

Internet Sectoral Overview

Smart cities: Information and communication technologies and the development of more sustainable and resilient cities

The concept behind the idea of smart cities has gained the spotlight in recent years, especially because it is considered a concept that leads down a path toward urban sustainability. This concept, which emerged together with concerns about increased urbanization rates and the growing use of information and communication technologies (ICT), has been present in urban agendas and in the goals of international agencies, such as the United Nations (UN), the International Telecommunication Union (ITU), the UN Human Settlements Programme (UN-Habitat) and the Organisation for Economic Co-operation and Development (OECD).

In 2015, the UN established 17 Sustainable Development Goals (SDGs), agreed upon by 193 countries via the approval of the document *Transforming Our World: The 2030 Agenda for Sustainable Development*. Its main objectives

are to end poverty, protect the planet, ensure that all humans beings can enjoy a prosperous life, achieve universal peace, and mobilize partnerships to achieve the SDGs. In order to “shift the world onto a sustainable and resilient path” (UN, 2015), the 2030 Agenda is comprehensive and encompasses a wide set of issues. These include: the eradication of poverty (SDG 1); gender equality (SDG 5); reducing inequalities (SDG 10;) and sustainable cities and communities (SDG 11). In this context, ICT stand out in the quest to achieve the SDGs, whether directly or indirectly – i.e., it may be explicit in the targets and/or indicators and in the strategies outlined to reach specific goals. This is the case for smart cities which, although not mentioned explicitly as a goal or indicator, are present in the strategies designed to reach Goal 11 involving sustainable cities and communities.

Rapid urban growth requires that cities and local governments have greater agility and more resources to provide services and meet the demands of their populations.

Following principles similar to those in the 2030 Agenda, the New Urban Agenda (NUA) approved in 2016 by the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) presents the commitment of countries to promote smart cities, “to promote inhabitants’ quality of life, promote economic growth and protect the environment from degradation” (UN Human Settlements Programme [UN-Habitat], 2015). Taking advantage of the opportunities provided by ICT and making innovative technologies available to citizens, the NUA seeks to boost sustainable economic growth and service provision in cities. At the international level, this commitment has expanded even more the understanding of smart cities as a possibility for facing urban challenges.

Recognizing the strong relationship between smart cities and technologies, the ITU has also discussed this topic, inaugurating the initiative United 4 Smart Sustainable Cities (U4SSC), which aims to incentivize public policies that consider the use of ICT for cities to become smart and sustainable. In an interview in this edition of the Internet Sectoral Overview, Maria Cristina Buetti of the ITU gives details about how the organization has worked with the topic.

Still in the context of international organizations, the OECD has also been developing actions based on the topics in the 2030 Agenda. In partnership with the Inter-American Development Bank (IADB), a study was carried out about how technologies can contribute to reaching the SDGs. More specifically, it provides details about how ICT use – an integral part of smart cities – can improve the delivery of public services and enhance the results of public policies in areas such as safety, mobility, better use of resources, and sustainable development (Organisation for Economic Co-Operation and Development [OECD] & Inter-American Development Bank [IBD], 2016).

Smart cities, ICT, and sustainable development

The concept of smart cities is based on two main pillars: growing urbanization and the digital revolution. Rapid urban growth requires that cities and local governments have greater agility and more resources to provide services and meet the demands of their populations. According to the UN (2013), it is estimated that by the year 2050, over 70% of the world population will be living in cities. In Latin American countries, this estimate surpasses 85% – a percentage that had already been reached by Brazil in 2010. In this context, it is important that cities prepare for such population growth in order to meet the needs of their citizens sustainably, using ICT strategically to provide public services and in public administration processes.

The second pillar is associated with the broad dissemination of digital technologies among populations. Expansion of ICT infrastructure in cities, rapid dissemination of digital devices, and increases in numbers of connected users create a favorable environment for local governments to innovate in service delivery. For Professor Maria Alexandra Cunha, of the Fundação Getulio Vargas's Sao Paulo School of Business Administration (FGV-EAESP), "the use of technology in cities can contribute to universalizing housing, universalizing and improving basic services and transportation, maintaining and recognizing the value of cultural and natural heritage, reducing negative environmental effects caused by cities, establishing public and safe urban spaces, expanding participation and inclusion, and reducing inequalities while also increasing the resilience of cities in the face of disasters or big events."

Information and communication technologies have the potential to enable the adoption of positive and viable ecological and economic solutions for urban centers. In smart cities, ICT allow the collection of information and data in real time, providing a more precise understanding of the use of resources, service provision and lifestyles of the population (ITU, 2014). In addition to providing holistic views of cities, real-time data also helps underpin public policies and the decision-making processes of public managers and citizens.

According to the ITU Focus Group on Smart Sustainable Cities (FG-SSC) (ITU, 2014), robust ICT infrastructure is essential when thinking about smart and sustainable cities. However, the mere presence of ICT does not necessarily imply smartness in cities, because, as expressed by Professor Maria Alexandra, "improving life in cities will not happen 'naturally' through the use of technology. I believe in the potential of technology to expand the reach of actions in cities with the goal of transforming them into places where people have better lives, however, this needs to be constructed. Technology also carries the potential to widen inequalities, increase control over people and reinforce illegitimate power structures."

For this reason, the concept of smart cities is not limited to the use of technologies in city management, but is part of a broader idea, which, according to the professor at FGV, "combines technology, urban management, and the implementation of new models for relationships among urban actors to improve the life of those who live in cities." One example is the Rio Center of Operations (COR) of the city of Rio de Janeiro. In the same physical facility, this Center integrates different urban services and operations (including public institutions and public service providers) to anticipate solutions and develop more agile responses to unexpected and emergency situations in the city and decrease their impact on the daily lives of citizens. Another initiative is in the city of Curitiba, which implemented traffic lights that when activated by elderly citizens cards, increase pedestrian crossing time. Maria Alexandra points out that "in Brazil, [for example] we observe the implementation of numerous applications within the scope of mobility – electronic bus tickets, use of GPS by buses, and the onset of smart traffic lights that prioritize public transportation in bus lanes or [to] improve traffic."

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In turn, the concept of smart cities extends beyond providing services to citizens via the use of ICT. More broadly speaking, the goal of smart cities is to improve life in cities.

What are smart cities, anyway?

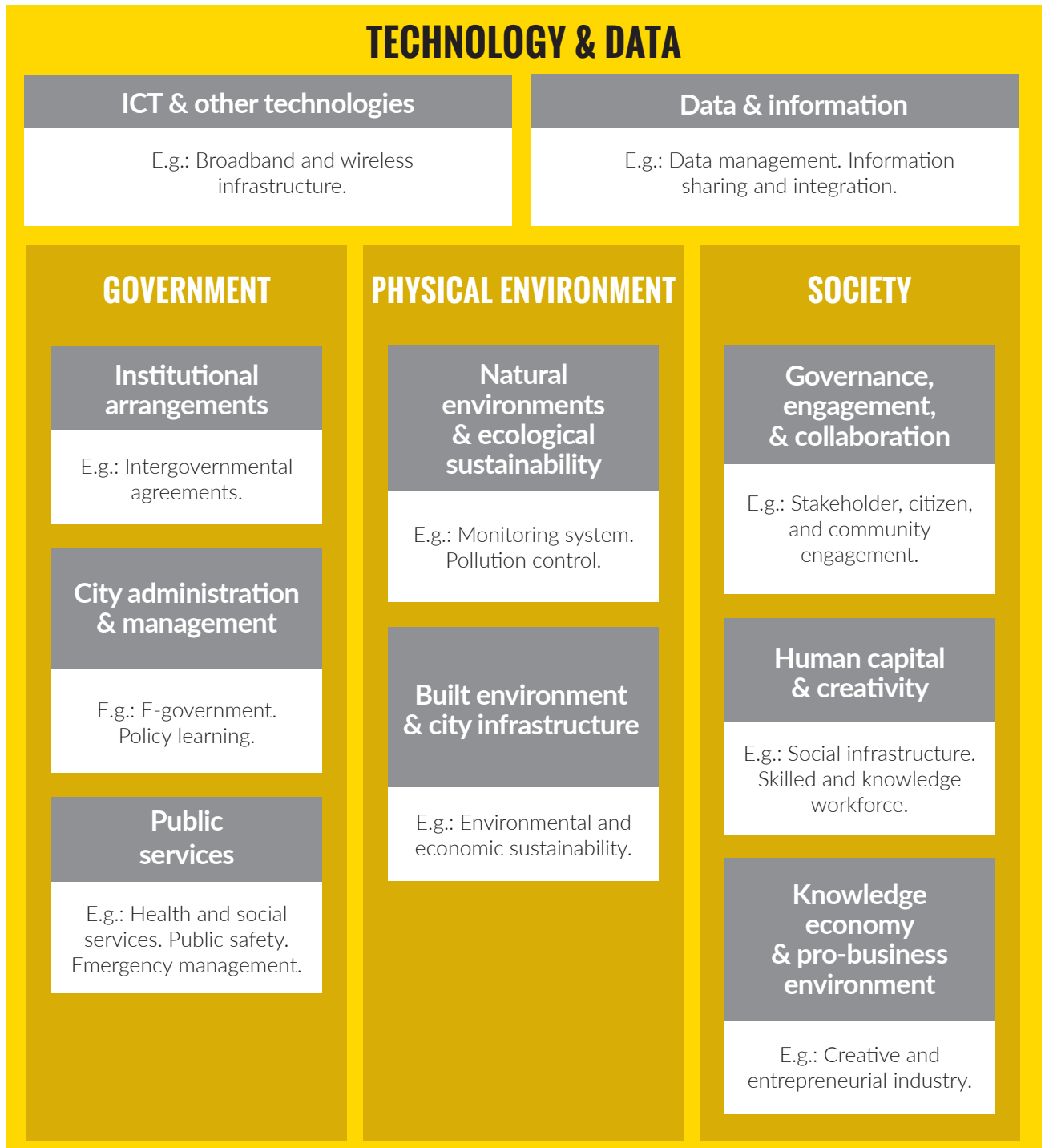
Despite the various initiatives surrounding the topic of smart cities, it is important to note that the concept does not have a single or consensual definition. Furthermore, it tends to be confused with the concept of digital cities.

According to Ojo, Dzhusupova and Curry (2016) and Estevez, Lopes and Janowski (2015), digital cities have technologies in their central infrastructure systems that allow service provision via ICT, like virtual ‘extensions’ of cities. In turn, the concept of smart cities extends beyond providing services to citizens via the use of ICT. More broadly speaking, the goal of smart cities is to improve life in cities. In addition to providing services to citizens more quickly, efficiently, and with greater capillarity, smart cities should consider and balance different perspectives about local problems based on integrated and multidimensional perspectives, breaking with the idea of silos that is often present in urban administration. Furthermore, the decision-making process to address local challenges must take into account data generated by various applications and sensors around the cities, which enable quicker and more assertive actions.

In sum, despite the different definitions of smart cities, the following common points have been identified by researchers in the area: (i) the use of ICT in cities; (ii) the presence of physical and network infrastructures; (iii) improved provision of services to populations; (iv) the combination, integration and interconnection of systems and infrastructures to allow social, cultural, economic, and environmental development; and (v) visions of a better future (Gil-Garcia, Pardo, & Nam, 2015).

In addition to these common components, authors also emphasize holistic views of cities that encompasses ten components, divided into four dimensions (Figure 1). It is worth noting that, according to this understanding, the “technology and data” dimension is present in all the components.

Figure 1 – SMART CITY ELEMENTS AND COMPONENTS



Source: Adapted from Gil-Garcia, Pardo and Nam (2015).

(...) in addition to challenges related to how to operationalize the transition to smart cities, local governments must consider the advantages and disadvantages of this type of initiative (...).

Challenges to building smart cities

There are many challenges to be overcome before a city can be considered a smart city, in terms of both resources and more operational issues, that are expressed in different contexts and levels, depending on location, region or country. Thomaz Ramalho, Human Settlements Officer of the UN-Habitat Regional Office for Africa, affirms that “the presence of urban challenges, such as lack of sanitation, drinking water, and solid waste collection, prevalence of slums, and absence of adequate public transportation, among other shortages typical of cities in developing countries, eclipse the need for modernizing information technology infrastructure, energy efficiency, and automation, among other topics linked to smart and resilient cities. Government officials in these cities must always consider whether to invest in optical fiber in central neighborhoods or in sewage systems in peripheral areas.”

Understanding that contextual situations can prevent or hinder a city’s transition into a smart city is paramount when formulating and implementing initiatives, going beyond predicted benefits.

To this end, in addition to challenges related to how to operationalize the transition to smart cities, local governments must consider the advantages and disadvantages of this type of initiative, in order to develop strategies that can decrease or bypass any possible negative effects that can emerge. Angelidou (2014) lists some of these disadvantages: the digital divide (with social and economic inequalities reinforced by technical advances); gentrification¹ or spatial polarization due to lack of homogeneous distribution of technologies; proprietary software and its high cost, lack of integration with other systems and ownership of collected data; and citizen control and surveillance, including privacy, transparency and personal data collection issues. To address this last point, managers and citizens must be able to decide, conscientiously, about data collection and use by urban sensors and applications regarding their ownership and privacy.

In fact, the digital divide and inequalities reinforced by technological advances should be addressed when designing and managing initiatives. Thomaz Ramalho asserts that “the promotion of digital inclusion should be intrinsically associated with the topic of smart cities. This is a particularly complex challenge in cities in developing countries, which are characterized by urban fragmentation and concentration of investment in more privileged urban zones, within the already mentioned reality of scarce resources and urban challenges and shortages. Promoting more participatory governance mechanisms, which can be enhanced by digital technology, can counter this reality.”

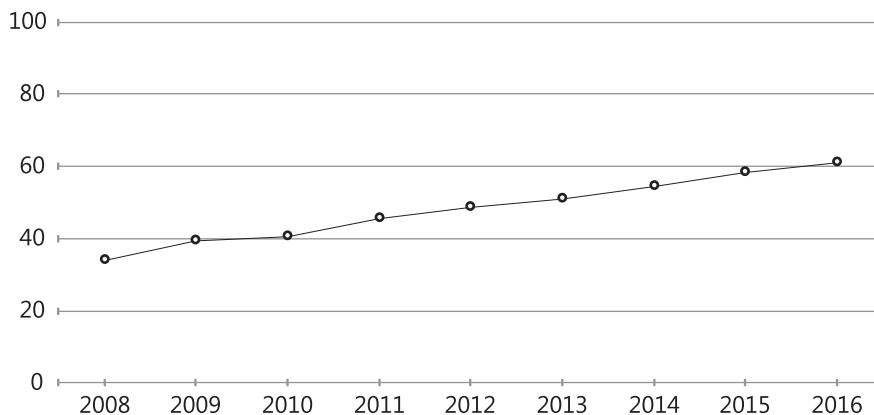
Considering that the provision of urban solutions based on the use of technologies is one of the essential components for building smart cities, digital inclusion is a key issue so that the population as a whole can benefit from the opportunities provided. Otherwise, smart city initiatives can lead to deepening of inequalities in both ICT access and access to urban services.

¹ A social phenomenon that results from the transformation process of urban centers due to a shift in social groups that affects a region by changing the dynamics of the location’s composition.

Deepening the discussion about this topic implies, for instance, understanding the profile of the population that does not use the Internet. Data from the ICT Households surveys showed that in 2016, 61% of Brazilians were Internet users (Brazilian Network Information Center [NIC.br], 2017). Although this proportion has grown in recent years (Chart 1), it shows that in 2016, almost 40% of the population in Brazil were not Internet users.

Chart 1 – PROPORTION OF INTERNET USERS BY TOTAL

Percentage of the total population



Source: ICT Households 2016 (NIC.br, 2017)

Advancing in the transition to smart cities implies, not only developing and investing in infrastructure, but also allowing those who wish to use the Internet to do so, and consequently, to use the services and content that can be accessed online. In addition to inequalities in terms of access, inequalities in levels of use must also be considered. In this vein, Maria Alexandra states that, “there are differences in how people or even enterprises and local governments benefit from technological solutions, be it because of lack of skills, or according to their age, gender, income, level of education and geographic region”.

Although the development of solutions involving ICT is a crucial point for new city models, it will be of no benefit if excluded populations are not taken into account, because this change might exclude them even more. Improvements in quality of life enabled by smart cities must include all their citizens.

Another current challenge is monitoring and measuring the various components associated with smart cities. Different organizations and initiatives have expended efforts to establish metrics to measure the level of a city's smartness, in order to assess the city as a whole – not just the implementation of specific initiatives. This can be understood as a challenge to measuring smart cities, because there are no universal solutions that will meet the demands of every city (so how can we measure the smartness of cities if public policies are different in each context?)

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In addition to establishing the most effective indicators for this measurement, another challenge lies in their national and international comparability. Maria Alexandra explains that, “different realities within the national territory, different sizes of cities, differences in economic activities, cultural and natural heritage, or different social indicators can attribute different meanings to what it means to ‘improve life’ in cities. Along the same lines, international comparability is also challenging. We need to allow for comparisons while also recognizing aspects or phenomena that are only locally relevant, because they are of special interest for policymaking in the country, region and even the city.”

Despite the opportunities and positive aspects associated with the transition to smart cities, all stakeholders must be aware of the challenges that may arise from this shift. Therefore, it is important to advance in discussions about how to overcome these challenges, so that the benefits provided by public policies in this area are optimized for all citizens, keeping the focus on the possibility of a better and more sustainable quality of life.

Despite the opportunities and positive aspects associated with the transition to smart cities, all stakeholders must be aware of the challenges that may arise from this shift.

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Interview

ICT and sustainable urbanization

To comment on the studies, trends and experiences relative to smart cities, we interviewed Maria Cristina Bueti, Advisor for the Thematic Group of the ITU Telecommunication Standardization Sector (ITU-T) about Internet of Things and Smart Cities, a focus point of the U4SSC and a focus point of ITU-T for Latin America.

I.S.O._ What is the role played by ICT in enhancing sustainable and resilient cities, particularly in Latin American contexts?

C.B._ The 21st century is the era of cities. What the world is witnessing today is an inexorable urbanization wave with more than half of the global population living in urban areas. This has led to a myriad of pressures including population increases, urban sprawl, climate change, environmental pollution and fiscal stress. In preparation for this transition to the urban realm, we have an opportunity to leverage the multidimensional concept of sustainable development. Information and communication technologies (ICT) play a catalytic role in this endeavor, since they are able to propel cities along a development trajectory that includes environmental sustainability, equitable social and economic growth, and resilience.

The main role of ICT in the context of smart sustainable cities (SSC) is providing an extensive network of interconnected devices that are capable of aggregating and analyzing data to improve our understanding of how complex city ecosystems behave. ICT also forms the core channels for dissemination of urban services to improve the quality of life of city residents. Additionally, within the urban domain, ICT, using collected data sets, can help identify where and how behavioral changes could increase city sustainability, which can act as a feedback loop and assist with improving the quality of existing services in cities.

I.S.O._ Why are smart cities considered key to achieving Sustainable Development Goal 11 (SDG11)?

C.B._ With the rapid growth in population, it is expected that nearly 66% of the world's population will be living in cities by 2050. In this situation, the quest for sustainable social and economic development and environmental protection should be deeply rooted in urbanization.

Sustainable Development Goal 11 (SDG11) is based on this very idea and aims at making cities inclusive, safe, resilient and sustainable. With reference to this SDG, smart sustainable cities (SSC) could be considered beacons of social and economic development, since they are able to solve daunting



**Maria
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of Things and
Smart Cities

“(…) it must be noted that sustainable urban design and architectural frameworks are key elements in improving living conditions while preventing inequality and exclusion.”

Maria Cristina Bueti

challenges and adopt the key targets embedded in this goal. In this context, we can safely assume that the global transformation toward smart sustainable cities presents a pragmatic approach to pursuing growth with due regard for ecology, social protection, wealth creation, and social equity, using ICT. These features of SSCs make them efficient tools for accomplishing, not only the urban targets set forth in the 2030 Agenda for Sustainable Development but also the New Urban Agenda, which establishes the new global standard for sustainable urban development.

However, we must acknowledge that sustainable urbanization (as envisioned in SDG11) is not an end in itself. The battle to achieve “sustainable development” while sustaining “meaningful globalization” in cities will continue for the decades to come.

I.S.O_ How can the Internet of Things (IoT) maximize the achievement of SDG 11?

C.B_ While pursuing SDG11, it must be noted that sustainable urban design and architectural frameworks are key elements in improving living conditions while preventing inequality and exclusion. The integration of these elements into all sectors of the urban fabric, (especially) using technologies for SDG11, is still a challenging prospect. While ICT brings new tools for better planning at the stakeholder level, increased participatory communication between citizens and representatives and the smooth delivery of urban services can only be brought about by improved infrastructural frameworks encompassing extensive networks of interconnected devices that are able to coordinate their activities and act independently with limited human intervention.

More importantly, with the help of IoT devices and networks, aspiring SSCs can move away from segregated vertical silos of functionally oriented service providers in areas such as energy, telecommunications, water, transport, health and others toward new innovative, interoperable and collaborative models that connect these silos by promoting information sharing, integration and cross-sector collaboration for user services, and interconnection of systems. In addition to their current capabilities within urban ecosystems for sustainable urbanization, IoT infrastructures must incorporate privacy and security into their functioning, which will facilitate the acceptance of this technology and improve our chances of achieving the core targets of SDG11.

I.S.O_ In the context of smart cities, what are the challenges in terms of stakeholder engagement?

C.B_ While SSCs hold immense potential for overcoming the challenges posed by rapid urbanization and heightened vulnerability due to stressors such as climate

change, SSC decision-makers also face operational, financial, technological and human resource challenges, including effective engagement and participation of citizens. Limited stakeholder involvement in smart city planning will lead to a feeling of discontent among citizens and also lead to promotion of the vested interests of certain players. In this scenario, SSCs will not cater to the needs of their citizens and will only promote the activities and technologies of a few influential players.

The ITU acknowledges that promoting effective, sustainable city planning and development requires the support, commitment and involvement of a variety of public and private stakeholders. On the stakeholder involvement front, the ITU-T Supplement, Smart Sustainable Cities: Setting the Stage for Stakeholders Engagement provides all interested stakeholders with a clear overview of roles and responsibilities, including a series of recommendations that can help maximize their contributions to SSC goals.

In order to foster inclusive approaches, city decision-makers should take into account the diversity of stakeholders supporting the development of SSC initiatives and projects.

I.S.O_ What are the challenges in measuring smart cities?

C.B_ While many may think that the incorporation of ICT into existing urban services is the main challenge for SSCs, interoperability of smart city services and monitoring SSC progress remain the areas where most urban stakeholders falter.

The establishment of SSCs is a long-term process and cannot be achieved overnight, so it is essential that a set of indicators be defined that not only allow comparability, but also promote sustainable development and allow each city to quantify improvements as time passes. Realizing this, the ITU has been advocating the development of key performance indicators (KPIs) which can not only improve interoperability of urban services worldwide, but also assist with measuring and monitoring a city's journey toward becoming a smart city.

This international set of KPIs for SSCs are the first of their kind and can be used to assess how successful cities have been in accomplishing their established smart sustainable city goals. The KPIs can also help each city identify the areas that need improvement while implementing the KPIs.

While these KPIs are expected to cater to all aspiring smart cities, it is acknowledged that a city's specific resources and ability to collect data for the KPIs may vary, and may influence the level of success obtained vis-a-vis the KPIs. Nevertheless, the development of these indicators has been a revolutionary move and can essentially form the basis for national smart city policies and strategies, and maybe even international legislation in the future.

"(...) promoting effective, sustainable city planning and development requires the support, commitment and involvement of a variety of public and private stakeholders."

Maria Cristina Bueti

Domain Report

The dynamics of the registration of domains in Brazil and the world

The Regional Center for Studies on the Development of the Information Society (Cetic.br) carries out monthly monitoring of the number of domain names registered in the 16 largest country code Top-Level Domains (ccTLDs) in the world. Combined, they exceed 105 million registrations.

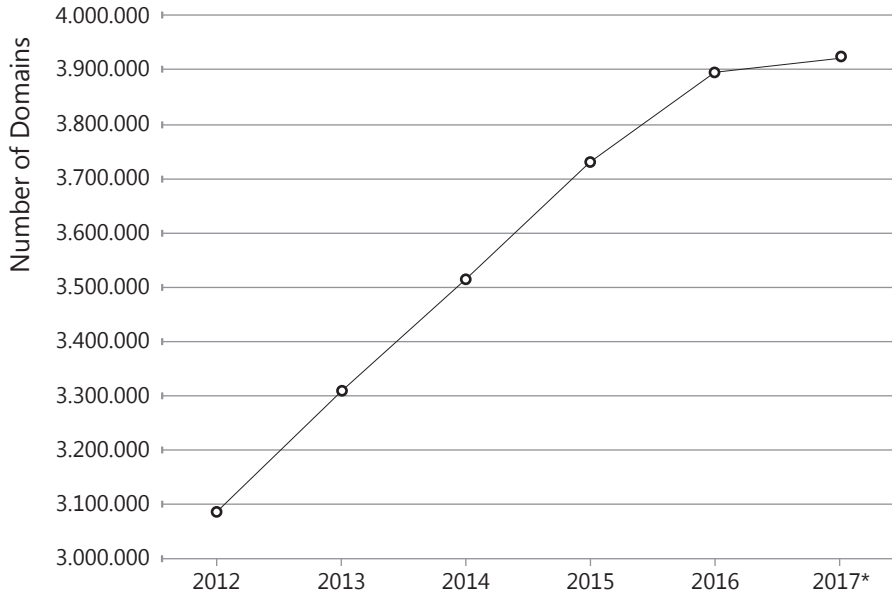
In September 2017, the domains registered under .cn (China) reached 20.69 million, followed by .tk (Tokelau) Germany (.de) and the United Kingdom (.uk), with 18.89 million, 16.24 million and 10.04 million records, respectively². Brazil had 3.93 million registrations under .br, occupying seventh place on the list. With 1.88 million registrations, Spain (.es) ranked 16th, as can be seen in Table 1.

Table 1 – REGISTRATION OF DOMAIN NAMES IN THE WORLD – SEPTEMBER 2017

Position	ccTLD	Domains	Ref.	Source
1	China (.cn)	20.686.593	Feb/17	www.cnnic.com.cn/sjzs/CNymtj
2	Tokelau (.tk)	18.896.758	Sep/17	research.domaintools.com/statistics/tld-counts
3	Germany (.de)	16.243.936	Sep/17	www.denic.de
4	United Kingdom (.uk)	10.039.279	May/17	db.nominet.org.uk/news/reports-statistics/uk-register-statistics-2017
5	Netherlands (.nl)	5.767.327	Sep/17	www.sidn.nl
6	Russia (.ru)	5.473.698	Sep/17	www.cctld.ru
7	Brazil (.br)	3.932.509	Sep/17	registro.br/estatisticas.html
8	European Union (.eu)	3.669.145	Sep/17	research.domaintools.com/statistics/tld-counts
9	Australia (.au)	3.136.296	Sep/17	www.auda.org.au
10	France (.fr)	3.103.750	Sep/17	www.afnic.fr/en/resources/statistics/detailed-data-on-domain-names
11	Italy (.it)	3.058.154	Sep/17	www.nic.it
12	Canada (.ca)	2.635.642	Sep/17	www.cira.ca
13	United States (.us)	2.630.232	Sep/17	research.domaintools.com/statistics/tld-counts
14	Poland (.pl)	2.603.236	Sep/17	www.dns.pl/english/zonstats.html
15	Switzerland (.ch)	2.084.580	Jun/17	www.nic.ch/reg/cm/wcm-page/statistics/index.html?lid=em*
16	Spain (.es)	1.884.247	Sep/17	www.dominios.es

² It is important to note that variations exist among ccTLD reference periods, although it is always the most updated one for each country that is used.

Graph 2 – TOTAL NUMBER OF DOMAIN REGISTRATIONS PER YEAR FOR .BR – 2012 TO 2017



*Data in reference to September 2017.

Source: Registro.br

In September 2017, the five generic Top-Level Domains (gTLD) totaled more than 161 million registrations. With 128.01 million registrations, the .com ranked first, as shown in Table 2.

Table 2 – MAIN GTLDS – SEPTEMBER 2017

Position	gTLD	Domains
1	.com	130.145.795
2	.net	15.013.676
3	.org	10.429.793
4	.info	6.116.546
5	.biz	2.134.164

Source: DomainTools.com.

Retrieved from: <http://research.domaintools.com/statistics/tld-counts/>



SMART CITIES



What are smart cities?

Even though the term does not have a single definition, smart cities can be understood as a series of solutions for urban problems developed through the use of ICT. They embody strategies that provide faster, more effective solutions with greater capillarity, enabling easier and quicker access to urban services, and promoting better quality of life for citizens and more sustainable social and economic development.

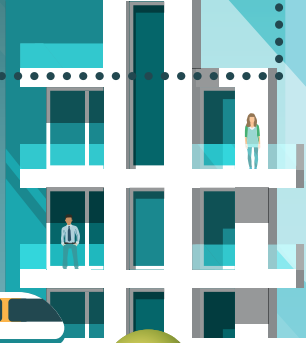
What is the difference between smart cities and digital cities?

These concepts are commonly confused, and they are distinguished by the level and nature of the capacity of cities to relate to digital technologies. Digital cities work as “virtual extensions” of cities, by providing access to infrastructure and services using ICT. Smart cities, in turn, involve the use of smart urban systems. Furthermore, these systems should be capable of generating data that will serve to inform decision-makers and, consequently, provide input for evidence-based public policies.

What makes cities “smart”?

There is no checklist or step-by-step guide regarding what smart cities must be like, because local governments must create and develop their own policies and initiatives, considering, for example, local contexts, available resources, and the stakeholders who integrate their ecosystems.

However, among other things, smart cities should be capable of addressing old and new urban challenges, through the use of ICT, in a holistic and integrated manner, considering the participation of local players in building visions for the future of their cities.



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TEXT

MAIN TEXT

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GRAPHIC DESIGN

Comunicação NIC.br

PUBLISHING OF ENGLISH EDITION

Grappa Marketing Editorial
(www.grappa.com.br)

ACKNOWLEDGEMENTS

Maria Alexandra Cunha
(FGV-EAESP)
Maria Cristina Bueti
(ITU-T)
Thomaz Ramalho
(UN-Habitat regional office for Africa)

The Internet Sectoral Overview is also available in Portuguese at cetic.br/publicacoes/indice/panoramas/



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