management

A smart, sustainable city is an innovative city that uses information and communication technologies and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, and environmental aspects.[6] It is attractive to citizens, entrepreneurs, and workers, and generates a safer place with better services and an innovative environment that encourages creative solutions, creating jobs, and reducing inequalities. Therefore, it promotes a virtuous cycle that not only produces economic and social well-being, but also ensures the sustainable use of its resources and better quality of life in the long run.

In order to improve people's lives, a complete Smart City project should take into account the human, social, and environmental aspects of urban centers. Therefore, the concept of Smart City needs to incorporate aspects relating to governance, infrastructure, and human and social capital. Only when these elements are taken together, cities become effectively smart and capable of promoting sustainable and integrated development.

Smart Cities should not be seen as projects for the distant future. They are currently linked to the various stakeholders of the city, both public and

[5] Interview granted to the TMForumInform portal in the event Smart City InFocus (Sept. 11- 13, 2015, Yinchuan, China) http://inform.tmforum.org/features-and-analysis/featured/2015/10/peter-sany-smart-cities-are-where-technology-comes-alive/

[6] International Telecommunication Union (Focus Groups on Smart Sustainable Cities, 2014).

CLUB TREKING SANTA MARIA-RS / CC BY 2.0

The use of mobile applications enables increasing citizen participation, thus facilitating the adoption of participatory management practices

private, that use different technologies. These technologies include fixed and mobile high-speed broadband connectivity networks, data collection through an extensive network of smart sensors, data analysis software, mobile applications, social media, and web portals, among other tools.

Added to this set of resources is the phenomenon of mobile Internet, with the massive global adoption of smartphones and mobile broadband connections. This phenomenon creates a large contingent of connected citizens and takes participatory management to a whole new level. In addition to facilitating the delivery of alerts, mobile services, and information to the population, the use of applications on smartphones allows for an increase of citizens' participation as it enables them to send data and information to management and control centers in the city. *The Mobility Report 2015*[7] estimates that, in five years, 70 percent of the global population will own a smartphone and will be responsible for producing 80 percent of all mobile data in the world.

Latin America has the world's fourth largest mobile telephone market, according to data from GSMA Latin America.[8] The growth rate of mobile Internet use in the region is one of the highest in the world. In September 2014, 31 percent of mobile devices in Latin America (LA) were smartphones

[7] Ericsson. Mobility Report 2015, June 2015. http://www.ericsson.com/mobility-report

[8] GSM Association Latin America. Study "The Mobile Economy Latin America 2014" (GSMA Intelligence) http://www.gsmamobileeconomylatinamerica.com/

with active Internet access (216 million), and this number is expected to grow to 605 million by 2020 (66 percent of mobile devices), with 80 percent of them using 3G and 4G high-speed connections. LA will then have the second largest installed base of smartphones worldwide, according to the GSMA study, and the penetration of mobile Internet will reach close to 50 percent of the local population, further favoring participatory management practices and the provision of mobile services to citizens.

A Smart City integrates its different areas by using broadband commu-

SMART CITIES UNDER THE EMERGING AND SUSTAINABLE CITIES INITIATIVE

The journey to the modernization and transparency of governments requires, essentially, migrating from the traditional management model to a smart management model by combining technology, people, and processes in innovative ways.

In smart management, government and finance processes (registries, taxes, and public services to citizens, among others) are digitized, and access to data is agile. The old silos have disappeared and government mission-critical systems interrelate and exchange information with each other through digital channels, enabling managers and staff in different departments to work as teams under an integrated, collaborative, and always updated vision.

Most importantly, under smart management, citizens benefit from better public services and are active participants in public management.

Based on our experience with the Emerging and Sustainable Cities Initiative, we believe in a broader and more comprehensive definition of Smart City. To us, a Smart City is one that puts people at the center of development and planning, according to a long-term vision. It puts the public transportation system and the democratization of the use of public spaces at the center of planning, thus preventing the city's growth in areas of risk and vulnerability to natural disasters. It places public safety, utilities, response to emergencies, availability of water resources for future generations, and citizen participation high on its agenda. It uses technology as a tool for outlining goals and a long-term vision.

The Smart City is more efficient and provides economic development, better services, and better quality of life. It is attractive to citizens, entrepreneurs, and workers who want to succeed, and generates a safer space with better services, which can develop creative solutions, create jobs, and reduce inequality. It ultimately generates a virtuous cycle that produces economic and social well-being.

nication networks, cloud computing, smart mobile devices, analysis software, and sensors. This set of digital resources captures data generated by different agents (people or devices) and processes this data, thus generating information and knowledge that supports decision making and therefore provides a better quality of life and benefits to its citizens.

From this point of view, digital technology is not an end but a means for transforming the traditional infrastructure of the city into a living and sustainable ecosystem that works as a two-way street, capturing data from and bringing benefits to the people and businesses that live and work in the city (*check "Data in favor of the city" on page 39*).

A Smart City integrates its different areas by using broadband communication networks, cloud computing, smart mobile devices, analysis software, and sensors

Some examples from these cities include smart bus stops, which provide users with real-time bus schedules, and parking lots that identify the presence of cars through a combination of motion sensors and wireless communication, giving drivers real-time information on the availability of parking spaces.

Sensors distributed throughout the city provide real-time data on citizens' flows, noise levels, and other forms of environmental pollution, as well as traffic and weather conditions. This allows authorities to optimize the city's operations, including improved environmental management, optimization of urban mobility, and economic and social sustainability.

Public lighting connected to the data communication network is highly efficient and allows for the dynamic management of lighting levels according to local conditions with significant results in energy savings.

Waste containers are connected by wireless networks and equipped with sensors that monitor the amount of waste, humidity, temperature, and even type of contents. The data, which are sent to the sanitation department and waste collection companies, enable better planning of collection routes by updating truck drivers, in real time, about the routes, thus optimizing the cost of waste management services.

In the area of security, the available technologies help preserve the integrity of the public agent and contribute to improving the adopted procedures. In the traditional city, there are policemen patrolling the streets. In the Smart City there are security cameras, which in addition to identifying suspicious activities, prevent crimes and save time and human resources in

RIO OPERATIONS CENTER \ RAPHAEL LIMA

One of the most iconic examples of a Smart City along these lines is Rio de Janeiro, with its Rio Operations Center (COR)

a meaningful way. And when associated with analysis software, they can identify unusual situations and perform image recognition.

Furthermore, data geo-referencing and analysis of the crime rate in different areas of the city allow the police to work more efficiently in repressing crime, and enable government and civil society to take more assertive preventive measures. With this type of information it is possible, for example, to pay more attention to young people living in areas considered to be marginalized and where government presence is scant, and to develop educational and cultural policies and programs that seek to improve the future of those in a vulnerable situation.

One of the most iconic examples of a Smart City along these lines is the city of Rio de Janeiro, Brazil, with its Rio Operations Center. In this center, the city analyzes data collected by sensors scattered throughout the urban area, and views images collected by over 1,000 cameras. The center, built in 2010, works 24 hours a day and brings together 500 employees from 30

different departments. Furthermore, it monitors activities related to transportation, energy, communications, public safety, and health, in addition to associating different data, in particular weather forecasts, to anticipate problems and respond to emergencies.

Cities are the basis for the economic and social development of contemporary societies, but they need to be better prepared to support the accelerated growth of an increasingly digital population. Investing in a smart plan to make the provision of public services increasingly efficient and improve the quality and intensity of interaction with citizens through technology ensures governments not only a financial return on investment, but also a good political reputation, as it involves the population through open and participatory management.

Investing in a smart plan to make the provision of public services increasingly efficient and improve the quality and intensity of interaction with citizens ensures governments not only a financial return on investment, but also a good political reputation

Now that we know what a Smart City is, we will start our journey toward its implementation. The next chapter describes the prerequisites for migrating from a traditional city management model to a Smart City.

A SMART CITY HAS FOUR MAIN FOCUSES:

It is sustainable: It uses digital technology to reduce costs and optimize resource consumption so that its current administration does not compromise its use for future generations;

It is inclusive and transparent: It has direct communication channels with citizens, operates with open data, and allows for the monitoring of its finances;

It generates wealth: It provides adequate infrastructure to generate high-quality jobs, innovation, competitiveness, and business growth;

It is made for citizens: It uses digital technology to improve the quality of life of people and give quick access to more efficient public services

DATA IN FAVOR OF THE CITY

The collection, integration, and analysis of data to improve the operation of urban systems and the quality of life in the city was named "Urban Informatics" by the Center for Urban Science and Progress (CUSP) of New York University. CUSP was created in 2012 as the result of a public-private partnership between New York University, New York City and a consortium of technology companies.

BOBBY MIKUL / CC BY 2.0

HERE IS A CUSP EXAMPLE OF HOW URBAN INFORMATICS CAN CHANGE TRAFFIC

The most important aspect of this example is that it is not restricted to New York City, and with the choice of similar technologies it could be used in any city in LAC.

TO LEARN MORE PLEASE VISIT:
http://cusp.nyu.edu/urban-informatics

1 The Department of Transportation of New York City receives images generated by cameras installed on major roads and main intersections of all five boroughs. The images, which are generated in real time, provide valuable data on traffic flow in the city streets.

2 Researchers found a way to consolidate this information with data on weather conditions received from weather stations, data sent by the drivers of the city's taxi fleet, and even data from mobile applications like Waze;

3 Using technologies such as data modeling, analytics tools, geographical information systems (GIS), and model simulation software, researchers can reduce traffic congestion, change the timing of traffic lights, improve signage, and create traffic alert systems using mobile applications, among other resources;

4 By implementing these suggestions, the city can reduce congestion and improve urban transportation services, but the benefits may be even greater: reduce pollution by decreasing the time vehicles are idling, reduce the number of times people arrive late to work, improve the time it takes them to get home, and reduce transportation expenses. Most importantly, the city will have the ability to better manage traffic in the event of natural disasters or emergencies, ensuring the rapid flow of emergency services.

DOWNTOWN WARSAW / SKITTERPHOTO

Warsaw, Poland

Smart Cities

chapter 3

The digitization of public services is one of the items that enables optimizing the public apparatus, which is a starting point toward a Smart City

Xalapa, Mexico

The journey toward the Smart City

Governments face the constant challenge of providing quality public services that are accessible to all citizens in the most efficient way. Improving communication channels with citizens and increasing public management transparency contributes to that. But, before fully implementing a Smart City, municipalities need to start by incorporating into their management processes basic Information and Communication Technology tools. These tools will facilitate managing their human, material and financial resources; monitor their use; measure the performance of different departments and the results of the use of resources; and plan and determine their future use.

The transformation of a traditional city into a Smart City is not a simple task and requires the commitment of both executive leaders and different public management units and departments

In other words, governments need, above all, to manage themselves so that when they start their transformation project, they can integrate the new data and acquired knowledge into their existing set of information to serve as the basis for a new integrated urban planning process.

The digitization of public services, for example, is one of the items that enables optimizing the public apparatus for the journey toward a Smart City. Internet portals that allow citizens to request services, obtain documents, and make online payments are examples of what can be considered a basic step toward the computerization of municipalities. It precedes the adoption of a more complex plan for computerizing the urban center.

The transformation of a traditional city into a Smart City is not a simple task and requires the commitment of both executive leaders and different public management units and departments, as well as the selection of a leader responsible for monitoring the entire project. This plan must be understood as an integrated, multisectoral, and collaborative vision.

Making a city smart takes more than technology. Besides considering a

long-term vision, it is important to take into account the human resources required for a project to evolve rapidly and firmly. Therefore, it is important to invest in the training of people as much as in the acquisition of technology *(check box on the following page)*. With regard to human resources, it is essential to seek expert consultants to assist in the development and training of the people involved in the project to provide them with the necessary knowledge to both work on the implementation of the project and contribute ideas that lead to the innovative use of technology.

Another key human aspect for the Smart City project is leadership. Every Smart City project requires a leader with authority to spearhead this transformation and the ability to bring in allies. This leader must be able to create and defend the vision of the future for making city management more efficient, as well as to unite efforts to realize it. It requires someone from the government to be responsible for the entire initiative, using the vision as a roadmap of the project. This person needs to establish all the connections between the different actors and stakeholders, and make sure that they all share the same goal.

This is a municipal project, not the project of a single administration. It requires having a long-term vision and building strategies that will not be discontinued

Developing a Smart City project involves several stages and challenges. It requires a prior diagnosis of the problems of the city and the government and an assessment of the opportunities. The design of a smart solution implies identifying the technological resources needed to develop projects that have an impact and, at the same time, are financially feasible; defining the strategic plan and its implementation stages; identifying funding sources; mapping benefits for citizens; and monitoring actions with a focus on these benefits.

But it is also necessary to consider the human and material resources needed to make this project feasible. Properly-sized teams that are trained, motivated, knowledgeable, and effective are essential for the project to succeed.

In addition, it is necessary to involve technical personnel from different areas, who should start building knowledge and management paths to be shared. This is a municipal project, not the project of a single administration. It requires having a long-term vision and building strategies that will not be discontinued. It should be a project designed and built in stages

QUALIFIED PROFESSIONALS ARE A PREREQUISITE FOR A SMART CITY

A leader

A Smart City is born from a clear vision of the future and materializes with the help of a person sensitive enough to carry out this vision and mobilize the agents needed to make it happen. In this sense, the leader's role is essential to guide the city toward the proposed vision.

A manager

Every Smart City project needs a person dedicated full time to the project. This person must have the skills and authority to make things happen.
The necessary skills include:

- Knowledge of both information technologies and technologies that will be deployed to solve urban problems defined as priorities.
- The ability to influence and interact with a wide range of people, including the development and operation teams and sponsors of the initiative. It means knowing how to communicate with different actors.
- The ability to coordinate actions during and after project implementation. In general, the areas and people involved are not very clear about individual and collective duties. The manager must be clear about the flow of processes in order to define responsibilities and evaluate the performance of the teams.

A multidisciplinary team

Redesigning cities so that they become smarter requires a combination of efforts and diverse knowledge. Many projects come up against the lack of multidisciplinary teams able to put them into practice. Integration and cohesion are at the heart of each Smart City. Breaking the silos that usually divide government departments is essential to avoid the so-called "islands" of automation and management, thus saving time and money in the deployment of communication systems and infrastructure, and avoiding duplication and overlapping of efforts. The teams should have complementary skills and work together, and if necessary, partnerships should be established or service providers hired to fulfill functional gaps.

Continuous training

Implementing a Smart City entails a true cultural revolution, which requires both public officials and citizens to change their habits and behaviors. To enjoy the benefits afforded by the increasing use of technologies capable of solving urban problems, people who live and work in Smart Cities need to be able to use them. For citizens, this training, which should be continuous, aims to make them active participants in the city's transformation process by generating and consuming data. Training, therefore, involves digital inclusion (full knowledge of tools and wide access to digital information and communication technologies). For governments, it implies a continuous process of learning and use of tools so as to incorporate technology to the everyday operations of the government.

DANANG SKYLINE / PIXABAY / CC BY 2.0

that follow and overlap each other, but without trampling the processes and gains already achieved: it is a project always focused on serving citizens.

Although this path is neither simple nor short, the benefits of choosing to transform a city increase in the medium and long term, and may be seen in the short term; its starting point is an overview of the city and all its dimensions, its challenges, the wishes of its citizens, and the opportunities provided by technology. This set of items ultimately leads to the develop-

Shanghai, China.
The benefits of transforming a city increase in the medium and long term and can be seen in the short term

ment of a plan focused on a transformation project through the alignment of actions carried out over a timeline.

A Smart City transformation project starts with a detailed study of priority problems that affect the largest number of people. These problems should be identified and analyzed with a multisectoral approach, and subsequently addressed in order to enable, with the best use of technology, the provision of innovative responses. The project should break the management silos

SHANGHAI SKYSCRAPERS / CC BY 2.0 / EDITED IMAGE

Shanghai, China

or islands, seeking, in major urban challenges, a new vision of the future. This study leads to the creation of a comprehensive action plan focused on integrating resources and eliminating barriers between departments and sectors, involving citizens in a participatory management process, and using technology resources to collect data on the city and to process and generate information. This information, in turn, enables understanding city's operation, solving problems, and predicting scenarios.

It is also very important to develop a monitoring and evaluation plan. Performance indicators that will be monitored based on predefined deadlines need to be considered and developed. The information collected must

flow, feed, provide feedback, and generate process improvements. It should bring increasingly faster and more efficient responses, allowing for the adoption of results-based management.

The general plan should start with one or more pilot projects and move forward with firm steps that are appropriate to the institutional and financial capacities of the city. When seeking financial resources to implement their vision of a Smart City, municipal managers can design an investment funding plan that has a global plan to be implemented in stages. This process requires offering the funding sources a holistic vision and a timeline, and identifying one or two pilot projects to start a virtuous cycle of planning, execution, monitoring, and learning.

A Smart City's transformation project starts with a detailed study of priority problems that affect the largest number of people

As technology is a constantly evolving force, it is important to consider that the plan for a Smart City is a plan also aimed at taking advantage of this technological evolution. Therefore, managers need to systematically incorporate in their plans strategies to stay abreast of new technologies, so as to increase the supply of resources and benefits to citizens.

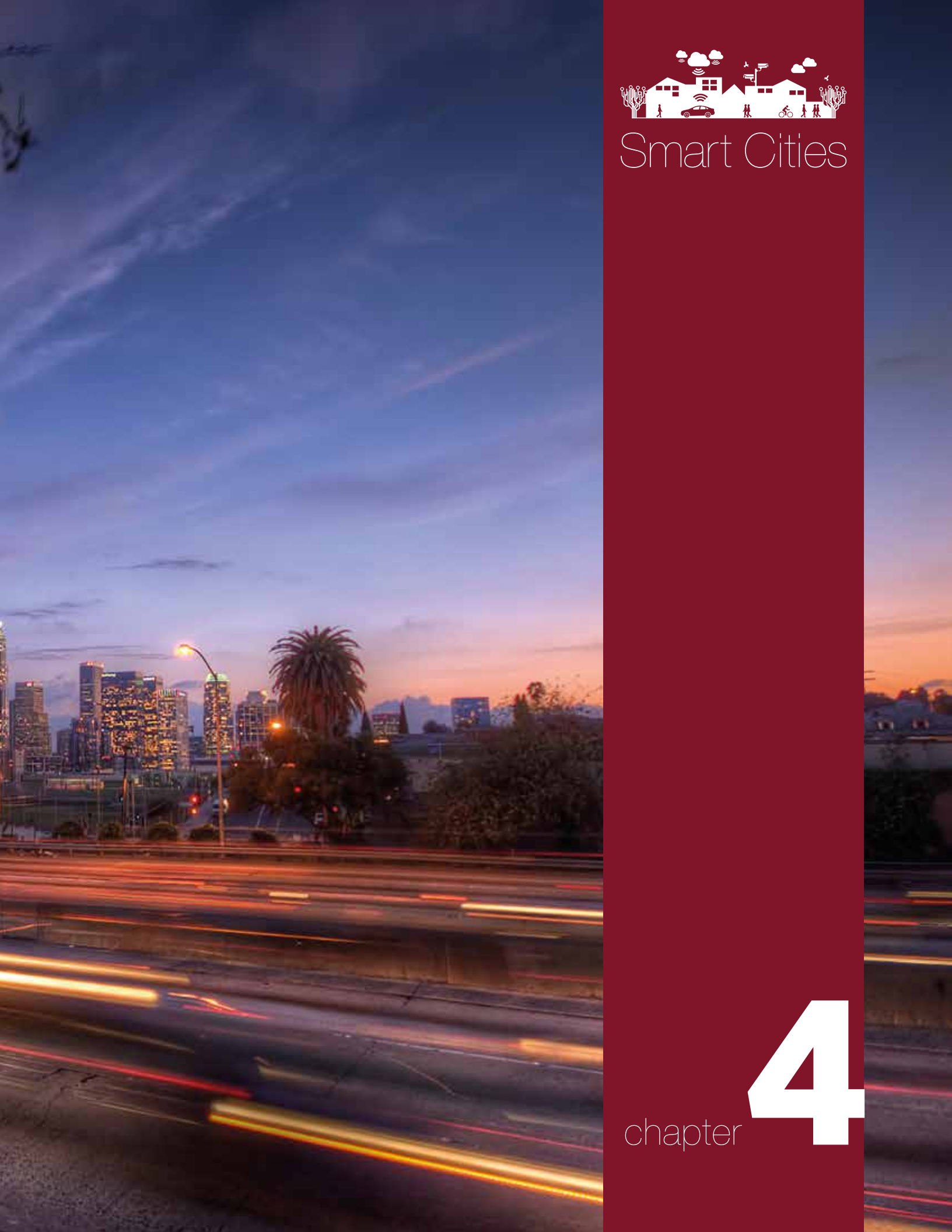
When looking at the future of the city, it is important to consider different technology options to find answers to increasingly complex problems, but one step at a time. This makes municipal management more aligned with the demands of citizens and generates many benefits such as reduced maintenance costs, improved use of funds, lower environmental impacts, and creation of wealth opportunities and new jobs.

As public managers work to create more dynamic, sustainable, creative, resilient, attractive, inclusive, and innovative cities, it is inevitable to think of a new urban planning based on the Smart Cities concept. After all, you can't manage what you don't measure, and one of the most important characteristics of the Smart Cities' platforms is precisely that they base their operation and decision-making on the collection and analysis of city data.

The next chapter will provide an overview of key technology elements involved in a Smart City project. And in Chapter 6 of this Guide, readers will find a proposed checklist for the development of a Smart City project, showing how to integrate the human and technological aspects of Smart Cities in a comprehensive way and transform this integrated perspective into a concrete project.

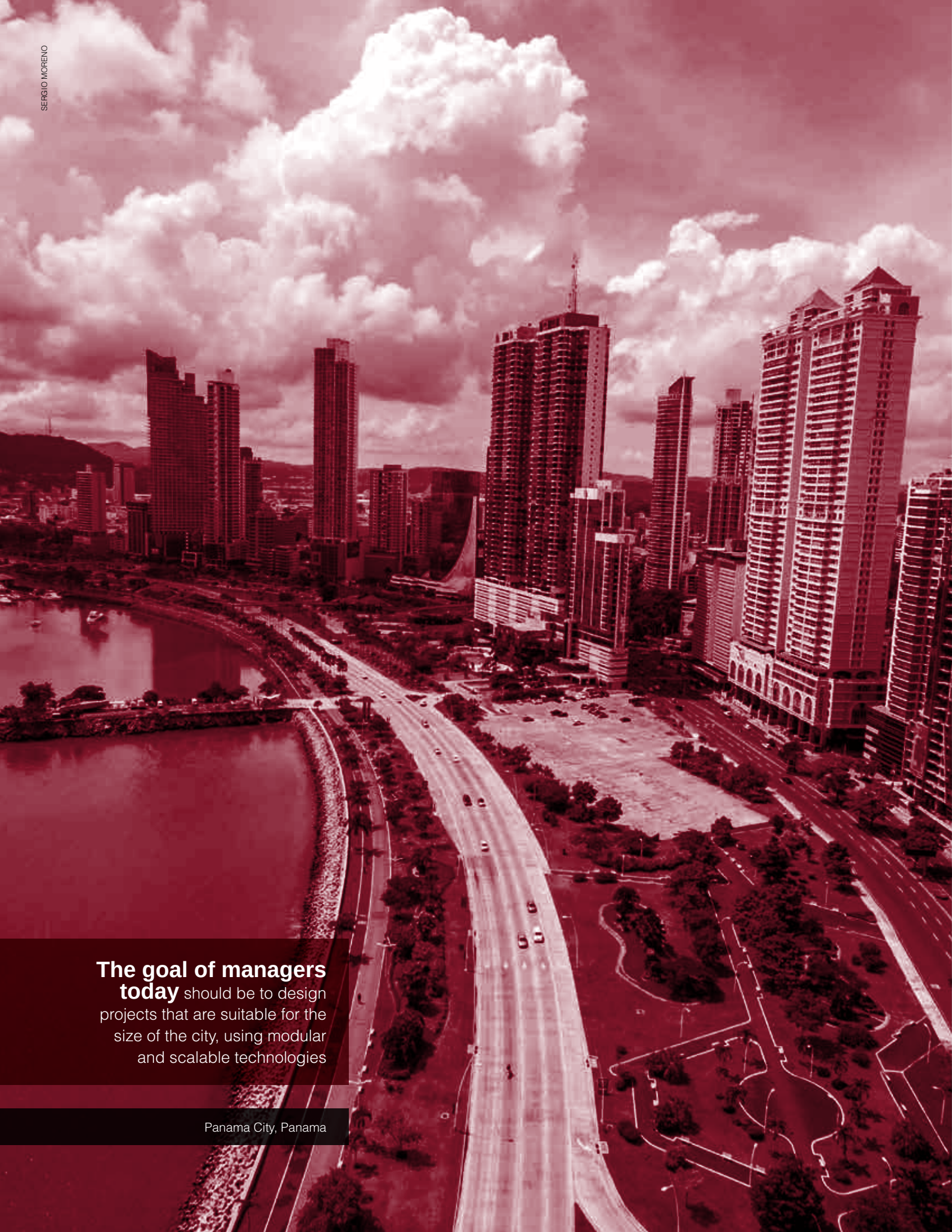
NEIL KREMER

Los Angeles, United States



Smart Cities

chapter 4



SERGIO MORENO

The goal of managers today should be to design projects that are suitable for the size of the city, using modular and scalable technologies

Panama City, Panama

Architecture of the Smart City

As they become more accessible, further reaching and cheaper, Information and Communication Technologies (ICT) change the urban setting, either by empowering citizens, who are increasingly connected through smartphones and mobile devices, or by becoming part of the urban planning as key elements used by the municipal governments in the search for efficiency, sustainability, and quality of life for the population.

Understanding the basic components of technological solutions and their possibilities is an important step to start a Smart City project. Many projects have failed in the past because they neglected issues such as: proper planning; previous diagnosis of the general needs of the city; and wrong choice of technologies that could not keep up with the evolution and became obsolete, or impacted the cities' budgets because they were bulky, oversized, and had a high cost and low return.

The goal of managers today should be to design projects that are suitable for the size of the city, use modular and scalable technology with open standards for widespread adoption, can be combined with collaborative platforms, and are connected to the population through easy-to-use mobile applications. These projects should then be combined with an Open Data, Big Data, and analytics project that would enable making fast and efficient decisions, in addition to extracting predictive analysis.

This section is not intended to dive deep into technical details, but rather to provide an overview of the technological scenario available today for Smart Cities, which allows local managers to have a realistic starting point for their urban digital transformation projects.

"When looking at the future of the city, it is important to consider different technology options to find the answers to increasingly complex problems, but it should be a step-by-step process"

THE “FOUNDATIONS” OF A SMART CITY

Regardless of the application, a Smart City solution involves processes, technologies, and people. From a technology standpoint, it invariably has four basic components:

4

Communication interfaces (services, web portal, mobile applications) to send and receive information from people and companies associated with Open Data platforms and e-government that favor participatory management and the transparency of the public structure;

3

Integrated operation and control centers equipped with computers and software applications that receive, process, and analyze the data sent by the sensors, provide monitoring and display panels, manage devices remotely, and distribute information to departments, institutions, and the population;

2

Sensors and connected devices that capture different signs from the environment and send them through the networks to computers in the control and management centers of the cities, covering different thematic areas such as traffic, safety/security, assistance to the population, emergency situations, and natural disaster alerts;

1

Connectivity infrastructure: broadband Internet networks (fixed and/or mobile) to send and receive data.

All these elements fuel an innovation line, activating the private sector from the creation and development of startups to interaction with large ICT companies

Although the four items are essential, without the first two – high speed data networks (fixed and/or mobile broadband) and sensors and mobile devices – it is not possible to think of a Smart City project

Using a construction analogy, in the setup of a Smart City, data networks and sensors are the foundation upon which the whole structure will rest.

1. THE FOUNDATIONS OF A SMART CITY: CONNECTIVITY INFRASTRUCTURE

A Smart City plan requires ensuring not only the existence (or development) of broadband networks that can support digital applications, but also the availability of this connectivity throughout the city and to all citizens. This communication infrastructure can be a combination of different data network technologies using cable transmission, optical fiber, and wireless networks (Wi-Fi, 3G, 4G, or radio). Optical fiber is the current technology that ensures faster connection speeds on the ground and enables creating high-quality and high-speed Wi-Fi networks, which are essential for connecting sensors and devices.

Nonetheless, optical fiber networks are a new element in developing countries that only now are beginning to expand their coverage, starting from deployment in large urban centers. On the other hand, both the fast growth in the use of mobile broadband and strategies by telecom operators that seek to increasingly offer mobile access plans guarantee to municipal managers a significant number of citizens connected through their smartphones. This enables establishing communication channels by providing, for example, mobile applications installed in digital devices.

WHAT SHOULD BE CONSIDERED ABOUT DATA NETWORKS

- The municipality needs to set the urban communication infrastructure as the number one priority in its management plan. Guaranteeing the existence of wired or wireless data communication networks is the basis to ensuring the pathways by which information will flow through the city.
- Solutions based on wireless networks or overhead cables can be a more competitive option. It is estimated that excavations for the installation of communication cable networks or the reinstallation of undersized networks can represent up to 80 percent of the installation cost.
- In network expansion or the construction of new buildings, include in the project the installation of high-speed network cables (or ducts), electric power points, and sizing of the network to support sensors and wireless access points.

HYPOTHETICAL CITY WITH A POPULATION OF 250,000 TO 500,000

Infrastructure consisting of 600 km of fiber optic cables to connect: cameras, sensors, municipal public entities, and the Integrated Operation and Control Center.

50 km for the Fiber Optics Backbone

- Bandwidth of 4.5 Gbps
- 1.5 Gbps for the 400 Cameras (~3.75 Mbps/camera)
- 3.0GBps for the public entities (~10Mbps/local)

550 km for the last mile of connection through optical drop cable

Municipal Network Integrates:

- Municipal buildings and public squares
- Video monitoring points
- Traffic signal controllers, variable message panels, sirens, electronic barriers, speed sensors, and parking system
- Average speed per fiber: 100Mbps (upload and download)

Telephone connection (3G/4G) - for monitoring public vehicles, cameras, and sensors

Connectivity for:

- Sensors and Cameras
- The Integrated Center to receive data from external sources and transmit them
- Contact Center: IP telephony (10 answering positions and 10 operating positions) to receive and manage demands
- Internal connectivity at the Center to provide access to data and information

Sensors and Cameras

- 400 monitoring cameras
  - 140 for public areas, security, and surveillance
  - 100 municipal buildings (city hall, day care centers, schools, hospitals, etc.)
  - 100 for traffic (monitoring, speed radar, and portals with license plate reading)
  - 20 body cameras for police officers and inspectors (3 cameras each)
- 20 panic and security buttons
- 20 information kiosk – services to citizens
- 100 GPS trackers using (3G/4G) for monitoring public vehicles
- 20 sensors for monitoring areas with a focus on the environment and risk areas
- 50 various sensors

Investment estimate* – Our experience with the Emerging and Sustainable Cities Initiative allows us to estimate that, for a hypothetical city with a population between 250,000 and 500,000, an average density of 46 people per hectare and an area of 162 km^2, the cost of a Smart City project ranges from USD 20 million to USD 30 million. This amount covers the implementation of an infrastructure based on a backbone of 600 km of fiber optic cables connecting 100 institutions. It considers the installation of surveillance cameras, sensors and computers; the development of dedicated applications; the deployment of both a database and an IOCC; and the training of public officials and consultants. A pilot can be started with a budget between USD 7 million and USD 10 million.

**Estimates depend on the city's existing infrastructure and on the number of equipment and institutions that will be connected. Taxes, labor charges, and operation and maintenance costs also affect the amount of investments.*

2. THE FOUNDATIONS OF A SMART CITY: SENSORS

A city becomes more efficient to the extent that it is able to obtain data generated in the environment, through installed infrastructure, by service providers, in buildings, in the streets, and by people, and then process these data and turn them into information that enables making decisions that can mitigate, organize, anticipate, or predict many urban challenges.

Capturing these data sometimes requires installing sensors and also video cameras in the physical infrastructure of the city, connecting them to each other and to a data communication network, and using the data sent in real time to support decision making. Moreover, when analyzed historically, the data enable anticipating future events and supporting the development of new services and/or public policy. Therefore, sensors are, along with the data network, the foundation in the construction of a Smart City.

The extensive network of smart sensors captures data that are transformed into information to produce knowledgeable to support decision-making and ensure better quality of life and benefits to citizens

The universe of smart devices connected to the Internet using wireless connections to "talk" to each other is called the Internet of Things (IoT), which includes machine-to-machine (M2M) connections, connections between devices equipped with microprocessors, and digital environment sensors.

Because it is a far-reaching universe, the estimated total number of IoT devices varies according to different studies. Cisco expects the number of connected objects to reach 50 billion by 2020.[9]

Sensor networks enable capturing huge amounts of data and can be designed for multiple purposes *(see suggestions in the panel on page 60)*. The simplest example of the use of sensors combined with cameras is traffic management from cameras installed at intersections and heavy traffic routes, and from motion sensors installed in streets, parking lots, urban transportation, or above-ground vehicles. Linked to a network of remotely controlled traffic lights and digital signage systems, they enable, for example, controlling traffic by changing the timing of traffic lights according to the number of cars on the street, giving right of way to buses, rerouting traffic to other areas in emergency situations, using digital variable message signs, and avoiding congestion.

Motion sensors on the streets can also be used to identify free parking spaces, and cameras at intersections can be used to monitor traffic and urban security.

[9] Cisco. "Connections Counter: The Internet of Everything in Motion" (http://newsroom.cisco.com/feature-content?articleId=1208342)

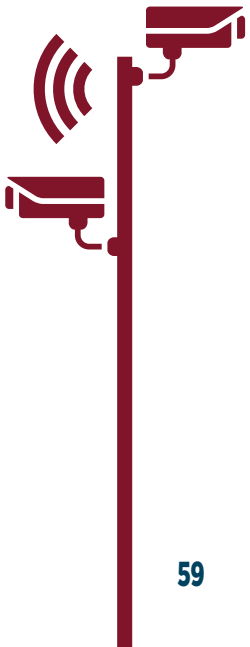
Global Positioning System (GPS) devices installed in emergency service vehicles – police, fire department, ambulance – enable knowing the location of these vehicles. Then, by using information from traffic sensors and cameras, combined with the ability to remotely control traffic lights and dynamic signage systems, these vehicles can be routed through regular traffic, and the best routes can be identified, allowing them to reach emergency situations faster and more efficiently.

The same GPS devices installed in trucks authorized to collect construction waste can indicate whether this waste is being taken to disposal sites previously licensed by the environmental agency.

Sensors can measure, track, and locate a multitude of elements in the environment, such as: light, temperature, motion, water flow, power consumption, weight, humidity, etc. The data they produce, when analyzed and compared, can help make municipal services more efficient and cheaper, thus simplifying the lives of residents.

The use of connected sensors and cameras in the urban environment varies and is becoming increasingly broader. Surveillance and monitoring cameras, for example, have made incredible advancements in terms of technological resources, size, and connectivity, to the extent of opening up new areas of opportunity for Smart Cities. When coupled with specific software, fixed cameras connected to the traffic surveillance system and to security systems can now use powerful lenses and zoom capabilities that allow, for example, facial recognition of people in the crowd or identification of the behavior pattern of an individual in the midst of a group of people.

Cameras attached to aerial drones and ground robots are already being used, for example, for aerial reconnaissance in urban events, monitoring of public works, monitoring of risk areas (construction collapses, bomb threats, fires), and monitoring of agricultural areas. Wearable cameras, such as those installed in police uniforms or firefighter helmets, allow not only to follow the work of these professionals, but also, when associated with a remote wireless communication system, to ensure the "virtual" presence of an expert in risk areas. From the control center, emergency responders can be guided on what to do in more complex situations that require the assistance of an expert.



SENSORS AND CAMERAS TRANSFORMING THE LIVES OF CITIZENS

How can digital technology make a city better

STREET LIGHTING

Smart sensors in lampposts automatically turn the lights on and off according to the ambient light or pedestrians' movement

ENERGY UNDER CONTROL

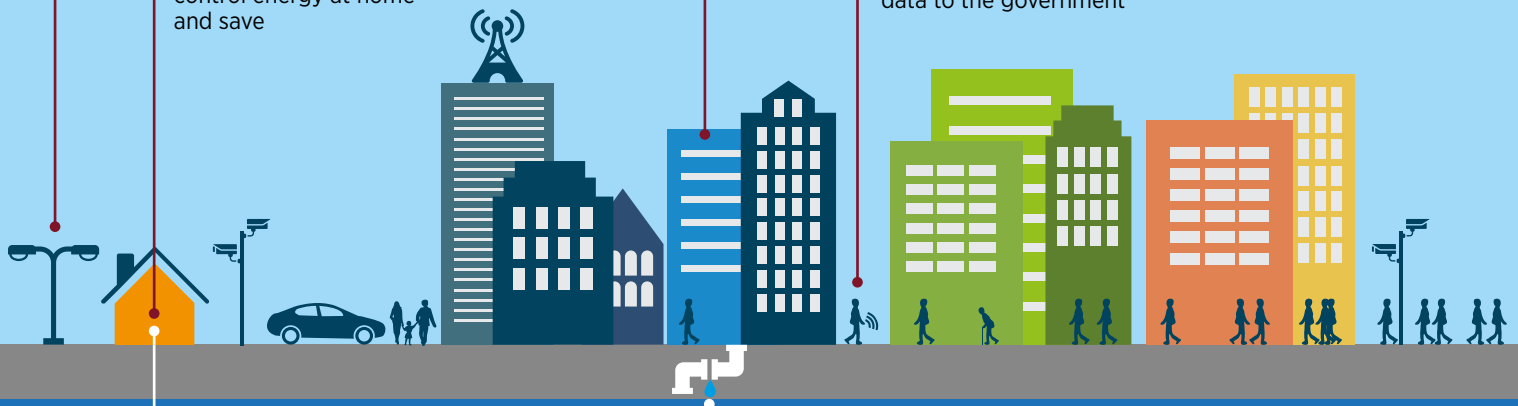
Sensors installed in the domestic power grid associated with Smart Grid features allow citizens to control energy at home and save

SAFETY IN BUILDINGS

Environment monitoring cameras and motion and temperature sensors installed on doors and windows provide remote surveillance and prevent risks and damage

CONNECTED CITIZENS

Using mobile applications and smartphones with cameras, citizens can receive alerts and useful information as well as send data to the government

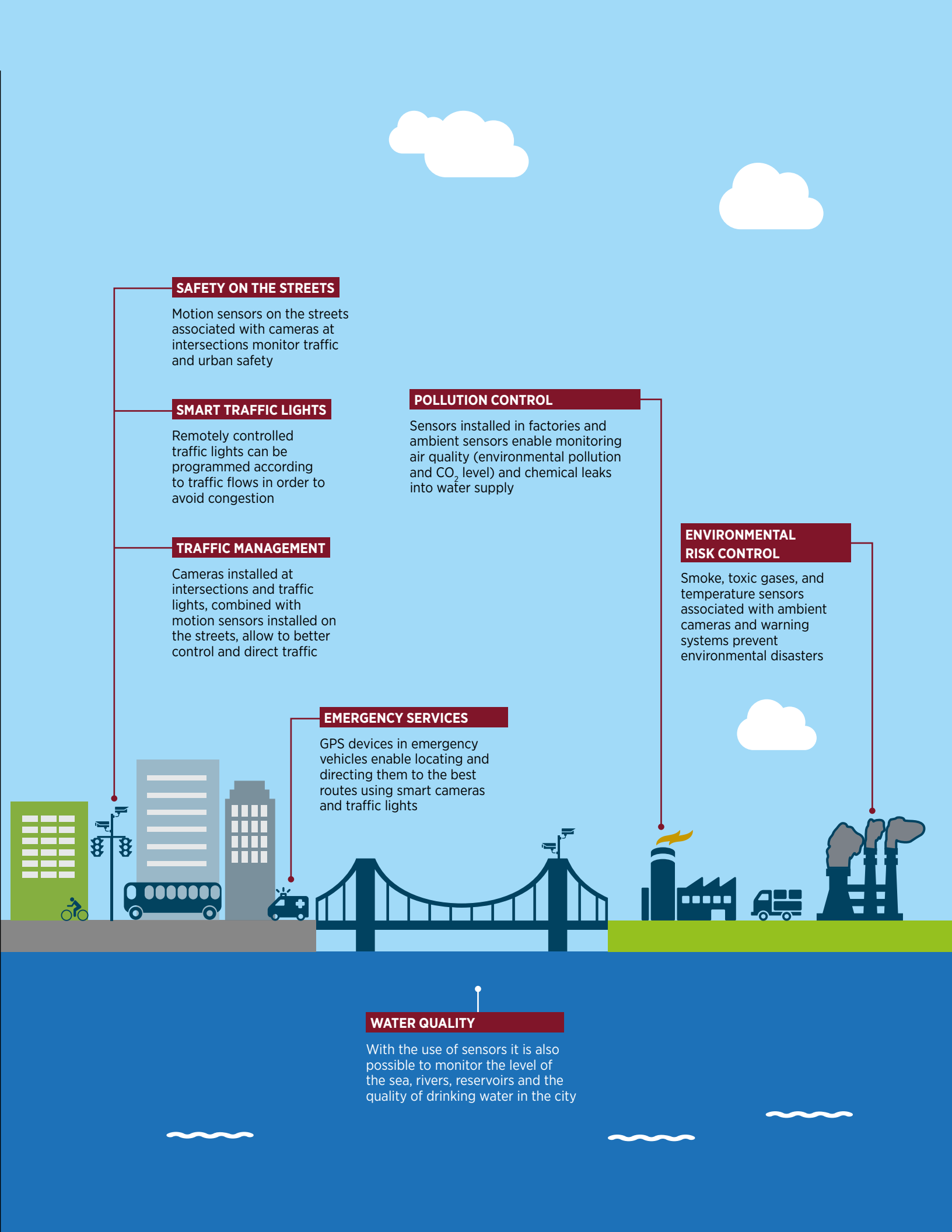


SMART CONSUMPTION

In homes, smart digital systems enable citizens to monitor and control individual water consumption

MANAGEMENT OF WATER RESOURCES

Water pressure sensors in the pipeline monitor the water flow and identify any leaks in the city's network


SAFETY ON THE STREETS
Motion sensors on the streets associated with cameras at intersections monitor traffic and urban safety
SMART TRAFFIC LIGHTS
Remotely controlled traffic lights can be programmed according to traffic flows in order to avoid congestion
TRAFFIC MANAGEMENT
Cameras installed at intersections and traffic lights, combined with motion sensors installed on the streets, allow to better control and direct traffic
POLLUTION CONTROL
Sensors installed in factories and ambient sensors enable monitoring air quality (environmental pollution and CO_2 level) and chemical leaks into water supply
ENVIRONMENTAL RISK CONTROL
Smoke, toxic gases, and temperature sensors associated with ambient cameras and warning systems prevent environmental disasters
EMERGENCY SERVICES
GPS devices in emergency vehicles enable locating and directing them to the best routes using smart cameras and traffic lights
WATER QUALITY
With the use of sensors it is also possible to monitor the level of the sea, rivers, reservoirs and the quality of drinking water in the city

In the health sector, cameras are gaining strength in more complex telemedicine applications as well as in simpler applications, such as those available to patients who need constant care. Without leaving home, they use a webcam attached to their personal computer to talk to a doctor at the hospital or health clinic at scheduled times (or in emergency situations).

The mobile digital technology of smartphones is a new element in the cities that should be taken into account in any Smart City equation or project that considers active citizen participation. A smartphone should be seen as a device capable of being both a channel for receiving and distributing information, and a networked smart sensor.

Mobile technology is a new element in the cities that should be factored into any Smart City equation or project that takes into account the active participation of citizens through smartphones

Today's smartphones are extremely powerful fast-connection computers, equipped with extremely high quality photo and video cameras and a set of highly sophisticated sensors including GPS, Wi-Fi, NFC (Near Field Communication), Bluetooth, compass, microphone, gyroscope, light sensor, accelerometer, barometer, thermometer, magnetometer, and hygrometer. That is, citizens with a smartphone are the best real-time urban sensor, and they are increasingly interested in getting involved in city affairs.

If a text message alert application for the population with smartphones or an application that allows people to check public transportation schedules and find out when the next bus is coming seem obvious to you, consider that these same citizens are equipped to collect and transmit information back to the integrated management centers, and often times they are willing to share data if they can see the value of this exchange for their quality of life.

An excellent example in this case is Waze, a mobile app for navigation that allows users to find the best route in traffic. When using the application, they are providing, among other things, their geographical location, speed, and route while also receiving data from millions of other users.

3. THE FOUNDATIONS OF A SMART CITY: THE INTEGRATED OPERATION AND CONTROL CENTER (IOCC)

Regarded as the materialization of the integration of resources and systems in a Smart City, the Integrated Operation and Control Center (IOCC) brings together in one place technological infrastructure (computers, app systems, and digital system monitors), physical infrastructure (operating rooms,

PANEL OF SENSOR USES AND EXAMPLES

Security

- Area monitoring by cameras
- Motion and noise sensors for perimeter control
- Body cameras as part of the uniform
- GPS for geographical mapping of events and location of vehicles
- Door and window sensors associated with alarm systems

Mobility

- Motion sensors on streets and roads
- Smart traffic control light
- Cameras for street and road monitoring
- Dynamic electronic signage system on streets and roads
- Automatic toll
- GPS for fleet monitoring and location
- Control of parking spaces

Health

- GPS and ambulance route optimization system
- GPS bracelets for seniors
- Ambient noise sensors and monitoring of falls
- Temperature sensors for refrigerators with medical products and vaccines
- Smoke, toxic gas, and ultraviolet radiation sensors integrated to alert systems

Utilities

- Sensors for automatic adaptation of street lighting
- Smart grid
- Individual monitoring of energy consumption
- Water pressure monitors in pipes for leakage control
- Monitoring of household water consumption
- Monitoring of water levels in reservoirs

Urban infrastructure

- Building security and motion sensors
- Remote shutdown of electrical equipment and ambient lighting
- Temperature, smoke, and humidity sensors for libraries, museums, and other sensitive environments
- Building door and window sensors
- Fill-level sensors for public waste containers

Environment

- Air quality meters (environmental pollution and CO_2 levels)
- Noise sensors for noise pollution
- River and reservoir water level control
- Earthquake and landslide sensors
- Quality control of drinking water
- Sea level and water quality control

crisis management rooms, etc.), process infrastructure, and personnel and representatives of various government agencies and service providers, with a focus on a collaborative and integrated approach to the issues to be addressed in what should be the brains of the Smart City.

A Smart City project can start with only a theme or department and still have a simpler version of the IOCC that incorporates an intersectoral and collaborative vision. Gradually, new elements and departments can be added as the project expands. For example, it can start by addressing mobility and still involve the department of mobility and transportation, urban planning and fire departments, the health sector, the electricity company, the urban services department, the police, etc.

Integration and cohesion are at the heart of each Smart City. Breaking the silos that usually divide the government departments is critical. The teams should have complementary skills and work together

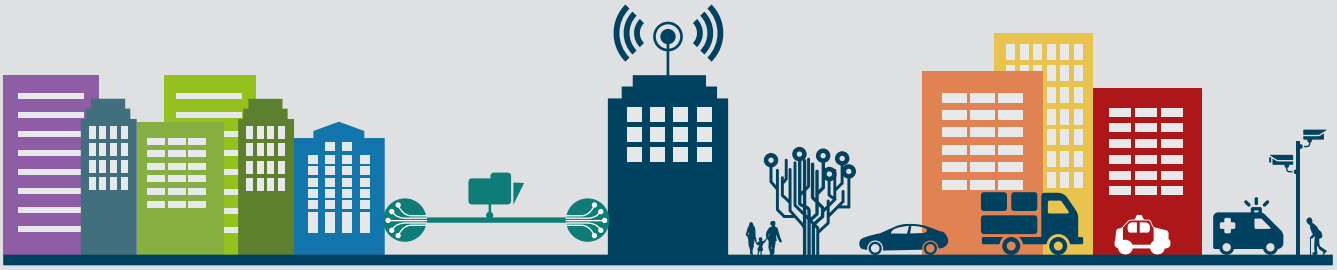
For new projects, it is essential to have an overview from their onset and use an integrated perspective through their completion. For existing projects, to which an integrated control center is expected to be added, it is important to focus on the collaboration of different entities and consider integrating these departments in the same physical space or in a real-time interoperability and connection structure.

The IOCC is connected to the city in real time through the Internet and various communication networks, with thousands of sensors and digital devices scattered around the urban area, including video cameras and other information-generating devices. It is equipped with computers and programs for processing large amounts of data, and with analysis systems that allow their operators to follow the movement of the city in real time, make decisions that enable acting in everyday situations, or act quickly in emergency situations such as floods, accidents, or serious security situations.

One of IOCC's most interesting attributes is intelligence, which gives it the possibility of predictive analysis from the confrontation and analysis of a large amount of data (Big Data) in real time with historical data. This feature enables making decisions for preventive action, whenever possible, before problems occur or worsen.

Another important point is the ability to establish collaborative processes and bring together representatives of different city services in one place, and instantly connect with emergency services (police, fire department, ambulance, civil defense, and others). This integration facilitates communication and hence can reduce the waiting time for help or for solving problems.

INTEGRATED OPERATION AND CONTROL CENTER - IOCC



CONNECTED SENSORS AND CAMERAS SEND REAL TIME DATA AND IMAGES TO IOCC COMPUTERS AND SCREENS

IOCC TEAM MONITORS IMAGES AND DATA COMING FROM THE CITY AND SENDS CONTROLS, ALERTS, AND SIGNALS TO CITIZENS AND DIFFERENT CITY SERVICES

IOCC

RIO OPERATIONS CENTER \ RAPHAEL LIMA

Real-time data collection and predictive analysis enable anticipating problems and minimizing crises

Accelerates decisions by bringing together in the same environment representatives of different municipal management areas

Establishes a model of participatory and collaborative governance with transparency

Enables working with a unified vision of all vital areas of the city

Precisely because of its ability to store and analyze a large amount of data, the IOCC also allows for the development of Results-Based Management systems, which in turn enable the local government to monitor the administration. Its main component is the indicators system, which shows, for example, the level of fulfillment of the predictions contained in the government plan or how many days the city takes to issue a permit or approve a construction project. These systems inform if the city is on target and if it is getting better or worse, in addition to recording the impact of the decisions made.

One of the best known Integrated Centers worldwide is the one in Rio de Janeiro, alongside others such as the operation centers of Anyang in South Korea, Madrid in Spain, and Orlando in the United States.

A Smart City is that which places people at the center of development, incorporates information and communication technologies into urban management, and uses these elements as tools for an effective government

4. THE FOUNDATIONS OF A SMART CITY: COMMUNICATION INTERFACES

Once the Smart City Information Technology infrastructure has been deployed to become part of the urban fabric, a layer of communication applications and systems needs to be added, which will work as interfaces between management and citizens and the different structures and departments of the city. These systems can serve as collaborative platforms, i.e., the creation of mobile applications that allow data collection and participatory management by citizens – and/or allow the city to communicate with them to send emergency alerts or transportation tips. This is a good example of what we call communication interfaces.

Working with open platforms available to the entire population is one way to ensure that all human elements in a city have access to digital services within the urban center.

In addition to mobile applications, it is also important to consider adding web-based platforms for access to information by different city departments, access to services, as well as channels for citizen participation. The use of cloud computing platforms, combined with the growing use of mobile devices such as smartphones, has much to offer to cities seeking to be smart and to managements seeking to become increasingly open and transparent.

AT THE SERVICE OF CITIZEN PARTICIPATION – In many cities, the increasing use of digital platforms accessible via the web or smartphones integrates citizens into various spheres of government: from requesting services to monitoring municipal administration accountability.

Implementing a Smart City entails large investments. The estimated amounts required to implement a Smart City project of a hypothetical city was presented in the box at page 57.

So far we have understood the importance of migrating from a traditional management model to a Smart City management model, the main features of a Smart City, and the tools we need to take into account when considering implementing it. We will now move on to making this project more tangible. In the next section of this Guide, we offer some practical examples of cities in Latin America and the Caribbean and other regions that have already started their transition process from traditionally managed cities to Smart Cities. We will see that while always challenging, there are ideas and concrete projects that have combined urban development and adaptable technology to the most different circumstances and levels of development.

Discussion Forums - Online platforms where citizens have the chance to comment, suggest, and vote on proposals submitted by the government or other citizens.

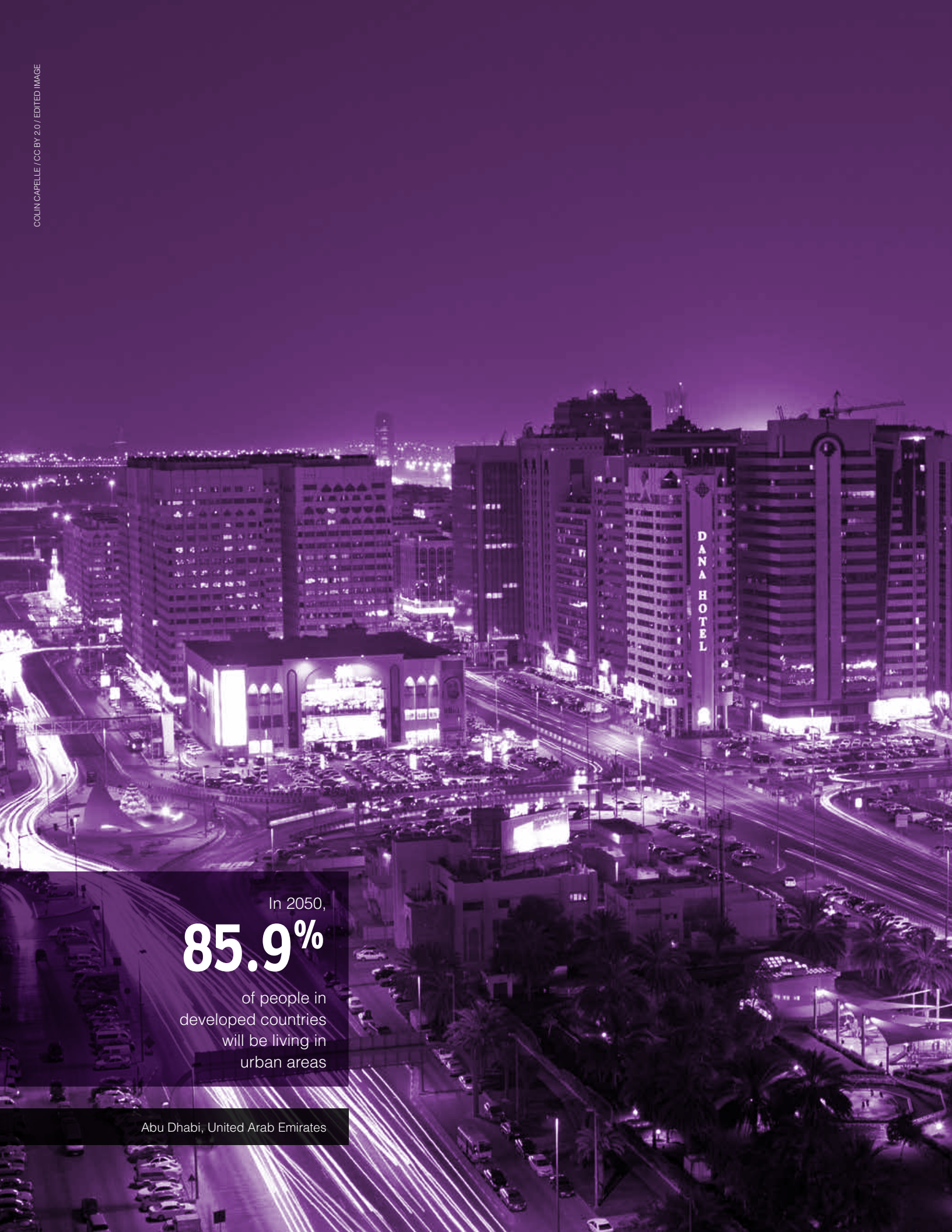
Mobile Applications - Allow citizens to interact with the government to report on the city's infrastructure problems and public safety risks, request services or repairs, and receive alerts and reports.

Thematic Social Networks - Used mainly to collect data for analysis. One of the features enables to conduct polls, calling for popular participation in decision-making processes.

NASA

Smart Cities

chapter 5



In 2050,

85.9%

of people in developed countries will be living in urban areas

Abu Dhabi, United Arab Emirates

chapter 5

Cities that make it happen

In several regions of the world it is possible to identify cities that are pioneers in the adoption of the Smart City concept. They are references of good practices to all municipalities wishing to follow the path of more efficient management based on the generation, collection, and processing of data. Thanks to new technologies, they have succeeded in computerizing, interconnecting, and endowing intelligence to the city's basic systems.

Based on the changes made in each of these cities, it is easy to identify management improvements in the areas of security, urban mobility and traffic control, energy and water services, waste management, integrated response to emergencies, and citizen participation.

Below is a description of how some of these Smart Cities have succeeded in organically linking information-processing technologies to existing infrastructure systems in order to optimize resources, manage costs, increase revenue, and make their processes and services better and more efficient, thus improving the quality of life of its citizens.

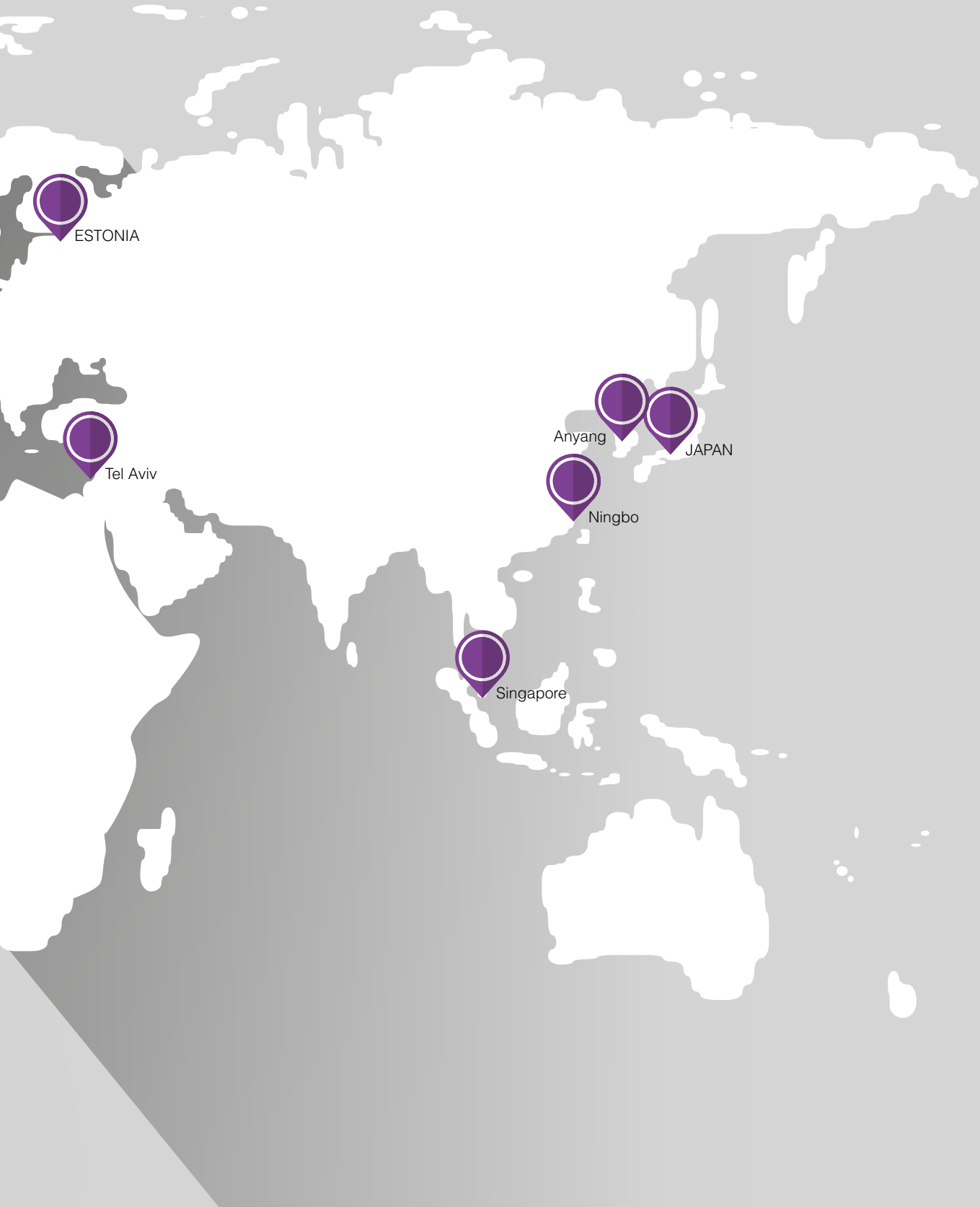
Many of these models, even those implemented in larger cities or remote regions, can be replicated in the cities of Latin America and the Caribbean (LAC). They use multiple and diverse smart solution alternatives for each management challenge, which can be implemented at different scales, promoting equal opportunities and benefits.

To facilitate understanding and navigating the document, the following cases have been divided into areas containing the challenges and some of the existing solutions to address them. These are followed by concrete examples of cities that promote these solutions in an interesting fashion.

Many of these models, even those implemented in larger cities or remote regions, can be replicated in the cities of Latin America and Caribbean

CITIES THAT MAKE IT HAPPEN

In several regions of the world it is possible to identify pioneering cities that have adopted the concept of Smart Cities. They are references to good practices for more efficient management. In the following pages, we detail how each of them used innovative technologies to solve specific problems of public administration.


ESTONIA
Tel Aviv
Anyang
JAPAN
Ningbo
Singapore

Toward citizen security

CHALLENGES: According to the 2015 edition of the annual study conducted by the NGO "Consejo Ciudadano para la Seguridad Pública y Justicia Penal"[10] (Citizen Council for Public Security and Penal Justice), of the 50 most violent cities in the world, 42 are in LAC. The average homicide rate in the region is 25 deaths per 100,000 people, or three times the world average. The costs of violence and insecurity are extremely high. In Uruguay, for example, they represent as much as 3.1 percent of the country's Gross Domestic Product. Emerging and Sustainable Cities Initiative (ESCI) studies confirm the urgency and scope of the problem. In public opinion polls carried out during the diagnostic phase of the methodology, public safety appears consistently as a top priority, even when sociodemographic variables such as gender, age, and income are accounted for. We can understand, therefore, that security is an urgent matter for all.

SOLUTIONS: Public safety requires coordination of various agencies to monitor and act in public areas while respecting the rights of citizens. Using cameras and sensors, 24/7 electronic monitoring systems improve the effectiveness of service provision with smaller teams. The analysis of the data generated helps to build more effective security and violence prevention programs for the various areas of the city. It also enables responding to emergencies and city security incidents in a comprehensive and organized fashion, by determining and coordinating the entity that should be involved according to the event and seeking support from other organizations and companies with expertise when needed.

EXAMPLES: Cities like Buenos Aires, Medellin, Niteroi, and New York have implemented solutions according to the operational capacity of their respective administrations, all based on the systematic monitoring of public spaces.

10) http://www.seguridadjusticiaypaz.org.mx/biblioteca/prensa/download/6-prensa/231-caracas-venezuela-the-most-violent-city-in-the-world

BUENOS AIRES, ARGENTINA

Highlight: Police modernization and integration of emergency systems

RODRIGO PAREDES

In 2011, in view of the high crime rate in the city, Buenos Aires decided to modernize the police and their operating protocols. To that end, it promoted the change of computerized systems and voice and data communication networks, deployed security cameras and sensors and connected vehicles, and trained police personnel to operate the new security devices. In addition to ensuring a better police response to crime by updating their modus operandi and incorporating new technologies that allowed for a more efficient deployment of security forces throughout the jurisdiction of Buenos Aires, the system was integrated with 911 emergency services and centers. This contributed to improving results and helped change the sense of security of its citizens.

The Unified Emergency Coordination and Control Center (CUCC) manages incoming phone calls and coordinates the actions of the competent bodies and areas that operate in each case: civil emergencies (Civil Defense and Logistics), medical emergencies (SAME), security incidents (Metropolitan Police), and traffic control (Traffic and Transport Control Agent Corps). It also allows joint collaboration with other national entities such as the federal police, the fire department, and power and water supply companies.

MEDELLIN, COLOMBIA

Highlight: Integration of security and emergency actions

SECRETARÍA DE MOVILIDAD DE MEDELLIN

The smart solutions implemented by the city of Medellin are grouped into three main projects that integrate services, systems, and technologies from each of the agencies that are part of the local government structure. Among them is the Integrated Emergency and Security System (SIES-M), created in 2013 and coordinated by the Urban Security Company. The SIES-M brings together, in a single Operations Center, representatives of more than 10 government agencies responsible for responding to emergencies. These include agencies from the security, transportation, and health sectors, the Administrative Department for Disaster Risk Management, and the Environment and Social Welfare Secretariat.

The system concentrates the calls made to number 123, which is used by citizens to report incidents, thus activating the police, emergency medical vehicles, etc. With just one call, the different services can respond in a coordinated manner. The information provided by phone is cross-referenced with data from 823 video surveillance cameras distributed throughout the city (40 percent of them located in higher-risk areas) and data from the systems of 10 government agencies. Since 2013, this integrated system has also relied on data generated from a geo-referenced mobile application for anonymous reporting. Based on this knowledge, the response strategy to the identified events is defined and the mobilization of responsible actors is initiated, including those from the urban mobility sector, since the integration of SIES-M to the Mobility Control Center systems.

TONGERON

NITEROI, BRAZIL

Highlight: Alerts to security forces through the use of panic buttons

Although public security in Brazil is the responsibility of state governments, some municipal governments understand that they need to collaborate. Thus, in May 2015, Niteroi, a city in the Metropolitan Area of Rio de Janeiro, inaugurated its Integrated Public Security Center (CISP), which gathers all state, federal, and municipal security forces, plus the Fire Department, the Transportation Department (NitTrans), and Civil Defense. CISP receives data from 600 monitoring cameras, 50 of them with a 360-degree range of image capture, and fixed and mobile panic buttons (80 of them installed in heavy traffic areas like bus terminals, public schools, housing complexes of the federal social program Minha Case Minha Vida, universities, etc.).

These fixed panic buttons are linked to video devices. When activated by a trained agent, they send the signal to the system, which issues a geo-referenced alert within CISP, indicating the exact location of the event, including images of the site. Mobile buttons are applications installed on the agents' smartphones. After identifying an event of relevance, police officers can ask for help by pressing a button. In four seconds, an alarm goes off at CISP, which also starts receiving real-time images recorded

by the smartphone camera, and this activates the dispatch of a police unit to the site. The captured images are stored in a database and may be requested by the Civil and Federal police to facilitate investigations. The use of smartphones with geo-referencing software significantly increases productivity in two ways: to collect both preventive and event information, and as a decision-making support tool.

NEW YORK CITY, UNITED STATES

Highlight: Data processing – high-speed processing of monitoring camera images, frequency of offenses, and criminal records.

DORLI

New York City has a long tradition in the strategic use of data analysis to solve urban violence problems, starting with the creation of CompStat, a service that compiles data collected from city monitoring systems (with cameras and sensors), cell phones, police cars, etc.

The information collected is analyzed and made available to police officers on duty, besides being accessible at any time from tablets installed in cars and smartphones. Thus, during an event, officers now have online access to the suspect's criminal record. If these suspects are wanted or have been charged with a crime, police officers can check their features on a digitized database and from detailed information (e.g. photo, age, or body signs such as scars) make the arrest. To provide greater transparency to police approaches, while at the same time protecting both police and citizens, the New York City government has adopted the strategy of using a body camera attached to the police officer's uniform. Having a video recording, from the police officer's perspective, helps in many ways – even for cost reduction. With the use of body cameras, the police department has reduced the amount of compensations paid as a result of lawsuits for wrongful conduct.

THE RAPID IDENTIFICATION OF A NOISE DOES MAKE A DIFFERENCE

Over the past five years, the city of Santander, Spain, has become the prototype of a Smart City. Thousands of sensors of various types have been deployed by the city to be monitored from control rooms that bring together government agencies, in order to integrate systems, coordinate actions, and reduce operating costs. These sensors capture information on public lighting, temperature, motion, and especially noise. When installed in traffic lights, noise sensors are able to detect the siren of police cars and ambulances, allowing these vehicles the right-of-way to reach their destination faster by avoiding traffic jams. A more sophisticated use of these sensors can also enable detecting emergency situations such as a person's fall, a cry for help, or a gunshot. In the event of a cry for help or a gunshot, the authorities can be alerted immediately.

Thirty-three noise sensors, similar to those installed in Santander and identical to those already installed in 50 cities in the United States, have been installed in a violent neighborhood in the Brazilian city of Canoas, state of Rio Grande do Sul. They are able to pinpoint the exact location of a gunshot.

MUNICIPALIDAD DE SANTANDER

Santander, Spain

Sustainable urban mobility

CHALLENGES: Mobility is another major challenge for cities in LAC. In 2010, there were 60 million cars in the region, and by 2025 another 80 million vehicles are expected to be added to this fleet. These vehicles travel the roads and contribute to increased congestion, serious accidents, and the emission of pollutants and greenhouse gases. In a large city in the region, the average daily commute is 3 to 4 hours. In the Action Plans developed during the implementation of ESCI in cities of the region, mobility was the most common topic, having been raised in more than 30 cities.

SOLUTIONS: Controlling and organizing traffic and reducing accidents in the city by investing in traffic monitoring and management systems are common goals to many Smart Cities. Results to be achieved include the use of speed radars and the adaptive and real-time programming of traffic lights, taking into consideration, among other factors, the concentration and flow of vehicles (allowing priority to ambulances, police cars, and dedicated bus lanes), the concentration of pedestrians, and the speed of vehicles. Another common concern is the provision of more efficient public transportation systems, suitable for urban development and social equity in relation to commutes. Many of the solutions are intended to prepare the city for the future implementation of a multimodal transportation system, involving different means (bicycle, subway, dedicated bus lanes, light rail vehicles), thus helping to reduce fuel consumption, gas emissions, and commute times, as well as improve air quality.

EXAMPLES: Bogota and Medellin began to solve the urban mobility problem by implementing effective public transportation solutions.

THEMIKEBOT

BOGOTA, COLOMBIA

Highlight: Integrated public transportation system

In the late 1990s, Bogota began to undergo a major transformation with the implementation of the TransMilenio project that combines a fast and affordable bus transportation system (Bus Rapid Transit, or BRT), which travels long distances on dedicated lanes on main city roads, and the deployment of more than 400 kilometers of bike lanes. The TransMilenio network is 113 km long, has 137 stations, and 12 lines that now integrate the ITS (Integrated Transportation System). Neighborhoods are serviced by smaller and lighter buses, divided into five route categories (urban, special, complementary, connector, and feeder). Together with the implementation of horizontal and vertical signage, smart traffic lights, and monitoring cameras, the ITS has significantly improved urban mobility in the city.

A website and a mobile application (Moovit) allow the population to plan their daily route by combining TransMilenio with the integrated routes identified by colors. Payment is made from a prepaid card system, which includes the single-rate option. A recent survey by the newspaper *El Espectador*[11] showed that one in five car users has migrated to the public transportation system, attracted by both travel speed and low cos ts.

JORGE GOBBI / CC BY 2.0

MEDELLIN, COLOMBIA

Highlight: Smart urban mobility system

For many years, Medellin considered the need to implement a smart mobility system by integrating information and communication technologies, transportation infrastructure, and different types of vehicles, seeking to efficiently manage these components and improve mobility in the city. The Intelligent Mobility System of Medellin (SIMM) uses 40 photographic cameras to detect traffic violations, 80 monitoring cameras, 600 networked traffic lights, and 120 traffic lights with vehicle detection sensors able to capture traffic information (intensity, number of passengers, average speed, etc.). In addition, the system has a fleet of 3,800 buses equipped with GPS and speed and occupancy sensors.

The information generated by each SIMM component is transmitted to the

11) http://www.elespectador.com/noticias/infografia/transformacion-de-transmilenio-tras-15-anos-de-operacio-articulo-603632

Mobility Control Center of the Transportation and Traffic Department. This unit is responsible for monitoring traffic, its logistics, predictive analytics, and systems of communication with public officials, as well as for generating information for citizens through electronic panels, mobile applications, and social networks. The Mobility Department integrates a range of citizen service strategies, including online services. The Twitter account of the Transportation and Traffic Secretariat of Medellin was rated the most influential in the country among all public agencies. The results are encouraging. With instruments that control more than 80 percent of urban transportation, the city of Medellin has reduced the number of urban traffic accidents by 24 percent.

SANTANDER, SPAIN

Highlight: Use of sensors in urban traffic management

Having implemented the Smart City project in 2010, Santander uses the concept of the Internet of Things (IoT) based on the installation of three types of sensors: static (placed at different fixed points of the city to measure temperature, humidity, precipitation, light, pressure noises in water pipes, etc.), dynamic (installed in moving vehicles such as buses, taxis, police cars, garbage collection vehicles), and participatory (applications used by citizens that can send information about problems on streets/roads, e.g., El pulso de la ciudad, www.elpulsodelaciudad.com/).

More than 200 sensors have been placed under the asphalt at points of entry to the city, to measure traffic intensity. Buses, taxis, and police cars also report their position and speed in real time, allowing for the constant mapping of traffic conditions. Ten panels strategically located at the city's entrance and downtown area inform drivers about the availability of parking spaces. Tags and labels located at bus stops provide information on lines, schedules, waiting


MANUEL ALVAREZ

times, and routes. All this information is available to the public on websites and mobile applications (SmartSantanderRA and Google Maps), allowing them to choose between different alternatives to get to their destination, thus reducing travel times, congestion, and CO_2 emissions.

PLANNED FOR PEDESTRIANS

The City of Masdar, currently under construction in the region of the Arabian desert of Abu Dhabi, is being planned to be 100% sustainable and geared to pedestrians. For this reason, the municipality has decided to adopt an underground transportation system based on electric cars and buses, with train and subway lines servicing the entire city, thus avoiding the need for many vehicles on the streets. Additionally, as the city has been designed for pedestrians, there is great concern about creating nice sidewalks, of adequate width and with shade.

Also, the City of Masdar has a zoning classification that allows residential, commercial, and entertainment areas to be close to each other, thus avoiding the need for long commutes by public or private vehicles.

URBANSCRAWLDC.COM / CC BY 2.0

Risk management and disaster prevention and response

CHALLENGES: Human beings have intensified their interventions in the environment to meet their needs, causing increasingly constant and intense imbalances. Cities are facing a higher risk of flooding due to improper soil use and soil impermeabilization, disorderly occupation of the banks of water bodies, and lack of both appropriate solutions to urban water management and adequate infrastructure. All this is aggravated by climate and environmental change. The increased number of buildings and impermeable surfaces, for example, prevents the soil from absorbing water, thus increasing urban temperature, forming islands of heat which result not only in more storms but also in human and material losses, besides putting the health of the population at risk. Increased rainfall has the power to multiply the incidence of vector-transmitted diseases, leading to increased outbreaks of diseases such as dengue fever. On the other hand, the increase in drought periods can be accompanied by a disturbing number of respiratory diseases such as asthma.

SOLUTIONS: Environmental disasters have been more frequent in LAC in recent years. For that reason, some cities in the region have started to invest in the implementation of specific systems to identify the occurrence of floods, mudslides, landslides, erosions, gales or cyclones, earthquakes, droughts, forest fires, etc. The goal is to alert the public in advance of probable emergency situations and thus reduce the risk of disasters by taking appropriate response measures. These systems are also useful to assess where a particular event occurs more frequently, enabling the adaptation of necessary infrastructure.

EXAMPLES: Actions for Disaster Risk Reduction necessarily mobilize different spheres of society and involve different levels of government as well as citizens. Solutions implemented in Japan already help minimize the impact of natural disasters and save lives. In LAC, successful examples can also be seen in cities such as Rio de Janeiro.

MOYAN BRENN

TOKYO, JAPAN

Highlight: Coordinated actions in emergency situations

In Japan, people begin to be trained on how to react to an earthquake early on, while still in school. In addition, action plans are coordinated by one of the most advanced civil defense systems in the world, supported by technologies designed to avoid or minimize the impact of disasters. Tokyo is the role model of this prevention strategy, coupled with rapid response to critical events through coordinated actions. The city's civil defense works on a permanent basis, because preparing for earthquakes, floods, typhoons, and hurricanes has to be part of people's culture.

In addition to a sophisticated system with 4,000 control points equipped with seismographs to predict earthquakes and quickly alert the population, a specific agency responsible for managing natural disasters relies on the integrated action of communication systems, traffic control, control of smart energy, gas and water networks, and survival bunkers equipped with food supplies, solar-powered smartphones, and bikes. All this facilitates the action of trained agents in the 72-hour period following the disaster. One of the most important pillars of this system is communication between agents and citizens to provide guidance. That is why the Tokyo Skytree, the tallest digital broadcasting tower in the world was built with technology to enable uninterrupted operation. It is through it that this entire service network communicates. In addition, the tower was built to transmit digital TV signal (Digital Terrestrial Broadcasting, or DDTV) to the entire city. Its height of 634 meters, which makes Skytree taller than the tallest buildings in Tokyo, enables doubling the DDTV signal and also extending the digital signal to mobile terminals. At the top of the tower, high precision monitoring

cameras are able to identify fires, among other events, at a distance of 18 kilometers, thus alerting the authorities.[12]

RIO DE JANEIRO, BRAZIL

Highlight: Integrated risk management system

COR-RIO

Extreme events in the past five years have produced a record number of negative impacts on the population of Rio de Janeiro, displacing thousands and killing hundreds of people. The city might have to endure an increase of up to 3.4 degrees Celsius in average temperatures over the next 65 years, and in 2080 the sea level could rise between 37 and 82 cm. Preparing the city to meet these challenges is not a simple task, but some actions have already been put into practice. The city is focused on the five priorities set out in the Kyoto Protocol (make disaster reduction a priority; know the risk and take action; build understanding and awareness; reduce risks; and be prepared and ready to act) and has promoted actions that meet these requirements, such as investing in a weather radar and a rain gauge network installed in mobile phone towers, which help Civil Defense monitor rainfall.

Civil Defense is one of the agencies integrated into the Rio de Janeiro Operations Center (COR-Rio), which also has a landslide prevention system fed with data collected by sensors installed in hazardous slope areas mapped by Geo-Rio. COR-Rio is able to issue alerts with extremely high precision and anticipation of probable storms, floods, and landslides. By relying on the monitoring camera system, it also coordinates the action of the relevant agencies in cases of flooding and obstruction of public streets. One of the main vectors of this integrated emergency response system is interaction with society. By SMS, the web, or social networks (especially on Twitter at: @operacoesrio) the government keeps the public informed in times of crisis. In addition, a siren alarm system was installed in residential communities of high-risk areas.

12) http://www.japantimes.co.jp/news/2011/03/20/national/media-national/planning-pays-off-as-nhk-takes-its-quake-news-global/#.V2kydvkrJpg

The search for energy efficiency

Resources such as water and energy are becoming increasingly scarce. They need to be used rationally and intelligently. This entails not only efficiency gains in consumption, but also the preservation of water sources, the use of renewable sources, and even proper waste collection and disposal.

A UN study[13] estimates that in 2030 an additional 50 percent of energy and 40 percent of water will be required as a result of population increase in urban areas and a growing demand from the middle class. Fortunately, modern

13) UNEP Global Environment Outlook Study (http://www.unep.org/geo/)

Havelland, Germany

MAINOVA AG

information and communication technologies are available to governments to optimize supply and consumption management in cities.

CHALLENGES: Reducing consumption to conserve natural and financial resources is the main objective in the energy sector, which sees investment in renewable sources as one of the viable alternatives. At the municipal level, this task involves a commitment to urban sustainability through the promotion of structural and coordinated actions with service providers.

SOLUTIONS: Among the solutions available to mayors are the replacement of street and public building lighting systems with low power consumption LED lamps, and the use of photoelectric and motion sensors to automatically turn the lights on and off and adjust their intensity according to the environment needs. Furthermore, the use of smart grids needs to be regulated, so as to promote the rational use of electricity also on public roads, in homes, hospitals, public buildings, and industries.

EXAMPLES: Case studies of cities like San Diego and Thisted, which have adopted, at least in part, the solutions mentioned above, are a good reference for mayors interested in implementing them.

SAN DIEGO, UNITED STATES

Highlight: Smart street lighting system

The San Diego project is a good example of how public-private partnerships can drive innovation and promote return on investment for those involved. In 2014, San Diego became the first city in the U.S. to use smart LED lamps in street lighting. Equipped with photoelectric sensors, wireless transmitters, and microprocessors, the lamp poles form a network capable of providing real-time information on energy consumption in each region of the city, besides following remote commands for adaptive light control and cost reduction. Another advantage is that the same system that controls lighting on roads can issue alerts in the event of hurricanes, from sensors capable of reporting the

SISSI FAN / CC BY 2.0

wind intensity and controlling other environmental factors such as the flow of people and vehicles.

Citizen participation was essential for the choice of the new public lighting system. The choice was made only after surveys were conducted with five groups that oversaw the evaluation of the city's maintenance services. In addition to improving public lighting, the city is trying to save on costs by negotiating with the electricity company an average rate instead of a flat rate, since it can measure more easily public lighting consumption on every street in the city..

THISTED, DENMARK

Highlight: 100 percent sustainable with the use of renewable energy sources

With a population of 13,000, the city was awarded the Renewable Energy Prize of the Danish Ministry of Energy and the renowned European Solar Prize for its successful use of renewable energy sources, in addition to being designated as the future headquarters of a national test center for large wind turbines. The process of turning Thisted into an internationally renowned pioneer carbon neutral city had the participation of citizens, NGOs, and local companies, and started after farmers began to invest in wind turbines and biogas plants on their properties.

WAYNE NATIONAL FOREST

The replacement of the city's energy matrix started in the 1980s, with investments in wind and solar energy, biogas, geothermal plants, biomass burning, and waste heat from industry. Today, the city generates 274 million kWh of electricity from renewable sources, which accounts for more than 100 percent of the city's consumption needs and 219,336,000 kWh for heating, or the equivalent to 80 percent of consumption. This means that 90,000 tons less CO_2 is released into the atmosphere. Through new energy supply initiatives, the local government expects to both care for the environment and create jobs from sustainable energy development.

For smart water management

CHALLENGES: For decades, environmentalists have warned that fresh water is a scarce resource on the planet. Meeting global water supply is one of the biggest technical and human challenges of this century. More than 1 billion people living in cities will probably live on less than 100 liters per day – the UN limit for a healthy life - and more than 3 billion will have no water for a month each year, according to a study published in the Proceedings of the National Academy of Sciences of the United States of America.[14]

SOLUTIONS: Possible measures include investment in reuse technologies that assist in the creation of incentive policies on the responsible use of water. Another important problem is the waste resulting from leaks in pipelines, networks, branches, connections, reservoirs, and other operating units in supply systems. These leaks occur mainly in distribution network pipes and are caused especially by excessive pressure in regions with great relief variation. One solution is to manage leaks and losses by using sensors of water level, quality, flow, pipe pressure, etc.

EXAMPLES: Some cities have become role models in water management by using available technology wisely. Among them are Singapore, Nassau, and Las Vegas.

Vitoria, Brazil

YURI BARICHIVICH

14) http://www.pnas.org/content/108/15/6312.full.pdf

CHENSIYUAN

SINGAPORE

Highlight: Water reuse and desalination

Drinking water has always been a problem for more than five million people on the island of Singapore. The need to supply this population with drinking water justifies the adoption of various strategies for seawater desalination and wastewater recycling on a large scale. About 10 percent of the water consumed every day in Singapore comes from the sea, and 30 percent from the NEWater project.[15] The first desalination plant was installed in 2005, but water reuse has proved a cheaper strategy. Today the city has specific regulations for treating each type of wastewater. The transformation of water seeping from toilets and drains involves several stages. First, it goes through standard treatment plants. Then, it is purified by microfiltration, reverse osmosis, and ultraviolet waves. Five of these plants are scattered around the country, and the latest one was opened in May 2010.

Regarding the fight against waste, the use of electronic sensors has contributed to reduce leaks in the water distribution network. There are 130 pressure and quality sensors spread around the pipes taking readings every millisecond, generating much faster samples than those obtained with the use of conventional systems. When there is a leak in a pipe, an alert is transmitted via a Wi-Fi network to the central server, which identifies the source by triangulating the geolocation data of the sensors. Monitoring of the network also assures consumers that the water reaching the taps is safe and suitable for drinking, which is something especially important when desalinated and recycled wastewater has become an essential part of supply in the city.

15) Singapore: NEWater Project (http://www.pub.gov.sg/water/newater/Pages/default.aspx)

SARAH BENTON

NASSAU, BAHAMAS

Highlight: Loss detection and management

In Nassau, in The Bahamas, the Water and Sewerage Corporation (WSC) supplies drinking water to 250,000 people. Over the past three decades, it has been seeking solutions to reduce losses, an extremely important task on an island where 90 percent of the water supplied to the population comes from desalination plants. In 2012, the volume of unaccounted-for water resulting mainly from leaks in the infrastructure but

also, to a lesser extent, from theft and measurement errors, reached 58 percent. Since then, the government has decided to invest in a physical loss-containment plan, focusing on a wide variety of cutting-edge technologies for pipe repair and replacement, active leakage control, pressure management, advanced micro measurement management, and fraud combat. Controlled by software, the monitoring and control system reduced the volume of unaccounted-for water to 29 percent in 2014.

Furthermore, from the use of the system, the WSC was able to authorize occasional stoppages of the treatment plant for preventive maintenance, with little or no effect on supply. With the reduction of leaks, labor costs have also fallen. Employee overtime has dropped and more people are available for other activities. To better serve the population, the software allows better management of service orders. Water loss is expected to fall by more than 10 billion gallons over the project life cycle. This means savings of seven million liters of diesel and 33 GWh of electricity that would otherwise be used if that amount of drinking water were to be produced.

LAS VEGAS, UNITED STATES

Highlight: Smart Water Network (SWAN)

MAXIMILIAN MÜLLER / CC BY 2.0

Located in a desert, Las Vegas has a population of two million people and receives 35 million visitors a year. Located in one of the hottest and driest regions in the world, the city was recently forced to endure water shortages because of the climate change that has led to long periods of drought. In a first analysis, water supply to the city seems to be an impossible task, especially in view of federal laws that limit the amount of water that the city can draw annually from Lake Mead (an artificial reservoir with a capacity of 15 trillion cubic meters of water, which currently meets 90 percent of consumption needs in the metropolitan area) and the Colorado river, where the Hoover Dam is located. The solution found was to combine a draconian regulation with a lot of technology to reduce waste. This year, for example, some communities in southern Nevada began testing a technology based on sensors that detect soil moisture and activate the irrigation system only when the soil needs water. Anything is worth it when it comes to saving such a precious asset.

The Las Vegas Valley Water District (LVVWD) is strongly committed to the efficient use of water, and aims to lower the per capita consumption to 199 liters in 2035, which is the limit set by the Southern Nevada Water Authority. At the end of 2014, as a result of the measures adopted, consumption had fallen to 205 liters per person/day. There is still much work to be done. Therefore, the LVVWD has been seeking new alternatives, among them the use of smart water networks. It is no accident that the district has been working on establishing best practices for the digital applications that will manage and operate the physical elements of the system such as pipes, pumps, valves, and tanks. The system performs leak calculations based on the analysis of data collected in real time and on historical data for both the intake and distribution networks. It is able to manage the Active Leak Control and exchange data with Maintenance Management Systems to identify the most critical infrastructure from the point of view of leaks/breaches, thus supporting managers to solve the "repair or replace" dilemma and prioritize interventions in distribution networks.

Las Vegas, United States

CHENSIYUAN

Keeping an eye on proper waste disposal

CHALLENGES: Proper urban waste management is another issue of growing concern to public officials, with direct impacts on health, the environment, and people's quality of life. Cities are strong emitters of methane (CH_4), which has a global warming potential 21 times greater than that of CO_2. According to a UN study,[16] the current waste generated in the world is around 1.3 billion tons/year, with an estimated 2.2 billion tons/year by 2025. The financial and environmental costs to manage such a significant amount of waste are enormous. The same UN study estimates that up to 50 percent of municipal budgets are spent on urban waste collection and disposal.

SOLUTIONS: To date – and this is a common problem in many cities in LAC – solid waste has been managed in an uncoordinated manner. Technology helps to have a systemic view of the process, from prevention during the generation phase to reuse, including collection, transportation, and the most appropriate treatment for each type of waste. Among the most commonly used solutions are: underground reservoirs with fill-level sensors that warn when the limit is about to be reached, so that waste can be removed; selective collection; recycling; replacement of dump yards by landfills and incineration plants that promote drainage; treatment of manure (liquid resulting from the decomposition of organic waste); and conversion of wet waste and methane to energy (gas).

EXAMPLES: The city of Itu (state of Sao Paulo, Brazil) has begun to address the issue of waste disposal management in an integrated manner in order to reuse it as much as possible, and dumping the minimum amount possible in landfills. The Spanish city of Santander, in turn, has automated garbage collection by investing in the use of smart containers.

16) United Nations Environment Programme (UNEP) and the United Nations Institute for Training and Research (UNITAR) – Study Guidelines for National Waste Management Strategies: Moving from Challenges to Opportunities (http://www.unep.org/newscentre/Default.aspx?DocumentID=2752&ArticleID=9637&l=en)

ITUEMDESTAQUE.COM.BR

ITU, BRAZIL

Highlight: Selective garbage collection system

The city of Itu, in the interior of the state of Sao Paulo, has resorted to a public-private partnership, effective until 2041, to implement a selective garbage collection system using 3,300 containers distributed throughout the city. People take their garbage, properly separated into recyclables and non-recyclables, to the containers rather than having the city collect it door-to-door. This strategy reinforces the educational effect of the Environment Secretariat's awareness programs for people to learn how to properly separate what can be recycled. Itu already collects 10 tons of recyclable waste per day. The local government's goal is to convert 70 percent of the 3,600 tons/month of wet waste into electricity or gases.

The location of containers of organic, recyclable, or underground waste (with fill-level sensors) is determined based on studies that take into account the existence of waste-generating businesses. Each location is connected to a monitoring system able to indicate the need for repair or replacement through software developed specifically for this purpose. The routing of collection, according to the load of each container, reduces the number of streets the truck needs to travel, as well as collection time and fuel expenses. Moreover, since collection is mechanized, there is also a reduction in the number of work accidents. The health issue has also been taken into account. Containment prevents garbage from being left on the streets exposed to rain and animals, as well as from spreading, clogging storm drains, and attracting vectors.

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SANTANDER, SPAIN

Highlight: Automated waste collection

In Santander, one of the most automated services is the selective collection of solid waste. Public waste containers "inform" when they are full, thus avoiding unnecessary collection. The project involves the implementation of a complete technology solution, which includes sensors that measure volume, moisture, odor, and gas emission, among other indicators, in the dumps; radio frequency tags (RFiD) and near field communication (NFC); dual antenna (GPRS/GPS); GPS in garbage trucks; mobile applications to assist in the collection and maintenance work; and tracking software that

allows unified monitoring and management of operations. The integration of these elements with the infrastructure of the SmartSantander program, which enables real-time data analysis, is today the main decision-making tool for the urban solid waste management company.

Developed in partnership with the University of Cantabria, the pioneer project integrates automated waste collection and automatic container alert. Furthermore, the technological initiative involves the active participation of citizens who, through a mobile application, can also identify areas in need of attention and cleaning, and send alerts to management. Benefits of the model include reduced CO_2 emissions from fuel savings achieved by optimizing collection routes, lower man/hour costs, citizens' motivation to separate waste into wet and recyclable, and prevention of vector-transmitted diseases by preventing containers from overflowing.

Santander, Spain

MANUEL ÁLVAREZ

In education teachers are the way

CHALLENGES: Changing the educational context to improve student performance and reduce failure and dropout rates is a concern in cities of all sizes. Several initiatives see the computerization of schools and the delivery of computers to students as a solution. Results in developing countries tend to be better than in developed countries, according to the Global Information Technology Report 2015 of the World Economic Forum (WEF).[17] But even in these cases, according to the WEF's assessment, technology will only work if accompanied by a strategy to generate online content, connectivity, and collaboration among participants, shifting the focus from students to teacher training.

SOLUTIONS: Education can benefit in many ways in the context of a Smart City project, but all of them require, as a fundamental condition, the guarantee of broadband connectivity in schools. Once this condition is met, solutions can be identified such as perimeter security cameras connected to the public security system, door and window sensors and alarms, automatic switch-off system for lights and electrical equipment, and smoke and toxic gas sensors. In the context of school transportation, GPS tracking enables following bus routes and reducing students' time in traffic. In school management, the use of databases and school records, online enrollment and place selection, and parents' access online or via a mobile app to students' grades and performance reports facilitates communication between the school and the family. In addition, collaborative platforms for students' access to study contents and materials are important tools. For teachers, the use of collaborative platforms for knowledge exchange between schools and online courses are strengths for training.

17) World Economic Forum (WEF). Global Information Technology Report 2015. (http://reports.weforum.org/global-information-technology-report-2015/)

EXAMPLES: Two cities - Tacoma (United States) and Montreal (Canada) are examples of cities that invest in the digitization of school information, mobile applications, and predictive data analytics as tools to improve assistance to students and increase learning and pass rates.

TACOMA, UNITED STATES

Highlight: With data analysis, teachers increase students' pass rates

The pass rate among public high school students in the port city of Tacoma, Washington State, was 55 percent in 2010, well below the country's average of 81 percent. Public school management in Tacoma invested in a public-private partnership project[18] to create a large cloud database, gathering all existing information on the school record of each student. The database contains students' grades, class attendance indicators, health information, and other data related to the student's life. These data are crossed-referenced by teachers with information on historical performance averages in different school subjects. By using 72 different data viewing modes, teachers can identify behavior and learning patterns to help students overcome difficulties. Teachers received training in predictive analytics tools based on electronic spreadsheets, enabling them to track data and intervene when students show learning difficulties before problems escalate and get out of control.

The result is that by the end of 2014, the pass rate in Tacoma schools rose dramatically, reaching 78 percent. For the biennium 2015/2016, school management in Tacoma plans to evaluate the data and grade sheet of students coming from the fifth grade of elementary school to find out if they will need help in high school.

18) Microsoft. Schools use real-time data to improve learning outcomes and boost graduation rates (http://blogs.technet.com/b/microsoft_in_education/archive/2015/11/10/schools-use-real-time-data-to-improve-learning-outcomes-and-boost-graduation-rates.aspx)

MONTREAL, CANADA

Highlight: Mobile apps eliminate school paper files and save teachers' time

The Montreal School Board, a public entity responsible for teaching English in Montreal (Canada), was dissatisfied with the volume of students' paper files. The use of paper hindered not only access to information, which had to be local, but also the cross-referencing and analysis of data. In a public-private partnership, the board worked with a startup to migrate the information to digital format and create the Hall Monitor mobile application, which gave teachers and school management the ability to monitor students and record data on each of them using a mobile device anywhere, on or off campus.

According to the school, the main result achieved is time saved. Teachers used to spend up to five hours a week visiting the archives to search data or fill out new forms. This time can now be spent working with the students. From the success of Hall Monitor, the school and its technology partner have created a new application to improve the collection of information on students with special needs, and centralize these data. Again, this has afforded teachers more quality time with their students.

In health, technology works for the benefit of life

CHALLENGES: Regardless of their size and development stage, cities around the world face the same health challenges: extend quality care to as many citizens as possible, both in urban centers and remote regions; reduce costs through prevention programs that improve the quality of life of the population; and manage a longevity scenario in which a growing portion of the population will reach older ages. The question is: How can this be done by combining the growing demand with tight budgets, guaranteeing access to specialized services even in remote locations?

SOLUTIONS: Opportunities in the health area depend entirely on the supply of broadband connectivity not only in hospitals, clinics, and health centers, but also in homes. Broadband connection (fixed and mobile) associated with video conferencing and unified communication platforms open new perspectives for the computer-based provision of healthcare services at home, telemedicine practice in distant clinics, remote support for diagnostics, and online training for professional in remote areas. In the patient-monitoring area, electronic medical records, mobile applications for monitoring physical activities, wearable devices with sensors for monitoring vital signs in elderly and disabled patients, GPS to facilitate tracking and mobility of ambulances, and emergency buttons connected to call centers are some of the numerous health opportunities for cities.

EXAMPLES: In Estonia, the United States, and Japan, e-health initiatives include unification of people's health data in an electronic medical record, digital identity that allows people to get medicines using digital prescriptions, use of tablets for the well-being of the elderly, and analytics systems to prevent deaths during heat waves.

OLEKSIY MARK

ESTONIA

Highlight: Electronic medical record integrates data on the health of the population

Estonia, a small country in the Baltic Sea, near the Gulf of Finland and Russia, is possibly one of the best examples of a digital society. With a population of 1.3 million, the country has managed to ensure that nearly 100 percent of the population has a digital identity, materialized in an ID card that is used by citizens to interact with virtually all public services in the country. One of the components of Estonia's e-gov structure is the health system, which has as its backbone the Electronic Medical Record, a nationwide system that integrates all data from different health service providers and transforms them into a single electronic medical record. It can be accessed by patients, physicians, hospitals, clinics, and even pharmacies to monitor the health of each citizen.

Although they reside in a nationally centralized database, each electronic medical record is updated with data from different sources. By checking it, doctors can access the results of a patient's blood test or view X-ray images directly from their offices. In an emergency, the patient's ID Card provides critical information such as blood type, allergies, recent treatments, medication, and even prenatal care data for pregnant women. The general system data is also used by the health ministry to generate statistics, identify patterns, track epidemics, and assess whether the health budget is being used properly. The ID Card can also be used by patients to get medication in pharmacies using the e-prescription system[19].

19) For more information visit: https://e-estonia.com/

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SAN FRANCISCO, UNITED STATES

Highlight: Open data and analytics prevent deaths during heat waves

As climate change leads to a surge in extreme heat waves, cities are increasingly facing the risk of climate-related diseases which, if untreated, can cause the premature death of children and elderly people. The San Francisco Department of Public Health (SFDPH) has invested in the open data concept and developed a tool to help eliminate the problem by anticipating risks. According to data from the SFDPH, in 2010 the city endured 11 days

of extreme heat, and the projections made in the context of climate change point to 21 days in 2050 and 94 in 2090. The SFDPH claims that 69 percent of vulnerabilities to extreme heat can be predicted.

The Health Vulnerability Index identifies, on an online interactive map, the level of vulnerability of the population to the effects of extreme heat in each area of the city. In addition to data on temperature, the index cross-references 21 other variables, such as physiology of the local population, neighborhood infrastructure, architecture, traffic and transportation, socioeconomic factors (age, race, educational level, average salary, poverty rate), air quality, proximity to green areas, existence of day care centers or nursing homes, and indicators of pre-existing health conditions such as rates of asthma cases. By anticipating the risks in each region, the tool allows city managers to take proactive action before extreme heat reaches the city and causes damage.[20]

JAPAN

Highlight: Tablets and mobile applications improve quality of life for the elderly

Japan Post Group, the entity responsible for providing postal, banking, and insurance services to 115 million people in Japan, has started an unprecedented project to improve the quality of life of the country's elderly by providing them with tablets equipped with especially-developed mobile applications to connect them to health services, community, and family. In Japan, 25 percent of the population (33 million people) is elderly, and in 40 years (2055) senior citizens will represent 40 percent of the population.

The applications have been designed to provide reminders and alerts to users about medication, exercise and diet programs, and medical appointments, and to allow seniors to connect with public services and their families, as well as do their grocery shopping without leaving home. The applications were designed with large buttons for ease of use, and its accessibility features include large fonts, captions, and speech recognition for dictation. The pilot project initiated by Japan Post with 1,000 people in 2015 is set to expand in stages, and the goal is to reach between four and five million people in 2020. The tablets are distributed at no extra charge as part of a service plan with monthly payment offered by the Japan Post Group.[21]

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20) San Francisco Department of Public Health. (http://www.sfhealthequity.org/elements/climate)

21) Apple. Press Center (https://www.apple.com/pr/library/2015/04/30Japan-Post-Group-IBM-and-Apple-Deliver-iPads-and-Custom-Apps-to-Connect-Elderly-in-Japan-to-Services-Family-and-Community.html)

Electronic government and digital inclusion

CHALLENGES: Promoting and improving the efficiency and image of public administration by providing services through digital channels (websites and mobile applications) and seeking to involve citizens in public policy building and decision-making processes are tasks that require special attention. There is a consensus among UN member states that promoting sustainable development entails building bridges of confidence between citizens and public institutions. These institutions, in turn, must be increasingly effective, accountable, transparent, and democratic. Therefore, they need to enhance institutional efficiency and expand the government's capacity to meet the demands of citizens.

SOLUTIONS: Information and Communication Technologies are the operational component of the objective to better serve citizens and ensure their participation through e-government actions. Among them is the provision of infrastructure (free points of access to government services and training, including Wi-Fi hotspots) and digital services, with the purpose of improving administrative processes and their impact on society.

Para, Brazil

ASCOM SEDUC - PARA

EXAMPLES: Rio de Janeiro and Chihuahua are Latin American cities that have stood out worldwide due to the offer of access, usability of applications, quality of information, transparency, interaction, and a number of transactional services promoted by their e-government programs and commitment to digital inclusion.

MAURICIO BOUSKELA

RIO DE JANEIRO, BRAZIL

Highlight: Use of applications to interact with the population

In early 2015, the government of Rio de Janeiro started the Data Rio project, which makes the database generated by the city available for study and projects, such as the development of applications that help facilitate the lives of citizens and tourists. There are 15,000 files with 400 terabytes of information, including bus location by GPS coordinates, synchronization of traffic lights, and numbers for the 1746 Call Center. The initiative is part of the Carioca Digital project, a web portal that intends to bring the local government into citizens' homes 24 hours a day in an agile, personalized, and easy fashion. Services available in the portal include tax status of cars and real estate, traffic tickets, reports and performance rates of students enrolled in public schools, and access to 1746 Call Center, where citizens can check their requests, their progress, and open new calls.

On the government side, the 1746 Call Center has improved city management. The service has established targets that, if met, result in higher amounts of budget allocation to municipal agencies responsible for meeting the demands of the population, and also for lesser time for each service. In the first 5 years of operation, the satisfaction index of the 1746 Center was above 70 percent. Amongst the most demanded services are debris removal, irregular parking, requests for street light repair, tree and vegetation management and pothole repair. The Center operates 24 hours a day and has capacity to answer 300 simultaneous calls and 600 thousand per month. Contact can be made via phone (dialing 1746), through smartphone applications on iOS and Android, and through the site www.1746.rio. Additionally, in 2015 the center launched a service for reporting illegal constructions via WhatsApp.

CHIHUAHUA, MEXICO

Highlight: Wireless broadband Internet coverage

Located in northern Mexico, on the border with Texas, the city of Chihuahua offers its 843,000 residents free access to Wi-Fi Internet in dozens of public places in the city, such as squares and parks participating in the Chihuahua Digital City program. The project was made possible by a public-private partnership with local operators of telecommunications services. The Wi-Fi coverage complements access to e-government services and digital inclusion programs focused on training people in the use of the technology, available in the free Internet service centers installed in the city.

The key goal is to democratize access and encourage citizens to take ownership of public spaces, using high-speed access for various topics, including communication; business; study; citizen participation; promotion of social activities; use of services, such as the issuance of tax payment forms and certificates; assistance to citizens through organizations that provide support for women, pensioners, and cultural entrepreneurs; as well as accountability of government activities. One of the most commonly used services is the release of statements related to problems identified using a geo-referenced map.

LUCY NIETO / CC BY 2.0

Citizen participation

CHALLENGES: Engaging citizens in city management in order to generate a virtuous and smart cycle of service delivery and evaluation is the main objective in promoting Smart City policies. Therefore, it is important that municipal administrations create ways to involve people with the city, either to bring them quality information and services or to get their feedback on the city and their help to find out faster where the problems are, and solve them.

SOLUTIONS: Communication networks associated with mobile devices, especially smartphones, enable adopting new two-way communication channels between government and citizens. Mobile applications, online platform, provision of free connectivity services, and digitization of public services are tools to promote the integration between the city and its residents.

EXAMPLES: The city of Tel Aviv uses a combination of mobile application and digital identity to offer services to citizens and to get information from them. In China, the city of Ningbo uses people's smartphones to improve urban mobility and better manage its resources.

TEL AVIV, ISRAEL

Highlight: Citizen-city integration through app and smart card

The core of the participatory citizenship project of the Israeli city of Tel Aviv lies on the "Digi-Tel" platform. It combines the provision of a digitalized resident identity card transformed into a smart card, with the use of a mobile application for smartphones, SMS and email messaging, a web portal, and the digitization of its public and cultural services. This set of products and services benefits from free public Wi-Fi connectivity in the city, which now has 410,000 residents, of which more than 30,000 have the Digi-Tel card and can access the benefits wherever they are.

Digi-Tel connects citizens with the city by providing a two-way

YOTAM FROM / CC BY 2.0

communication channel. Through the application or the web, residents can access relevant information to their day-to-day life, receive alerts according to their location or interests, access public services, enjoy discounts in cultural events, and easily inform public managers about problems in the city, whether it is an open manhole or a traffic accident. Holders of the Digi-Tel card can also access the platform site and through a custom page pay their bills, receive information about events in their areas of interest, and interact to improve public management. Having a card is optional and citizens above 13 years of age can apply for their digital identity.[22]

NINGBO, CHINA

Highlight: iCityBoss app puts the city in the hands of citizens

The Chinese city of Ningbo, with 1.5 million people, develops its Smart City initiatives based on various public-private partnerships. Several public and management services have been digitized. The iCityBoss app has been developed to ensure connection between citizens and the city, as well as participatory citizenship, and it aggregates data from sources such as government, institutions, and companies in order to provide a central point of interaction with a variety of Smart City services. The app uses the GPS capabilities of smartphones to send real-time data on citizens' location, allowing for the reception of more accurate data on transportation.

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Benefits for citizens include an average 10-minute reduction in the wait time for public transportation or a 15-minute reduction in the time spent looking for a parking spot in the city. The government estimates annual savings of USD 4.9 million due to more efficient traffic management, coordinated actions, and sharing of resources between different municipal departments. Citizens can interact with the local government by communicating problems and submitting suggestions.[23] According to the city of Ningbo, the application already totals 1.2 million downloads and currently has 200,000 active users.

22) Tel Aviv. Online Information Center (http://www.tel-aviv.gov.il/eng/Pages/HomePage.aspx)

23) Ningbo. Smart Cities: managing traffic in China (http://www.rtinsights.com/smart_cities_ningbo/)

Integration of systems and operations

CHALLENGES: To meet the increasingly diverse challenges mentioned earlier, Smart Cities are integrating the collection and processing of data generated by cameras and sensors in a single location in the city: the Integrated Operation and Control Centers. In these centers, multisectoral teams work collaboratively, supported by modern technological tools that streamline decision-making, especially in emergency situations.

SOLUTIONS: Development of an interconnected systems platform of public management and of a powerful communication system able to support it.

EXAMPLES: In order to solve citizens' problems related to transportation, security, disaster prevention, and response to emergencies, Anyang, a Korean city near Seoul, has progressively implemented the technologies that transformed it into a Smart City model and enabled cooperation between different government systems and departments.

ANYANG, SOUTH KOREA

Highlight: integration of public systems and operations

The first Smart City project was the Bus Information System in 2003, which evolved into the Intelligent Transportation System. In 2007, the kidnapping of two girls led citizens to declare war on crime. This motivated the creation of a safety net and an effective crime prevention system that now has 3,500 closed circuit TV surveillance cameras throughout the city. In the last 12 years, therefore, the city of Anyang has been able to provide its citizens with real time

ANYANG CITY U-INTEGRATED CENTER

Anyang, South Korea

information on the schedule and location of buses, traffic, and crime prevention. This crime prevention system has proved largely successful. However, it was necessary to continue its development, and the way to do so was by integrating all these systems and some others into a centralized system coordinated by the Anyang Smart City Center.

The Integrated Urban Control System of Anyang combines surveillance networks for crime prevention and traffic control with the management of public services such as maintenance of public roads and firefighting, among others. It is divided into a monitoring unit and an operating unit. In the monitoring unit, which works 24/7 in a situation room, 30 civilian professionals are coordinated by three police officers. The operating unit, in turn, is managed by civil servants. Information flows bilaterally in the system in real time between the center and the field facilities and public departments, in order to promote and take advantage of synergies. One of the factors that contributed to the success of the Center was the construction of a fast and stable communication infrastructure, both wired and wireless. The results are easily measured. After implementation of the Center, the crime rate in Anyang began to fall 17.8 percent a year on average.

As we can see, there are currently dozens of examples of Smart City initiatives that can serve as a reference and an inspiration for new projects. The examples provided in this chapter have in common the decision of municipal managers to put people at the center of development by incorporating information technology into urban management. The next chapter will describe the steps required to start the migration from traditional management to a Smart City management.

BARCELONA, EXCELLENCE IN SMART CITY

As seen throughout this Guide, a Smart City can be understood as a city capable of responding quickly (or early) to the needs of its citizens – while taking into consideration its characteristics, vocations, and even its limitations – thereby improving the citizens' quality of life. Barcelona, capital of Catalonia, Spain, is among the cities that come closer to materializing the Smart City concept.

Barcelona is an example of smart management for sustainability. It is not by chance that the city is always at the top of the annual ranking of Smart Cities, to the extent of receiving, in 2014, the European Capital of Innovation award, attracting more and more people to the city for work and leisure, thus increasing the challenge of preserving the quality of life of residents and visitors.

The government runs 22 smart management programs, integrated to allow the optimization of city operations, including improved environmental management and economic and social sustainability (http://smartcity.bcn.cat/es/). The city has smart bus stops, which connect to the optical fiber network providing users with real time bus schedules, tourist information, and digital ads with USB charging plugs for mobile devices, as well as free Wi-Fi hotspots.

Parking lots identify the presence of cars by combining lights and metal detectors through a wireless broadband network, informing customers of space availability, and allowing them to pay for the service.

Sensors distributed at various points in the city provide real-time data on the flow of people, noise, and other forms of environmental pollution, as well as traffic and weather conditions. Access to the traffic system was made available for pedestrians and drivers to check, on their smartphones, the best option for moving around the city.

The highly efficient lighting system is connected to the underground fiber network. Several features have been added, such as closed-circuit monitoring, air quality sensors, and Wi-Fi, helping to dynamically manage the level of lighting according to local conditions, thus generating significant energy savings.

Waste containers are connected by wireless networks and equipped with sensors that monitor the amount of waste, and even detect the presence of hazardous materials. The data are received by the secretariat and cleaning companies and enable better planning collection routes. Truck drivers are updated in real time about routes, thereby reducing the costs of waste management services.

All of these factors reflect initiatives of sustainable city growth in many levels, including smart lighting, mobility, and residual energy (heating and cooling networks); social innovation; project partnerships between research centers, universities, and private and public partners; and "smart services" provided in a flexible, continuous, and agile fashion through ICT.

MAURICIO BOUSKELA

London, England

Smart Cities

chapter 6

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Every Smart City project should consider

6 steps

that ensure the achievement of the expected results

Sydney, Australia

The roadmap

As seen in the previous chapter, several cities around the world are implementing smart initiatives that result in better services for their citizens, making them more attractive to both businesses and tourists, and ultimately, a better place to live, work, and visit.

From the information presented so far, we can draw principles to migrate from a traditional city management model to a Smart City model.

First, it is essential to count on the leadership of the mayor or the chief executive of the city. This leadership should be reflected in the support of the municipal government, other local authorities, and public and private institutions that are related to the city. With it, we can start thinking about a project with a comprehensive and integrated vision that promotes collaboration between institutions. This is the kind of vision that will ultimately lead to a multisectoral management model.

Second, as we saw in chapter 3, materializing this vision requires implementation capacity. In this sense, a smart government with a group of trained professionals sharing this multisectoral perspective is essential to set this transition process in motion. It is this group led by the project manager that will be able to plan and monitor the transition. The examples presented in the previous chapter show that the process starts with a small step, usually the implementation of a pilot phase, which enables monitoring, evaluating, learning, and presenting concrete and measurable results, not only to society but also to government sectors attached to traditional management models.

The Smart City project should be built in stages that follow and overlap each other without trampling the processes and gains already achieved. Start with one or more pilot projects, taking firm steps that match the size of the city's institutional and financial capacities

Finally, the transition process to Smart Cities does not happen without collaboration, both internally, within the government, and externally, in their relationship with citizens. While government officials are important because they are familiar with the challenges and virtues of management, citizens represent the beginning and end of the project evaluation cycle. In this sense, it is essential to develop ways to interact and measure residents' satisfaction.

To facilitate the path to a Smart City, it is important to invest in the exchange of experiences with those who have already begun and have followed different paths. Learning from those who have done the transition is good practice for a task that requires persistence and long-term vision. After all, the development of Smart Cities is a State – and not a government – project.

Successful Smart City projects began in areas that enabled generating an impact with a relatively small investment of both resources and time, and led to major benefits for the population

When we think of a Smart City project as a long-term process, it makes sense to remember that the starting point must be carefully thought out. Successful Smart City projects began in areas that enabled generating an impact with a relatively small investment of both resources and time, and led to major benefits for the population.

While each city has a particular profile and specific needs, a plan for a Smart City is only successful if it sets clear project cycles, i.e., with a beginning, middle, and end. Moreover, it is reasonable to think that focusing on improving areas that impact the daily life of the largest share of the urban population is a good starting point.

In this sense, projects such as the digitization of services to citizens are a good start, since they facilitate the internal organization of the government while improving public service. The digitization of services, when done within parameters of fiscal management, also contributes to increased revenue. This creates a virtuous cycle that can even facilitate the investments needed for the development of Smart Cities.

Another Smart City project that usually has a very positive effect in the sense of highlighting the benefits of technology use, is the digitization and integration of urban transportation systems. These services, besides affording users greater flexibility, ensure greater transparency with respect

THE ROAD TO THE SMART CITY

Leadership
Appoint a leader capable of defending the objective of the project and bringing in partners

Team
Set up a multidisciplinary team coordinated by a dedicated manager

Citizen participation
Create mechanisms to listen to the population at every stage, starting from the identification of problems

Problems
Identify the situation of the city by mapping the critical issues that require smart answers

Diagnosis
Examine the actual conditions of the city (resources, infrastructure, technology) to address the situation

Technology
Identify smart technological solutions to address the problems identified

Financing
Identify sources of funding for implementing and supporting the actions planned

Partnerships
Identify and establish partnerships with government and private sector (businesses, academia, NGOs)

Action Plan
Develop a plan to implement the solutions identified (actions, priorities, schedules, costs, indicators, etc.)

Pilot Project
Develop pilot projects that test the proposed solution with a well-defined scope, objectives, and responsibilities

Implementation
Put into practice the actions planned in the pilot and implement the project

Metrics
Assess the results and errors of the pilot project from pre-defined performance indicators, including the overall satisfaction level of the population

Continuity
Use the results to acquaint government areas with the lessons learned and motivate change in processes

YURI BARICHIVICH

Vitoria, Brazil

to the costs of transportation, thus improving the regulatory capacity of public agencies.

Projects related to increased safety through the use of technologies are also usually very well received by the population, especially in Latin America, where public opinion polls conducted under the ESCI places safety as the major issue of concern for citizens. In these cases, the use of technologies, such as monitoring cameras in areas with high crime rates, smart lighting, and integration of information with police stations, are good examples that show to the public the benefits of having a Smart City.

In addition to the examples above, the path to a Smart City can also start as a reaction to adverse events occurring in the city. The city of Rio de Janeiro, for example, made the decision to invest in the use of technology in the wake of the floods and landslides that occurred during the heavy rains that hit the city in 2010. Unfortunately, these problems are not unique to Rio, and the use of rain gauges, monitoring cameras, and early warning systems can be an excellent starting point for a Smart City, with short-term concrete and visible results.

Literature on the topic provides other information that seeks to make the process simpler, based on the experience of cities that have successfully followed this complex path. We have grouped and summarized the information most frequently mentioned, common to most Smart Cities of today, and set up a roadmap for the implementation of a Smart City.

In general, every Smart City project should take into account six steps to avoid generating an effort that will not lead to the expected results. To achieve these steps, it is important to think holistically and understand that the city's problems and their solutions are intersectoral. In addition, it is recommended to start small, even if thinking big. It is important to draw a Smart City vision at the local level, but start its implementation with one or two pilot projects. These projects, however small, require the same level of effort and planning as a full project in order to succeed and be replicated on a large scale. Finally, it is essential to learn from each of the project cycles, documenting them and making honest assessments of the hits and misses in its application. These are the steps to be followed:

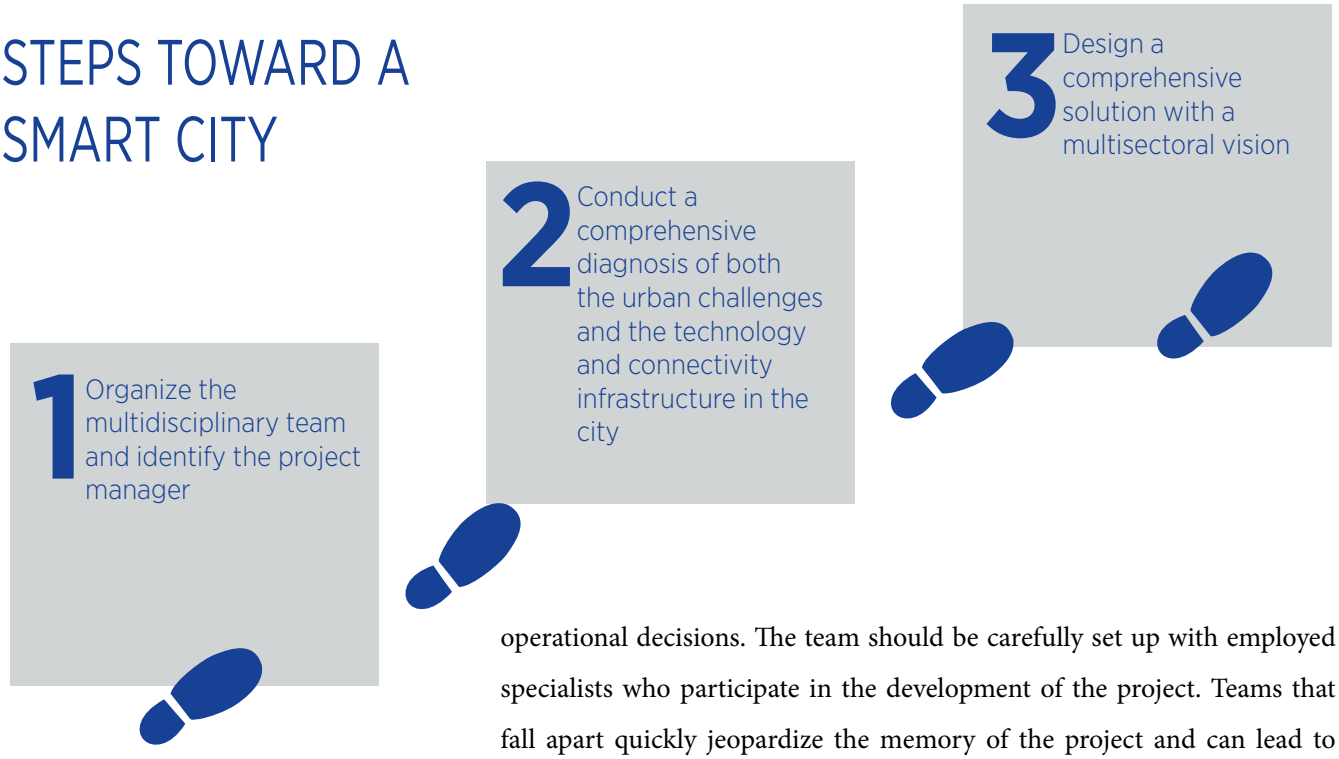
Six steps should be taken into account to avoid generating an effort that will not lead to the expected results. To achieve these steps, it is important to think holistically and understand that the city's problems and their solutions are intersectoral

1. ORGANIZE THE TEAM

Every Smart City project requires visionary leaders, with authority to take this transformation forward and capable of gathering allies and partners. This leadership must be able to create and defend the vision of the future proposed in the initiative to make the city administration more efficient and effective, and join efforts to realize it. However, as seen in chapter 3, a vision, unless accompanied by instruments to put it in motion, will hardly concretize on its own. Thus, in addition to the leader, a Smart City needs a multidisciplinary team coordinated by a manager dedicated exclusively to

the task. In this sense, the first step on the road to building a Smart City is to organize the team, which will use the leader's vision as a project roadmap.

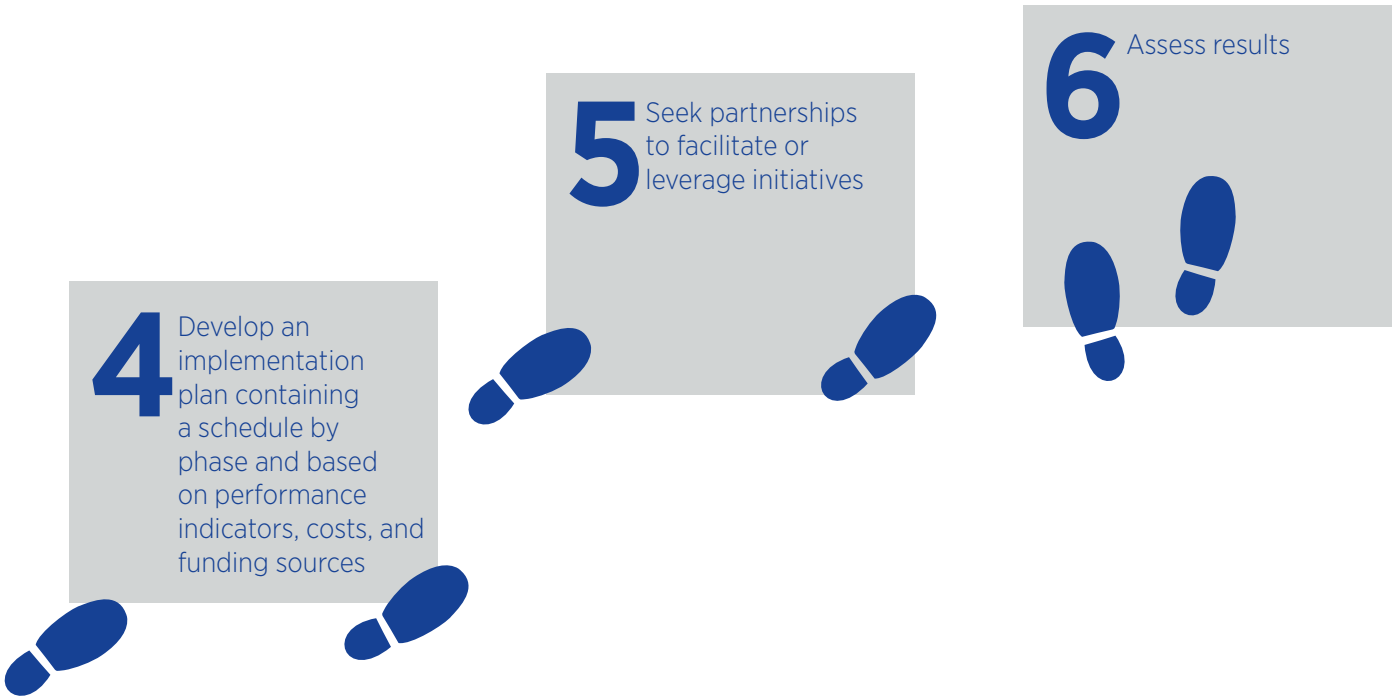
The manager must be fully aware of all connections between the different actors and make sure that they all share the same goal. The multidisciplinary team, in turn, is the project engine, ensuring progress in the desired direction and recording the lessons learned along this road. This team should be composed of representatives of each area, with sufficient technical knowledge and management skills to make strategic and



operational decisions. The team should be carefully set up with employed specialists who participate in the development of the project. Teams that fall apart quickly jeopardize the memory of the project and can lead to constant changes in strategies and solutions, which may harm the image of the project to all stakeholders.

2. MAKE THE DIAGNOSIS

The success of any Smart City depends on the solid understanding of its challenges, i.e., it requires a complete diagnosis of the problems (current and future) and of the actual capabilities of the government to solve them. In other words, knowing the limitations of the city and the complexity of the projects to be developed is critical. *(Check the experience of the city of Vitoria in the Box on page 121).*



Keep in mind that building a Smart City is an incremental process consisting of several small steps. The first step is to identify the most pressing urban challenges and, at the same time, the opportunities for government intervention in order to overcome them under a multisectoral, integrated, and collaborative vision.

Second, in addition to the diagnosis of the challenges existing in the city, it is essential to conduct a thorough examination of the available technological infrastructure in the city itself and in public institutions that provide services. This evaluation includes aspects of connectivity (coverage, speed, and technological options available for broadband data communication), systems, and equipment. Moreover, it is very important to clearly understand the institutional aspects relating to partnerships with telecommunication service providers and IT vendors. These can be a valuable source of knowledge, through the exchange of experiences, and of resource savings, in case of partnerships.

Third, it is very important to perform a deep and honest diagnosis of the institutional capacity, and especially of human resources capabilities. This will enable tackling possible limitations at the very onset of the process.

Finally, remember: a good diagnosis cannot be made without involving

Every Smart City project requires a leader capable of creating and defending the vision of the future that will lead to a more efficient public administration and unite efforts to realize it

stakeholders. In addition to civil servants, citizens and businesses established in the city should also be heard. A good way is to hold public, online, or in-person consultations to identify problems and propose suggestions of alternative ways to solve them.

Only with the definition of the leadership and the development of a proper diagnosis will it be possible to pinpoint areas where smart interventions are most needed and will have a greater impact.

3. DESIGN A HOLISTIC SOLUTION WITH A MULTISECTORAL VISION

A plan for a Smart City is only successful if it establishes well-defined project cycles

Once the comprehensive diagnosis of the challenges and potentials of the city has been made, a plan of the Smart City with multisectoral solutions and clear estimates of costs and benefits needs to be prepared. Many cities have difficulties in projects for lack of clarity of the benefits that the initiative can offer. Therefore, technology issues, institutional aspects, and their regulatory frameworks need to be taken into account.

This plan should also be devised with a focus on the integration of technology and management systems. Traditional cities tend to work with their departments as islands or silos, which leads to duplication of efforts and projects as well as higher costs. Thinking about Smart Cities requires thinking in a collaborative and integrated way about the elements that constitute them. Remember: thinking about management and how the municipal administration is organized is critical for a Smart City.

Another important point is the identification of alternatives and technological solutions. The technology industry is moving at a fast pace, and few government leaders understand all digital technology opportunities and alternatives that allow them to correctly identify the values, or even the right choices, needed to ensure that the first investments will be the correct basis for successive improvements of the solutions adopted. Knowledge of the city's current technological infrastructure – connectivity, equipment, people – and the possibilities of upgrading to newer, more efficient technologies is also an important factor at the negotiating table with vendors. In this sense, the role of both the multidisciplinary team and the project manager is very important.

Finally, it is necessary to identify the funding sources to implement and

maintain the planned actions. The biggest barrier to Smart Cities has been the financial sustainability of projects. Tax revenues are declining in many cities, making the cost of solutions increasingly difficult to be sustained. A good planning of the project phases enables predicting the successive needs of funds, which can be raised from different sources and have the support of different players.

4. DEVELOP AN IMPLEMENTATION PLAN

When reaching this point it is important to have a well-defined scope as well as objectives and responsibilities. This will allow you to set timelines and targets. For Smart City projects, it is recommended to divide the timeline into stages that favor institutional arrangements, the signing of the necessary agreements, and funding cycles.

Moreover, the small steps should be unequivocal, usually with a clear description of the project, with a broad and concrete vision of a Smart City. However, it is even more important that its implementation starts with one

IN VITORIA, CITIZENS GIVE THEIR OPINION ABOUT THE CITY'S CONNECTIVITY AND CHALLENGES

In the city of Vitoria, state capital of Espirito Santo, Brazil, citizens collaborated with the government in the task of identifying some of the city's obstacles to becoming a Smart City. Among the data collected, an email survey sought to make a diagnosis of the Internet access and digital services provided by the city.

The survey, which was developed by Cisco in partnership with the local government and the IDB, interviewed more than 7,900 people on their perception of e-government services in the areas of security, mobility, environment, health, and education. Questions covered topics such as accessibility, quality of its connectivity, frequency at which these individuals or companies interacted with public authorities on the Internet, quality of public e-services provided, etc.

The answers enabled identifying positive aspects of the services provided by the city, as well as areas that needed improvement, and served as the basis for the proposal of a strategy to help the city advance on the path to becoming a Smart City.

or two pilot projects. These projects, however small, require the same level of attention and planning as a full one. At the same time, they can provide faster results and valuable lessons for other, more comprehensive projects.

Another important task is to define the metrics that are more appropriate for project management. It is essential to remember that the right metrics depend on a clear understanding of what one wants to accomplish. They should be associated with ways to know whether the project is reaching its goals or not.

A Smart City should be structured on several technology or service providers. Creating a smart ecosystem is necessary to avoid dependency and the risk associated with a single solution provider

5. SEEK PARTNERSHIPS

Although Smart City projects can be created with public funds, an important step is to identify opportunities to establish partnerships with the private sector, academia, NGOs, and other levels of government, since many Smart Cities were born from public-private partnerships. These partnerships are interesting from both a technical and fundraising point of view.

In addition, a Smart City will be structured on several technology or service providers. Creating a smart ecosystem is necessary to provide end customers with all the solutions and services without the dependency and the risk associated with a single technology vendor. With that in mind, the roles of each player (public officials, partners, and vendors) and the expected results should be well defined. This will determine the real value needed for a win-win relationship and to ensure service quality in the end.

Smart City solutions are a good opportunity to develop startups by promoting the retention of talent, innovation, competitiveness, and entrepreneurship in the city, the region, or even the country.

Many cities around the world have created "civic innovation laboratories" to involve the public in the digital transformation process of the city, and take advantage of collaborative technologies and social networks. One of the main objectives of these laboratories should be to produce evidence on models that can more effectively harness the power of everyone's collaboration to diagnose the most urgent problems to be solved by the government, and the propose solutions.

The implementation of these laboratories can start at a small scale and evolve gradually with a pilot project, but they always need to keep a vision of

INNOVATIVE MADRID, AN INITIATIVE FOR THE FUTURE

The Smart Madrid project – Madrid MiNT – is the largest Smart City project in Europe; it depends on the role of its citizens to develop and maintain a new urban service management model based on quality indicators. Citizens pointed out what needed to be changed and continue to provide inputs on the information they receive.

To consolidate the strategy, the government of Madrid had to rethink all the management and control systems in the city, and identify those that were missing, in order to have a global view of the city and take integrated action. Therefore, the MiNT also constitutes the technological challenge of integrating the information, technologies, and management systems of the largest city in Spain. For information to flow from where it is produced (cameras, sensors, and management systems of various municipal departments) to where it is needed (the integrated operation and control center) it was necessary to establish a number of communication, data standardization, and operations protocols.

It also required investing in infrastructure and communication interfaces. These support citizen relation systems, which enable the city administration to enhance transparency strategies, Open Data, and citizen participation; government systems, which consolidate information in visual, quick access tools, taking advantage of modern augmented reality technologies and geographic information systems (GIS); and the integrated urban management system, which is responsible for coordinating the systems' interaction protocols and coordinated operation.

In short, in Madrid the redistribution of responsibilities, collaboration, and citizen connection are related to the use of technology oriented to the common good.

JOSE A. \ CC BY 2.0

the concept as a whole, of collaboration supported through open platforms, encouraging citizen- and private-sector participation. In practice, this means that cities can start by investing in collaborative technologies to discuss problems and solutions, presenting the solution of problems to citizens, using online tools that allow people to discuss ideas, and decide which ones should be implemented.

In order to incorporate new technologies and embrace the potential of the Smart Cities' solutions, increasingly connected citizens require that cities and their managers provide faster, more efficient, and more connected services, with the opportunity to interact and collaborate with public open data.

It is essential to learn from each of the project cycles, documenting them and making honest assessments of what went right and what went wrong in their application. It is also very important to develop a plan to monitor performance indicators

6. EVALUATE RESULTS

Learning and finding out which technological solutions are worth investing in requires carefully evaluating the projects listed in the plan and sharing experiences with other cities in the country and around the world. From there, indicators should be developed to measure the results, return on investment, and the satisfaction of the population, and to carefully evaluate the mistakes to avoid repeating them.

Monitoring, evaluating, and providing feedback to full urban planning and development is very important to the learning cycle in a Smart City. The measurable results of each small project, along with positive publicity and the involvement of citizens, will give an impetus to future projects. The use of indicators and transparency in data dissemination are powerful allies with regards to public opinion and the partners involved. It must be shown that the project is working, that the provision of services is improving people's lives, and that it is bringing visible changes to the dynamics of the city.

Inside city halls, Smart City projects should be seen as strong allies to change processes and motivate the managers of different government agencies. It must be shown that although the control centers are the brain of the project, many of those who work indirectly in their operation play an important role for the objectives to be achieved. Thus, it is necessary to provide feedback to the different areas of government with lessons learned, with successes and failures, and use the project to motivate process changes and adjustments in public management. This way, everybody wins.

Bogota, Colombia

VICPABLO / WIKIMEDIA

Valdivia, Chile

Smart Cities

chapter 7

OMAR URAN / EDITED IMAGE

IDB's support is based on three pillars:

urban, environmental, and fiscal sustainability

Medellin, Colombia

How can the IDB help?

Since its founding in 1959, the Inter-American Development Bank (IDB) has striven to find innovative and effective approaches to address Latin America and the Caribbean's (LAC) economic, social, institutional, and environmental development challenges, helping to lay a foundation for sustainable development in the region. Today, the Bank is the main funding source for development in the region.

Current focus areas of the Bank include:

- **Social inclusion and inequality;**
- **Productivity and innovation;**
- **Economic integration;**
- **Gender equality and diversity;**
- **Climate change and environmental sustainability;**
- **Institutional capacity and the rule of law.**

The IDB helps customers and partners develop projects and provides funding, technical assistance, and expertise to support interventions aimed at the development of the region. The Bank interventions, in general, come in the form of products such as loans (with or without sovereign guarantee), technical cooperation (refundable or non-refundable), and project-specific grants. Each of these products has specific features such as objectives and eligibility, financial, and implementation requirements.

The Bank's strong presence in LAC enables the collection of knowledge of the problems that are hindering or slowing the sustainable growth of

Since 2011 the Bank has been developing action plans for municipalities in Latin America and the Caribbean, seeking to support the construction of urban sustainability strategies and, in this context, their paths toward becoming Smart Cities

cities. Loan and technical cooperation agreements implemented over so many years of action also suggest ways to solve these problems, allowing the exchange of experiences between countries.

Several innovative studies and projects in the field of development enable the Bank to work on technological solutions to different issues in different cities, building knowledge, and turning them into real opportunities for innovation in urban management. IDB's support for the development of the Smart Cities theme can be achieved through these different products, according to the priorities agreed by the Bank with each country.

Cumana, Venezuela

RAMÓN ZAMORA

Since 2011, the IDB has been developing action plans for municipalities in LAC, seeking to support the construction of urban sustainability strategies and, in this context, their paths toward becoming Smart Cities.

This support is in line with the IDB's Emerging and Sustainable Cities Initiative (ESCI), with a multidisciplinary approach based on three pillars: urban sustainability, environmental sustainability and climate change, and fiscal sustainability and governance (www.iadb.org/cities). Phase 1 (identification and diagnosis of action areas) and Phase 2 (prioritization of action areas) of the ESCI are extremely rich with regards to detailing and prioritizing the cities' problems. During Phase 1, more than 120 indicators are collected in 23 thematic areas, and an extensive and representative public opinion survey is prepared, bringing into the process the citizens' perception on topics of relevance to the mayor and public managers.

In these phases, the ESCI seeks great participation of the public authorities and different spheres of government, public and private companies, universities, civil society, and the general public. The ESCI, therefore, offers a comprehensive starting point and goal for assessing the possible paths on the journey toward a Smart City.

The ESCI seeks to transform technological solutions into knowledge and actual opportunities for innovation in urban management

In addition to the intersectoral diagnosis proposed in Phases 1 and 2 of the ESCI, the initiative also incorporates a variety of actions in the context of Smart Cities, starting with an assessment of needs, the viable technologies to provide broadband connectivity, and main challenges of each municipality (in several urban management action areas), and then identifying the opportunities for the benefits that the use of Information and Communication Technologies can provide. Typically, these assessments are developed with the support of the governments of IDB member countries or the private sector,[24] and seek to take advantage of the internal mobilization in municipalities to support mayors who lead the ESCI implementation process in the city and seek innovation and technology to improve the lives of its residents.

Smart City projects prepared by the Bank included the development of integrated solutions to meet the demands of the cities in the areas of security, traffic, transportation, response to emergencies and disasters, connectivity, governance, and Integrated Operation and Control Centers

24) Examples of partnerships include the Government of Republic of Korea, companies like Cisco, Everis, IDOM, Microsoft, Moon Engineering, NEC, Saab, the Korean Research Institute of Human Settlement (KRIHS), and consultants.

for the cities of Goiânia, Vitória, João Pessoa, Palmas, and Florianópolis in Brazil; Barranquilla, Valledupar, and Villavicencio in Colombia; Montevideo in Uruguay; Montego Bay in Jamaica; Valdivia in Chile; Nassau in The Bahamas; and Guadalajara in Mexico.

Finally, in order to generate knowledge from successful cases of cities that used technology to become smarter, the IDB, in association with the Korea Research Institute for Human Settlements (KRIHS) has developed ten international case studies of cities of different sizes that play prominent roles in the theme of Smart Cities: Anyang, Medellin, Namyangiu, Orlando, Pangyo, Rio de Janeiro, Santander, Singapore, Songdo, and Tel Aviv.

The ESCI operates in cities with populations between 100,000 and 2 million. Expanding the use of technology to improve the management of cities and the provision of services is a relevant area of work under the Initiative

These cities are already harvesting the results of the changes brought forward to become Smart Cities, and have begun their journey for different reasons: to respond to serious incidents that surprised them, to seize opportunities for government initiatives, or to meet the growing demands of citizens for better services.

In the case of Anyang, South Korea, the triggering effect of this transformation occurred in 2003 with the kidnapping of two children; in Rio de Janeiro, it was a storm surge in 2010 that left the city with dozens of dead and hundreds of homeless people. Similarly, vulnerability to natural disasters was the main reason why the city of Orlando decided to build its operations center in 2001. In the case of Tel Aviv, the great motivation was to improve communication and the provision of customized services to its residents ("Digi-Tel" platform) and foster collaboration with startups and the private sector for the implementation of innovative solutions. In Santander, the path started with a research project sponsored by the European Union.

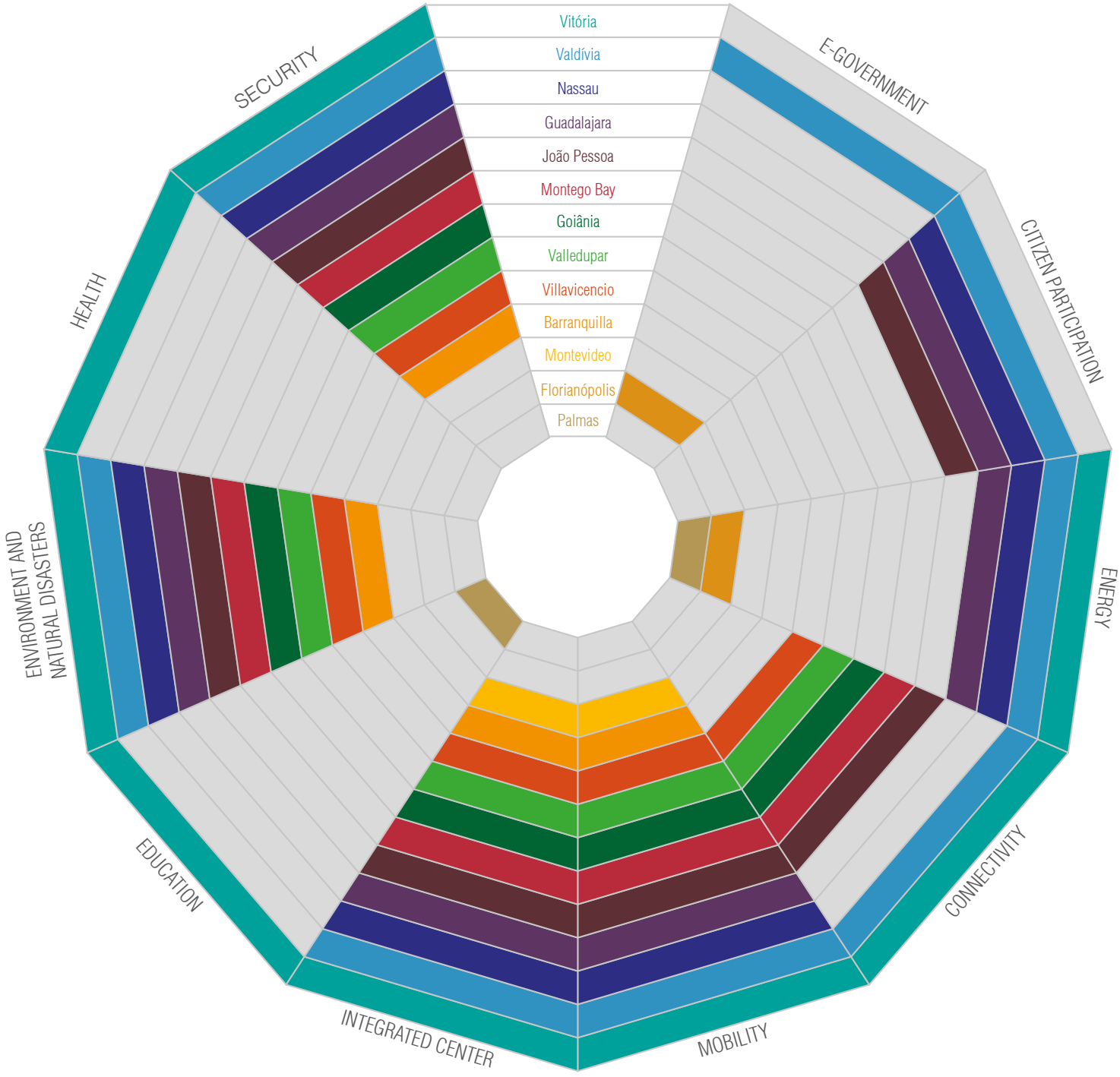
In every city, the leadership of mayors was critical to the success of these initiatives. These processes, which were started and conducted in different ways according to the local context, have generated important results for the cities. In the case of Medellin, for example, the Smart Mobility System generated savings of about USD 20 million in socioeconomic costs related to traffic accidents. Anyang, in turn, succeeded in reducing its average crime rate by 17.8 percent with the use of technology. Orlando, with its operations center, besides responding in a more efficient and coordinated manner to weather events, improved the safety of the population and tourists by

integrating monitoring activities. Santander, after the development of the project with the European Union, began to receive support from the private sector and universities, bringing other excellent results. These cases show that projects that are planned in an integrated manner and implemented with dedication can actually improve life in the cities.

HOW IS THE IDB HELPING?

SMART CITIES PROJECTS IN LAC

The IDB is supporting the design of Smart Cities Projects on several topics in LAC cities:



CASE STUDIES

Besides designing Smart Cities Projects in LAC, the IDB has developed case studies in collaboration with KRIHS:

Access the complete publication at:

http://www.iadb.org/en/20271.html

1 ANYANG, Rep. Korea

With 600,000 inhabitants, the city located in the surroundings of Seoul has been implementing its Smart City strategy since 2003. Having started this path in the area of mobility, today it also incorporates public safety and disaster prevention initiatives. The Integrated Operation and Control Center functions as the platform that aggregates, analyzes, and distributes the collected information, favoring the use of data to improve management.

2 MEDELLIN, Colombia

Located at around 400 km from Bogota, more precisely in the department of Antioquia, Medellin is the second largest city in Colombia, with about 2 million inhabitants. Since 2004, it has been implementing strategies to become a Smart City, focusing on the creation of mechanisms of interaction with citizens in the areas of mobility, environment, and public safety.

3 NAMYANGJU, Rep. Korea

Driven by population growth, crime rates and traffic, Namyangiu, a city of 650,000 people, began its path to become a Smart City in 2008. Today the city offers a number of civic services available via smartphones in area such as safety, traffic, and incident information. It also boasts interesting multifunctional 'smart poles' that combine street light, CCTV, and traffic signal controller to promote efficient use of roadside facilities.

4 ORLANDO, United States

The famous international destination for theme parks makes use of an Operations Center to anchor its Smart City strategy. Established in 2001, it includes transportation services, police, and fire departments for monitoring and response of road, criminal, and natural incidents. In addition to the center, Orlando also incorporates intelligent initiatives in the areas of water and solid waste management.

5 PANGYO, Rep. Korea

Pangyo is a new city, built from 2003 onwards. Founded with the goal of being Korea's Silicon Valley, it has a Smart City strategy since its foundation. The city, now with 87,000 people, interacts with citizens through intelligent kiosks, and performs real-time monitoring of public lighting and water. It also develops innovative methods of generating revenue to cover maintenance costs through advertising.

6 RIO DE JANEIRO, Brazil

With about 6.3 million inhabitants, the main focus of the Smart City strategy of Brazil's second largest city is its Operations Center. Built in 2010, it allows the monitoring of the city in real time, the planning of actions, and the management of crises with varying degrees of complexity. In addition, it serves as the focal point for other various Smart City initiatives in the city.

7 SANTANDER, Spain

Located in Spain and home to 175,000 people, it stands out for its large monitoring capacity with thousands of sensors and an innovative governance structure for the coordination of actions. Alliances built between the university, the municipality, and the private sector make Santander an exemplary case of intelligent management and innovation, particularly in the areas of solid waste, public lighting, and mobility.

8 SINGAPORE, Singapore

The Asian city-state represents a unique and interesting case. It has a Smart City strategy based on a 'Smart Nation Vision', established in 2014, which seeks to provide cutting-edge infrastructure and make use of technology to overcome challenges such as urban growth, sustainability, and aging population. It covers the areas of mobility, transportation, security, energy, construction, education, and health.

9 SONGDO, Rep. Korea

Part of the Incheon Free Economic Zone, Songdo is an iconic Smart City in the Republic of Korea. It serves as a hub concentrating business events and IT companies, biotechnology, and R&D. Started in 2008 and still under development, the project is divided into six sectors, including transportation, security, disaster prevention and response, environment and interaction with citizens, and IOCC. Its Smart City strategy is managed by a public-private partnership.

10 TEL AVIV, Israel

In recent years, the Israel city of 400,000 inhabitants has developed a unique approach to smart cities thought from citizens' initiatives. The case study explains the decentralized strategy of the Tel Aviv, demonstrating how to achieve a high level of smart urban services at low cost, using mainly local innovation environment and Open Data.

RAMÓN ZAMORA

Nassau, The Bahamas

Smart Cities

chapter 8

Conclusions and prospects

The concept of Smart Cities and its use has advanced since the last century, and over this period of more than 20 years has not only progressed in the type of offer of technology and applications, but also changed hands when it comes to the implementation initiative.

The American researcher Boyd Cohen,[25] who holds a PhD in urban strategy, describes the evolution of the engagement of cities in the concept as a three-phase process: Cohen named the **first wave** Smart Cities 1.0. It is characterized by projects offered by technology vendors to municipal managers who were not fully prepared to understand all the impacts of technological solutions on the city or quality of life of citizens.

The second wave, Smart Cities 2.0, is marked by the initiative of the municipality – innovative mayors and managers – that sees the potential of technology and is able to define projects focused on technological solutions that improve the quality of life in the city. This is the phase we are at right now – where mayors want their cities to be smart and need help (knowledge, technical and financial support, etc.) to put this transformation into practice.

In the third wave, Smart Cities 3.0, the differentiating element is the fact that citizens are active participants in the process, helping design the next generation of smart and more sustainable cities. As an example, Cohen mentions the city of Vancouver, Canada, which involved 30,000 people in the co-creation of the Vancouver: Greenest City 2020 Action Plan; and the city of Vienna, Austria, which included citizens as investors in solar power plants in order to reach its renewable energy target in 2050.

An important element of Smart Cities is that there is no single solution for all, as each city is unique in its cultural, economic, political, territorial,

25) Fast Company – Article published on Aug. 10, 2015 (http://www.fastcoexist.com/3047795/the-3-generations-of-smart-cities)

and environmental characteristics. But the scenario has never been so fraught with examples, tools, and sources of funding and information for municipal managers to seek ideas and create their own project. They have an advantage: they have the citizens on their side.

It is important to remember the advantages of shifting the city from the traditional management model to the Smart City management model. The various examples provided in this Guide and many other success stories around the world demonstrate concrete improvements in the problems faced by public managers:

In smart management, the ability to plan and anticipate needs increases, actions are coordinated and integrated, resources are shared, investments can be scalable, and cost savings is enjoyed by all;

In urban infrastructure enhanced by the latest technology, the level of service offered to the population improves considerably, with savings of financial and human resources, and greater efficiency, safety, mobility, automation, and flexibility. Real-time monitoring of environmental conditions and problems enables acting promptly on solutions or avoiding crises by anticipating scenarios;

The engagement of citizens increases when they benefit from a single and unique online platform. It is easier and faster to find and access services, participate in city initiatives, communicate with and receive information from the government and its departments, and contribute to urban management.

To be considered smart, a city must necessarily incorporate aspects related to improving governance, planning, infrastructure, and how this is reflected in its human and social capital

Digital technology should not be seen as an end but as a means that enables transforming the traditional infrastructure of the city into a living and sustainable ecosystem that brings benefits to the people and businesses living and working there

The Open Data policy brings transparency and increases confidence in managers. Data monitoring systems and interdepartmental communication channels eliminate the old silos and replace misinformation and duplicity through integration between teams and the smart and shared use of data, human resources, technology, and funds. Public management results improve and costs are reduced.

As seen in this Guide, rapid urban growth, often uncontrolled, translates into immense challenges. Indeed, the twenty-first century will be an extremely challenging period, given that the growth phenomenon probably will not be contained. Added to this are global warming, overpopulation, and the likely shortage of drinking water. In the developing world, in view of the lack of infrastructure and the particular vulnerability of parts of the population, attention and efforts should be doubled. The cities of Latin America and the Caribbean are in this group and therefore face major challenges. However, because of their relative economic development in recent decades, they are able to improve their management and thus enhance people's lives.

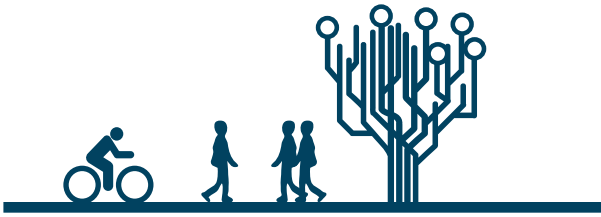
The Smart City management model fits perfectly in that philosophy, and is an ally that should not be neglected. To meet the challenge of becoming more human, cities need to reconcile growth by redesigning themselves, creating environments that are safer, more sustainable, and better to live in. Technology has a key role in this context. It is essential to establish a relationship between the traditional elements that make up a city and new technologies.

Redesigning cities so they become smarter means to integrate different efforts and knowledge – such as architecture, urban planning, engineering,

Information and Communication Technologies, and environment, among others – to link the connectivity infrastructure to the world of technology embedded in objects such as monitoring cameras, vehicles, traffic lights, and street furniture. All this must be done without losing sight of the analog aspects that make up the urban space.

For this purpose, technology should not be understood as an end but rather as a means to sustainability. It is not enough to invest in smart systems, operations centers, and applications alone. Smart solutions for cities should come from integrated analysis and proposals for a plan that considers governance and economy issues. They should focus on aspects that result in improved social and economic conditions, as well as the supply of infrastructure and services provided by local governments.

Building Smart Cities means joining efforts and taking advantage of the best we have, in order to overcome challenges and improve people's lives. In view of the challenges currently presented and of the projects for the near future, transforming traditional management models into Smart City models is not just an opportunity, it is an imperative. In this process, people, governments, the private sector, and civil society should all participate. Technology, now so present in the lives of citizens, is also part of that. With its reach, ability to reduce distances, organize information, and improve responses at both the individual and community levels, technology cannot be left aside when thinking about the future of cities. Fortunately, in LAC today we already have the conditions to take solid steps in that direction. Its continuity depends on the efforts of all, and local governments in the region play a key role in inducing these processes. The IDB, together with its partners, has the knowledge and experience needed to help cities in this endeavor.



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