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A CALL TO CITY LEADERS:

MAKING OUR CITIES SMARTER, SAFER, AND MORE EFFICIENT

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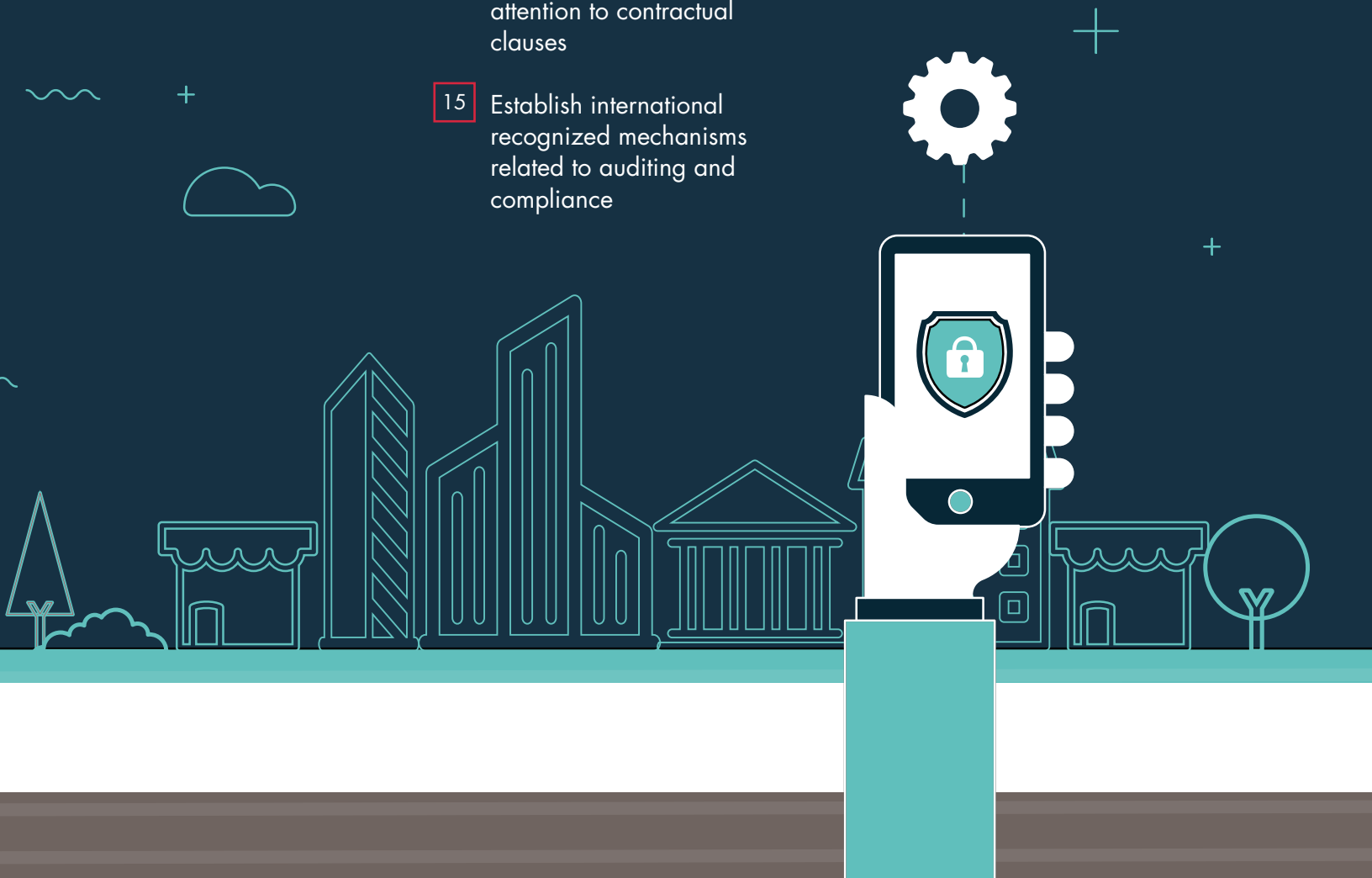

A CALL TO CITY LEADERS:

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EXECUTIVE SUMMARY

Cities are becoming "smart" and are both producer and consumer of data. Mobile apps are changing cities, already supporting improvements in traffic management, health, and other important areas. This white paper gives an overview of the ongoing social, political and technological developments that are being embraced by cities. It briefly explains inter-related concepts such as *Big Data, Application Program Interfaces* (APIs); *the Internet of Things* (IoT), *Cloud Computing, Artificial Intelligence* (AI). Further, it presents some examples of the institutional changes that are being promoted by cities willing to take full advantage of this new era. Lastly, some concrete steps that should be taken by city leaders willing to foster sound technological development are outlined. Such steps will allow for a sustainable city development.

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INTRODUCTION

As the band U2 has said the "more you see, the less you know" which applies to cities,[1] as they are being profoundly changed by new technologies. They are not only "cities of blinding lights",[2] but cities of connected devices, things, machines, sensors, and have been transformed into producers of data and consumers of data. Indeed, "smart cities" are able to strengthen their approach to development by integrating different data and digital technologies. Examples of the ongoing transformation of cities are embedded cameras into streetlights which monitor pedestrian traffic, geographic processing tools that are combined with traffic information and considerably improve traffic; mobile apps that allow citizens to report crime scenes instantaneously; or using low cost sensors to improve waste management systems.

Cities both produce large amounts of data and also consume large amounts of data. Analyzing this data can help policy-makers make more informed decisions and may uncover opportunities to optimize processes and systems and to reduce costs. It might also ultimately contribute towards better city planning, improving the quality of life of citizens.

This white paper describes what is making cities "smarter", how this modernization benefits citizens and the technologies behind these transformations. To fully take advantage of the technological revolution, leaders in each city need to better understand how to leverage all the data that is gathered, as well as the technologies behind the new "smart cities" paradigm. Local leaders need a holistic strategy to harness the power of this newly available data by removing unnecessary barriers for data processing and usage while taking into account security concerns.

[1] Referring to a song called "City of Blinding Lights", by U2

[2] Id.

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WHAT MAKES A CITY "SMART"

1

Cities are under increasing pressure to innovate and use technology to accommodate growing populations in dense urban areas. Indeed, the percentage of the population that lives in urban areas has been increasing rapidly, and by 2030 it is expected that 5 billion people will be living in urban areas (UN, 2017). For different reasons, many of those who live in urban areas breathe air that does not meet international safety standards, face longer commutes due to the urban sprawl and issues related to waste collection, and/or live in slum conditions (UN, 2017). To accommodate such influx of people, cities need to become more "inclusive, safe, resilient, and sustainable," as outlined by the United Nations' "Sustainable Development Goals" (UNSDGs).[3]

Given the scenario described above, many have understood that policies directed towards cities are a must. Indeed, a report published by the UN shows that three in every four countries in the world are developing national-level urban policies (UN, 2017). Such development is largely being supported by Information and Communication Technologies (ICTs), which are helping them to become "smarter".

The term "smart cities" has been popularized over the past few years. While definitions for the term "smart city" vary, a city is generally considered "smart" when it integrates "data and digital technologies into a strategic approach to sustainability, citizen well-being, and economic development" (CDAIT, 2018, p. 22, citing Urban Tide and Scottish Government, 2014)

Smart cities are both producers of data and, at the same time, largely rely on data to make estimations, policies, and decisions. The term "big data", a concept that is crucial to smart cities, refers to as "a massive amount of data that can be analyzed and used to make decisions" (Rafferty et al., 2016) and it "play[s] a major role in urban knowledge discovery and planning support" (Thakuriah et al., 2017).[4]

While cities have always been able to collect and analyze data, the development of technologies enables a new paradigm, with a "potential to turn urban areas into large-scale experimental test beds for data-driven innovation" (OECD, 2015). Big data's main characteristics are its "volume, variety and velocity" (Rafferty et al., 2016), and this allows it to be a major driver of innovation, productivity, and data-driven decision-making process for city planners. Nguyen and Boundy (2017) have studied five cities in the United States and found that, in all of them, big data is already "altering the way in which decisions are made in local government by supplying more data sources, integrating cross agency data, and to use predictive rather than reactive analytics to make decisions" (p. 533).

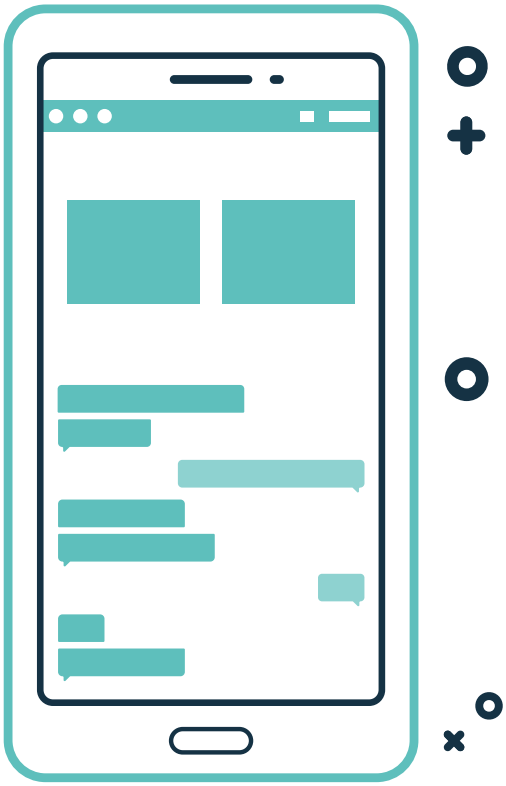
[3] Goal #11 of the United Nations' "Sustainable Development Goals" (UNSDGs) is "mak(ing) cities and human settlements inclusive, safe, resilient and sustainable" See: https://sustainabledevelopment.un.org/sdg11

[4] While there are several reasons to praise the advancements brought about by the use of data and technology to make predictions, it is important to understand the limitations of making decisions based on prediction methods, as taking into context different aspects is needed, as well as approaching problems through multidisciplinary lenses (Athey, 2017).

BOX #1:

MOBILE APPS CHANGING CITIES

The ability of city planners to understand the needs of the citizens has dramatically improved over the past years thanks to data collected by various mobile applications. In Rio de Janeiro, for example, data inputs from mobile applications have been useful in helping the city to understand travel times and to address other issues (Schreiner, 2016). Geographic processing tools combined with traffic information from citizens' inputs through a mobile application have also helped Rio improve its ability to address other issues such as flooding (Waze, 2018).



A key tool to access the data in a particular city is the incorporation of Application Program Interfaces (APIs) in government systems. APIs are "essentially a contract" that allow for different partners or developers to access data and services so that different applications can be built (Woods et al., 2011). The openness of these APIs varies, and they can be open to any developer, to specific persons only or used within the context of a particular team. Furthermore, the API provider describes the different functionalities that are made available or offered, as well as how and when they might be altered, any limitations, and/or legal and business constraints (Woods et al., 2011).

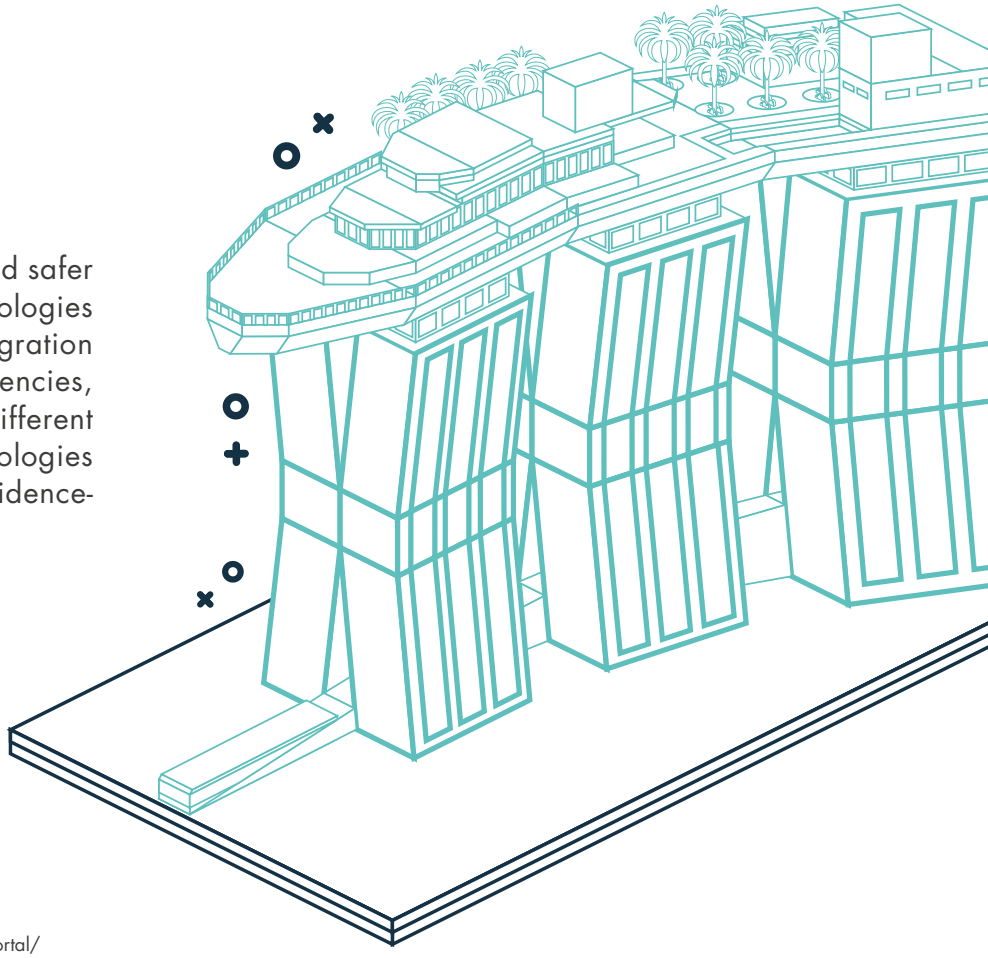
Cities now count with several APIs linked to different products, services and technologies, but such data sometimes ends up in silos rather than being part of a broad and shared data ecosystem. These data silos leave "smart city devices sidelined from the conversation with commonly-used apps" (Young, 2018,p. 2). Solutions aimed at solving this problem are starting to be developed, optimizing API functionalities and improving overall use of the data.

BOX #2:

SINGAPORE AS A SMART-CITY

In the sovereign city-state of Singapore, a marketplace for APIs was created by the government (IRAS API Marketplace)[5]. It is a "place where the Government releases many data sets to the public to build applications and services" (Singapore Government, 2015), and it is part of the "Smart Nation Singapore" Program, which also comprises other aspects such as an Open Data Portal (Id.). Other programs and policies make Singapore "smart", such as its level of understanding of cybersecurity. For example, a National Cybersecurity Centre was created in 2014, and in 2015 a Cybersecurity Agency and a cybercrime command within the Singapore Police Force were created (CSA, 2016).

Cities are now smarter, more efficient and safer because of apps, APIs and other technologies that allow for news forms of analysis, integration and use of databases, bringing efficiencies, cost reductions and innovation. The different cases outlined below show how technologies are helping cities and supporting evidence-based decision making.



[5] See API Markeplace - https://apiservices.iras.gov.sg/iras/devportal/

2 WHAT ARE SOME EXAMPLES OF TECHNOLOGIES THAT ARE HELPING CITIES TO BECOME SMARTER, SAFER, AND MORE EFFICIENT?

Some of the key drivers to make a city a "smart city" are the existence of widely deployed sensors that produce real time data streams, the new and sophisticated types of data analysis and algorithms, the ability to process such data in ways that were not possible before, the decrease in data storage costs, and improvement in computational power (Hill et al., 2017). When considering policies and budget allocation for making their cities smarter, city planners now have an immense volume of data sets to analyze and to use in their policy decisions. Prior to making such decisions they need to understand the different types of technology concepts that are in the background of the innovations that can be possibly implemented. In addition to the benefits of harnessing big data, other technologies used for urban planning include: the Internet of Things (IoT); *Cloud Computing; Artificial Intelligence* (AI) *and Machine Learning* (ML):

2.1 The Internet of Things (IoT)

The Internet of Things (IoT) is "characterized by using smart and self-configuring objects that can interact with each other via global network infrastructure" (Ge et al., 2018, p. p. 601). This mechanism is a true game-changer for cities by facilitating interconnections between various objects, devices, and sensors. Cities are then able to optimize different systems and services, such smart infrastructure, smart buildings, smart industrial environment, smart cities services and smart energy, water and waste management, as described in the **Annex 1. (See below)**

Practical examples:

Different IoT deployment cases that affect transportation were highlighted by the Center for Development and Application of Internet of Things Technologies (CDAIT). San Diego, California, deployed an "intelligent network citywide", optimizing traffic, parking, and energy by embedding cameras into streetlights so that pedestrian traffic is monitored (CDAIT, 2018, p. 29). San Antonio, Texas and Atlanta, Georgia have initiatives of IoT connected lights, which help reducing traffic congestion, accidents, and visibility (CDAIT, 2018, p. 30). Other uses of sensors besides the ones related to transportation are given by Gutierrez *et al.* (2018), who described an experiment in the city of Patras, in Greece, which showcases how sensors integrated to smartphones can be used for data collection experiments, and even to monitor the concentration of nitrogen dioxide (NO2) in different parts of the city.

2.2 Cloud Computing

Cities produce terabytes of data every day. To leverage this data, governments need to leverage new technologies to store the large volume of information so it can be used either in real time or at a later date.

Large institutions – including public sector ones – used to enable the analysis of data they gather through building large data warehouses. Data warehouses are referred to as "central repository of information coming from one or more data sources" (Amazon Web Services, Inc., 2016). This is an expensive process not only because of the initial investments involved in setting the warehouse up, but also because there are costs involved in maintaining the warehouse, hiring skilled persons to administer, analyze and protect data hosted in it, in addition to the costs involved in hardware and software licenses. As stated by Nguyen and Boundy (2017), "cities often do not calculate the costs associated with collecting, cleaning, managing, and updating big data" (p. 533). However, it is now possible to transfer such warehousing as well as all IT functionalities to the "cloud" at much lower costs and with greater access to analytical tools and other services such as Artificial Intelligence and Machine Learning.

This transfer to the "cloud" means that data is no longer stored in government datacenters, but with a third-party service providers on more resilient and secure infrastructure, with no upfront cost or commitment to long-term investments, and with the ability to scale quickly as needed. These new possibilities may be useful for cities that are now able to collect a large amount of data and make sound policy decisions based on it.

Practical examples:

In 2018, the city of Medellin, Colombia launched a free mobile app through which citizens are able to record videos of the crime scenes they experience, and such videos are shared in real time by authorities. The videos might be shared maintaining the anonymity of citizens (e.g. IP addresses are not stored). Videos are sent to a cloud based data warehouse which is managed by the city of Medellin and centrally monitored by police and law enforcement agents.[6]

2.3 Artificial Intelligence (AI) and Machine Learning (ML)

Defining "Artificial Intelligence (AI)" is not simple but AI has been recognized as "programme whose ambitious objective is to understand and reproduce human cognition; creating cognitive processes comparable to those found in human beings" (Id., p.4) since the 50's. Over the past decade, however, AI has entered a new phase because of Machine Learning (ML), one of AI's mostly used expressions (Villani, 2018). As Brauneis and Goodman (2018) explain, ML is a process in which computers test a huge number of correlations to make predictions about future behavior or future events, allowing for data-driven decision-making processes. Such techniques "mark the gradual transition from a programming approach to one that involves learning" (Villani, 2018, p. 20).

The public sector already uses machine-learning techniques "for allocating fire and health inspectors in cities as well as a variety of other urban applications" (Athey, 2017, p.1), but this data-driven decision making brings new challenges and opportunities.

[6] This information is based on e-mail correspondence exchanged with officials from the Medellin city government.

Practical examples:

Glaeser *et al.* (2015) describe that it is possible to create a "predictive algorithm trained through machine learning" (p.30) through which the history of *Yelp* reviews combined with the "history of inspection outcomes" are used to predict how likely it is to find sanitary violations in restaurants, bringing efficiency to the work of inspectors, who would be able to focus their efforts in restaurants more likely to be infringing rules.

3 HOW SHOULD CITY GOVERNMENTS DEAL WITH DATA?

Data is becoming one of the most valuable resources city officials have to evaluate citizen's needs, make predictions, and ultimately make policy and planning decisions. The vast benefits of the data also comes with responsibilities, and as the volume of datasets grow, cities have an increasing responsibility to manage and secure their data.

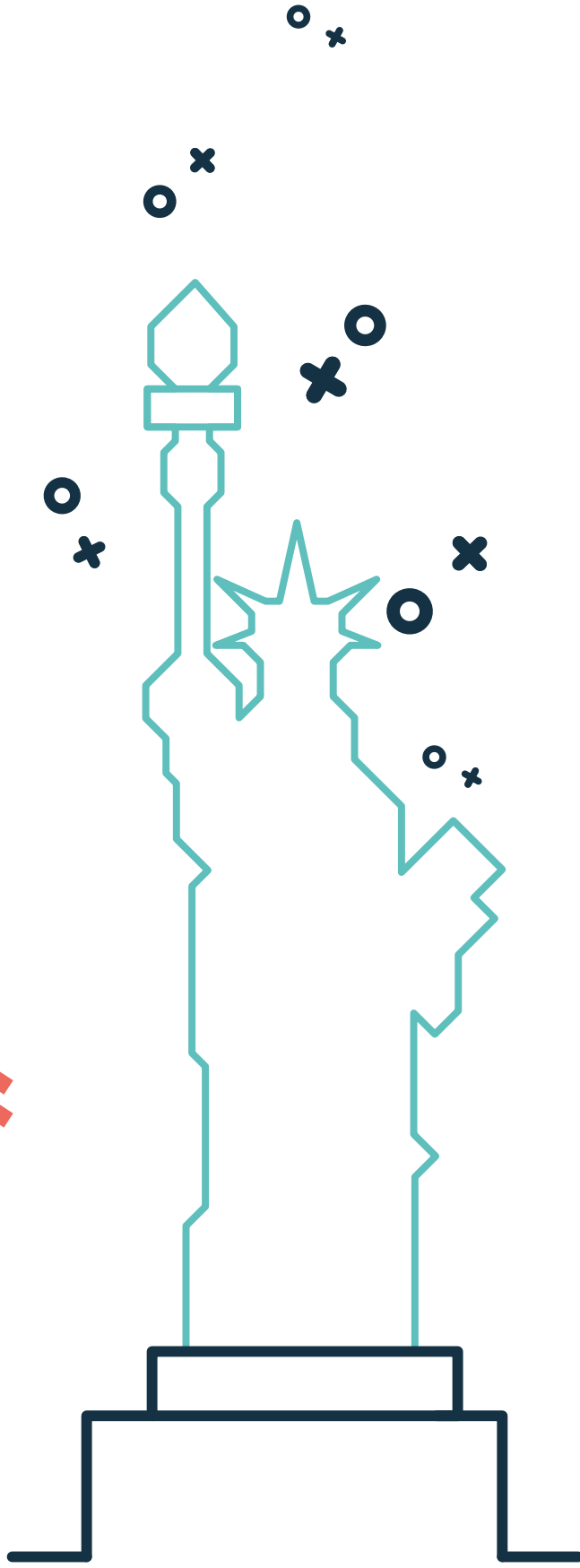
A study conducted in 2016 found that local governments in the United States are constantly being breached, and that the lack of funding and the scarce human resources available were the main barriers for properly addressing cybersecurity concerns (Norris et al., 2017). Indeed, cities have been increasingly targeted by hackers. Norris et al. (2018) discuss the hack that occurred in Atlanta and in Baltimore in 2018, two metropolitan cities in the United States, and argue that, in both cases, despite the fact they could have been prevented, they were not. In Atlanta, government employees were not able to turn their desktops on for five days after a ransomware attack (Blinder and Perlroth, 2018). Baltimore suffered an attack to the city's dispatch system supporting services such as direct 911 and other important parts of the emergency system of the city (Reuters, 2018).

BOX #3:

NEW YORK, PRIVACY AND CYBERSECURITY

The New York City Cyber Command (NYC3), launched in July 2017 by an Executive Order of Mayor Bill de Blasio (E.O. #28), is a clear indication that city planners are starting to realize they have a role to play in cybersecurity. NYC3 has three different duties for the municipal government: (i) setting information security policies and standards; (ii) directing the incidence response and cyber defense of the whole city; and (iii) guiding the mayor and city agencies in cyber defense and information risk (E.O. #28). In 2018, Mayor de Blasio went on to hire a "Chief Privacy Officer" (NYC, 2018).

"NYC Secure", launched by NYC3 in 2018, is a free city-sponsored app that warns citizens about possible threats and protects devices from malicious content (NYC Secure, 2018). The app does not "access any personally identifiable information" and operates "under a strict privacy policy and technical controls, with regular monitoring and enforcement" (NYC Secure, 2018).



The incidents cited above illustrate how important it is to pay close attention to data protection and cybersecurity aspects when governing a city. Officials should have a comprehensive strategy on how and where data is stored, how much it will cost, and what level of security is needed.

As explained by Van Zoonen (2016) the concept of data in the case of a smart city "extends beyond the big numbers churned out by monitoring technologies, and also includes the data present in city registers, the data from government or corporate surveys, and the data from social media updates" (p. 472). Thus, it is important to highlight that while new technologies, processes and

databases exist, older databases that have existed for much longer are also exposed and need to be protected and secured.

Governments around the world have, or are in the process of, creating or adopting rules, regulations and frameworks to ensuring the appropriate use of data. Europe's General Data Protection Regulation (GDPR),[7] which entered into force in May 2018, is now considered a key element in the development of the digital ecosystem in Europe (and worldwide). Any "processing of personal data" related to individuals in the EU must respect the rules established by the GDPR. This means that city governments within Europe as well as governments, companies or organizations targeting the European market will have to comply with it.

Another example of existing framework that might be used by cities is the "National Institute of Standards and Technology (NIST) Cyber Security Framework (CSF)", comprised of three key elements (framework core, implementation tiers and framework profiles) (Keller, 2018), as well as NIST's "IoT-Enabled SmartCity Framework" (IES-City Framework), released in 2018 (NIST, 2018). Cities that have regulations in place and/or have adopted frameworks might consider implementing compliance mechanisms to ensure that the rules and frameworks are upheld. Additionally, other authors discuss best practices to address privacy and data protection, as well as the use and reuse of data and other important data governance concerns (See e.g. Van Zoonen, 2016; SmartImpact, 2018).

An important aspect in the governance of data is the reliance on private companies in the deployment of technology-based services. For this reason, it is imperative that agreements are carefully written to protect data and so that ownership is retained by government institutions contracting with private institutions. Ownership of data involves ethical and political aspects, and different cities in Europe have even added a "data ownership clause" to their procurement contracts (although access and ownership might not always be granted on an exclusive basis) (SmartImpact, 2018). This demand for data ownership is already understood by the major cloud providers, which allow customers to retain ownership and control of their content.

Other issues for city leaders should be aware of include the transparency of contractual terms as well as the privacy and security of the data. Barik et al. (2017) highlighted that developing a cybersecurity policy at the city level is important, and that policies should be designed after taking into consideration what is appropriate to the city, what its objectives are, which commitments should be made, and which improvements should to cybersecurity systems should be continuously made. Incident management, service continuity management, and disaster recovery are also crucial parts in the formulation of cybersecurity policies (Barik et al.; 2017). Some cities have built out agencies and/or cyber-commands specifically focused on cybersecurity, such as New York and Singapore, both referenced in this document.

Cities in the Americas are some of the most advanced smart cities, as well as some of the least advanced ones. While the level of awareness of these different needs and development of these policies may vary across cities, many are considering undertaking measure to strengthen their policies, processes, and frameworks.

[7] Regulation (EU) 2016/679 - https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1532348683434&uri=CELEX:02016R0679-20160504

BOX #4:

SMART CITIES IN THE AMERICAS

Levels of development of smart cities and data governance vary across cities in the Americas, and while there are several projects in place, they are still far from being considered truly smart (Calderon et. al, 2017; Halleux and Estache, 2018; McKinsey, 2018). A study published by McKinsey from 2018 shows that cities in Latin America are comparatively less advanced in terms of their development as smart cities if compared to North American, European and cities in China and East Asia (McKinsey, 2018). The strength of the technology base of a smart city, comprised of sensors, communication and open data portals, was measured by McKinsey and Latin American countries lack behind "particularly in installing the sensor layer, which is the most capital-intensive aspect of smart city development" (McKinsey, 2018, p.79). In regard to smart applications being deployed in the region, most relate to mobility, a similar trend found in other regions (McKinsey, 2018).

4 WHAT CONCRETE STEPS CAN BE TAKEN TOWARDS THE CREATION OF A SUSTAINABLE AND SECURE SMART CITY?

Cities around the whole world are constantly re-assessing their roles and needs in promoting a good data ecosystem. Even the most developed and rich ones do not have all the answer to this ever-changing landscape. New technologies, new types of threats, and new frameworks are constantly created. For this reason, this document provides a summary of some of the steps that can be taken towards creating smart cities that are sustainable and secure. This list below is not a comprehensive guide but rather a brief overview of some important initial steps that can be taken city leaders. .They will certainly help them creating more "inclusive, safe, resilient, and sustainable" cities, such as what the UN's Sustainable Development Goal # 11 aims to achieve.

4.1 Undertake an initial assessment and identify how data can be better used

Cities should assess their current services, databases, processes, and activities that involve the collection, the storage, the use and/or the reuse of data. Different technologies as well as different services and areas of the government should be involved in this assessment. Further, this initial assessment should identify ways of fostering the use of data by different parts of society e.g. through APIs with optimized functionalities and that are not left in silos. The assessment should also comprise an assessment of the mobile apps that exist and the ones that can/should be created.

4.2 Consider strengthening institutional aspects

To bolster institutional knowledge and capabilities, some cities create agencies or offices specifically focused on privacy and cybersecurity. Funding mechanisms should be put into place in order to ensure continuity of these efforts, and a plan related to hiring and training qualified professionals is also necessary. Moreover, as described by Halleux and Estache (2018), governments across different levels should be committed to transparency and should make conscious efforts to be politically aligned so that benefits of large amounts of data available trickle down to activities and policies at the local level.

4.3 Consider adopting existing frameworks and pay close attention to contractual clauses

Adopting international or industry frameworks and standards at the national and local government levels (e.g. National Institute of Standards and Technology (NIST) Cyber Security Framework (CSF) or standards from the International Standards Organization (ISO)) allow for more rapid implementation, greater support involved parties, and confidence in having a solid and auditable program. Further, while using the latest technologies (e.g. storing data on the cloud) helps smart cities becoming more resilient, cost-effective and efficient; governments need to pay attention to how

contracts and agreements are written. For example, governments might consider adding a "data ownership clause" to procurement contracts, and the terms of this ownership might vary. In some cases, ownership will not be granted on an exclusive basis, but having full control of these terms is necessary. Several other aspects related to the governance of these contracts might also be taken into consideration, such as the privacy and the security issues involved in these different contractual arrangements.

4.4 Establish international recognized mechanisms related to auditing and compliance

Different frameworks, laws, rules and processes might be in place, but cities should make sure they are properly implemented, and that compliance can be measured. Compliance should be checked on a regular basis, and corrective actions should be in place, as well as enhancements, creating an environment that is beneficial for all parties (Barik et al, 2017). Further, adopting international frameworks and standards mentioned above is a way to address this issue as vendors are required to comply with strict rules and are evaluated by recognized organizations.

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ANNEX 1
Different IoT uses for smart-cities

5

- **Smart Infrastructure**
  - Smart Lighting
  - Connected Streets
  - Smart Parking Management
  - Connected Charging Stations
- **Smart buildings**
  - Safety & Security Systems
  - Smart Garden & Sprinkler System
  - Smart Heating & Ventilation
- **Smart Industrial Environment**
  - Forest Fire Detection
  - Air/Noise Pollution
  - Snow Level Monitoring
  - Landslide and Avalanche Avoidance
  - Earthquake Early Detection
  - Liquid Presence
  - Radiation Levels
  - Explosive and Hazardous Gases
- **Smart City Services**
  - Smart Kiosk
  - Monitoring of Risky Areas
  - Public Security
  - Fire/Explosion Management
  - Automatic Health-Care Dispatch
- **Smart Energy Management**
  - Smart Grid
  - Smart Meters
- **Smart Water Management**
  - Potable Water Monitoring
  - Chemical Leakage
  - Swimming Pool Remote Measurement
  - Pollution Levels in the Sea
  - Water Outflows
  - River Floods
- **Smart Waste Management**

Source: Bhardwaj (2018)

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