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ICT for Sustainable Development. Recommendations for Public Policies that Guarantee Rights

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UNESCO PROLOGUE

Why ICT?

Before you become too entranced with gorgeous gadgets and mesmerizing video displays,
let me remind you that information is not knowledge,
knowledge is not wisdom, and wisdom is not foresight.
Each grows out of the other, and we need them all.

Arthur C. Clarke

It is easy to become entranced with information and communication technologies (ICT). There is no denying that they are an unprecedented revolution in the history of humankind. It is said that when Abraham Lincoln was assassinated in 1865 (a little over 150 years ago), it took 13 days for the news to arrive in European capitals. Today, it would take no more than 13 seconds.

This radical change, often called the 4th Industrial Revolution, has transformed social, commercial, political and cultural relationships at practically all levels of life (for better or, not rarely, also for worse).

Therefore, right from the outset, we must acknowledge the obvious: it is no longer possible to discuss development, human rights, and democracy without discussing ICT. However, it is equally important to consider the need to avoid Manichean attitudes: being overwhelmed by the marvels of ICT, or completely appalled by the evil they can generate. The point of balance lies precisely in fostering the marvels (opportunities) and mitigating the evils (risks).

The 2030 Agenda offers us a privileged window for applying this approach. In each of the Sustainable Development Goals, ICT can enable the implementation of the proposed targets, or can intensify the inequalities they seek to fight against.

The paper in your hands aims to address concrete questions in this debate: How can ICT foster the implementation of the Sustainable Development Goals? What public policies are necessary to boost the use of ICT as tools for the development, protection and promotion of human rights and democratic consolidation, and, in turn, avoid the potential for these same ICT to produce opposite effects?

These two key questions guide this paper, which deepens a discussion of the utmost relevance that gains new characters every day: Artificial Intelligence, the Internet of Things, the ethics of algorithms, Big Data, and others that are sure to come.

This paper is part of a joint effort by Cetic.br and the UNESCO Montevideo Office to disseminate the discussion among different actors. This includes, for example, a MOOC about the same themes, developed in partnership with the SDG Academy.

Albert Einstein once said that the human spirit must prevail over technology. For us, this is precisely the point: making humans the center of the agenda and leaving no one behind. Within an adequate policy framework, technology can collaborate enormously to this end.

Enjoy your reading!

The editors

ICT for Sustainable Development. Recommendations for Public Policies that Guarantee Rights

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ICT FOR GLOBAL TRANSFORMATION: OPPORTUNITIES AND CHALLENGES

The **digital technology revolution** is decisively contributing to the **modification of economic, social and political standards**. The emergence of information and communication technologies (ICT) has opened up a new field of possibilities and opportunities, which until very recently were hardly imaginable, for developing freedom of expression, access to information, transparency, and surveillance by citizens regarding development processes and dynamics.

In the last 30 years, the advance of ICT has often been referred to as a factor of development in itself. The significant development of the digital agenda has posed a number of problems, ranging from technical standards in Internet access infrastructure to ethical concerns about the use of social media (UNESCO, 2015b). The passage of time has shown that, along with the accelerated changes that ICT have brought to economic and social processes, it is necessary to analyze and understand them from a political economy perspective that includes different aspects related to regulatory frameworks, access policies and safeguarding of rights, in order to **ensure that ICT contribute to development in terms of sustainability, inclusion and social justice**.

The approval of the **2030 Agenda and the 17 Sustainable Development Goals (SDGs)** not only represents an international agreement on desirable goals, but also supposes **profound and far-reaching global transformations** to the world of today.

The present *policy paper* seeks to provide decision-makers with tools for reflecting on the design and development of public policies to **ensure that ICT contribute to development in terms of sustainability, inclusion and social justice**, in line with the commitments embodied in the 2030 Agenda and the SDGs.

The 2030 Agenda Declaration confirms the importance of ICT to opening up major possibilities for the acceleration of human progress. The Agenda deems that **ICT play a facilitative and supportive role**, particularly **in skill development**. However, within the framework of the goals and targets of the Agenda, there are few specific references to ICT and its adoption in specific policies. In order for ICT to facilitate or support this global transformation of the development model that drives the 2030 Agenda, some global challenges need to be considered.

Digital inequalities

Equality is an aspiration of the 2030 Agenda and its 17 SGDs and, at the same time, is a guiding principle in achieving the implementation of the appropriate public policies. In a context of digital transformation, it is necessary to take into account the so-called digital divide. In general terms, the **digital divide** refers to existing inequalities in ICT access, use and appropriation resulting from interactions with other social, economic and cultural inequalities, such as rural/urban habitats, socioeconomic levels, educational levels, gender, etc. However, the digital divide is also linked to other aspects, such as quality of technological infrastructure, devices and connections, digital skills and, above all, cultural capital to transform the information that circulates into relevant knowledge at an individual and/or collective level.

Although the potential of ICT to positively contribute to sustainable development and the 17 SDGs is immense, it must also be taken into account that **ICT expansion can cause disruptions in traditional economic and social structures**. For example, ICT could increase income inequality and concentrate all economic benefits if specific efforts are not made to ensure inclusion and universal accessibility, as well as to support skill development (Sharafat & Lehr, 2017).

It needs to be taken into consideration that digital inequalities are phenomena that are not independent of existing socioeconomic conditions in societies where ICT expansion occurs. On the contrary, the digital divide is associated with substantial inequalities in education, health, income, housing, employment, gender and access to drinking water and food.

Therefore, development and expansion of ICT, by their nature and versatility, **do not alone determine the results in the development of societies**. In other words, there is no causal relationship between ICT expansion and levels of development in a given society; contexts, institutions and human factors co-produce these results. In the process followed to date, two challenges seem to have arisen that explain why the fruits of development have not been disseminated as widely and equally as Internet and mobile phone access.

The **first challenge** refers to the **gap between investments in digital technologies and the economic policies, institutions, and human complements** that are equally important for transformation. Investments in technology cannot replace these other factors, which have the potential to allow technologies to contribute to achieving results in development. Normally, leadership in countries is located in ministries dedicated to access and connection supply issues, far removed from the ICT needs of other sectors and ministries, such as health and education. Something similar happens in international aid agencies, where experts from the ICT sector have their own connectivity initiatives, and do not interact with experts in education, governance and the environment.

The **second** challenge is in relation to gaps **between key elements of the ICT ecosystem**, such as **connectivity infrastructure**, the **local ICT services industry**, **skills for maintaining infrastructure and systems**, **applications to link the needs of local users, and institutions** for synchronizing these highly interdependent elements. Generally, ICT development is fragmented among various ministries and actors who are focused on science and technology, finance, education, industry, trade, telecommunications regulatory agencies, Internet providers, digital content providers, etc. (Hanna, 2016).

The **gender digital divide** warrants special mention, since in accordance with the integrated and multidimensional focus that the 2030 Agenda requires, the gender equality perspective not only incorporates all the actions in SDG 5 to promote women and girls, but also includes all the SDGs: gender equality is a principle that must permeate all political action in the strategies to implement the 2030 Agenda (UNESCO, 2017, 4).

The persistence of the gender digital divide is directly related to the sexual division of labor and socioeconomic conditions and structures in which there are still notable differences in wages, recognition and possibilities for women to fully develop their capacities (GISW, 2013). It would be advisable to work on comprehensive solutions to reduce this digital divide, through actions such as those that go hand-in-hand with culture and link social and economic dimensions through creative industries, cultural tourism, and heritage preservation, through women and girls who are creators and producers with full participation in cultural life (UNESCO, 2017).

Rights and internet universality

The 2030 Agenda is based on human rights and is committed to bringing full rights to all people (UNESCO, 2017). During the 37th session of the General Conference of UNESCO, in 2013, the Member States confirmed the principle of **applicability of human rights to cyberspace** (UNESCO, 2015b). That same year, UNESCO launched the concept of **Internet universality**. This concept highlights the norms and values of interconnected and interdependent behavior that underpin the Internet, as well as the need to strengthen them in order to harness their full potential for sustainable development (UNESCO, 2015a).

To this end, the Member States agreed on **four normative principles** that should guide the development of the Internet, which must be: i) **human-rights**-based, ii) **open**, iii) **accessible to all** and iv) nurtured by **multi-stakeholder participation** (R.O.A.M. principles).

Therefore, democratic forms of **international Internet governance** are required, corresponding to **civil and political** rights on the Internet (such as rights to freedom of expression and association on the Internet, rights to privacy and security, etc.), **economic, social and cultural** rights (right to access infrastructure regardless of where one lives, right to equal access for men and women, right to access and to create culturally and linguistically diverse content, right to affordable access, in terms of language, income and level of education, etc.) and **global rights or rights of peoples** (right to peace, right to safety from cybercrime, cybercorruption and cyberterrorism, and right to technological development, etc.) (Del Rio, 2012).

To help governments and other stakeholders define and evaluate their national Internet environments and develop digital policies and agendas to promote the principles of universality, UNESCO created an Internet universality indicator framework. This tool reflects the integrated nature of the 2030 Agenda and its 17 SDGs, which need to be more cohesively connected to policies at the national, regional and international levels. For this, the recommendations include promotion of stronger links between research, social sciences and the formulation of public policies, comparability of international data for observing trends, and establishment of priorities and evaluation of policies (UNESCO, 2017).

ICT promotion and governance

As mentioned earlier, issues related to **Internet governance** have become the key focus of current discussions that explore the relationship between ICT and development processes. The crucial aspect is the assignment of different roles to the various stakeholders involved in the Internet development process. The weight and role of the involved actors, as well as the mechanisms and institutions that will be chosen with shared, but different, responsibilities are the main subject of current discussions.

It is true that the issue of **multi-stakeholder partnerships** for sustainable development is relevant for the SDGs. However, especially for ICT initiatives in relation to the SDGs, it is also important to bear in mind the current challenges that need to be overcome in the formation of these partnerships: ensuring that they are sustainable and long-term; overcoming difficulties to achieve agreements on joint goals and activities; balancing different interests and determining the contribution levels expected of each member; identifying resources; cooperating between partners from the private sector and national institutions; and monitoring and assessment throughout the process to enable reassignment of resources according to their results (Geldof, 2011). In relation to inequalities, it is also essential to incorporate more vulnerable local groups into the discussions, in order to integrate agendas and local needs in terms of technologies and sustainability of their development processes.

CONTRIBUTION OF ICT TO SUSTAINABLE DEVELOPMENT

There are various ways in which ICT can contribute to sustainable development and accelerate achieving the SDGs. While it is true that there is no specific SDG dedicated to ICT, at least three types of contributions of ICT to sustainable development can be identified.

1. From the point of view of rights, it is essential to point out the role of ICT in **ensuring access to information** in a globalized and interdependent world. As will be seen below, lack of access to information prevents the consolidation of equitable societies, hinders democratic guarantees and generates inequalities.

2. In addition to viewing ICT as a right, these technologies can be **effective tools to consolidate and guarantee other rights** linked to the 2030 Agenda and the SDGs. For this reason, it is advisable to adopt ICT in public policies aimed at promoting sustainable development and more just and sustainable societies.

3. In this sense, ICT are also fundamental for **measuring the 2030 Agenda**, in terms of strengthened accountability, and monitoring and follow-up of the SDGs and proposed targets.

Access to information and the Sustainable Development Goals

Universal commitment to ensuring **access to information** entails recognition by the international community that this principle **is a basic human right** and, at the same time, **a requirement for achieving all the SDGs**.

SDG 16.10 requires signatory countries to "**ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements**." More specifically, indicator 16.10.2 refers to the "number of countries that adopt and implement constitutional, statutory and/or policy guarantees for public access to information." The advocates of this objective argue that, without open and constant information, discussion and analysis, SDGs cannot be measured, much less achieved. By the end of 2016, 113 of the 193 member countries of the UN had passed laws to ensure public access to information (Orme, 2017). However, since this was relatively recent, they have not yet been fully implemented.

Universal public access to information involves distinct issues related to Internet **connectivity**, **availability of relevant information** (which supposes that it is generated, made pubic and actively publicized by all the actors, in addition to being socially and economically relevant), **accessibility** (understood as the possibility of all people to access, without difficulty, the resources and services available on the Internet, regardless of language, culture, geographic location, skills of users, etc.) and **affordability** of information (in relation to the price to pay to access it). Public access to information also requires the promotion of public Internet access centers and Internet access universalization programs.

Media and informational literacy (MIL) of the **general population** is likewise indispensable, in order to access information, so that people can benefit from significant access to information and, thereby, participate in the definition of policies, hold governments accountable, and demand their rights to improve and enhance their opportunities for economic, social and political development (income generation, access to services, participation in democratic processes, etc.).

Access to information is also a necessary condition for **democratic governance and fighting corruption**. ICT can facilitate access to public information and promote transparency and, thus, help

citizens to be proactive and hold governments accountable for their actions. Knowledge of public policies can enable social control of political actors responsible for the administration and use of public resources. Among the targets of **SDG 16 (peace, justice and strong institutions)**, some are directly related to access to information, such as: "Develop effective, accountable and transparent institutions at all levels" or "Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements."

The following policies would require them to be transversally integrated into national development plans and/or digital agendas, backed by budgets and the corresponding action plans.

Public policy proposals for access to information

Access to information requires four key elements (Garrido & Wyber, 2017), that need to be taken into account when defining public policies:

- Infrastructure for access to information and communications
- The necessary skills of people and all social actors to access, use and appropriate information
- A positive social context for its utilization
- A favorable legal and political context

ICT solutions for sustainable development

In addition to their potential to improve access to information, a wide spectrum of ICT services, resources and solutions (applications for access to health, optimization of natural resources, digital resources for research and education, citizen participation and public administration, among others) can undoubtedly enhance and support public policies to accelerate achieving the SDGs (NetHope, 2015). Among other outcomes, these solutions may:

- **Provide opportunities to simplify and improve the efficiency and effectiveness of activities** being implemented within the entire sphere of development (environmentally, politically, in the field of democratic governance, and in the promotion of social rights and equity).
- Provide access to a new range of digitally enabled products and services that strengthen **citizen participation, development of local economies, local innovation and local communities.**

Recommendations for public policies involving ICT solutions for the SDGs

- **Compatibility of ICT solutions** with existing infrastructure (whether fixed and mobile broadband are available) and physical equipment (hardware) in use at the local level and among more vulnerable populations and in more remote areas, ensuring public access to this infrastructure and equipment.
- **Availability of relevant ICT solutions and applications** in local languages and user-friendly formats that are accessible on all devices, which ensures access to and management of ICT solutions by all individuals and social actors who require them, at whatever scale, through implementing concrete measures aimed at ensuring access by the more vulnerable segments of the population, in addition to specific, transversal gender-related measures, to prevent these policies from increasing or perpetuating inequalities.
- National policies that ensure **universal connectivity and public access** to the Internet to

all segments of the population and throughout the country, along with a gender perspective.

- **Necessary skills** for accessing and managing available devices and applications to ensure that people with fewer resources are not harmed by these systems or marginalized; imparted through extensive traditional, digital and information literacy programs. National policies to **strengthen** digital, communication and information **skills in public administration** (at all levels and in all sectors), **companies, and civil society organizations**, to promote significant participation in multi-actor, multi-level and multi-sector partnerships that enable establishing the basis for generating virtuous cycles of incorporation of ICT into development.
- National polices to **promote innovative ICT solutions in business, educational and scientific systems**; through training researchers (for example, strengthening "reverse innovation" in less-developed countries -LDCs) and teachers of all levels (new tools and cosmovisions); and in secondary and university teaching curricula, promoting innovation and ICT solutions that contribute in the mid-term to a **digital culture** for the SDGs.
- Digital policies aimed at **promoting ICT solutions and applications** in different sectors (e-business, e-health, e-banking, e-learning, e-science, e-environment, etc.) through public-private collaboration, if necessary, and with the participation of the sectorial actors involved in each context.

ICT for measuring development

ICT can not only contribute to achieving the SDGs, it can also measure them. The data revolution can progressively improve the capacity of countries to generate relevant information for tracking SDG progress. In addition, data provides an important basis for **evidence-based decision-making**, which means that national governments need greater capacities for statistical production and analysis, greater availability of solid data, and more accountability among development actors at the national and international levels. This also requires developing common norms and methodologies, as well as new areas of measurement and new data collection, processing and distribution instruments that ICT can facilitate (UNDP, 2017). The adoption of big data[1] for measuring the 2030 Agenda has been considered by national statistical institutes from around the world at events such as the UN Data Forum (https://undataforum.org/). The reported experiences have included utilization of data generated by the use of mobile phones and social networking websites to measure migratory flows, displacement of refugees and the spread of epidemics. The potential of the large volumes of data produced by the developing digital economy, particularly through technologies such as the Internet of Things (IoT)[2], cloud computing and artificial intelligence, also give rise to problems involving data access and exchange, data protection, privacy and security, and ethical issues, among others. These will have to be addressed and will oblige national statistical systems to develop protocols that can harness new data sources (UN-Statistical Commission, 2018).

1 In this publication, the term **big data** (in lower caps) will be used when referring to "any voluminous amount of structured, semi-structured and unstructured data that has the potential to be mined for information". And the term **Big Data** (capitalized) will be used for the concept elaborated by UN Global Pulse (2016), which makes reference to "an integrated research and development focus (including measurement and assessment of development) which involves three interrelated components: data generation, data analysis and data ecosystem" (see more details about this focus on pages 69-70).

2 Internet of Things refers to the digital interconnection of everyday objects with the Internet.

Public policy proposals to strengthen access to information

Policies	Description
Open data policies	Should include actions ranging from policy decisions to technical solutions, which identify different roles, collaborations and partnerships between governments, companies, civil society and other data users that can help governments and data users to develop solid open data programs.
Open solution policies	Actions aimed at promoting **open access** (OA), **open data** (OD), **crowdsourcing** and **open educational resources** (OER).
National digital media and information literacy (MIL) policies	The areas and competencies would be: **hardware and software operations**, **information and data literacy, communication and collaboration, digital content creation, security, problem solving** and **competencies related to** the 21st century skills (Global Alliance to Monitor Learning-GAML, 2018).
Universal access, universal service and access funds	Social policies for **financing mobile devices and Internet connection**, etc., that ensure that the rights of poor and vulnerable sectors of the population are not violated in terms of access to information and online services, and that enable taking advantage of the possibilities that access to information bring for individual and collective economic, social and political development (UIT/BDT, 2007).
Open government policies	Should incorporate actions to: **a) improve levels of transparency and access to information** through opening up public data (to exercise social control over governments and facilitate accountability) and reusing information from the public sector (to promote innovation and economic development); **b) facilitate citizen participation** in the design and implementation of public policies (and influence decision-making); and **c) promote the generation of opportunities for collaboration and innovation** among the various actors, particularly between public administration, civil society and the private sector, to co-design and/or co-produce public, social and civic value (CEPAL-United Nations, 2017).
Transparency policies of companies and other social actors	Increase corporate responsibility and the accountability of institutions and the private sector, which entails promoting corporate responsibility in areas such as the environment, consumer protection, community participation and fighting corruption (CEPAL-United Nations, 2017). Promote among companies (as well as the media) and other social actors (NGOs, universities, political parties, foundations, etc.) publicizing **the "triple bottom line"** (economic, social and environmental), as well as the **contribution/impact of their activities on the SDGs** and the inclusion of the SGDs in their annual sustainability reports, so that they can be subject to monitoring and control by citizens (UN Global Compact, 2016).

Source: Prepared by the authors from WBG (2017), UNESCO (2015b), Global Alliance to Monitor Learning-GAML (2018), UIT/ BDTb(2007), CEPAL-United Nations (2017), Open Government Partnership (2017) and UN Global Compact (2016).

ICT AND THE SDG INDICATORS

In a resolution adopted by the General Assembly of the United Nations (September 25, 2015), which approved the 2030 Agenda and the 17 SGDs, a mandate was given to the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDG) to create and configure a **global indicator framework for the SDGs and their 169 targets** (United Nations, 2015a).

The Statistical Commission established a definitive list of **230 indicators to measure 169 targets**.[3] In this scenario, there is a need to consider the **heterogeneous degree of availability and development of these indicators**, given that many of them cannot yet function as such.

In the three years since work was started to develop the global indicator framework, the emphasis of the work has shifted from the pressure to develop this global framework to the **need to develop skills**, particularly those of national statistical institutes. These skills include the ability to disaggregate data, not only by income, sex, race and population groups, but also by local and municipal levels, in order to incorporate all the realities that national averages obscure from view, and thereby fulfill the mandate to **leave no one behind**. The emergence of initiatives that seek to facilitate data incorporation through nonconventional sources, such as mobile phones, satellites, social networks and scanned data, is also noteworthy (Adams & Judd, 2018)

The Statistical Commission of the United Nations (UNSTATS) is trying to establish mechanisms for the coordination, homogenization and homologation of national statistical efforts to achieve a **complete and functional global indicator system** (UNSTATS, 2018). National statistical systems are of crucial importance in making significant advances in the global indicator system, since States and their statistical systems will ultimately transmit, estimate and validate the data that will be used in global monitoring. It is necessary to take into account that global information processes with SDG indicators will be based primarily on data and statistics produced by national systems. Therefore, the use of tools and standards that enable automated data exchange will be essential.[4]

The principles established for completing a global indicator and monitoring system are:

a. **Transparency**: data and metadata are open and sharable; all adjustments and estimations must be transparently declared; and the methodologies used must be shared by all parties.

b. **Collaboration and communication**: among national statistical organizations, agencies that store data, and other involved parties. This is essential to ensure an effective flow of data and its international comparability with high quality standards. Open communication will enable all parties to fully understand what is occurring during each stage of the process.

c. **Professional and scientific standards**: The concepts, definitions, classifications, sources, methods and procedures used in the production of statistics should be chosen according to professional and scientific standards and be built with transparency.

3 These indicators have been classified into three different tiers according to the acceptance of their methodology and the availability of sufficient data. Tier I includes those that have established methodologies and large amounts of data, where data is regularly produced by at least 50% of countries and reach 50% of the population in every region where the indicator is relevant; Tier II refers to indicators that have established methodologies but lack sufficient data because they are not regularly produced by countries; and Tier III corresponds to indicators that do not yet have established and accepted methodologies.

4 Examples include the Statistical Data and Metadata eXchange (SDMX) and application program interfaces (APIs) by online means.

Recommendations for ICT public policies aligned with sustainable development

1. Design, assess and implement **comprehensive public ICT policies that are consistent with sustainable development principles**, with sufficient budgets and the necessary coordination and participatory bodies. These digital transformation policies should be integrated into national and local development plans and strategies aligned with the 2030 Agenda.

2. Fully use **advances in science, technology and innovation (STI) in the economic, social, environmental and cultural spheres that promote sustainable development**, in coordination and communication with other academic, civil society, business and multi-level actors (international, state, regional and local).

3. **Public ICT policies should have a focus on human rights**, as well as guarantee the principle of applicability of the right to access to cyberspace and the R.O.A.M. principles that should guide Internet development.

4. Ensure that states' use of the **Internet** is **efficient, transparent, uncensored, equitable and participatory** with respect to provision of services, and also in their relationship with citizens through open government and expansion of democratic venues.

5. Incorporate different aspects related to **equity in regulatory frameworks, access policies and safeguarding of rights** to ensure that ICT contribute to development in terms of sustainability, inclusion and social justice. It should also reduce the digital divide within and among countries, and between rural and urban populations, older and younger people, those with and without disabilities, and men and women.

6. Collaborate in the **definition of Internet governance and regulation**, based on the principle of shared responsibility in the international realm, for better development of digital agendas that incorporate multi-stakeholder partnerships and seek balances that securely ensure the privacy and needs of users, as well as approaches focused on users, collaborative mechanisms to improve security, and open web platforms consistent with the Open Stand principles (Internet Society, 2015).

7. Develop **national development strategies or plans based on ICT** that respond to the potential for social and economic innovations that can be achieved through proper use of ICT. These plans should focus not only on the issue of infrastructure (broadband extension, mobility for improving ICT access, and technical standards), but also on reduction of inequality, incorporation of ICT in policy areas such as health, agriculture and environmental protection, and ethical concerns regarding the use of social communication, among others.

8. Monitor the **transition from traditional economies to digital economies**, reducing social and environmental costs to a minimum and tackling the challenges that arise in terms of jurisdiction, oversight, privacy, security and equity in terms of access to what are already key resources of new economies, nationally and globally.

9. Exercise **digital leadership** based on a deep understanding of how ICT interact with other complementary factors, such as economic policies, government institutions, management capabilities and organizational structures and business practices. Align ICT investments with policies and complementary investments in the sectors and organizations to be transformed.

10. Incorporate to **the definition of public access to information policies**: infrastructure for accessing information and communications; the necessary capabilities of people and all social actors; a positive social context for its use; and a favorable legal and political context (Garrido & Wyber, 2017). It is also recommended to transversally incorporate policies for open data, open solutions, digital, media and information literacy and universal access, universal service and access funds into development plans and/or digital agendas.

11. Regarding the use of **ICT solutions**, incorporate measures in national development plans, digital agendas and sectoral policies that guarantee: a) compatibility of ICT solutions that ensure public access to them; b) availability of ICT solutions and applications that ensure access and management by all people and social actors;

c) affordable connectivity and access to devices and applications; d) necessary skills for accessing and managing available devices and applications, especially to ensure that people with fewer resources are not negatively affected; and e) regulations that make access to ICT data and solutions foreseeable.

12. Develop **national policies to strengthen the digital, communication and information skills** of public administration (at all levels and in all sectors), companies and civil society organizations; national policies to promote innovative ICT solutions in business, educational and scientific systems.

13. Define **ICT promotion policies** that guide applications and development of local content, based on local needs. This requires that the people responsible for policies pay attention to the aspects of transformation, such as change management, skills, incentives and culture.

14. To use **ICT to measure development** efficiently, national governments must: a) foster and promote innovative solutions in relation to the availability and use of ICT devices, platforms and applications for data generation, data analysis and the creation of data ecosystems; and b) incorporate such actions into national development plans, digital agendas and national statistical systems.

15. **Develop skills, particularly among statistics producers, in order to have accurate, reliable and clear indicators linked to ICT and/or the Internet** that provide evidence for improving public policies. Apart from breaking down data by income, sex, race and population groups, it is also useful to have indicators at local and municipal levels to try to incorporate all the realities that national averages obscure from view and thereby fulfill the mandate to **leave no one behind**.

16. Comply with the recommendations of the Statistical Commission of the United Nations (UNSTATS) to establish **mechanisms for the coordination, homogenization and homologation of national statistical efforts** to achieve a complete and functional global indicator system.

ICT FOR SUSTAINABLE DEVELOPMENT.
RECOMMENDATIONS FOR PUBLIC POLICIES THAT GUARANTEE RIGHTS

1 ICT: OPPORTUNITIES AND CHALLENGES

1.1 ICT in the face of new global challenges and the 2030 Agenda

The approval of the **2030 Agenda and the 17 Sustainable Development Goals** not only represents an international agreement on desirable goals, but also supposes **profound and far-reaching global transformations** to the world of today. These transformations create a need to seek integrated solutions that require new approaches and integrated actions (United Nations, 2015a). The principle of sustainable development that underlies and inspires the 2030 Agenda is "transformative change for countries and their citizens to become responsible, green, global citizens" (UNESCO, 2017).

The 2030 Agenda, as different organizations have stated, is **a universal, multidimensional, inclusive and comprehensive agenda**. However, these affirmations are not sufficient on their own to achieve universality, multidimensionality, inclusiveness and comprehensiveness in implementation processes. It will be necessary to delve deeper until several issues have been clearly defined: what the interrelationships are between the 17 goals; what decisions have been made regarding the different dimensions of sustainable development (economic, environmental, social, governance and cultural); and proper exploration of what universality means. Therefore, to understand and implement what the 2030 Agenda proposes requires a **multisector, multilevel, multidimensional and transformative** approach to the current distribution of power that shapes inequalities and unsustainability (Martínez-Osés & Martínez, 2016).

The 2030 Agenda recognizes the importance of fully harnessing science, technology and innovation (STI) and ICT for sustainable development (UNESCO, 2017). There is ample empirical evidence demonstrating that ethically-managed STI are essential for development. However, it is the 2030 Agenda and the SDGs that, for the first time, explicitly and universally recognize STI as a key force for sustainable development that is valid transversally for all the SDGs (UNESCO, 2017).

The 2030 Agenda Declaration confirms the importance of ICT for opening up major possibilities to accelerate human progress, as do innovation and technology in various spheres, such as medicine and energy (United Nations, 2015a). The Agenda deems that **ICT play a facilitative and supportive role**, particularly **in skill development**. However, within the framework of the goals and targets of the Agenda, there are few explicit references to ICT and its adoption in specific policies. Target 9c refers to increased access to ICT, and three others (targets 4b, 5b and 17.8) mention its utility for strengthening scholarships in the educational sphere, empowering women, and carrying out banking operations in very poor countries. The indicators are also part of the Declaration, and ICT can play a crucial role in the satisfactory development of the indicator framework, which will be examined in Section 3.

To establish an adequate and complete relationship between ICT and the SDGs, as a global agenda for sustainable development, at least two aspects must be taken into account: possible contributions that ICT can bring to implementation of the Agenda; and analyzing the sustainability of interventions with ICT specifically designed to eradicate poverty and reduce inequalities (Sharafat & Lehr, 2017), as well as reverse climate change and promote environmental sustainability. In short, as has already been pointed out, the SDGs promote a new integrated approach that underscores the potential for ICT to enable opening up new possibilities for human progress and, at the same time, requires a review of the material production of goods and services based on sustainability criteria. Information and communication technologies are also goods and services that are produced and consumed and, therefore, should also be reviewed to modify unsustainable modes of consumption and production.

In fact, the key role that ICT play in determining current social and economic processes, at the local, national and international levels, seems undeniable. Nowadays, information and communication technologies are an **essential tool** that is used by both individuals and institutions of all types, and they have opened up new possibilities for everyday life, business and the mechanisms of government. The SDGs will be implemented in a context marked by new possibilities for making use of and sharing information, and designing, monitoring and evaluating policies. Therefore, a number of issues will be crucial: Internet access, availability of open access to information resources, protection of personal privacy, promotion of surveillance by citizens, and rights of expression in a world that is growing in digital terms. (UNESCO, 2015b).

Likewise, and in terms of understanding the sustainable development promoted by the SDGs as a multidimensional process, it is necessary to incorporate an analysis of the **implications of ICT**, not only in relation to their impact on the global economy, but also, and primarily, from the perspective of the environmental impacts of their accelerated expansion. The main challenge is that certain aspects of the ICT sector are highly unsustainable, in terms of both their **environmental impact** and their business model (Unwin, 2017). Despite the debate on this issue, it is still not possible to ensure that expansion of ICT will occur within a proven environmentally sustainable framework. For this reason, it is highly recommended to constantly monitor the impact of these technologies through, for example, the Global e-Sustainability Initiative (GeSI) and its evaluation framework (GeSI, 2016a).

It is also necessary to address the **social dimension** of sustainable development in reference to ICT and analyze the risks related to increased social, economic and political **inequalities in access** to ICT, to the point that they are already threatening the stability and ability to grow of some countries (Sharafat & Lehr, 2017).

The annual World Summit on the Information Society (WSIS) established in Geneva 2003 and, especially, in the Tunis 2005 Agenda (CMSI, 2005) the general framework by which the United Nations has incorporated ICT into its development initiatives. The annual forums, especially the meeting in 2015, have established the relationship between the 11 WSIS action lines and the 17 SDGs (UIT, 2015), analyzed in Section 2.

1.2 Critical perspectives on the digital agenda: opportunities and risks

The **digital technology revolution** is decisively contributing to the **modification of economic, social and political standards**. The emergence of ICT has opened up a new field of possibilities and opportunities, which until very recently were hardly imaginable, for developing freedom of expression, access to information, transparency, and surveillance by citizens regarding development processes and dynamics.

The emergence of smartphones and expansion of Internet access coverage has catapulted Internet use, multiplying its possibilities. More than 4 billion people — over 50% of the world's population — have Internet access, and 57% obtain it through mobile phones (CEPAL, 2018). It is calculated that, in 2019, 80% will access the Internet through mobile phones (Internet Society, 2015), as shown by the fact that in 2017 there were already 5 billion mobile phone users (UIT , 2018). In less than a decade and a half, connection technology has shifted from GPRS to 4G, resulting in faster and easier access to data transmission. Consequently, in terms of traffic, the apps market has already exceeded traffic generated by browsers, which has created new business opportunities in entertainment, leisure, education, health, and finances, among many others. Governments have also started to use the Internet to interact with citizens, making information available and providing new mechanisms for consultation and participation (Internet Society, 2015).

Growth in the use of applications has accelerated at an amazing pace. In 2017, 175 billion applications were downloaded. Around 40 apps were actively used on each smartphone; users, on average, used these devices approximately three hours per day. In January 2018, over 3 billion people used social networking websites monthly, especially through mobile devices (42% of the world's population). Meanwhile, the use of e-commerce platforms for buying consumer goods has grown

to 1.8 billion online purchasers worldwide (23% of the population) (CEPAL, 2018).

In the last 30 years, the advance of ICT has often been referred to as a factor in development. The emphasis has been placed on access to connectivity. There has been a kind of utopian vision of ICT, in the sense that access on its own would lead to social and economic transformation. For better or for worse, while technological innovation has been the central narrative in Internet development during the last decade, the narrative of the next decade may shift to aspects of Internet governance, policy and regulation (Dutton, 2016).

Complementary to this, as a product of the extension of the digital agenda to various economic production processes, it has been said that big data is the new disruptive element of the global economy, as oil has been in previous decades (The Economist, 2017). It should be noted the data has its own characteristics, such as being reproducible and noncompetitive in use, with marginal and transport costs close to zero, and increasing returns to scale (more information and more accurate algorithms and predictions) (CEPAL, 2018).

At the same time, the spectacular development of the digital agenda has posed a number of problems, ranging from technical standards in key Internet infrastructure to ethical concerns about the use of social media (UNESCO, 2015b). The passage of time has shown that, along with the accelerated changes that ICT have brought to economic and social processes, it is necessary to analyze and understand them from a political economy perspective that includes different aspects related to regulatory frameworks, access policies and safeguarding of rights, in order to **ensure that ICT contribute to development in terms of sustainability, inclusion and social justice**.

The social consequences of the technological revolution cannot be viewed from a naive perspective, because they generate disruptions and risks in social and economic relationships. This requires an analysis framework for actions corresponding to proper management of these disruptions. The ubiquity of new digital technologies is now a reality and ushers in all kinds of possible changes for global development. However, thus far, their promise as factors of development is still just a vision, and their potential is far from being fully developed. This potential, in terms of increased productivity, sustainable growth, social and economic inclusion, improved governance, intelligent collective decision-making, and provision of responsible services, continues to be reserved for specific communities and is far from having been transformed into a generalized development model (Hanna, 2016).

Likewise, the risks associated with the digital agenda have grown substantially. Data breaches on the Internet have increased recently, affecting a growing number of users, reaching the public sphere and the agenda of citizens' concerns[5].

These and other cases have engendered a certain mistrust of the Internet on the part of users, consumers and employees. The main causes of increased data breaches are attacks for reasons of espionage and political influence and to obtain financial benefits. The issue of protection of personal data is a challenge for operators of platforms and their operating logic. In addition, many identities and large amounts of personal data have been stolen and used fraudulently in recent times (Internet Society, 2015). As a result of all this, there is a growing feeling that governments and companies wield new and unexpected powers of surveillance based on the wide variety of personal data shared on the Internet (GISW, 2013).

This situation creates challenges that cannot be overcome just by research and new advances. In the relatively short period of just the last decade, the center of attention and key focus of innovation have shifted from mobile connectivity and cloud computing[6] to the ecosystems of the Internet of Things and data management through

5 The cases of Cambridge Analytica, Facebook and the U.S. elections are paradigmatic of the risks associated with security of personal data.

6 Cloud computing, known simply as "the cloud," is a paradigm that enables offering computing services through a network, which is usually the Internet.

artificial intelligence[7], robotics and blockchain, whose applications will demonstrate their full potential through 5G networks (CEPAL, 2018). Thus, the world of today is characterized not only by **hyperconnectivity**, but also by the overlap of the traditional and digital economies with their respective social relations and institutions **navigating between two worlds**.

> *This results in a new, digitally interwoven system in which models from both spheres interact, giving rise to more complex ecosystems that are currently undergoing organizational, institutional and regulatory transformation with an urgency imposed by the speed of the digital revolution. In the short run, the coexistence of two schemes can be expected to give rise to uncertainties and frictions in the areas of greatest symbiosis (CEPAL, 2018).*

This symbiosis refers not only to the incursion of the digital economy into sectors previously reserved for the traditional economy, but also to the **digitalization of production systems**. The automotive industry and financial sectors appear to be undergoing a major transformation in terms of the degree of digitalization of their products and services, and in the production process itself. It is expected that, by 2020, the sectors of health, manufacturing, agriculture, mining, transportation and energy will have digitalized their activities the most (CEPAL, 2018). Apart from the adaptation of companies' business strategies to the digital agenda, new businesses based on digital mediation, tourism, urban transportation, home delivery and hospitality are also emerging, and give rise to the coexistence of the gig economy and sharing economy.

All of this generates enormous challenges in matters related to jurisdiction, surveillance, privacy, security and equity, in terms of access to what are already considered key resources of the new economy. And these challenges cannot be addressed solely at the national level or as matters of national security; they need a **clearly cosmopolitan focus**, as a coherent requirement for dealing with issues that transcend geographic boundaries (CEPAL, 2018). In other words, the digital revolution directly affects allocation of resources, labor relations, and social and power structures. In short, it affects current development models and visions. Therefore, it seems imperative to review development concepts and, particularly, the relationships between digital technologies and appropriate public policies for promoting equitable and sustainable development as proposed by the 2030 Agenda and the SDGs.

1.3 Digital inequalities

Equity is an aspiration of the 2030 Agenda and its 17 SGDs and, at the same time, serves as a guiding principle for appropriate public policies to implement them. In a context of digital transformation, it is necessary to take into account the so-called digital divide. The Organisation for Economic Co-Operation and Development (OECD) defines the digital divide as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies and to their use of the Internet for a wide variety of activities." (OECD, 2015) Although no one denies the existence of the digital divide, there are various points of view regarding its extent and the reasons for its existence. This gap refers to different levels, within and among countries, between rural and urban populations, and between young and old people, not to mention the gender digital divide.

It needs to be taken into consideration that digital inequalities are not phenomena that are independent of existing socioeconomic conditions in societies where ICT expansion occurs. On the contrary, the digital divide is associated with substantial inequalities in education, health, income, housing, employment, gender, and access to drinking water and food. Therefore, the digital divide must be understood and treated precisely within the context of these social and economic inequalities. Inequalities in relation to access to connectivity and the skills, services and knowledge associated with the technological revolution have elements in common

7 Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (acquisition of knowledge and rules for use of information), reasoning (using rules for achieving approximate and definitive solutions) and self-correction. The particular applications of artificial intelligence include expert systems, voice recognition and artificial vision.

with analyses of social inequalities. Policies to reduce the digital divide have focused on providing ICT access, but poor or marginal population groups have rarely been incorporated into the formation processes of these policies; doing so would have helped provide a nuanced and specific understanding of their needs (GISW, 2013). There is controversy as to whether the digital divide is expanding or not, depending on which indicators are used to measure it. There is an increasing number of aspects to take into consideration as dimensions for measuring the digital divide. In addition to the digital divide, it is also important to measure the "second-tier" digital divide, which considers that the socioeconomic characteristics of individuals (such as level of education, gender, income, age group), motivational differences, and distinct digital capabilities and skills give rise to unequal use, even among those who have Internet access (Van Dijk, 2005); (DiMaggio, Hargittai, Celeste, & Shafer, 2004); (Van Deursen & Van Dijk, 2013). From this perspective, public policies for access and connectivity are not enough; interventions are needed that promote formal education, on-the-job training, and development of digital skills.

Although the potential of ICT to contribute positively to sustainable development and the 17 SDGs is immense, it must also be taken into account that **ICT expansion can cause disruptions in traditional economic and social structures**. ICT can increase income inequality and concentrate all the economic benefits, if specific efforts are not made to ensure inclusion and universal accessibility and support skill development (Sharafat & Lehr, 2017). What can be done to ensure that access will be expanded in a way that is safe and respects privacy, allowing easy choice among platforms, and making sure that content will be available, affordable and relevant for all users? (Internet Society, 2015).

Access to ICT is accelerating in ways previously considered unthinkable, along with capacities to perform operations, access information, modify standards of employability, and use multiple services. However, the fact that the world is still far from having achieved universal connectivity shows that the gap is expanding between those who have and do not have access. For this reason, numerous institutions and some governments have adopted universal connectivity as a strategy. This entails addressing challenges related, not only to investment and supply of services, but also to unequal demand factors, which depend on different socioeconomic, educational and employment conditions. It would be advisable for any proposal for **"leave no one behind"** in terms of connectivity and its potential benefits, to incorporate a concerted universalization strategy focused on groups with disabilities, indigenous populations and poor communities. Subsidies and incentives for certain groups would be indispensable measures in any strategy to universalize the benefits of connectivity.

Extension of connectivity has focused on new market niches, such as young people and women, but without following policy plans based on universal access. However, issues related to class, gender, living in urban areas, or disability continue to confer comparative advantages on some population groups compared to others. (GISW, 2013). Many economic and social functions, as well as public and private services, have shifted to the Internet. Jobs are changing or being eliminated, and new ones are being created, and this can affect labor rights. Aspects of educational systems are being transformed, but this is not always based on parameters that improve education. Therefore, **for the Internet and technologies to actually help strengthen rights, a new public policy framework needs to be developed** in order to enable better harnessing of the advantages of ICT, as well as preventing and tackling new challenges resulting from technological development (Burch, 2017).

Some recent reports have recognized that the contributions of ICT to development have not always been as successful as anticipated. According to these reports, the contribution of ICT to economic growth has usually been associated with increased inequality, which is telling at a time when reducing these inequalities is considered to be the main goal for developing economic policies; at least, as much as the pursuit of economic growth has been for decades (OECD, 2015).

Consequently, **development and expansion of ICT**, by their nature and versatility, **do not alone determine the results in the development of societies.** Contexts, institutions and human factors co-produce these results. In the process followed to date, two challenges have arisen that explain

why the fruits of development have not been disseminated as widely and equally as Internet and mobile phone access.

The first challenge refers to the gap between investment in digital technologies and the economic policies, institutions and human complements that are equally important for transformation. Investments in technology cannot replace these other factors, which have the potential to enable the contribution of these technologies to the achievement of development results. Normally, leadership in countries is assigned to ministries dedicated to access and connection supply issues, far removed from the ICT needs of other sectors and ministries, such as health and education. Something similar happens in international aid agencies, where experts from the ICT sector have their own connectivity initiatives, and do not interact with experts in education, governance and the environment.

The second challenge is in relation to key elements of the ICT ecosystem, such as connectivity infrastructure, the local ICT service industry, skills for maintaining infrastructure and systems, applications to link the needs of local users, and institutions for synchronizing these highly interdependent elements. Surveys by international organizations has shown that, in the last few years, most Latin American countries have adopted broadband dissemination programs (UIT, 2013) or national strategies for the use of information and communication technologies in education (Sunkel, Trucco, & Espejo, 2014). However, not many countries have adopted a holistic approach to the kinds of social and economic innovation that can be achieved through effectively harnessing the potential offered by ICT. It is also observed that, generally, ICT development is divided among various ministries and actors dedicated to science and technology, finance, education, industry, trade, telecommunications regulatory agencies, Internet providers, digital content providers, etc. (Hanna, 2016).

The gender digital divide warrants special mention since, according to the integrated and multidimensional approach of the 2030 Agenda, perspectives on gender equality are not only incorporated in all the actions contained in SDG 5 for the promotion of women and girls, but are also included in all the SDGs. Data must be disaggregated by sex in the Agenda's implementation and follow-up frameworks, and promotion of gender equality and empowerment of women are fundamental in every sphere of transformation addressed by the Agenda. In other words, gender equality is a principle that must permeate all political action in implementation strategies of the 2030 Agenda (UNESCO, 2017).

As a result of unequal power relations between men and women, the latter have fewer options to partake of the financial, educational, social and health resources offered by the digital agenda. In terms of Internet and mobile phone access, women lag behind men — 250 million and 200 million less than men, respectively — (UIT , 2018). Furthermore, only 10% of the technological jobs in the Silicon Valley are held by women, and only 6% of applications are developed by them.

This analysis of the gender digital divide seems to indicate that, insofar as Internet access and mobile phone use are concerned, it may have been substantially reduced in some places in the last 10 or 15 years. This is the case in Latin America, where 48% of people who use the Internet are women. However, there is unequal representation of men and women in technological careers, access to funding for research and development, development of prototypes, software, etc., and jobs in technology hubs. Therefore, analysis of the gender digital divide must include dimensions that extend beyond access to the Internet and different devices, such as computers and mobile phones. Such analysis should include, among other aspects, use, ability to create and disseminate content, and the existing inequality with respect to the presence of men and women working in technological sectors such as video games, apps and software development, where, according to the ITU, only 6% of ICT applications designers are women, and less than 6% are software designers (UIT News, 2016). The low number of women in senior positions in major tech companies is also not very encouraging; in 2016, only three were led by women: IBM, Oracle and Xerox (UIT News, 2016).

As stated earlier, the persistence of the gender digital divide is directly related to the sexual division of labor and socioeconomic conditions and structures that still indicate significant differences in wages, recognition and possibilities for women

to fully develop their capacities (GISW, 2013). It would be advisable to work on comprehensive solutions to reduce this digital divide, through actions such as those that go hand-in-hand with culture and link social and economic dimensions through creative industries, cultural tourism and heritage preservation, through women and girls who are creators and producers with full participation in cultural life (UNESCO, 2017).

As for reducing the gender digital divide, it is also worth mentioning the EQUALS initiative[8], founded in 2016 by five partners: ITU, UN WOMEN, the International Trade Centre, GSMA and the United Nations University. It is too early to assess the results and impact of their actions, and there is a shortage of grassroots organizations made up of women among their current members. Nonetheless, the work of this global alliance may be important in pinpointing and removing barriers and obstacles that women encounter in rising to positions of responsibility and leadership; for companies to implement the UN Women's Empowerment Principles[9]; and for the creation of digital campaigns for equality.

1.4 Internet rights and universality

The 2030 Agenda is based on human rights and is committed to bringing full rights to all people (UNESCO, 2017). In 2013, during the 37th session of the General Conference of UNESCO, the Member States confirmed the principle of **applicability of human rights to cyberspace** (UNESCO, 2015b). That same year, UNESCO launched the concept of Internet universality, which was backed by the General Conference of 2015. This concept draws particular attention to the norms and values of the interconnected and interdependent behaviors that underlie the Internet and the need to strengthen those norms and values in order to harness their full potential for sustainable development (UNESCO, 2015a).

To this end, the Member States agreed on **four normative principles** that should guide the development of the Internet, which should be: i) **based on human rights**, ii) **open**, iii) **accessible to all** and iv) nurtured by **multi-stakeholder participation** (R.O.A.M. principles).

The concept of **Internet universality** recognizes — apart from infrastructure and applications — the network of social and economic interactions and relationships that have a high potential for enabling rights, empowering individuals and communities, and facilitating sustainable development (UNESCO, 2018a). "Understanding the Internet in this way helps to draw together different facets of Internet development, concerned with technology and public policy, rights and development" (UNESCO, 2018a, page 3). Because the Internet is becoming so significant in everyday life, work and identity in much of the world, it is increasingly difficult to distinguish **human rights within and outside the Internet**. The UN has said that the principle of human rights should apply to all aspects of the Internet (UNESCO, 2015b). This normative principle entails implementing pertinent mechanisms to guarantee and protect human rights in cyberspace, in both the international sphere and the framework of national public policies and digital agendas.

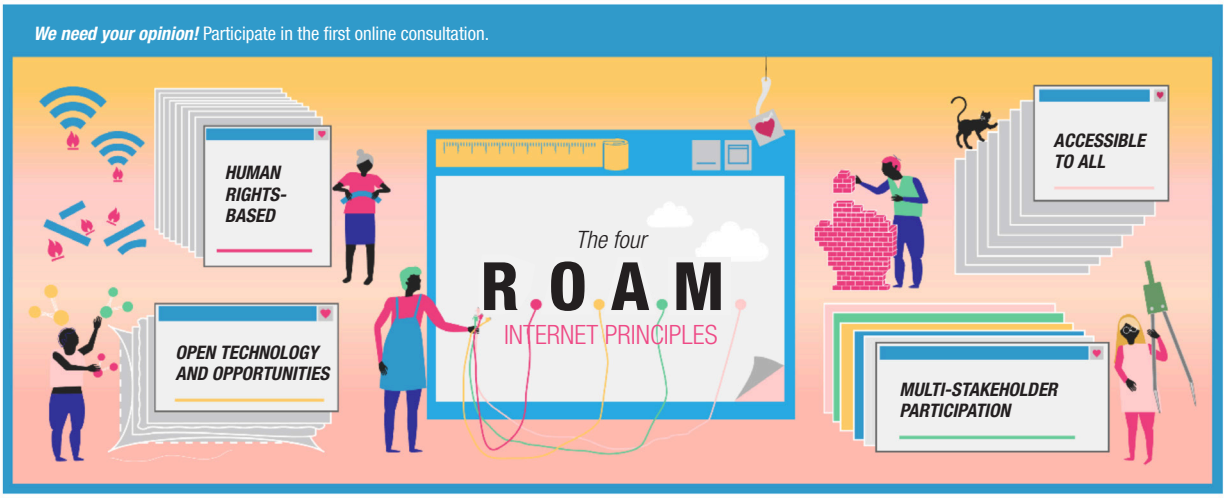
Therefore, democratic forms of **international Internet governance** are required for upholding **civil and political** rights on the Internet (such as right to freedom of expression and association on the Internet, right to privacy and security, etc.), for **economic, social and cultural** rights (right to access infrastructure regardless of where one lives, right to equal access for men and women, right to access and create culturally and linguistically diverse content, right to affordable access, in terms of language, income and level of education, etc.) and for **global rights or rights of peoples** (right to peace and right to protection from cybercrime, cybercorruption and cyberterrorism, right to technological development, etc.) (Del Rio, 2012).

The **principle of openness (open Internet)** emphasizes the need for open global standards, interoperability, open application interfaces, and open science, documents, texts, data and flows. In addition to technical expertise, open systems also need social, political and scientific support.

8 More information at: http://www.equals.org

9 More information at: http://www.unwomen.org/es/news/stories/2012/6/the-women-s-empowerment-principles-bringing-gender-equality-into-the-corporate-sustainability-frame

Figure 1: Internet Universality



Source: UNESCO (2018a, page 3).

Transparency and accountability are part of openness, as well as the dimension of the right to seek and receive information. Generation and dissemination of local content and the end-to-end principle[10] are also part of this principle. In this way, among others, rights and openness are interdependent (UNESCO, 2015b).

The principle of **accessibility to all** refers to overcoming aspects that give rise to the digital divide and exclusion based on skills, literacy, language, gender or disability. It also involves the need for sustainable business models for Internet activities, and trust in the preservation, quality, integrity, security and authenticity of information and knowledge (UNESCO, 2015b).

The fourth principle of Internet universality is **multi-stakeholder participation**. This refers to participation in decision-making that affect people's lives. "It recognizes the value of multi-stakeholder participation, incorporating users and a user-centric perspective as well as all other actors critical to developing, using and governing the Internet across a range of levels." (UNESCO, 2015b).

In recent years, numerous voices have been demanding a "fair and open" Internet, i.e., an Internet that is free from censorship and characterized by the right to freedom of expression and association. At the same time, governments, concerned about use of the Internet for crime and terrorism, have started developing regulatory policies to control online freedom, limiting the development of possibilities that the Internet offers for development and democracy.

To help governments and other stakeholders define and evaluate their national Internet environments and develop digital policies and agendas to promote the principles of universality, UNESCO created an Internet universality indicator framework[11]. This tool responds to the integrated nature of the 2030 Agenda and its 17 SDGs, which need to be more cohesively connected to policies at the national, regional and international levels. For this, it would be recommended to promote stronger links between research, social sciences and the formulation of public policies, comparability of international data for observing trends, and establishment of priorities and evaluation of policies (UNESCO, 2017).

10 End-to-end encryption (E2EE) Is a communication system where only users who communicate with each other can read messages.

11 After an extensive process that included public consultations and pilot studies, the final document with these indicators was presented in October 2018. For more information, please visit: https://en.unesco.org/internetuniversality

1.5 Promotion and governance of ICT for development

As mentioned earlier, Internet governance-related issues have dominated current discussions that explore the relationship between ICT and development processes. Although widely debated, the definition elaborated by UN WSIS in 2015 can be used as a benchmark: "Internet governance is the development and application by governments, the private sector and civil society, in their respective roles, of shared principles, norms, rules, decision-making procedures and programs that shape the evolution and use of the Internet." (UIT, 2015) The crucial issue is precisely the assignment of the different roles to the distinct stakeholders involved in the Internet development process.

In one way or another, the weight and role of each of the actors involved, as well as the mechanisms and institutions that will be chosen with shared, but different, responsibilities, are the main subject of current discussions. Similarly, in SDG 17, the call for shared responsibility and the joint participation of all actors does not permit delving deeper into determining the most appropriate division of these roles, in order to tackle the challenges posed by the governance of sustainable development and, in particular, Internet governance for this development.

The 2030 Agenda gives clear priority to partnerships, integrated approaches and integration. National and international institutions must play a significant role, as conveners, facilitators and implementers of multi-stakeholder partnerships, and support cooperation processes for implementing the SDGs. In short, a structured dialogue on financing involving all stakeholders is required (UNESCO, 2017).

It needs to be pointed out that there are notable differences among the 17 SDGs in terms of their development status and access to the relevant technologies for achieving them, as well as the experience and maturity of the international community in their application and assessment of their impact. In addition, the different actors (countries, international agencies, private companies and other actors) who develop, facilitate and adopt technologies vary in the ways in which they use technological potential to achieve the SDGs.

In sum, the issue of multi-stakeholder partnerships and their role in governance of the Internet and ICT to ensure their effective contribution to sustainable development becomes a fundamental and essential aspect, not only from the perspective of aggregation of stakeholders, but also in relation to the necessary incorporation of new types of multilevel coordination, with a specialized focus on the needs of vulnerable local groups, in addition to an analysis that enables understanding the different, albeit shared, responsibilities of the various stakeholders. It is true that the issue of multi-stakeholder partnerships for sustainable development is relevant for the SDGs and, particularly, for ICT initiatives in relation to the SDGs. However, it is also important to bear in mind the current challenges that need to be overcome in the formation of such partnerships: ensuring that they are sustainable and long-term; overcoming difficulties in reaching agreements on joint goals and activities; balancing different interests and determining the levels of contribution expected of each member; identifying resources; cooperating among partners from the private sector and national institutions; and monitoring and evaluating throughout the process in order to reallocate resources based on results (Geldof, 2011). As mentioned earlier in relation to inequalities, it is also crucial to incorporate more vulnerable local groups into these discussions, in order to integrate agendas and local needs in terms of technologies and sustainability of development processes.

2 CONTRIBUTION OF ICT TO SUSTAINABLE DEVELOPMENT

As mentioned earlier, there are various ways in which information and communication technologies can contribute to sustainable development and accelerate the achievement of the SDGs. While it is true that there is no specific SDG dedicated to ICT, at least three types of contributions of ICT to sustainable development can be identified:

1. From the point of view of rights, it is essential to point out the role of ICT in **ensuring access to information** in a globalized and interdependent world. As will be seen further on, lack of access to information prevents consolidation of

equitable societies, hinders democratic guarantees, and generates inequalities.

2. In addition to viewing access to ICT as a right, these technologies can be **effective tools to consolidate and guarantee other rights linked to the 2030 Agenda and SDGs**. For this reason, it is advisable to adopt ICT in public policies aimed at promoting sustainable development and more just and sustainable societies.

3. ICT are also fundamental for **measuring the 2030 Agenda**, in terms of strengthened accountability, and monitoring and follow-up of the SDGs and proposed targets.

2.1 Contribution of access to information to the SDGs

Universal commitment to ensuring access to information entails recognition by the international community that such access is a basic human right and, at the same time, a requirement for achieving all the SDGs. Access to information and knowledge is a prerequisite for building inclusive knowledge societies (UNESCO, 2015b). Information not only empowers people, but also allows them to exercise their rights, be economically active, learn new skills, hold their governments accountable, etc., apart from being crucial for economic, social and political development (Internet Society, 2015; World Bank, 2016b).

More explicit recognition of the importance of access to information in the 2030 Agenda is found in **SDG 16.10,** which requires signatory countries to **"ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements."** More specifically, indicator 16.10.2 refers to the "number of countries that adopt and implement constitutional, statutory and/or policy guarantees for public access to information." Advocates of this target argue that, without open and constant information, discussion and analysis, the SDGs cannot be measured, much less achieved. By the end of 2016, 113 of the 193 member countries of the UN had adopted laws to ensure public access to information[12] (Orme, 2017). However, since this was relatively recent, these laws have not yet been completely implemented[13].

In addition, the World Summit on the Information Society includes "Access to information and knowledge" in its C3 action line, as a requirement for achieving each and every SDG (United Nations, 2015b). The High-Level Political Forum on Sustainable Development 2017 (HLPF) maintained that high-quality, disaggregated, open data[14] is essential for providing support to decision-making and efforts to eradicate poverty, by addressing negative trends such as climate change, destruction of natural resources, and other factors that can undermine progress. In the view of the World Bank, "digital technologies have dramatically expanded the information base, lowered information costs, and created **information assets.** This **has facilitated** searching, matching and sharing of information, and contributed to **greater organization and collaboration among economic agents** - influencing how firms operate, people seek opportunities, and citizens interact with their governments" (World Bank, 2016a, page 8).

Information is a **tool of empowerment**. It can make all government budget planning figures available, through transparent and competitive bidding processes and greater accountability of government bodies, etc. It is also a tool **for increasing opportunities for secure livelihood.** It is necessary to emphasize not only the importance of access to information, but also the relevance and utility of information (UNESCO, 2018b).

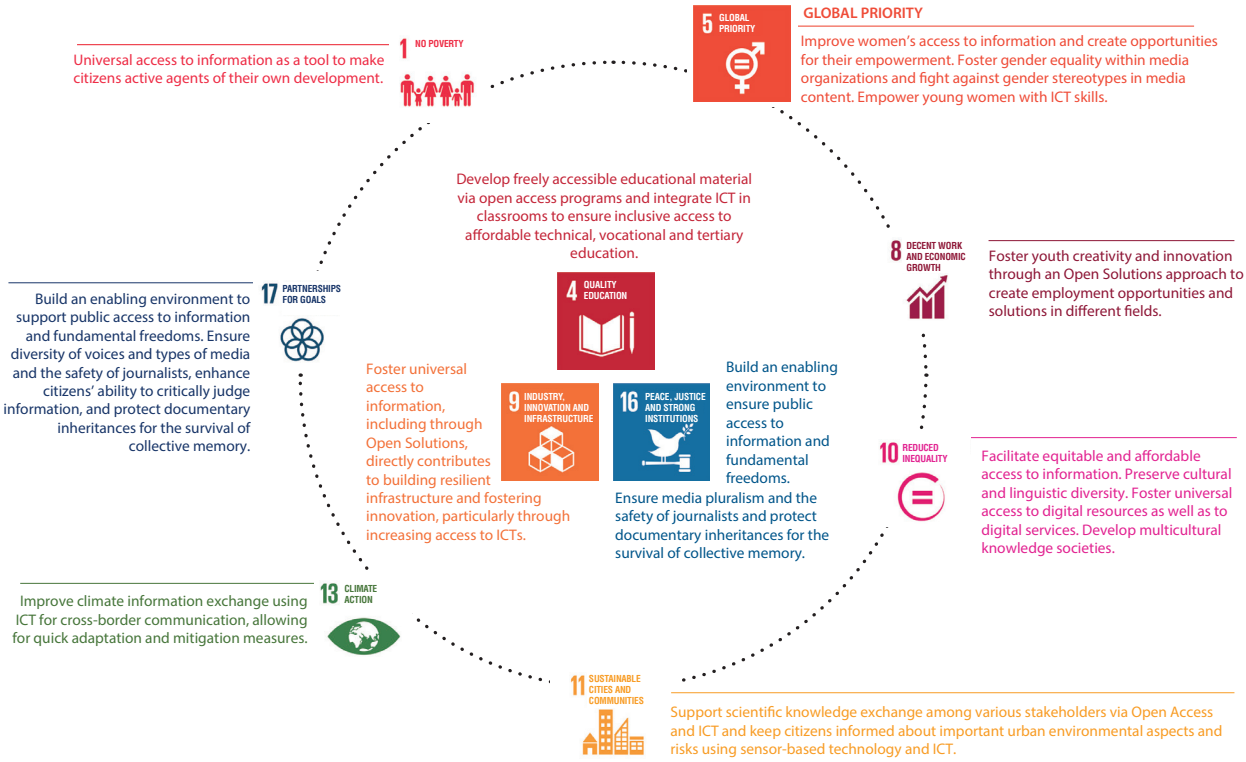
With regard to **how people, governments and companies use information resources** for access, exchange, use and creation of new information and knowledge, there is not much data

12 http://www.freedominfo.org/regions/

13 UNESCO is the agency responsible for providing information on the adoption and use of access to information laws, as the official indicator of Target 16.10. To underscore the worldwide importance of this principle, the Member States of UNESCO decided in 2015 to create the "International Day for Universal Access to Information," which is celebrated annually on September 28.

14 Open data is considered to be data with free access, reuse and redistribution, without any specific permissions required.

Figure 2: Contribution of freedom of expression and universal access to information to the SDGs.



Source: UNESCO (2017, page 18).

available for providing a panoramic view. According to data from the ITU (2015), lower rates of digital/informational skills in less developed countries are especially linked to **"productivity applications",** such as spreadsheets (18%) and the creation of electronic presentations with presentation software (17%).

According to Garrido & Wyber (2017, page 34)[15], 20% of people from less developed countries reported having taken **online courses**, compared to only 7% in more developed countries. However, only 39% of people from less developed countries used the Internet to access blogs, forums and discussion groups and to **read or download news** or books, compared to 75% in more developed countries. The reason for this gap is not clear, but it may be the product of limited resources in certain languages. In less developed countries, 27% of people searched for **online health information**, very similar to the percentage (30%) of those who did so in more developed countries. Whereas only 24% of people in less developed countries used the Internet to **obtain information from government organizations**, it was 56% in more developed countries. Similarly, only 14% of people used the Internet to **interact with the government**, as opposed to 57% in more developed countries. With respect to online banking, the difference was similar between developed and less developed countries (54% and 13%, respectively).

2.1.1. Dimensions of access to information

The concept of access to information has, historically, been expanding and adapting to the development of ICT and the information society. There are various co-existing visions in the inter-

15 Citing the ITU (2015), the regional averages are not representative of the world, but illustrate that a major gap exists.

national agenda but, in general, they have all risen above the initial restricted vision of access to public information and evolved toward a vision of public access to information and knowledge as a universal heritage. This requires guarantees of availability, accessibility, affordability and relevance, and affects, to varying degrees, all economic, social and political development actors (governments at all levels, legislative and judicial branches, companies, civil society, foundations, universities, media, etc.).

> *Access to information and knowledge encompasses the vision of universal access, not only to the Internet, but also to the ability to seek and receive open scientific, indigenous knowledge online, and to produce content in all forms. This requires initiatives for freedom of information and the building of open and preserved knowledge resources, as well as a respect for cultural and linguistic diversity that fosters local content in multiple languages, quality educational opportunities for all, including new media literacy and skills, and social inclusion online (UNESCO, 2015b, page 10).*

Universal public access to information involves distinct issues related to Internet **connectivity**, **availability of relevant information** (which assumes that it is generated, made public and actively publicized by all the actors and, in addition, is socially and economically relevant), **accessibility** (understood as the possibility that all people can access, without difficulty, the resources and services available on the Internet, regardless of language, culture, geographic location, skills of users, etc.[16]), **affordability** of information (in relation to the price paid in order to access it), **metadata**, **interoperability**, **open source computer programs**, **free content**, and **Creative Commons licenses**, as well as the needs of people with disabilities and other groups with specific needs. Public access to information also requires – especially in countries with lower household connectivity – **public Internet access points**, which also incorporate digital/information literacy programs and user support, such as public libraries.

Therefore, certain preconditions must be met, such as having the necessary adequate **infrastructure** (fixed and mobile broadband) and **devices** (computers, telephones, etc.) for connecting. Access via **mobile devices** is playing an increasingly important role in less developed countries, which must be taken into account when defining national digital policies and agendas.

Access to information also requires the availability of **locally relevant content** (open data, access to repositories, etc.), in **local languages**[17] **and with affordable formats, costs and technologies**. Regulatory frameworks that ensure freedom of expression and the right to seek and share information are likewise needed. In addition, the **gender digital divide** must be overcome, through implementing solutions that combine cultural factors and others related to skills (Garrido & Wyber, 2017).

Even when there is physical connectivity and relevant content, these are pointless if users cannot **apply them to problems** in the real world. This requires the **capabilities, skills and attitudes** (digital/information culture) that are necessary for people to identify, find and use existing information and potentially use it for improvement of their living conditions (employment, training, exercise of their rights, etc.), in the performance of their duties (civil servants, health workers, teachers, etc.), and for generating new information that they can share with their communities or other social actors. Therefore, access to information and knowledge includes the provision of **digital literacy** skills (ICT skills), **media** literacy (understanding of various types of media and formats through which information is transmitted) and **information** literacy (skills for seeking, evaluating, using and creating information effectively to achieve personal, social, occupational and educational goals) (UNESCO, 2018b).

16 Data journalism could be a great ally in this area. Information about government budgets can be presented in the form of raw figures, which is difficult for normal citizens to understand, or such information can be processed and provided in infographs or other formats that facilitates it being understood by any person. This aspect is relevant to the ability of citizens to hold government accountable.

17 According to Moreno (2017), over half (52%) of the content on the Internet is in English, almost double the percentage of Internet users in English-speaking countries (26%). The second most used language is Chinese, corresponding to 20.8% of the total, but only 2% of online information is in this language.

Figure 3: Potential of Big Data for the SDGs.

1 NO POVERTY

Spending patterns on mobile phone services can provide proxy indicators of income levels.

2 ZERO HUNGER

Crowdsourcing and tracking of food prices listed online can help monitor food security in near real-time.

3 GOOD HEALTH AND WELL-BEING

Mapping the movement of mobile phone users can help predict the spread of infectious diseases.

4 QUALITY EDUCATION

Citizen reporting can reveal reasons for student drop-out rates.

5 GENDER EQUALITY

Analysis of financial transactions can reveal the spending patterns and different impacts of economic shocks on men and women.

6 CLEAN WATER AND SANITATION

Sensors connected to water pumps can track access to clean water.

7 AFFORDABLE AND CLEAN ENERGY

Smart metering allows utility companies to increase or restrict the flow of electricity, gas or water to reduce waste and ensure adequate supply at peak periods.

8 DECENT WORK AND ECONOMIC GROWTH

Patterns in global postal traffic can provide indicators such as economic growth, remittances, trade and GDP.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Data from GPS devices can be used for traffic control and to improve public transport.

10 REDUCED INEQUALITY

Speech-to-text analytics on local radio content can reveal discrimination concerns and support policy responses.

11 SUSTAINABLE CITIES AND COMMUNITIES

Satellite remote sensing can track encroachment on public lands or spaces such as parks and forests.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Online search patterns or e-commerce transactions can reveal the pace of transition to energy efficient products.

13 CLIMATE ACTION

Combining satellite imagery, crowd-sourced witness accounts and open data can help track deforestation.

14 LIFE UNDERWATER

Maritime vessel tracking data can reveal illegal, unregulated and unreported fishing activities.

15 LIFE ON LAND

Social media monitoring can support disaster management with real-time information on victim location, effects and strength of forest fires and smoke.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Sentiment analysis of social media can reveal public opinion on effective governance, public service delivery and human rights.

17 PARTNERSHIPS FOR GOALS

Partnerships to enable the combining of statistics, mobile and internet data can provide better and real-time understanding of today's hyperconnected world.

Source: UN Global Pulse (2018).

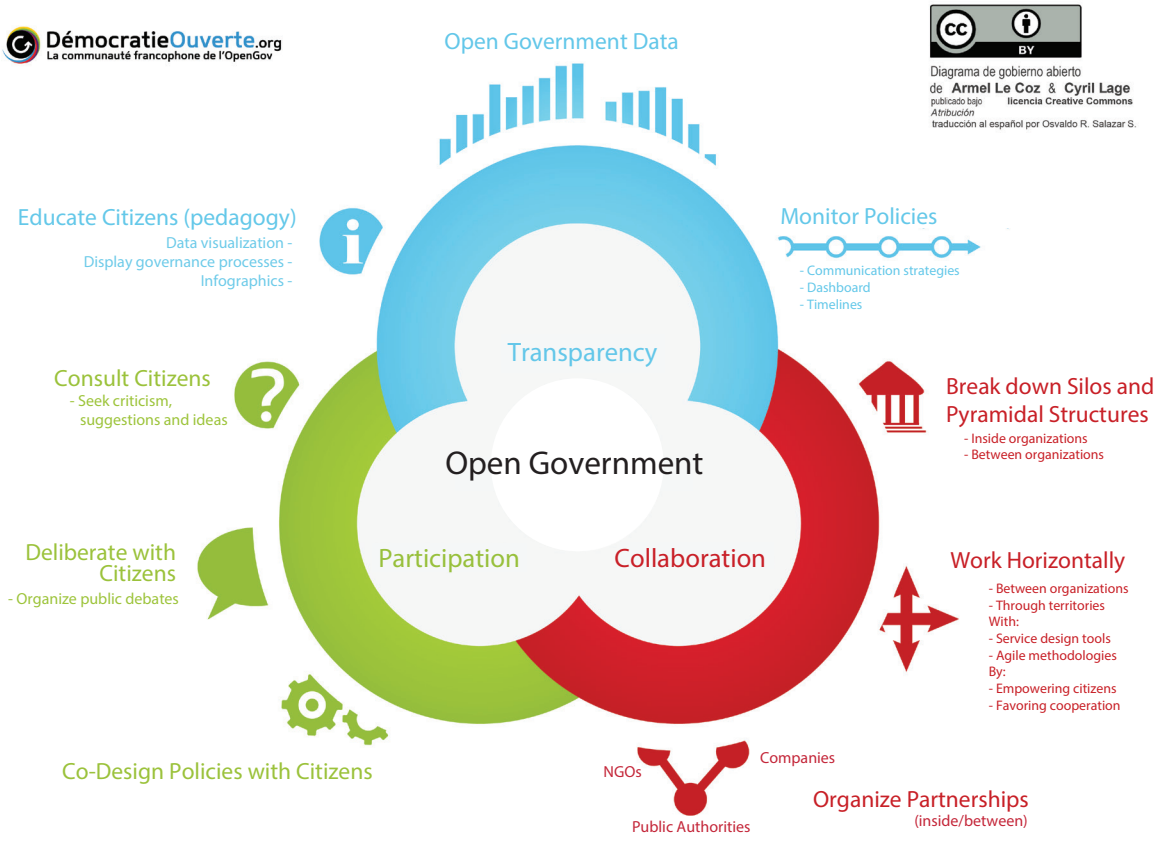
In order to move toward a digital/informational culture, a sufficient critical mass of individual and collective actors with the relevant capabilities, skills and attitudes is required. This should start with **governments, public administration and civil servants**, who should create and implement informed, data-driven policies, aimed at active transparency, accountability and mechanisms for open government, good governance and fighting corruption.

The generation of statistical data is also the responsibility of national governments, which should make it available for **reuse** by **information mediators** (such as communication media, the scientific community, companies, administrations and social organizations) to offer services linked through different channels, such as mobile ones (traffic, accommodations, time, equipment, schedules, accountability, health alerts, etc.), social networking websites (Twitter traffic, Twitter public transportation, Twitter sector data), webs, and apps (enrollments, procedures and services, schedules, etc.).

However, this is not sufficient. **Companies, communication media, universities and civil society**, among others, such as economic and social actors and information mediators, **need to incorporate the necessary capabilities and skills** for decision-making and transparency in their organizations and between management and labor.

Media and informational literacy of the **general population** is likewise indispensable, in order to access information, so that people can benefit from significant access to information and,

Figure 4: Dimensions of open government



Source: Democratie Ouverte (2016).

thereby, participate in the definition of policies, hold government accountable, and demand their rights to improve and enhance their opportunities for economic, social and political development (income generation, access to services, participation in democratic processes, etc.).

Access to information is also a necessary condition for **democratic governance and fighting corruption**. ICT can facilitate access to information and promote transparency and help citizens to be proactive and hold the government accountable for its actions. Knowledge of public policies can enable citizens to hold political actors accountable for the administration and use of public resources. Among the targets of **SDG 16 (peace, justice and strong institutions)**, some are directly related to access to information, such as: "Develop effective, accountable and transparent institutions at all levels," and "Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements."

According to the OECD (2017), governments around the world spend approximately $9.5 billion through contracts every year. This covers infrastructure, vital goods and services in health, education and basic services. However, the OECD, in its Development Co-operation Report 2017: Data for Development, points out that contracting information in most countries is not open to public scrutiny, and thus constitutes one of the main risks of corruption in governments. Studies have shown that **opening up data** to the public regarding purchases helps

reduce fraud and waste, as well as provide better services to citizens.

However, for open data to contribute to improved governance, it must be clearly coordinated with public decision-making processes (participation) and public accountability mechanisms (Open Government Partnership, 2017). The concept of open government combines the necessary aspects for good governance, such as transparency, collaboration and participation.

Open, participatory and responsible government, first of all, depends on people having **access to the information** of public agencies. A **transparent** government fosters and promotes **accountability**[18] of its administration toward citizens, in a simple and clear way, regarding what it is doing and its action plans (through open data, viewing of data, dissemination strategies). This creates the foundation for **meaningful citizen participation in the shaping of public policies and their follow-up and control**, which requires consultation with citizens and public discussions. **Collaboration** assumes cooperation, not only with citizens in general, but also with companies, associations and other agents, and enables joint work within the public administration among its employees and with other administrations (CEPAL-United Nations, 2017).

This vision incorporates the different dimensions to be taken into account for the analysis and establishment of national policies aimed at harnessing the potential of access to information for achieving the SDGs.

2.1.2. Recommendations for national public policies

Access to information requires that four key elements (Garrido & Wyber, 2017) be taken into account when defining public policies:

- **Infrastructure for access to information and communications**: connectivity (and material resources such as mobile phones and computers), which requires physical connection to information.
- **Necessary capacity of people and all social actors**: the body of functional knowledge, skills and resources that the population develops over time; this indicates whether and how information is used.
- **A positive social context for its use**: the variety of local cultural factors that shape how users interact with information.
- **A conducive legal and political context:** policies and regulatory frameworks that promote or hinder connectivity, affordability, inclusion and rights. Examples include spectrum management[19], universal access funds, copyrights, freedom of expression, privacy and security.

In addition, the following proposed policies would require transversal incorporation into national development plans and/or digital agendas, supported by budgets and corresponding action plans.

18 This refers to the process where citizens monitor and assess responsible performance by civil servants through mechanisms such as transparency and oversight. It assumes the possibility that undesirable results will be penalized through specialized bodies and courts of the government, citizens' votes and public opinion. Nowadays, it is considered a necessary mechanism for democracy to function and to fight corruption (Bovens, 2009).

19 This refers to the radio spectrum that is the means by which electromagnetic radio wave frequencies are transmitted. They allow telecommunications (radio, television, Internet, mobile telephony, digital terrestrial television, etc.), and are administered and regulated by the governments of each country.

Figure 5: Public policy proposals to strengthen access to information

Policies	Description
Open government policies[20]	Should include actions, ranging from policy decisions to technical solutions, that identify different roles, collaborations and partnerships between governments, companies, civil society and other data users that can help governments and data users to develop solid open data programs. Open data policies should include: • Support for open data through legal and licensing frameworks. • Generation and availability of sufficient and relevant quality data that is detailed, disaggregated and inclusive. This is essential for facilitating diagnosis, planning, decision-making and precision policymaking, as well as for data use and potential reuse[21] by all social actors. • Publication (and publicizing) of inventories and open repositories of data generated by governments and international organizations, at the local, national and international levels. • Creation of channels for feedback to the government by users of actual and potential data. • Prioritization of the sets of data that users desire/demand, in software, devices and affordable formats. • Measures to protect privacy rights.
Open solution policies[22]	Actions aimed at promoting **open access** (OA), **open data** (OD), **crowdsourcing** and **open educational resources** (OER) that enable sharing information openly and legally, and offer transversal strategic opportunities to improve decision-making processes and facilitate political dialogue, knowledge sharing and capacity building (UNESCO, 2015b).
National digital, media and information literacy policies	The areas and competencies would be: **hardware and software operations** (physical operations of digital technologies and identification of data, information and digital content for operating digital technologies); **information and data literacy** (seeking and filtering of data, information and digital content, and management and assessment of data, information and digital content); **communication and collaboration** (citizen participation, interaction and collaboration through ICT, etc.); **digital content creation** (development of digital content and programming, among others); **security** (protection of health, the environment, privacy, etc.)**; solution of problems** (identification of needs and technological responses, etc.); and **competencies related to the 21st century skills**) (Global Alliance to Monitor Learning-GAML, 2018). Incorporation of libraries (mobile, if necessary) into these policies.
Universal access, universal service and access funds	Social policies for **financing mobile devices and Internet connection**, etc., that ensure that the rights of poor and vulnerable sectors of the population are not violated in terms of access to information and online services that enable taking advantage of the potential of access to information for individual and collective economic, social and political development (UIT/BDT, 2007).
Open government policies	Should incorporate actions to: **a) improve levels of transparency and access to information** through opening up public data (to exercise social control over governments and facilitate accountability) and reusing information from the public sector (to promote innovation and economic development); **b) facilitate citizen participation** in the design and implementation of public policies (and influence decision-making); and **c) promote generation of opportunities for collaboration and innovation** among the various actors, particularly between public administration, civil society and the private sector, to co-design and/or co-produce public, social and civic value (CEPAL-United Nations, 2017).
Transparency policies of companies and other social actors	Should increase corporate responsibility and accountability of institutions and the private sector, which entails promoting corporate responsibility in areas such as the environment, consumer protection, community participation and fighting corruption (CEPAL-United Nations, 2017). Promote among companies (as well as the media) and other social actors (NGOs, universities, political parties, foundations, etc.) **publicizing the "triple bottom line"** (economic, social and environmental), as well as the **contribution/impact of their activities on the SDGs** and the inclusion of the SGDs in their annual sustainability reports, so that they can be subject to monitoring and control by citizens (UN Global Compact, 2016).

Source: Prepared by the authors from WBG (2017), UNESCO (2015b), Global Alliance to Monitor Learning-GAML (2018), UIT/BDT (2007), CEPAL-United Nations (2017), Open Government Partnership (2017) and UN Global Compact (2016).

2.2 ICT solutions for sustainable development

The potential of information and communication technologies to facilitate achieving the 17 SDGs through innovative digital solutions (GeSI, 2016b) is undeniable. This potential, however, does not lie as much in considering ICT solutions as an independent value, but rather in the opportunity they provide to be used as transformative tools to fight against inequalities; foster environmentally and socially sustainable economic models; improve the quality of life of the population; fight poverty; and promote more participative, democratic and pacifist societies.

Developing public policies aimed at promoting digital solutions linked to health, education, the economy, employment, science, governance and the environment is not so much a mandate in response to a blind commitment to increasingly incorporate more technology into society or to develop a specific business sector. Rather, it corresponds to a commitment assumed by all governments in the world to build economically, socially and environmentally sustainable development models.

In addition to their potential to improve access to information, as pointed out in an earlier section, there is a wide spectrum of ICT services, resources and solutions (applications for access to health, optimization of natural resources, digital resources for research and education, citizen participation and public administration, among others) that can undoubtedly enhance and support public policies to accelerate achieving the SDGs (NetHope, 2015). Among other impacts, these solutions may:

- Provide opportunities to simplify and improve the efficiency and effectiveness of activities being implemented within the entire sphere of development (environmentally, politically, and in the field of democratic governance and the promotion of social rights and equity).
- Provide access to a new range of digitally-enabled products and services that strengthen citizen participation, development of local economies, local innovation and local communities.

During the World Summits on the Information Society (WSIS+10), especially in the meeting of 2015, governments made an effort to link ICT with the SDGs. They established 11 action lines and started establishing guidelines for follow up on how ICT solutions can contribute to the SDGs (UIT, 2015).

This section is divided into the three main areas proposed by the global follow-up agency of the 2030 Agenda, the HLPF, because it enables establishing a framework to measure the contribution of ICT solutions to the SDGs. These areas also include the action lines and guidelines provided by the WSIS matrix, as presented in Figure 6.

- **2017 Eradicating poverty and promoting prosperity in a changing world** (SDG 1, 2, 3, 5, 9, 14 and 17).
- **2018 Transformation towards sustainable and resilient societies** (SDG 6, 7, 11, 12 and 15).
- **2019 Empowering people and ensuring inclusiveness and equality** (SDG 4, 8, 10, 13, 16 and 17).

20 Adapted from WBG (2017).

21 Reusers of open data: info mediators, companies, administrations and social organizations. The results of reuse are reflected through the following channels, among others: mobile (traffic, accommodations, time, equipment), networks, webs, apps.

22 UNESCO's Open Solutions program helps ICT leaders, professionals, researchers and users to support communities of practice, promote empirical research and publications, and organize events to exchange information globally, regionally and nationally. The program includes: Open educational resources (OER) that provide teachers and students with high-quality educational material that can be freely used, adapted and distributed; free access to scientific information, which allows scientists and researchers to exchange information and access the latest scientific developments; free open source software (FOSS), which offers a wide range of tools and processes to effectively create, exchange and share interoperable computing solutions.

Figure 6: Diagram and themes from the High-Level Political Forum on Sustainable Development

Source: High-Level Political Forum on Sustainable Development (2017).

2.2.1. ICT solutions for eradicating poverty and promoting prosperity in a changing world

As agreed at HLPF 2017, it is necessary to address the multiple dimensions of poverty in order to make progress in eradicating it. Privations in terms of health, education, housing, economic opportunities, natural resource management and gender equality have a direct correlation with poverty. For this reason, the Multidimensional Poverty Index (MPI) is a useful tool for analyzing conditions of domestic poverty that complements traditional income-based measurements. The Forum also believes that the principles of **fairness, stakeholder participation** and the **availability and use of** high-quality disaggregated **data** are **essential for decision-making and developing policies to eradicate poverty**, through applying specific measures (precision poverty alleviation) (United Nations, 2017a)**.**

ICT can be used for finding solutions that improve every dimension of the MPI, helping expand and improve people's access to health and education, and ensure provision of strategic products, such as food, energy and water. The net results in the eradication of poverty and the promotion of prosperity for all will depend on policies undertaken at the national and international levels to develop the capaci-

ties of countries in a wide range of policy areas, in order to maximize the benefits of these transformations and ensure their equitable distribution (UNCTAD, 2018).

Therefore, the biggest challenge is to identify how different **ICT solutions can be used to eradicate poverty and promote prosperity leaving no one behind** (SDGs 1, 2, 3, 5, 9, 14 and 17) **and how public policies can help this to be achieved**. According to the ITU-ICT4SDG (2017), there are four basic areas in which ICT play a particularly significant role in reducing poverty: i) making needs visible (different ICT solutions permit generation of data that provides information that is not accessible from official statistics[23]); ii) expansion of voice and empowerment (ICT solutions enable governments to be more efficient in implementing policies[24]); iii) promoting inclusive and sustainable growth (ICT solutions make it possible to overcome infrastructure deficiencies and raise productivity and innovation, since they enable income to be increased[25]); and iv) accelerating and maintaining progress (ICT solutions facilitate prevention of and recovery from crises that especially affect poorer segments of the population[26]).

The ICT solutions with the greatest impact on eradicating poverty and promoting prosperity identified in the WSIS (United Nations, 2015b) are: e-business, e-agriculture, e-health and, to a lesser extent, e-science, e-environment and e-employment, upon which this section is structured.

e-business solutions include a set of business management activities and practices resulting from the incorporation of ICT into business and their adaptation to the characteristics of the new economy. e-business[27] includes e-commerce[28], e-payment[29], e-banking[30], e-logistics[31] and

23 For example, new data taken from social networking websites and geospatial data sensors can fill in gaps in SDG data which enables making more timely, specific and effective interventions to reduce poverty. In Uganda, UN Global Pulse found that mobile phone credit purchases (i.e. SIM cards) closely corresponded to household consumption data (ITU-ICT4SDG, 2017).

24 ICT, for example, can strengthen the basic capacities of governments to expand and improve public services and information in difficult-to-reach, poor and marginal communities. Guatemala has used mobile phones to train more than 300 aspiring nurses through distance education, helping to reduce the critical lack of competencies (UIT-ICT4SDG, 2017, page 10).

25 In Ethiopia farmers are using mobile phones to check coffee prices. In Saudi Arabia, farmers depend on wireless technology to distribute scarce water for irrigating wheat crops. In Bangladesh, more and more women are starting productive telephony service businesses. (UIT-ICT4SDG, 2017, page 11).

26 During outbreaks of disease, large volumes of mobile data can help track people's movement, thereby helping to prevent, predict and prepare for the spread of fatal diseases, as in the case of Ebola in West Africa. Mobile phones are also vital for ensuring timely and precise payments to those who provide other critical health services that are on the front line of response to Ebola, enabling them to meet their own needs and provide continuous care. (UIT-ICT4SDG, 2017, page 11).

27 Online business or e-business refers to the set of business management activities and practices resulting from the incorporation into business of general, particularly Internet-related, information and communication technologies, as a new decentralized configuration of organizations and their adaptation to the characteristics of the new economy. e-business is a general concept that encompasses particular terms such as e-commerce, with which it is sometimes confused, in addition to e-payment and e-logistics, among others.

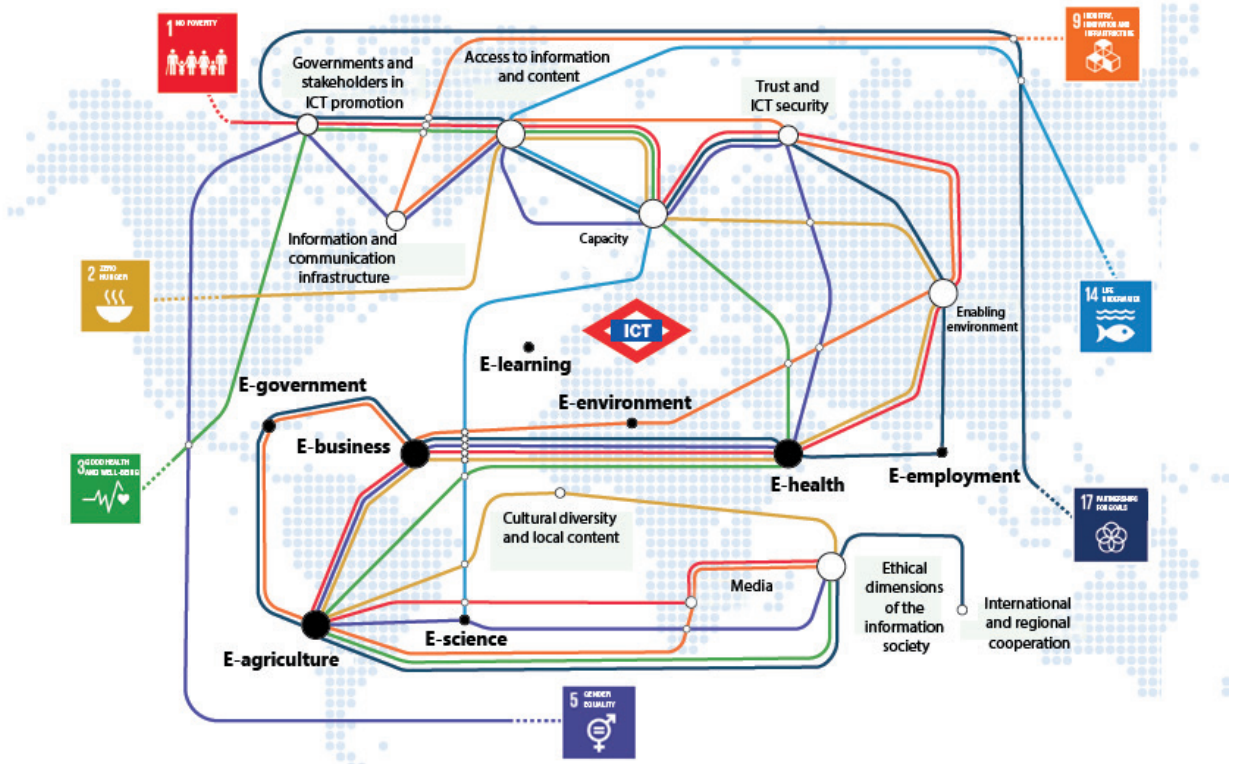
28 e-commerce consists of the distribution, sale, purchase, marketing and supply of information in relation to products or services through the Internet.

29 e-payments transfer money between buyers and sellers in electronic purchase-sales transactions through financial entities authorized by both parties. This includes: ATMs, bank transfers, electronic checks, debit and credit cards, and other systems such as micropatronage or online crowdfunding for financing concrete projects.

30 Virtual banking, online banking, e-banking or e-banking management is banking that can be done over the Internet. This can be through entities with physical branches or those that only operate remotely (over the Internet or by telephone): i) e-banking refers to a type of banking that is carried out by electronic means, such as ATMs, telephone and other communication networks; ii) Internet or online banking encompasses those tools that provide an entity with the ability to allow its customers to do their banking operations via computer with an Internet connection; iii) virtual banking or banking without a physical presence: a virtual bank is a bank with no office; the concept of virtual banking is usually associated with electronic banking (Muñoz Leiva, 2008).

31 Application of new information and communication technologies to traditional logistics.

Figure 7: ICT for eradicating poverty and promoting prosperity in a changing world



Source: Prepared by the authors[32].

front-and-back-office[33], among others. It also includes the use of electronic data interchange (EDI), customer relationship management (CRM), enterprise resource planning (ERP), and smart manufacturing. It also includes the adoption of network-based business models such as business-to-business (B2B) and business-to-consumer (B2C) and their integration through new strategic activities such as business intelligence (BI)[34] and knowledge management (KM).

Therefore, **e-commerce** can enable men, and especially women[35],to improve their access to economic resources, for example, by selling local goods and services online (SDG 1.4), which is premised on competencies and skills to manage ICT solutions linked to e-commerce, such as e-payment, e-logistics and e-banking (SDG 1.4, SDG 2.3, SDG 9.3). This, in turn, contributes to entrepreneurial capacity (SDG 3.5b), and access to and management of online microfinance

32 Prepared by crossing the SDGs identified by HLPF 2017 for eradicating poverty and promoting prosperity in a changing world and the potential ICT contributions identified in United Nation (2015b).

33 This refers to business management activities. Front office, in this case, would be ICT solutions in the relationships between a company or organization and its customers or users (including sales, distribution and marketing departments). Back office, in this case, refers to the application of ICT solutions to the set of activities for managing the company itself that have no direct contact with customers, such as human resource management, accounting and finance.

34 When BI is associated directly with ICT, it can be defined as the set of methodologies, applications and technologies that enable collecting, treating and transforming data from transactional systems, as well as unstructured information (internal and external to the company), into structured information for direct use (reporting, alerts, etc.)

35 In many developing countries, women, since they do not own land, sell products or need to generate income, constitute a sector that is potentially more open to innovation. Experience has shown that this has been identified by different development programs, such as those for income generation and microcredit, which represent an opportunity for innovative businesses linked to agriculture or other sectors. In some Guatemalan indigenous communities, women sell previously discarded products, such as macadamia nuts, which come from a tree used to provide shade in coffee plantations. Due to low local demand and good prices internationally, they are inserted through various e-business solutions into fair trade networks, thus increasing women's income, autonomy and empowerment.

(SDG 1.4, SDG 9.3), and also makes it possible to access e-health[36] (SDG 3) and e-learning[37] (SDG 4) services.

e-commerce also helps get natural resources to markets (e-logistics) and enables the use of remittances for paying for e-commerce services (SDG 1.4). Financial and payment management in medium and small businesses (e-banking) and mobile payments (e-payments) can serve as solutions to reduce poverty by requiring fewer resources in time, mobility and financing by enabling direct, almost real-time management. These **competencies and skills**, as well as having their own income, helps empower women (SDG 5), whose domestic and social independence will be strengthened, thereby expanding their opportunities to overcome poverty (SDG 3.5b, SDG 5).

Due to the risk that existing inequalities in relation to accessing e-commerce can lead to exclusion and deepening poverty, the United Nations Conference on Trade and Development (UNCTAD) has been leading the worldwide eTrade for All[38] initiative since 2016, aimed at helping developing countries unleash the potential of e-commerce.

The use of **e-business solutions in rural companies** can also play an important role in boosting the productivity of small food producers (SDG 2.3), for example, by facilitating access to production inputs, appropriate technology (SDG 1.5, SDG 2.3), knowledge and data of interest, access to markets and opportunities to add value (SDG 9), through access to fair trade and responsible consumption networks (SDG 12), which helps boost exports in developing countries (SDG 17.11). Therefore, the application of e-business solutions can help **supply** nutritious, healthy and more affordable food, and will also become a key tool for overcoming the new challenges currently faced by the **global food system** (SDG 17).

e-business can also contribute to building local and international markets for the distribution and sale of goods and services, based on the adoption of network-based business models such as B2B and B2C through insertion into existing networks or creating them within national policy frameworks and by opening up international purchase and sales mechanisms for small and medium-sized enterprises (SMEs) (SDG 9.3, SDG 17.11), which can streamline access to food and its distribution or significantly increase exports. It can also generate non-agricultural jobs **(e-employment)** in rural and distant regions, by offering, for example, tourism, logistic and cultural services, especially for women who, since they do not own land, have fewer means of accessing private resources (SDG 1.4, SDG 3.5b, SDG 5) (UNCTAD, 2018).

The application of ICT solutions to agriculture **(e-agriculture)**, fishing and other forms of food production provides crop care opportunities (early pest or disease warnings, SDG 15), and allows the selection of optimum transport, packaging and storage through **e-logistics** (SDG 2.3, SDG 9.1); what in turn serves to raise productivity (SDG 2.3 and 2.a) and avoid waste of agricultural and fishing products. This expands opportunities

36 e-health refers to healthcare practices that are supported by information and communication technologies. The term is simultaneously used in relation to computerized health care, or telemedicine. Main ICT solutions include: i) Electronic medical records: digital administration of medical records, which facilitates archiving, consultation, editing and exchange of patient data among various health professionals and with health centers, hospitals, specialists and pharmacies: ii) Telemedicine: includes all the variants of physical and psychological tests that do not require physical visits of patients to specialists; iii) Dissemination of information for citizens: includes both patients and healthy people who want to be informed about medical issues; iv) Dissemination of information for specialists: information services focused on the needs of health professionals (DSI, clippings, etc.); v) Virtual healthcare teams: groups of health professionals who collaborate and share information about patients through digital equipment (shared care model: interface between primary and secondary care in medicine).

37 e-learning means learning through the Internet. This type of online teaching/learning allows users to interact with material and trainers through the use of various computer tools.

38 etradeforall.org is an information center that helps developing countries navigate technical and financial services that they can use for boosting e-commerce. Through the platform, countries can connect with potential partners, get to know trends and best practices, access up-to-date e-commerce data and receive information on upcoming events. It was launched in July 2016 during the fourteenth session of the United Nations Conference on Trade and Development. Twenty-one international and regional organizations, national entities and development banks are currently members of the initiative. In cooperation with Business for eTrade Development (an advisory council led by the private sector that includes large corporations and small companies from developed and developing countries), eTrade foments inclusive development and the adoption of e-commerce.

to end hunger, achieve food security (SDG 2.a) and promote sustainable agriculture and fishing (SDG 12).

Use of ICT can also improve the accuracy levels of information that affects crops and fishing (SDG 2), which would enable farmers and fishermen to make immediate decisions. The data generated by technology devices, such as sensors, drones, satellites and mobile devices (SDG 9) provide input for making on-the-spot decisions and formulating public policies (SDG 17.17). This also helps create new jobs (SDG 5.5, SDG 8, SDG 17.9) related to the management of this technology **(e-employment)** and the data generated (SDG 9). ICT have the potential to rapidly collect large volumes of new information on agriculture and natural resources in all the fields targeted by the 2030 Agenda, ranging from nutrition to pest control (SDG 2) and water management (SDG 6).

Mobile phones can allow farmers, ranchers and fishermen to solve specific problems that previously required specialists and were more expensive. For example, the Food and Agriculture Organization of the United Nations (FAO)[39], the International Fund for Agricultural Development, and other public and private organizations are generating mobile applications that help small farmers analyze the soil, determine fertilizer needs, prospectively calculate harvest volume, manage their financial resources, and make online purchases, transactions and payments (UIT-ICT4SDG, 2017).

According to the FAO (2017), **mobile phones** are also an important ICT solution due to the information and communication benefits they provide, such as: establishing pre-sale price agreements (SDG 1, SDG 8); consulting meteorological and early warning information in order to adopt preventive measures for crops (SDG 1.5, SDG 9); having access to phytosanitary solutions (SDG 2); and finding relevant solutions for specific problems on specialized open platforms (SDG 4), such as Wikifarmer (the Wikipedia of agriculture, offered in various languages and adapted to the needs of users). This could enable them to increase their income and potentially reduce poverty (SDG 1). **SMS** and other instant messaging software can enhance contact with buyers and meet the needs of small farmers, thereby improving their ability to negotiate and deal with operators.

Digital images captured by **drones** (unmanned aerial vehicles) in remote locations are quick, efficient, reliable and indispensable for minimizing the effects of floods and severe weather events on food security (SDG 1, SDG 2). They can also generate detailed maps that help countries to better locate agricultural infrastructure projects (SDG 9) and facilities for services (health, education, irrigation, etc.) to serve rural communities (FAO, 2017).

The FAO (2017) promotes the use of **satellites** that provide teledetection services that enable semi-automatic, high-resolution mapping of the location of fishing grounds (SDG 2) and vegetation cover (SDG 15), in addition to direct access to an immense volume of satellite data (such as the Google Earth platform) (SDG 9). Thanks to geospatial data archives, Google (which dates back to 1972) offers training (SDG 4) in the use of its **software tools**, such as Open Foris and Collect Earth (SDG 9).

However, for **e-agriculture** to contribute to fighting poverty, an institutional framework is required that promotes ICT solutions that respond to specific needs tailored to local circumstances and conditions.

Lack of health and well-being is another dimension of poverty. It is increasingly evident that universal health coverage (SDG 3) cannot be achieved without the support of **e-health.** According to the World Health Organization, e-health is the profitable and safe use of ICT to support health and health-related fields, including healthcare services, health surveillance, sanitation and health education publications, knowledge and research (Global Observatory for eHealth, 2016).

39 The FAO has developed and implemented various initiatives for farmers and governments, which have resulted in the provision of mobile or Web-based tools, such as the Digital Service Portfolio (the first initiative, underway since 2016, aimed at developing four mobile applications for small farmers in Rwanda and Senegal on topics such as nutrition, markets, prices, animal health and weather forecasts) (ITU-ICT4SDG, 2017).

This definition includes what is known as **m-health**, which is the practice of medicine and public and private health with the support of **mobile devices**, such as mobile phones, portable computers, and tablets, to provide health services (electronic prescriptions, telecare services, electronic medical records, etc.) (SDG 2.1, SDG 5.6), collection of clinical data (big data) and its analysis (data analytics) for decision makers and policymaking (SDG 1.3).

m-health apps[40] include the use of mobile devices for exchanging medical care-related information among professionals and researchers **(e-science)** and patients (little data) and real-time monitoring of the vital signs of patients (**biosensors**) and direct provision of care (**telecare**), among other functionalities (Knowgarden.net, 2015) (Cornet, 2017). They also include the use of **social networking websites** for warning or prevention campaigns. Innovation in **m-health** has been progressing through reverse innovation[41] **(e-science)**, for example, in the creation of affordable **apps** or reverse vaccinology (SDG 1.5).

The possibilities opened up by **e-health** can help make health systems strong, efficient and well-administered, which ensures universal coverage (SDG 1.4) by reducing costs and increasing efficiency (SDG 1.3). Information and communication technologies (mobile phones, telecare, biosensors and apps) are indispensable for monitoring the health and nutritional status of different segments of the population, including vulnerable groups, such as elderly people, children, people with diseases such as HIV/AIDS, refugees and migrants (SDG 2.1 and 2.2). They also facilitate information collection, data analysis, planning and the necessary supply systems, as well as operations research **(e-science)** for assessing their impact (SDG 17.8) and improving decision-making and the formulation of policies to eradicate poverty. **Health data** and information systems are also necessary for providing alerts and controlling the spread of transmissible diseases (SDG 17.19).

However, globalization and the information society, and the new economy resulting from both processes, lead to major transformations and challenges that could increase poverty and inequality if various challenges are not taken into account through policies directly linked to national development plans, digital agendas and sectoral policies.

2.2.2. ICT solutions in the transformation towards sustainable and resilient societies

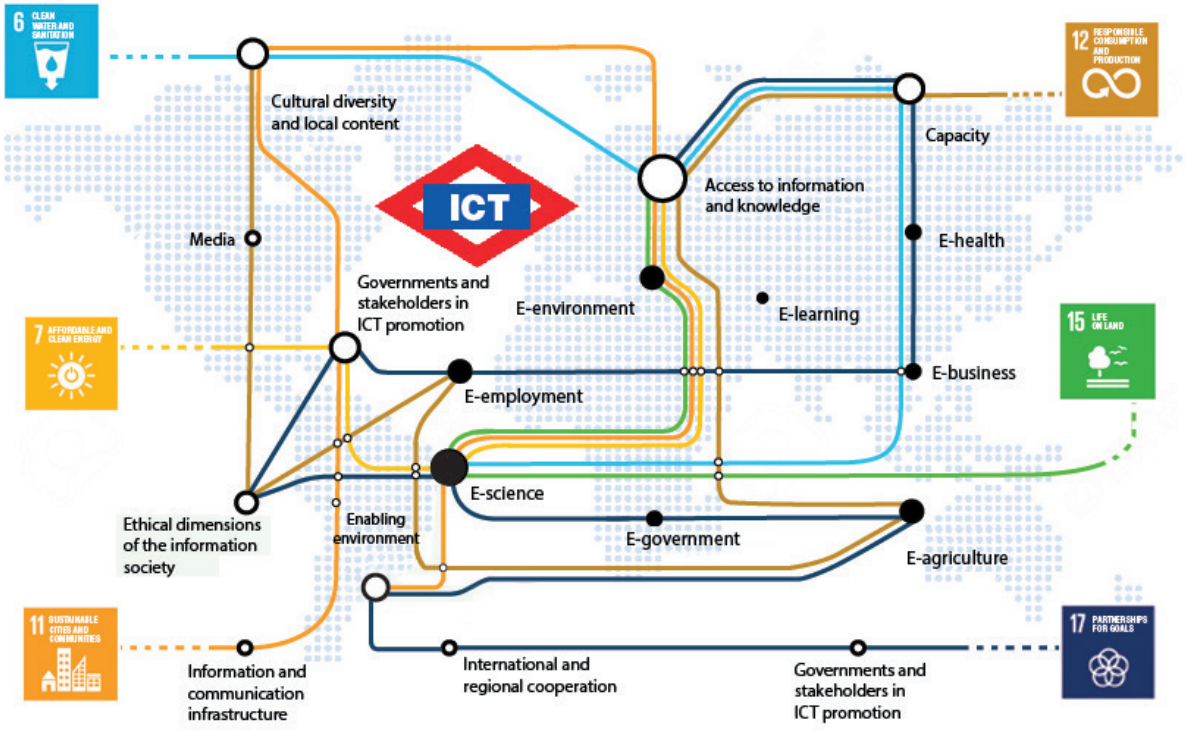
A second thematic area was established by the HLPF at its 2018 meeting: development. It focused on assessment and monitoring of overall progress in achieving the SDGs that are more directly linked to **transformation towards sustainable and resilient societies**. In addition to SDG 17, which focuses on strengthening ways to implement and revitalize the global partnership for sustainable development, this thematic area involves monitoring Goal 6 (ensure clean water and sanitation), Goal 7 (ensure access to sustainable energy), Goal 11 (make cities and human settlements sustainable and resilient), Goal 12 (ensure sustainable consumption and production patterns) and Goal 15 (protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss).

The ICT solutions with the greatest impact on achieving global transformation toward more sustainable and resilient societies, as can be seen from the WSIS matrix (United Nations, 2015b), are dedicated to scientific development **(e-science:** SDG 6, 7, 15 and 17), **e-governance** (SDG 17), **e-agriculture** (SDG 12 and 17), solutions aimed

40 The major companies that dominate the mobile and Internet markets are competing in the development of ways to put information in the hands of patients (on their mobile devices). E-health apps are making continuous strides forward, such as BYOD (bring your own device), wearables (smart watches, armbands, fitness trackers, wearable cameras, heart rate monitors and GPS tracking devices, etc.).

41 Reverse innovation refers to innovations seen for the first time or those that can be used for the first time in developing countries before spreading to the industrialized world. It also refers to the process by which products developed as low-cost models can meet the needs of developing countries, such as battery-operated medical instruments in countries with limited infrastructure, which later become innovative goods for buyers in Western markets.

Figure 8: ICT in the transformation towards sustainable and resilient societies



Source: Prepared by the authors[42]

at environmental sustainability (**e-environment**: SDG 11 and 15) and **employment** (SDG 12 and 17) and, to a lesser extent, those dedicated to business (**e-business**: SDG 17).

ICT policies, apps and resources that promote WSIS action lines, such as C3 (access to information and knowledge), C4 (capacity building), C5 (building trust and security in the use of ICT) and C8 (cultural diversity and identity, linguistic diversity and local content), are also important for contributing to the SDGs grouped under this thematic area.

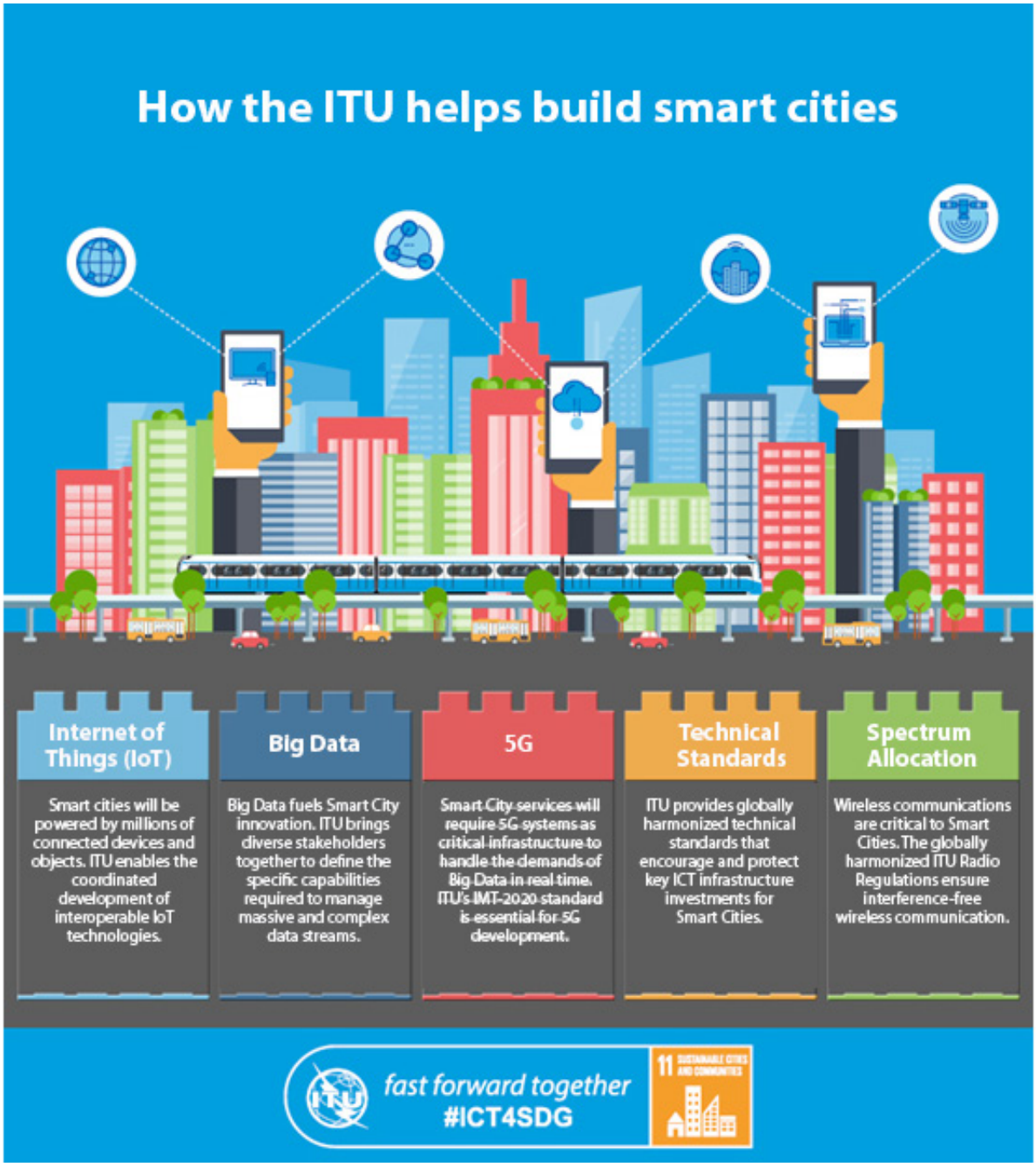
In relation to SDG 6 (ensure clean water and sanitation), according to the HLPF report (United Nations, 2018a), it provides an enormous opportunity to accelerate the global progress of the 2030 Agenda, due to the fundamental role of water and its impact in terms of human rights, reduction of poverty, elimination of inequality, development of peace and justice, and protection of the environment[43]. The right to water includes having access to and control over an increasingly scarce resource, as well as participating in its governance.

ICT solutions dedicated to scientific development **(e-science)** can contribute to achieving the targets of SDG 6, such as efficient water consumption, desalination, recycling and reuse technologies, water channeling technologies and access to resources. **ICT solutions for facilitating access to information and knowledge** (WSIS action line C3) can contribute to better water resource governance, with tools that promote transparency and raise awareness among governments and citizens in relation to water-related challenges. Other resources that also help achieve this goal, through free management of knowledge and

42 Prepared by crossing the SDGs identified by HLPF 2018 for transformation towards sustainable and resilient cities and potential ICT contributions identified in United Nations (2015b).

43 For example, achieving universal access to water is linked to gender equality. Women and children are responsible for collecting water in eight out of ten households where water is not directly supplied to homes. Bringing water sources closer to people reduces the time needed to collect water and leaves more time for educational activities, especially for women.

Figure 9: How the ITU helps build smart cities



Source: HLPF 2018. Adapted by the authors.

commitment to transparency, are mobile applications for analyzing water quality that are publicly shared through open data. The WSIS also promotes public policies aimed at **capacity building** (WSIS action line C4) to support governments in the development of ICT solutions for water harvesting, efficiency and reuse technologies, etc.

Another global challenge to the transformation of societies is linked to access to energy (SDG 7) (United Nations, 2018a). The promotion of ICT solutions dedicated to developing technologies in the field of **e-science**, which facilitate the use of renewable energy and clean energy to replace fossil fuel and oil-based energy, is necessary for achieving the SDGs.

Global and local transformation to promote more sustainable and resilient societies requires proposing **the transformation of cities**. Cities are the epicenters of an increasingly urban world and increasingly digitalized economies. Over half of the world's population currently lives in cities. SDG 11, dedicated to making cities inclusive, safe, sustainable and resilient, recognizes that "cities are incubators of innovation and help foster

increased employment and economic growth" (United Nations, 2017b), but that the rapid urbanization of the planet has brought in its wake huge challenges, including inadequate housing, increased air pollution and lack of access to basic services and infrastructure.

This, therefore, involves building smart cities with bold ways of governing and governments, which optimize the resources offered by ICT to improve people's lives and put social, environmental, economic and cultural rights at the heart of public policies. In this regard, there are already governments that have approved regulations that align the use of ICT with the sustainable development of cities. One of the most innovative examples is the case of Colombia (MinTIC, 2018)[44]. To genuinely transform cities, ICT can undoubtedly support the development of intelligent environments, with a focus on renewable energy, efficient use of resources, green planning, and the proposal and supervision of policies to reverse contamination. ICT applications for air and noise measurement, participatory planning, and water and waste management can facilitate the creation of this type of environment.

The effects of climate change on human settlements, natural disasters, and prevention of and reactions to emergencies, are also aspects that must be taken into account when designing public policies and their connection with ICT solutions that can facilitate their management. Therefore, implementing communication systems and technological solutions that support communication minimizes losses and facilitates recovery in case of disasters (WSIS action line C2, information and communication infrastructure).

In designing policies dedicated to the development of human settlements and resilient and sustainable cities, it is important not to overlook the large number of applications and ICT solutions that can help improve the environment of cities (**e-environment**), such as air control and waste collection devices. Air measurement systems are one of the most widespread examples in large cities, but also worth noting is the implementation of public policies to control pollution levels that involve promoting other mobility models, such as public bicycles, which require the development of digital applications to manage them.

Due to the social and environment impact of mobility on urban centers, another aspect to take into account is the support of ICT applications for developing sustainable mobility: traffic control, management of public transportation services, accessibility management, information panels and public bicycle networks, among others. Comprehensive public transportation models, combined and adapted to the door-to-door mobility needs of people with limited mobility, require accurate and reliable real-time information.

At the same time, creating sustainable cities requires **participatory citizenship**, and policies and instruments must be provided that facilitate participation and public-social partnerships (such as crowdsourcing) and bridge existing digital divides. One of the most relevant issues in urban planning, where policies have a direct impact on the quality of life of citizens, is related to the framework for participation and transparency underlying them. The regulation and implementation of ICT solutions that facilitate such participation is one of the key policies for achieving the SGDs (electronic services, connection among and with public institutions), and particularly affects the targets set forth in SDG 16.

In moving towards a more sustainable and resilient model of society, it is essential to review which changes need to be made in the current production and consumption model (SDG 12), in order to turn around environmental problems and social inequality in the world. The data provided by the SDGs follow-up report are not encouraging: "Globally, the material footprint rose from 48.5 billion metric tons in 2000 to 69.3 billion metric tons in 2010" (United Nations, 2017b). ICT can offer solutions for designing and implementing regulatory frameworks and policies that governments must adopt in order to reverse this situation[45].

44 Colombia has a Ministry of Information Technology. In March 2018, this Ministry submitted a draft of a resolution that establishes a public ICT policy to promote building a smart cities and territories model in the country.

45 For example, the development and implementation of ICT solutions dedicated to monitoring environmental impacts are essential for the design, application and development of environmental laws.

In addition to the urban environment, the rest of the **terrestrial ecosystems and the planet's biodiversity** are also in serious danger (SDG 15). Their protection is crucial to "mitigate climate change and provide increased resilience in the face of growing human pressures and mounting natural disasters" (United Nations, 2017b). ICT applications and solutions (e-environment) are instrumental for controlling and monitoring environmental impacts at the global level, and to facilitate their mitigation.

And, finally, the proposal to transform societies also requires a **transformation in ways of governing** (SDG 17 and 16), globally and locally, in order to facilitate democratic participation and create global partnerships so that policies are approached in a transformative, comprehensive way, bearing in mind the interconnections between the local and the global and at all levels of government. ICT solutions can facilitate achieving many of the targets set forth in SDG 17 and the whole set of SDGs. Solutions that facilitate free access to knowledge and exchange of information on scientific and technological advances, especially technologies that enable the design and management of policies in a more democratic and accessible way (facilitating bottom-up government), are fundamental to participatory governance and achieving the major transformations proposed herein. This means developing a form of "smart government" (MinTIC, 2018) as a transversal element that allows the development and implementation of policies that, as examined earlier, promote transparency; use of open data; electronic government to facilitate participation; and participatory co-design of policies.

Therefore, this requires maximizing the use of digital tools to identify and provide solutions for the problems of citizens and local and global environmental and social challenges, in pursuit of a development model that is conducive to sustainability, justice and resilience.

2.2.3. ICT solutions for empowering people and ensuring inclusiveness and equality

The third theme proposed by the HLPF, which will be addressed in the 2019 meeting, deals with the contribution of the SDGs to the empowerment of people and ensuring inclusion and equality. ICT solutions, resources and services for this objective are related to the **right to education** and shifting to an **inclusive and sustainable economy**, which guarantees all people **decent work**, in a **world where inequalities are reduced** in and among countries. This also involves the adoption of urgent measures to **combat climate change and its effects**, the **promotion of just, peaceful and inclusive societies**, and strengthening the means for implementing and revitalizing the **Global Partnership** for Sustainable Development.

As can be seen from the WSIS matrix (United Nations, 2015b), the ICT solutions with the potential for the greatest impact on achieving a global transformation toward societies where people are empowered and there is greater inclusion and equality are those dedicated to **employment** (SDG 4, 8, 10 and 17), **education** (SDG 4, 8 and 13), **e-agriculture** (SDG 4, 8, 16 and 17), **scientific development** (SDG 4 and 17), **e-business** (SDG 8 and 17), **e-government** (SDG 16[46] and 17) and, to a lesser extent, those that address environmental sustainability (**e-environment**) (SDG 13).

One of the big challenges of the 2030 Agenda is leaving no one behind, ensuring inclusion and equality through empowerment. Information and communication technologies, as a tool at the service of these environments, operate within an increasingly advanced digital culture[47], where the meaning of **digital citizenship** expands to include the various ways of participating in society that are facilitated by these networks (Jones & Mitchell, 2015, cited by (Hinostroza, 2017). Each person's participation in this culture, via distinct environments and tools, is not distributed equitably (See Section 2.1). Therefore, states

46 To achieve targets such as access to information and fighting corruption, not just e-government is important (or in broader terms as open government); other tools aimed at civil society are also essential, such as data journalism, data mining, and open and transparent budget initiatives.

47 It is important to remember that digital technology is a product of digital culture and not the other way around (Gere, 2008, cited by CGI.br & UIS, 2016).

and other actors with social responsibility are called upon to take urgent measures such that the achievement of these proposals ensures that this participation will be on equal terms.

In terms of **empowerment**, all-inclusive education is essential so that all can have the knowledge and necessary skills to promote sustainable development and sustainable lifestyles (SDG 4.7). Therefore, it is necessary to address the potential of education in the transition to societies that make it possible to change the production and consumption model mentioned in the 2030 Agenda.

Based on the principle of leaving no one behind, and in order to ensure equality and inclusion, the **inclusion of people with disabilities** in terms of access to and use of well-guided digital technologies is also important. ICT have great potential for making multiple means of communication possible – voice, text and gestures – so that people with disabilities can have access to information and interact with other people[48]. However, as the World Bank points out, the mere existence of technology is not sufficient to eliminate the gap in the socioeconomic inclusion of people with disabilities, since an adequate ecosystem is needed to promote the implementation of accessible digital technologies (World Bank, 2016c).

ICT solutions for education are an indispensable tool in the 21st century so that people can develop their skills and maximize their opportunities to learn and create. Education is crucial for eradicating poverty and is vitally important for reducing inequalities and for individual and collective empowerment. Education is a fundamental and enabling right. Therefore, the 2030 Agenda (especially SDG 4, but also SDG 3, 6, 8, 12 and 13) strives for inclusive quality education, as well as continued learning for all people. To increase the possibilities of achieving this, States can harness the potential of ICT-backed services, solutions and resources, such as **e-learning**.

The popularization of **mobile devices** with Internet connection broadens the potential for access, creation and circulation of information, interaction, social participation and integration into formal and informal education (CGI.br & UIS, 2016), which is indispensable for empowering people. To advance in inclusive, equitable and quality education, Internet access[49], for both students and teachers, continues to be one of the main challenges in terms of the design, implementation and evaluation of policies for their participation in digital culture[50]. Although still not fully achieved, some countries have designed and implemented policies to guarantee access to and use of digital technologies in educational contexts, sometimes in conjunction with transforming classroom teaching and learning practices, and to improve management of educational systems through information systems (Hinostroza, 2017).

Particularly noteworthy among the difficulties with using ICT in education is the lack of necessary skills[51], on the part of both teachers and students, to locate quality digital resources on the Internet, as well as insufficient preparation to significantly integrate the use of ICT into teaching practices. The OECD also mentions lack of clarity in learning objectives, which leads to expectations not being fulfilled as far as the impact of the technologies on teaching and learning (2015, cited by Hinostroza, 2017, page 10).

There are also clear limitations related to the need to transform ways of learning and teaching. In this regard, other key solutions include **open educational resources** (OER) and **massive open online courses** (MOOC) to ensure that men and women have equal opportunities for access to high-quality technical, vocational and higher

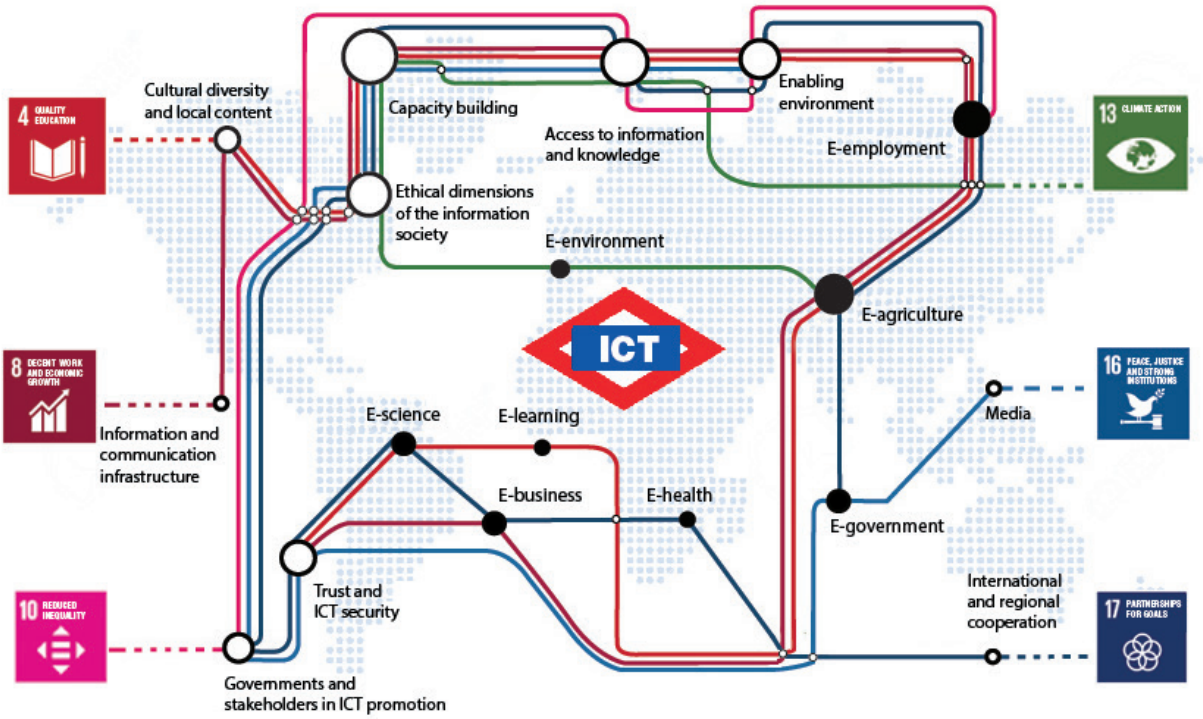
48 Voice recognition, magnification, and text-to-speech conversion help people with visual, cognitive, learning and mobility disabilities. Text messages (SMS), instant messaging, telephone relay systems and subtitling of videos reduce communication barriers for people with hearing and speech disabilities. Hands-free browsing systems and gesture-controlled interfaces assist people with severe mobility impairments to use digital devices (World Bank, 2016b).

49 In addition to the SDGs, the WSIS international agenda also promotes, through its 11 action lines, reducing global digital exclusion and expanding Internet access.

50 The SDG 4 indicators directly refer to the proportion of schools with Internet access and computers for educational purposes (4.a.1), as well as the number of young people and adults with ICT skills (4.4.1). One of the explicit targets of the goal mentions the need to significantly increase the number of scholarships available in higher education for developing countries, particularly in the realm of ICT (4.b).

51 Some of these skills are digital, divided into: functional skills for ICT use; digital skills for effective use of technologies; high-order skills; and computational thinking (See Hinostroza, 2017, page 16).

Figure 10: ICT for empowering people and ensuring inclusiveness and equality



Source: Prepared by the authors[52].

education, including university, as indicated in Target 4.3[53].

Among other applications, these resources can be used for the continuing education of teachers or for media and information literacy[54], which is necessary because of the proliferation of media and other information providers that are guided by technological advances in telecommunications. While this is an opportunity, it also becomes a challenge to assess the relevance and reliability of information. It is within this context that MIL requires the use of ICT to process information, and different skills to produce content (UNESCO, 2011).

Open education resources – materials that make use of language and diverse media – have become increasingly important in the sphere of public policies and are used for teaching, learning and research. They are disseminated under open licenses that enable free reuse, continuous improvement, and distribution for educational purposes (Hinostroza, 2017). Massive open online courses and online teaching tools enable teachers to allot more time to discussion and working with students who need greater support in specific skills and knowledge (World Bank, 2016b).

Among e-learning tools in the educational sphere, other practices include the use of video games, participation on social networking websites and communities, video production, animation, digital narration, applications such as

52 Prepared from crossing the SDGs identified by HLPF 2019 for empowering people and ensuring inclusion and equality and the potential contributions of ICT identified in United Nations (2015b).

53 Target 4.6 also involves ensuring that all youths and a substantial proportion of adults, both men and women, achieve basic literacy and numeracy.

54 UNESCO (2011) proposed a MIL curriculum for teachers, as a component of a comprehensive strategy for societies to achieve media and information literacy.

simulations and virtual experiments, and virtual science laboratories. There is also information for improving the management of educational systems.

Other ICT services are linked to helping people with some sort of disability, ensuring that the provision of distance learning is open to all people. Some countries are promoting the use of assistive technologies such as screen readers and voice recognition systems.

In another direction, ICT-enabled solutions, such as those linked to **e-learning**, serve to improve education, raising awareness and human and institutional capacity with respect to mitigating, adapting to, and reducing the effects of climate change, and providing early warnings, which would effectively complement the use of the tools that ICT provide for these purposes.

Apart from the application of these technologies to the educational realm, other tools and solutions with **social inclusion** potential are those that revolve around **e-business**. One of the general principles of the 2030 Agenda assumes that understanding the role of ICT in economic growth involves considering the environmental and social costs of such growth (SDG 8)[55]. Therefore, if the goal is to empower people, public policies must generate an adequate and sustainable ecosystem so that this growth is real and beneficial for human beings.

The rapid adoption of digital technologies in economies is related to benefits that are highly dispersed and whose indirect impact on growth is difficult to estimate. However, it is undeniable that, like energy and transportation, the Internet has become an essential part of the infrastructures of countries and a production factor in most activities in modern economies (World Bank, 2016b).

The **electronic registration of companies** facilitates the entry of new and innovative firms in the market and enables them to be online, start activities, and grow quickly, with relatively little personnel or investment of capital. At the same time, **online platforms** resolve trust and information problems through the use of comment and rating systems, as well as mechanisms for ensuring resolution of disputes.

While it is true that the Internet makes it possible for many small companies to participate in world trade, and that Internet use has been linked to productivity, efficiency, competence and innovation, the comprehensive approach of the 2030 Agenda requires a more systemic assessment that includes social issues (such as those related to labor conditions) and sustainability.

Another ICT service that has the potential to help achieve the SDGs is **digital financing**. The World Bank recommends that these services be accompanied by regulations that create a dynamic business climate and allow companies to harness digital technologies to compete and innovate, in addition to creating skills that enable workers, as well as management, to take advantage of the opportunities offered by the digital world, thereby avoiding monopolies and oligopolies (World Bank, 2016b).

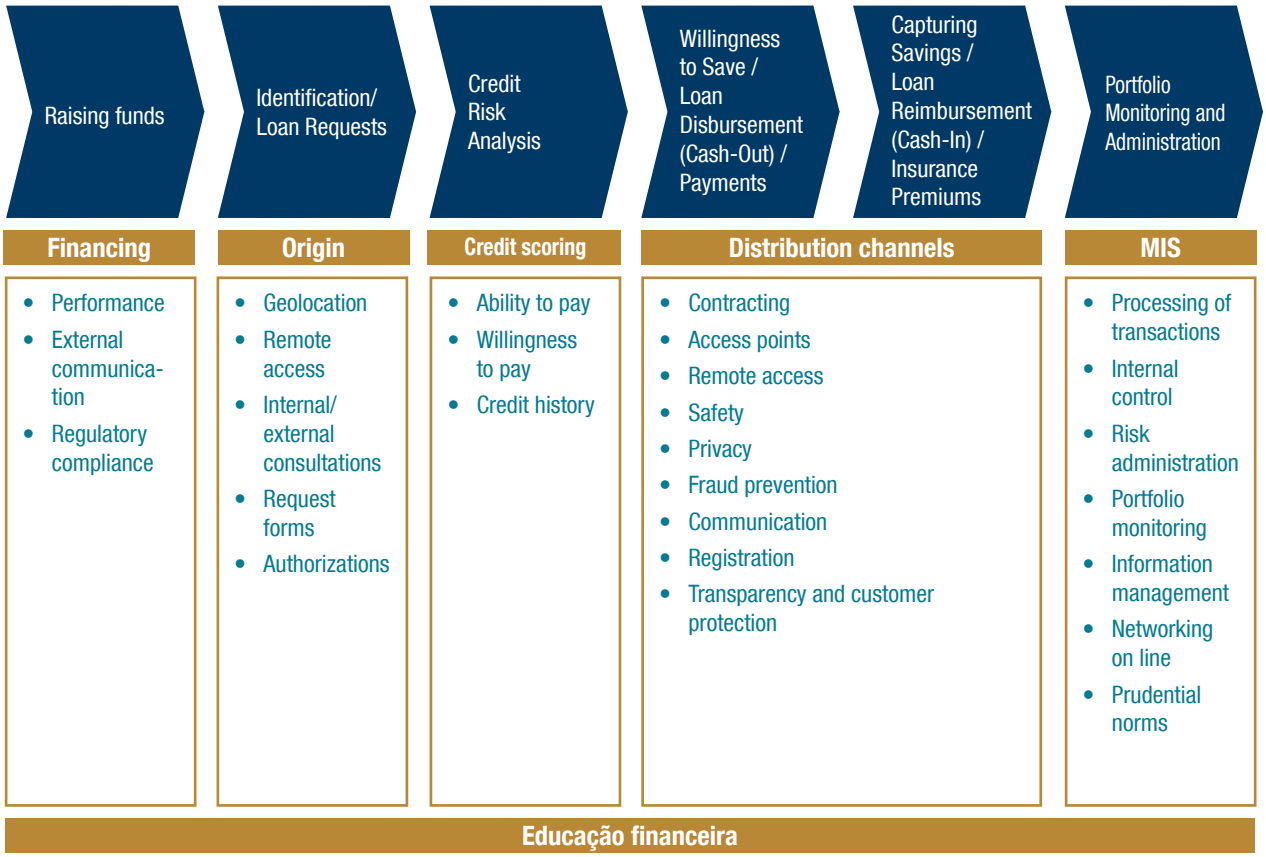
Advances in m-banking and microcredit are also important for achieving Target 8.10, since they can reduce transaction costs and, as a result, spur economic growth and competition in the banking system. These ICT-enabled solutions could reduce the transaction costs of migrant remittances to less than 3% and eliminate remittance corridors with costs higher than 5% (Target 10.c).

ICT have also made it possible to improve the quality, variety and scope of microfinancial services and meet some of the inherent everyday needs of people with few resources, who have historically been excluded from the financial sector due to their perceived profile as being high-risk and having low profitability. Microfinance entities have incorporated innovative mechanisms to interpret and design financial products and services that respond to the needs, preferences and circumstances of these people (Ontiveros, Martín Enríquez, & López Sabatés, 2014).

ICT are a determining factor in a number of key innovations that are taking place in the realm of financial services in countries with low levels

55 Indicator 8.2.1 refers to the real annual per capita GDP growth rate used to achieve Target 8.2 (Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labor-intensive sectors).

Figure 11: Potential use of ICT in the value chain of a microcredit entity



Source: Ontiveros, Martín Enríquez, & López Sabatés (2014).

of financial inclusion, such as branchless banking and no-frills accounts (Ontiveros, Martín Enríquez, & López Sabatés, 2014).

However, once the countless opportunities unleashed by ICT have been developed, it should also be pointed out that there are different problems related to this new digital economy that do not always favor achieving the SDGs. The World Bank notes that "The digital revolution can give rise to new business models that would benefit consumers, but not when incumbents control market entry" (2016b, page 4).

With regard to **e-employment** tools and solutions, the Internet can promote job creation and allow workers to be more productive[56]. **Totally automated Internet services** reduce marginal transaction costs, and new solutions and services foster creativity and innovation through an emphasis on open solutions to create employment opportunities in different fields and promote creative economies and ICT industries[57].

However, the automation of Internet services also has impacts on the labor market with ambiguous consequences for market structures, since

56 Above all, it can have an impact on Target 8.5 (full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value) and Target 8.8 (protect labor rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment).

57 An indicator from Target 8.3 refers to the proportion of informal employment in the non-agricultural sector, disaggregated by sex. This target focuses on promoting development-oriented policies that support productive activities, creation of decent jobs, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small and medium-sized enterprises, including through access to financial services.

low marginal costs result in large economies of scale that favor natural monopolies (World Bank, 2016b) by stifling competition and possibly resulting in excessive concentration of market power and the emergence of monopolies.

In addition, the short-term **social impact** on the labor market can be costly due to the time it takes for the traditional sector to adapt to the automation of these new services. This may result in loss of jobs and impoverished people coming up against stagnant wages and fewer opportunities. When numerous tasks are automated through the Internet, but workers lack the skills that the technology enables, this can generate greater inequality, whether or not it is accompanied by greater efficiency (World Bank, 2016b).

In such situations, and within the framework of **e-learning** applications, well-designed and managed **training activities on the Internet** help workers to enhance their skills. It is important to note that, in contexts where access to quality education and equal opportunities is not ensured, more qualified people may benefit to a greater extent from these technologies, which contributes to the reproduction of inequalities.

Apart from benefits in the field of health and the promotion of inclusive economic growth, the use of ICT for public management **(e-government)** enables democratic governance (where citizen participation is essential), the fight against corruption, the exercise of human rights (civil, political, social, economic and cultural) and media pluralism, in addition to a range of different e-services and tools for active participation and transparency of all actors (governments, civil society and companies) in the promotion of the rule of law[58]. In short, ICT can accompany the promotion of just, peaceful and inclusive societies (SDG 16).

The increased supply of sectoral and transactional online services has been possible through novel approaches to the adoption of new technologies, high commitment by leaders of countries and public administrations, effective and capable institutions, and reforms in regulatory frameworks. Most of this increase has been channeled via SMS services, mobile applications and easy-to-use tools from social networking websites (DESA/ONU, 2016).

The provision of public services related to health, education, justice, the environment, employment and culture through ICT, or **e-services** (SDG 16.3), means that larger numbers of people have access to services and information. It empowers and promotes the social, economic and political inclusion of all, regardless of age, sex, disability, race, ethnicity, national origin, religion and economic or other status (SDG 10.2). It can also ensure greater citizen commitment with respect to demanding and participating in the provision of quality public services.

Most countries have introduced online services for paying taxes and registering businesses. Online requests have also given rise to a growing number of certificates (birth, marriage, social security). This results in saving citizens time and money, and can have a significant impact on reducing poverty and enhancing the efficiency of institutions (DESA/ONU, 2016).

Citizen participation (SDG 16.7)[59] in designing, implementing and evaluating public policies is an important part of governance processes. Through e-government tools, citizens can participate in public matters and decision-making, as well as have greater control over their own lives. A survey by the United Nations Department of Economic and Social Affairs (UN DESA) (2016) underscored the importance of the potential of **e-government** for implementing the 2030 Agenda and the SDGs, since it seeks to improve the relationship between governments and citizens through public e-services, as well as enables access to public services that are more effective, accessible and better able to meet people's needs (UN DESA, 2016).

As for their potential to promote transparency and obligatory accountability, **e-government** tools can improve efficiency since they permit

58 Some of the references made in this section are complemented by access to information, addressed in Section 2.1 and other subsequent sections. ICT services have the potential to ensure access to information (Target 16.10).

59 Ensure responsive, inclusive, participatory and representative decision-making at all levels.

public access to information and open data (Target 16.10)[60] and protect basic freedoms in accordance with national laws and international agreements[61], as well as oversight of government by citizens. They enable effective and transparent institutions that are accountable[62], and enable citizens to have real-time access to affordable information on matters of general interest, transportation and citizen security. In other words, ICT play a crucial role in improving governance of States.

As pointed out earlier, 113 Member States of the United Nations[63] have laws ensuring the right of access to government information. At least 105 countries have online policies for open government information, and at least 113 have laws that protect personal online data. At the same time, it is already possible in 98 countries to access public services through personal digital identification, although there are still challenges to ensuring the privacy and security of personal data (UN DESA, 2016).

These tools can also increase the publication of open government data related to vulnerable groups. It would be recommended to find paths to ensure that these tools truly contribute to improving the lives of impoverished and more vulnerable people. Data regarding the location of health services and water sources close to suburban and depressed areas can improve the access of communities to essential social and economic resources (UN DESA, 2016).

To strengthen different means of implementation and to revitalize the Global Partnership for Sustainable Development (SDG 17), ICT offer the possibility of developing e-government services with the potential to mobilize global commitments among multiple stakeholders for the ultimate purpose of improving the lives of all people around the world, whether in terms of education, reduction of inequalities, health, or world governance, among others. In this context, ICT can assist in decision-making processes, accountability and participation on the part of governments from all countries, their civil societies and academic and business sectors[64].

In the initial stages of ICT development, it was thought that digital technological leaps would reduce gaps more quickly. However, that euphoria has given way to the realization that ICT are not a shortcut to achieving development, although they can be an enabling factor and perhaps an accelerator of development (World Bank, 2016b).

As in the previously mentioned case of social groups, countries start off from existing situations of inequality and with very distinct comparative advantages. For this reason, any ICT-based policy initiative must take into consideration the dynamics in play in a system that intensifies inequalities within and among countries. It would be simplistic to say that those who are able to adapt quickly to this evolving digital economy will reap greater dividends, whereas the rest will probably be left behind (World Bank, 2016b).

The services and solutions that facilitate access, exchange and intercultural dissemination of knowledge also contribute to reducing inequality within and among countries (SDG 10), by enabling meaningful learning and inclusive intercultural societies for all people, including marginal groups, migrants and minorities, etc.

Furthermore, when adopting urgent measures to combat climate change and its effects (SDG 13),

60 Indicator 16.10.2 refers to the number of countries that adopt and implement constitutional, statutory and/or policy guarantees for public access to information.

61 Indicator 16.10.1 refers to the number of verified cases of killing, kidnapping, enforced disappearance, arbitrary detention and torture of journalists, associate media personnel, trade unionists and human rights advocates in the previous 12 months

62 Indicator 16.6.1 refers to primary government expenditures as a proportion of original approved budgets, by sector (or by budget codes or similar), and 16.6.2 is in relation to the proportion of the population that is satisfied with their last experience of public services.

63 The Online Service Index assesses the online presence of Member States of the United Nations. More information at UN DESA, 2016, page 4.

64 In the sphere of international cooperation, government e-services can facilitate transparency in the delivery of aid; better planning, management and coordination; and capacity to monitor the flows of this aid and enhance its effectiveness. Citizens in developing countries can better understand what development aid is for and press governments to be accountable. For their part, citizens from donor countries can understand better which part of their taxes is used to promote sustainable development in the world and how.

ICT solutions and services **linked to e-science** and **e-environment** that permit the development of evidence related to knowledge on the subject, mitigation, adaptation and early warning are crucial.

As for the environment, ICT can contribute to political decision-making, changes in the habits of the world's inhabitants, and reduced carbon emissions. Technologies that offer accessible, affordable and relevant information help empower people, by providing more thorough knowledge of what climate change means and the national and international policies for combating it; this increases resilience to climate change and natural disasters.

A study published by the Global e-Sustainability Initiative and Accenture, SMARTer2030 (GeSI and Accenture, 2018), indicates that as smartphones, network sensors, intelligent electrical grids and other technological devices become faster, cheaper and more ubiquitous, their potential to generate environmental, economic and social benefits will also increase. This potential, according to calculations in the study, includes a 20% reduction in global carbon emissions by 2030, more than $11 trillion in new economic benefits, extension of online health care to 1.6 billion people around the world, and an estimated 30% increase in crop yields.

This vision is at odds with the realities that exist in some places, given its relationship with conflicts that can be generated in some regions by raw materials used in the manufacture of technology.[65] Another essential agenda is the reduction of e-waste generated by the disposal of devices, and carbon emissions attributed to the servers responsible for cloud computing services. Establishing appropriate measures that involve the various stakeholders, including manufacturers, is among the recommendations from the WSIS (UIT, 2016).

Finally, within the framework of multi-stakeholder partnerships, such as cross-border cooperation, it is important to support the use of ICT to coordinate policies for follow-up and presentation of reports based on evidence of adaptation, prevention and mitigation of climate change.

2.2.4. Recommendations of ICT solutions for the SDGs

Current efforts to use ICT solutions to achieve the SDGs are highly fragmented and insufficient in scale. A more concerted approach is essential and must incorporate **transversal policies aimed at minimizing the risks** of further deepening unequal access to ICT solutions, especially among more vulnerable populations.

From this perspective, national development plans, digital agendas and sectoral policies must **incorporate measures that ensure**:

- **Compatibility of ICT solutions with existing infrastructure** (whether fixed and mobile broadband are available) **and physical equipment** (hardware) in use locally and among more vulnerable populations and in more remote areas, ensuring public access to this infrastructure and equipment (through Internet cafés and/or mobile libraries).
- **Availability** of relevant ICT solutions and applications **in local languages and user-friendly formats, that are accessible from all devices, which ensures access to and management of ICT solutions** by all individuals and social actors who require them. This can be done by implementing concrete measures aimed at ensuring access by the more vulnerable segments of the population, in addition to specific, transversal gender-related measures, to prevent these policies from increasing or perpetuating inequalities.
- National policies that ensure **universal connectivity and public access** to the Internet to all segments of the population and throughout the country, along with a gender perspective.

65 It suffices to recall the case of the Democratic Republic of the Congo with coltan. This mineral, composed of niobium and tantalum, is indispensable in a wide range of technological applications.

- **Necessary skills** for accessing and managing available devices and applications to ensure that people with fewer resources are not harmed by these systems or marginalized; this should be imparted through extensive traditional, digital and information literacy programs.

In addition, national holistic strategies (with interaction among the different policies involved) that are **sufficient in scale** to promote cultural changes among all stakeholders involved are needed: governments, companies, civil society, universities, media, professionals and experts, political parties, trade unions, etc. These strategies should include:

1. National policies that ensure **universal connectivity and public access** to the Internet to all segments of the population and throughout the country.

2. National policies to **strengthen** digital, communication and information **skills in public administration** (at all levels and in all sectors), **companies and civil society organizations**, to promote significant participation in multi-actor, multi-level and multi-sector partnerships that enable establishing the basis for generating virtuous cycles of incorporation of ICT in the fight against poverty. An example is their obligatory incorporation in administration training schools and continuing education plans.

3. National policies to **promote innovative ICT solutions in business, educational and scientific systems**. These policies should be implemented in the training of researchers (for example, strengthening reverse innovation in LDCs) and teachers at all levels (new tools and world views); and in secondary and university teaching curricula, promoting innovation and ICT solutions that contribute in the mid-term to a **digital culture** for the SDGs[66].

4. Digital policies aimed at **promoting ICT solutions and applications** in different sectors (e-business, e-health, e-banking, e-learning, e-science, e-environment, etc.) through public-private partnerships, if necessary, and with the participation of the social actors involved in each context.

2.3. Use of ICT for measuring sustainable development

ICT can contribute, not only to achieving the SDGs, but also to measuring them, and consequently, to making **evidence-based decisions which, in turn, enable knowing departure and destination points**. The data and macrodata revolution can progressively improve the capacity of countries to generate relevant information for tracking SDG progress. António Guterres, Secretary-General of the United Nations, wrote in the Sustainable Development Goals Report 2018 that there are challenges faced in the collection, processing, analysis and dissemination of reliable, timely, accessible and sufficiently disaggregated data, and calls for better evidence-based policy-making:

> *Without evidence of where we stand now we cannot confidently chart our path forward in realizing the Sustainable Development Goals. (…) Today's technology makes it possible to collate the data we need to keep the promise to leave no one behind. But, we need political leadership, resources and commitment to use the tools now available (United Nations, 2018b, page 3).*

Countries are mainly responsible for carrying out the follow-up and review of the implementation of the SDGs, as well as adapting them to their national contexts (See Section 3.1). This will require an enormous amount of data, which will need to be produced and analyzed. This consti-

66 For example, e-business4all for careers in economics and business administration; e-agriculture4all for training agricultural engineers, veterinarians, etc.; e-health4all for careers in health science, nutrition and psychology; e-data4all for careers in IT, information sciences, data journalism, etc.; and e-government4all and digital policies for careers in political science, etc.

tutes a major challenge for statistical systems[67] in both developed and developing countries, since high-quality, timely and reliable data, disaggregated by income, sex, age, geographic location, etc., is necessary (PARIS21, 2018).

In addition, national governments will need better statistical production and analysis capabilities, greater availability of solid data, and more accountability among development actors at the national and international levels. This also requires the development of common norms and methodologies, as well as new areas of measurement and data collection, processing and distribution instruments – fields in which ICT have much to contribute (UNDP, 2017). The adoption of big data for measuring the 2030 Agenda has been discussed by national statistical institutions from around the world at events such as the UN Data Forum (https://undataforum.org/). Among the experiences reported is the utilization of data generated by the use of mobile phones and social networking websites to measure migratory flows, displacement of refugees and the spread of epidemics. It is also necessary to organize data producers, detect new sources and concentrate on information gaps.

The Sustainable Development Goals Report 2018 points out that, in many statistical systems, data requirements for the indicators are being added to already-existing work programs and national strategies for preparing statistics. Data and statistical systems have been the source of many important initiatives to create innovative tools and frameworks to incorporate new data sources, in order to fully harness the power of the data revolution and achieve the goals and targets of the 2030 Agenda. (United Nations, 2018b).

> *These efforts are especially important in identifying those left furthest behind, since data are increasingly disaggregated by income, sex, age, race, ethnicity, migratory status, disability, geographic location and other characteristics. This type of detailed information is the basis upon which effective policies are shaped (United Nations, 2018b, page 16).*

The United Nations, in the same report, points out that the rules for data and metadata exchange[68] for the SDGs will improve transparency and efficiency:

> *Working with data for the full implementation and review of the SDGs entails exchange and sharing of a large amount of data stored in different databases maintained by the various producers. A standard known as Statistical Data and Metadata eXchange (SDMX) provides a common language and vocabulary for data sharing and consumption. Since October 2016, a group of experts from countries and international agencies responsible for the development of the indicators have worked to develop an SDMX-based standard for SDG data exchange (United Nations, 2018b, page 16).*

As indicated in the Report, the hope is that the SDMX standard will be adopted by countries and international agencies to improve data exchange, dissemination and transparency in the preparation of reports on the SDGs at the national and international levels. The standard for data will be complemented by a standard for metadata (United Nations, 2018b).

The potential of large volumes of data produced by the developing digital economy, particularly through technologies such as the Internet of Things and cloud computing, also gives rise to problems involving data access and exchange, data protection, privacy and security, among others. These will have to be addressed and will oblige national statistical systems to develop protocols to be able to harness new data sources (UN-Statistical Commission, 2018).

67 For example, 77 developing countries have inadequate data on poverty. Around the world, only 56% of countries have birth registration data that is 90% complete (only 15% of countries in Africa, 33% in southern Asia and 36% in southeastern Sub-Saharan Asia have this information). Furthermore, only 37 countries have national statistics laws that incorporate the fundamental principles of the United Nations on official statistics. It is still necessary to solve serious methodological and strategic problems, including the need to find a reasonable balance between producing data for global monitoring, on the one hand, and for formulating national policies, on the other.

68 Metadata is data that describes other data, whereas macrodata refers to a set of data that is so large that traditional computer applications are not sufficient for treating it (see definition further down).

The Independent Expert Advisory Group on the Data Revolution for Sustainable Development (IEAG) defines the concept of the "data revolution," which guides the 2030 Agenda, as "**the integration of data coming from new technologies with traditional data, in order to produce relevant high-quality information, with more detail and at higher frequencies to foster and monitor sustainable development"** (UN Data Revolution Group, 2014, page 7)**.** This revolution also means increased access to data through much more openness and transparency and, finally, more empowered people, which leads to better policies. For controlling certain indicators, ICT devices may have the potential to be as relevant, and timelier and more profitable, than traditional data collection methods, and could enable the data cycle to coincide with the decision-making cycle (UN Data Revolution Group, 2014).

The widespread and constant use of telecommunications and other ICT devices continuously generates digital information from various sources, such as GPS, ATMs, mobile phones, satellites and social networking websites, among others. Therefore, what is known as **big data** is produced, characterized by high immediacy, large volume and great variety, which requires new tools and methods to efficiently capture, administer and process it. (BigData UN Global Working Group, 2018)

From the point of view of international development, **Big Data represents an integrated research and development approach** (including measurement and evaluation of development), which involves three interrelated components (UN Global Pulse, 2016):

- **Data generation**: generation and collection of large volumes of data with a large diversity of sources, including multiple ICT applications. An example would be using Twitter analytics and other social media data to assess the attitudes of different groups toward social problems, or their responses to different preventive and educational programs.
- **Data analytics**: organization and integration of multiple sources of data, and the application of data science and data analytics to finding previously undiscovered patterns and associations in the data, and to predicting outcomes of development interventions. A key element is the presentation of the findings of analysis in user-friendly formats (data visualization).
- **Data ecosystems**: ecosystems that link the multiple organizations and individuals that generate, analyze and use Big Data, combined with conventional quantitative and qualitative analysis.

Many forms of big data and data analytics have only emerged in the last few years. Most national and international agencies are still in the early stages of understanding big data and its possible applications in development. However, various agencies have already started to apply the big data approach to investigating the development, design, monitoring and assessment of programs.

Following are some case studies that illustrate how big data can be used to strengthen the monitoring of sustainable development programs (UN Global Pulse, 2016):

Use of satellite images to monitor changes in forest cover in protected areas [Sources: GEF and UNDP]

Satellite images are becoming increasingly refined, which enables combining different resolution levels for different purposes. Lower resolution data can use thermal images to detect types of crops, whereas higher resolution captures more details about other types/sets of data. These can be used to: Monitor the movement of populations, changes in forest cover and land use // Monitor the impact of natural and man-made disasters// Provide more economical, faster estimates of economic growth and poverty // Monitor the depletion of biodiversity.

Monitoring migration and shocks in the labor market using data from mobile phone calls [Source: World Bank]

Telephone companies keep very detailed records of all calls, including the duration of the call, the location of the person who calls, and the cost of the connection. While there are often limitations on access to these records, appropriately anonymous and aggregated mobile data can provide a valuable source of data for: Monitoring population displacement // Measuring seasonal and temporal migration (often ignored in periodic surveys) // Detecting the impacts of small-scale violence // Using connection purchase trends as a poverty indicator // Understanding cases of violence against women and domestic violence.

Mining Indonesian tweets and other social media to monitor food price crises [Source: UN Global Pulse]

Platforms such as Facebook and Twitter are available to the public and widely used to analyze people's attitudes and sentiments. When used in emergency situations (such as locating victims trapped by earthquakes and floods), it can be a challenge to distinguish valid information from irrelevant data. Monitoring can be useful for the following purposes: Identifying potential conflicts and emergencies using sentiment analysis // Monitoring the spread of diseases // Identifying poverty and food price trends // Predicting increases in unemployment or crisis-related stress // Monitoring violence against women and domestic violence // Analysis of social media for making immediate predictions.

Estimating migration flows using online search data (Internet/Text) [Source: UNFPA in partnership with UN Global Pulse]

Internet searches can be used to analyze the frequency with which words or phrases appear over time and in different geographic locations. UN Global Pulse and the United Nations Population Fund (UNFPA) conducted a study to explore how online search data can be analyzed to understand migratory flows. Using Australia as a case study, data from Google search queries from around the world were disaggregated by country and compared with official historical monthly migration statistics provided by UNFPA. Correlations were noted between relevant search queries (for example, searching for "jobs in Melbourne") and official migration statistics (number of people that migrated to Melbourne). Other possible uses include: Internet queries monitoring the frequency of keywords for understanding trends and identifying possible problems // Identifying indirect indicators for real-time monitoring of socioeconomic data that is normally collected through costly surveys and that require a lot of time // Analyzing sentiment // Lexical analysis for understanding the elements of culture or financial education to help design microfinance programs // More complex analysis of unstructured text data. (UN Global Pulse, 2014).
Summary available at: http://unglobalpulse.org/projects/migration-search-data
http://www.unglobalpulse.org/sites/default/files/UNGP_ProjectSeries_Search_Migration_2014_0.pdf

Use of crowdsourcing[69] for real-time monitoring of price trends of basic products [Source: WFP and FAO in collaboration with UN Global Pulse]

Crowdsourcing obtains feedback from a large number of people or groups. An example is a feasibility study carried out in Nusa Tenggara Barat, one of the poorest provinces in Indonesia, which involved recruiting a reliable network of local citizen reporters to send food price reports through a customized mobile phone app. This can combine direct responses from individuals with data collected during community or group meetings and sent as a summary of group agreements. This could include: Compiling opinions from communities and individuals on development priorities // Monitoring food price trends and other indicators // Obtaining feedback from particular groups, such as young people, eligible voters in a country, or people who give feedback on emergencies, such as floods, earthquakes and conflicts. (UN Global Pulse, 2015a).
Summary available at: http://unglobalpulse.org/projects/highfrequency-food-price-data-indonesia

Training communities to use GPS mapping to create maps of the services in their communities [Source: UN Global Data Innovation Competence. Indonesia]

GPS-enabled mobile phones can identify and record the location from which a call or audio or visual recording is made. This can be used to create maps that locate particular characteristics such as public services, or to locate where calls are made from. Applications include: Mapping the location of services such as water supply, bus stops or shops that sell food or other articles of interest // Mapping problem areas (for example, poor-quality services, high-conflict areas, high volumes of traffic accidents, electoral abuses, or the location of earthquake victims) // Controlling traffic density or routes used, for example, by motorcyclists or women who collect water or fuel (UN Global Pulse, 2015b).
Summary available at: http://www.unglobalpulse.org/blog/data-action-when-communities-engage-mapping-urban-villages-together

AQUASTAT integrated data platforms from the FAO: a reference source for many possible supervisory activities. Combines satellites and other data sources [Source: FAO]

Big data makes it possible to combine conventional data sources, such as censuses, national household surveys and agricultural surveys in real time from ICT sources, such as satellite images and drones, social networking websites, mobile phone records and digital financial transactions, to expand the range of data that can be incorporated into databases. Examples include: Integration of data from different departments and agencies to enable comparisons of indicators between agencies and over time // Integrating conventional data platforms with large amounts of data from sources such as Twitter // Real-time monitoring by selecting indicators that are available from public sources and are comparable among agencies, and often among countries, and that enable monitoring of trends over time. (FAO, s.f.).
More information available at: http://www.fao.org/nr/water/aquastat/main/index.stm

69 Crowdsourcing involves externalizing tasks traditionally performed by employees and contract workers, placing them in the hands of a large group of people or a community, through an open call.

2.3.1. Recommendations for the use of ICT to measure sustainable development

To tackle the challenges arising from the use of ICT for measuring development, national governments must:

- Foster and promote innovative solutions, in line with international personal data privacy and protection standards, with respect to the availability and use of ICT devices, platforms and applications to generate and analyze data. It is also necessary to create data ecosystems that help overcome lacks, reduce costs and increase the potential of ICT as providers of data from public policies. This will make ICT available for people's needs, evidence-based decision-making, and the definition, implementation and assessment of public policies that are consistently in compliance with high ethical standards.
- Incorporate specific transversal/shared actions into national development plans, digital agendas and national statistical systems. This includes: i) mobilization of national and international technical and financial resources; ii) development of national skills to use ICT for measuring development at all levels and in all sectors involved; iii) formation of solid and strategic partnerships between governments, research centers and companies for the production of data, methodologies and standards linked to national statistical systems; and iv) participation in and contribution to international incentives and pilot tests for this purpose.

3. MAPPING OF ICT IN THE SDG TARGETS AND INDICATORS

It is important that decisions to strengthen ICT public policies for sustainable development, aimed at achieving the SDGs, be mapped and framed within a context where there is still a heterogeneous degree of availability and development of the indicators, in general. In addition, to make progress in obtaining global data on ICT- and SDG-related indicators, States still need to make major efforts.

3.1. Current status of the global indicator system for SDG monitoring

In the resolution adopted by the United Nations General Assembly (September 25, 2015) approving the 2030 Agenda and the 17 SGDs, the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDG)[70] was commissioned to create and configure a global indicator framework for the SDGs and their 169 targets (United Nations, 2015a). The work was scheduled to be completed within one year, for approval in the 47th session in 2016, but the deadline was extended another year because full agreement couldn't be reached regarding a series of indicators. After the 48th session of the United Nations Statistical Commission in March 2017, without having achieved full agreement, the Commission recommended that the United Nations Economic and Social Council (ECOSOC) adopt a resolution containing the global indicator framework, which was adopted by the General Assembly on July 6, 2017, as a voluntary instrument that should be used by the countries to monitor and prepare national review reports (United Nations, 2017b).

Its adoption included a warning that it is only a preliminary set of indicators that needs to be fine-tuned annually and thoroughly reviewed by the Statistical Commission at its 51st session (2020) and 55th session (2025), and that it will also be supplemented by indicators at the regional and national levels, which are to be developed by the countries (United Nations, 2017b).

70 The Inter-agency and Expert Group on SDG Indicators was created in March 2015, in the 46th session of Statistical Commission. It is currently composed of experts and national statistical agencies from 28 countries (ECOSOC, 2017). The group has met face-to-face on six occasions, the last time in November 2017, in Bahrain. The purpose of these meetings is consultation and examining proposals from representatives of statistical institutions, social organizations and other actors, in addition to numerous tasks performed by electronic means.

In fact, in March 2016, a list of 229 indicators was proposed: 149 have been approved, and 80 are pending discussion. After that, the Statistical Commission established a definitive list of 230 indicators to measure 169 targets.[71] However, these indicators have been classified into three different tiers according to acceptance of their methodology and availability of sufficient data. Tier I includes indicators that have an established methodology and a large amount of data, and where data is regularly produced by countries for at least 50% of countries and of the population in every region where the indicator is relevant. Tier II refers to indicators that have an established methodology but lack sufficient data because it is not regularly produced by countries. Tier III corresponds to the set of indicators that do not yet have an established and accepted methodology. Approximately 40% of the indicators are in Tier III, since they are being or will be developed or tested in the future (ECOSOC, 2017).

Three years after the work was started to develop the global indicator framework, emphasis shifted from the pressure to create the framework to the need to develop skills, particularly those of national statistical institutes. These skills include disaggregating data, not only by income, sex, race and population groups, but also by local and municipal levels, in order to incorporate all the realities that national averages obscure from view and thereby fulfill the mandate to leave no one behind. The emergence of initiatives that seek to facilitate data incorporation through nonconventional sources, such as mobile phones, satellites, social networks and scanned data, is also noteworthy (Adams & Judd, 2018).

As of the date of this policy paper, 93 of the 230 indicators are considered be in Tier I, i.e., they are useful for measurements in at least 50% of the countries. The truth is that 42 are identical to indicators that already existed for measuring the SDGs, which leads one to suspect that essential aspects of the SDGs that make them transformative are lost. In SDG 16 on governance, only five of the 12 proposed indicators are in Tier I; in SDG 10 on inequality, only three of the 11 have achieved this level of functionality (Bissio, 2018). As will be seen, this is the case with the most relevant indicators with respect to ICT and the SDGs, which jeopardizes the achievement of efficient measurement of certain key aspects of the 2030 Agenda.

Approximately half of the 230 indicators are not useful for monitoring or preparing complete reports, since some lack the agreed measurement criteria (68) and others do not have sufficient data coverage (66). This affects critical areas of the SDGs, such as poverty, climate change, the environment, gender, inequality and governance. For example, in the case of measurements related to sexual and reproductive rights, UN Women underscores that less than one-third of the specific gender indicators are available and agreed on (UNWOMEN, 2018).

There are still goals for which more than half of the planned indicators are still in Tier III:

- SDG 10 on inequality: 5.
- SDG 12 on consumption and production: 10.
- SDG 13 on climate change: 5.
- SDG 14 on marine ecosystems: 7.
- SGD 16 on inclusive institutions and access to justice: 6.
- SDG 17 on means of implementation: 7

In particular, the indicators for SDG 17 have already received important comments and modification proposals to try to replace traditional indicators based on growth or gross national product deficits, in order to provide a macroeconomic behavior scorecard that would enable measuring stability through coordination and coherence of policies. This included proposals to review certain fundamental indicators in the ICT and SDG relationship, such as those in reference to Internet access (UNSD, 2015).

Furthermore, there are some indicators that run the risk of being revised or eliminated in subsequent reviews for lack of agreement. In some cases, for example, with respect to the three indi-

71 In reality, there are 241, but seven are repeated in pairs of goals, and two are intended to measure three different goals, resulting in only 230 different indicators. The list was made public in July 2016 (IAEG) and was formally adopted in July 2017 (United Nations, 2017).

cators for SDG 1, there is still no consensus as to which agency will take care of the data and, for this reason, they are still in Tier III. If this situation is not resolved, indicators that measure multidimensional poverty, as called for by the 2030 Agenda, may be lost.

In contrast to these situations, methodologies were completed and sufficient data was obtained in 2017 to enable certain indicators to move to Tier I. This was the case with indicator 5.b.1, which indicates the proportion of individuals with their own mobile phones, disaggregated by sex. This information will be instrumental in analyzing the evolution of overall access, and the gender digital divide, in particular.

The United Nations Statistical Commission is trying to establish mechanisms for the coordination, homogenization and homologation of national statistical efforts to achieve a complete and functional global indicator system. A series of recommendations and an action guide have recently been published to ensure that high-quality, internationally comparable data and statistics are used for global information about the SDGs (UNSTATS, 2018). National statistical systems are of crucial importance in making significant advances in the global indicator system, since States and their statistical systems will ultimately transmit, estimate and validate the data that will be used in global monitoring. It is necessary to take into account that global information processes with SDG indicators will be based primarily on data and statistics produced by national systems. It will be important to use tools and standards that make it possible to automate data exchange, such as the Statistical Data and Metadata eXchange and application program interfaces (API) through online means.

Therefore, the following principles are established for completing a global indicator and monitoring system:

a. **Transparency:** Data and metadata are open and sharable; all adjustments and estimations must be transparently declared, and the methodologies used must be shared by all parties.

b. **Collaboration and communication:** Collaboration and communication among national statistical organizations, agencies that store data, and other involved parties is essential to ensure an effective flow of data and its international comparability with high quality standards. Open communication will enable all parties to fully understand what is occurring during each stage of the process.

c. **Professional and scientific standards:** The concepts, definitions, classifications, sources, methods and procedures used in the production of statistics should be chosen according to professional and scientific standards and be built with transparency.

3.2. Analysis of the status of ICT & SDG targets and indicators

The 2030 Agenda recognizes that information and communication technologies have tremendous potential to accelerate sustainable development. However, as already indicated, only 5 of the 17 SDGs explicitly mention ICT (SDG 4, 5, 8, 9 and 17), and the Agenda only includes 7 indicators in its monitoring framework. This limited presence does not reflect the transversal and multisectoral contribution of ICT to the SDGs (Digital Watch Observatory, 2017).

However, during the 2015 WSIS, the participating organizations developed a matrix that provided a mapping of the SDGs, and the Summit proposed 11 action lines that indicated a multitude of transversal aspects and the critical role played by ICT. It also highlighted the insufficiency of indicators and availability of specific ICT statistics (UIT-CMSI, 2015), a proposal that was not sufficiently incorporated into the SDG monitoring framework.

Among the challenges identified at the 2017 WSIS meeting (UIT-CMSI, 2017) is the need to develop sets of **thematic indicators** within the framework of the Partnership on Measuring ICT for Development, in addition to global, regional and local indicators.

Along this line, various international organizations have been developing or are starting to develop sets of thematic indicators. UNESCO is developing **Science, technology and innovation indicators** for the SDGs and Internet universality which, like ICT indicators, are transversal in nature and may be able to measure the achievement of many SDGs. STI indicators capture how national innovation systems operate; STI infrastructure, including ICT infrastructure; supply of human capital; innovation processes; knowledge exchange/transfer and STI results, among others. In turn, **Internet universality** indicators capture the R.O.A.M. principles (see page 23) (UNESCO, 2018a), along with transversal indicators referring to issues such as gender and the needs of children and young people, sustainable development, trust and security, and legal and ethical aspects of the Internet.

One of the main achievements of the Partnership on Measuring ICT for Development[72] (the Partnership) has been to provide a methodological framework that establishes 60 standardized indicators for measuring ICT access and use, in order to contribute to advancement in the measurement of ICT in countries, by their governments, enabling comparisons between countries and evaluation of worldwide progress. The identification of a basic list of ICT indicators has evolved over time and, in 2016, included more than 60 indicators, which were agreed on through a consultation process involving the participation of governments, international organizations and experts in the field of measuring the information society (Partnership on Measuring ICT for Development, 2016). The areas covered are: (Barbosa & Jereissati, 2016)

i. ICT infrastructure and access (ITU)

ii. Access to and use of ICT by households and individuals (ITU)

iii. Access to and use of ICT by companies (UNCTAD)

iv. The ICT sector and trade in ICT goods (UNCTAD)

v. ICT in education (UNESCO)

vi. ICT in government (Partnership on Measuring ICT for Development)

The Partnership also recommends that the basic list be used as the basis for ICT data collection in countries. The indicators included in the main list are clearly defined and associated with statistical standards, which enables comparisons among countries. More and more countries are integrating the basic list of ICT indicators into their mechanisms for compiling existing data, including surveys of households and companies. The members of the Partnership provide assistance in this process to governments, including skill development and practical training for national statistical institutions (Partnership on Measuring ICT for Development, 2016).

Beyond identifying how ICT indicators are presented in the 2030 Agenda, the Regional Center for Studies on the Development of the Information Society (Cetic.br) conducted a systematic review of the presence of general, sectoral and thematic indicators at the level of targets and indicators, in order to harmonize different sources, perspectives and approaches that demonstrate the transversal contribution of ICT to the SDGs, as presented below.

After identifying the relevant reference sources, Cetic.br carried out a review to map all the connections between ICT and the 2030 Agenda, with respect to more general connections linked to the targets as well as more specific ones linked to the indicators. Then, the keywords related to information and communication technologies were identified.

In a second stage, the descriptions of the 169 targets and 231 indicators were analyzed, to identify explicit references to the adoption of ICT, as well as explicit references to ICT-related concepts/dimensions.

72 The Partnership for Measuring ICT for Development, launched in 2004, is an international initiative, with 14 regional and international organizations that participate in collecting and disseminating ICT statistics.

Finally, the literature on the socioeconomic impact of ICT was assessed, to connect other targets and indicators to ICT. Therefore, in this process, the relationship between ICT and the SDGs was classified into three levels, as follows:

1. **Indicators / targets that explicitly mention ICT and/or the Internet** (Figure 12).

2. **Indicators / targets that mention something about technology, communication or information.** The following keywords were used to identify them: new technology, (acquire) knowledge (and skills), technological development, (timely) access to information, information, early warning, technological upgrading, innovation, technological and technical support, efficiency, sustainability information, information and awareness, monitor/monitoring, technology transfer, transparent institutions, timely and reliable data (Figure 13).

3. **Indicators / targets that do NOT mention ICT or the Internet**, or include anything related to technology, communication or information, but are connected to a solid body of literature on the role that ICT play in specific areas (Figure 14). This includes:

- **e-government** and related dimensions, such as e-participation, open data, transparency, online information and provision of services (including green e-public procurement), that may contribute toward achieving most of the goals and targets.
- **Telehealth**, e-health and even m-health have great potential, especially for achieving Goal 3, although it extends further than that.
- **Mobile applications** can contribute to achieving various goals and targets, since mobile access is extensive, even though not universal.
- **e-learning** Open educational resources and massive open online courses (MOOC) have enormous potential for achieving Goal 4.
- **ICT-based solutions** and all the principles and solutions related to **smart cities** are closely linked to various goals and targets, especially Goals 9 and 11.
- **Open data** (not only government data) and digital services (not only public services) have an important role to play in achieving the goals and targets.

Figure 12. SDG indicators explicitly related to ICT

SDG	Target	Indicator
4	4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.	4.4.1 Proportion of youth and adults with **information and communication technology (ICT) skills**, by type of skill.
	4.a By 2030, build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.	4.a.1 Proportion of schools with access to: (a) electricity; (b) the **Internet** for pedagogical purposes; (c) **computers** for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions).
	4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and **information and communications technology**, technical, engineering and scientific programmes, in developed countries and other developing countries.	4.b.1 Volume of official development assistance flows for scholarships by sector and type of study.
5	5.b Enhance the use of enabling technology, in particular information and communication technology, to promote the empowerment of women.	5.b.1 Proportion of individuals who own a **mobile telephone**, by sex.
8	8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all.	8.10.2 Proportion of adults (15 years and older) with an account at a bank or other financial institution or with a **mobile-money**-service provider**.**
9	9.c Significantly increase **access to information and communications technology** and strive to provide **universal and affordable access** to the Internet in least developed countries by 2020.	9.c.1 Proportion of population **covered by a mobile network**, by technology.
17	17.6 Enhance North-South, South-South and triangular regional and international cooperation on and **access to science, technology and innovation** and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a **global technology facilitation mechanism.**	17.6.1 Number of science and/or technology cooperation agreements and programmes between countries, by type of cooperation.
		17.6.2 Fixed **Internet broadband** subscriptions per 100 inhabitants, by speed.

SDG	Target	Indicator
17	17.7. Promote the development, transfer, dissemination and diffusion of **environmentally sound technologies** to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed.	17.7.1 Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies.
	17.8 Fully operationalize the **technology bank** and **science, technology and innovation capacity-building mechanism** for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology.	17.8.1 Proportion of individuals using the **Internet.**

Source: Prepared by Cetic.br with data from ITU, OECD; UN DESA; WSIS.

Figure 13: ICT-related indicators, by keywords

SDG	Target	Indicator
1	1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, **appropriate new technology** and financial services, including microfinance.	1.4.1 Proportion of population living in households with access to basic services.
		1.4.2 Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure.
2	2.3. By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, **knowledge**, financial services, markets and opportunities for value addition and non-farm employment.	2.3.1 Volume of production per labor unit by classes of farming/ pastoral/forestry enterprise size.
		2.3.2 Average income of small-scale food producers, by sex and indigenous status.
	2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, **technology development** and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.	2.a.1 The agriculture orientation index for government expenditures.
		2.a.2 Official flows (official development assistance plus other official flows) to the agriculture sector.
	2.c Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate **timely access to market information**, including on food reserves, in order to help limit extreme food price volatility.	2.c.1 Indicator of food price anomalies.
3	3.7 By 2030, ensure **universal access** to sexual and reproductive healthcare services, including for family planning, **information** and education, and the integration of reproductive health into national strategies and programmes.	3.7.1 Proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods.
		3.7.2 Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000 women in that age group.
4	4.7. By 2030, ensure that all learners **acquire the knowledge and skills** needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.	4.7.1 Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment.

SDG	Target	Indicator
8	8.2 Achieve higher levels of economic productivity through diversification, **technological upgrading and innovation**, including through a focus on high-value-added and labor-intensive sectors.	8.2.1 Annual growth rate of real GDP per employed person.
	8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, **creativity and innovation**, and encourage the formalization and growth of micro-, small and medium-sized enterprises, including through access to financial services.	8.3.1 Proportion of informal employment in nonagriculture employment, by sex.
9	9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, **technological** and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.	9.a.1 Total official international support (official development assistance plus other official flows) to infrastructure.
	9.b Support domestic **technology development, research and innovation** in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities.	9.b.1 Proportion of medium- and high-tech industry value added in total value added.
12	12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate **sustainability information** into their reporting cycle.	12.6.1 Number of companies **publishing** sustainability reports.
	12.8 By 2030, ensure that people everywhere have the relevant **information and awareness** for sustainable development and lifestyles in harmony with nature.	12.8.1 Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment.
	12.b Develop and implement **tools to monitor sustainable development impacts** for sustainable tourism that creates jobs and promotes local culture and products.	12.b.1 Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools.
13	13.3 Melhorar a educação, aumentar a conscientização e a capacidade humana e institucional sobre mitigação global do clima, adaptação, redução de impacto, e **alerta precoce** à mudança do clima.	13.3.1 Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula.

SDG	Target	Indicator
14	14.a Increase scientific knowledge, **develop research capacity and transfer marine technology**, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.	14.a.1 Proportion of total research budget allocated to research in the field of marine technology.
16	16.6 Develop **effective, accountable and transparent institutions** at all levels.	16.6.1 Primary government expenditures as a proportion of original approved budget, by sector (or by budget codes or similar).
		16.6.2 Proportion of population satisfied with their last experience of public services.
	16.10 Ensure **public access to information** and protect fundamental freedoms, in accordance with national legislation and international agreements.	16.10.1 Number of verified cases of killing, kidnapping, enforced disappearance, arbitrary detention and torture of **journalists**, **associated media** personnel, trade unionists and human rights advocates in the previous 12 months.
		16.10.2 Number of countries that adopt and implement constitutional, statutory and/or policy guarantees for **public access to information.**
17	17.18 By 2020, enhance **capacity-building** support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of **high-quality, timely and reliable data** disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts.	17.16.1 Number of countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks that support the achievement of the sustainable development goals.
	17.18 Até 2020, reforçar o apoio ao **desenvolvimento de capacidades** para os países em desenvolvimento, inclusive, para os países de menor desenvolvimento relativo e pequenos Estados insulares em desenvolvimento, para aumentar significativamente a disponibilidade de **dados de alta qualidade, atuais e confiáveis**, desagregados por renda, gênero, idade, raça, etnia, *status* migratório, deficiência, localização geográfica e outras características relevantes em contextos nacionais.	17.18.1 Proportion of **sustainable development indicators** produced at the national level with full disaggregation when relevant to the target, in accordance with the Fundamental Principles of National Official Statistics.
		17.18.2 Number of countries that have national statistical legislation that complies with the Fundamental Principles of National Official Statistics.
		17.18.3 Number of countries with a national statistical plan that is fully funded and under implementation, by source of funding.

Source: Prepared by Cetic.br with data from Cetic.br; ITU, OECD; UN DESA; WSIS.

Figure 14. ICT-related indicators, based on literature review.

SDG	Goal	ICT Review
3	3 3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.	Telehealth, m-health, e-health
3	3.c Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in less developed countries and small island developing States.	Telehealth, e-health
4	4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	OER, MOOC
4	4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy	OER
5	5.4 Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate.	Online services
5	5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.	e-government
6	6.b Support and strengthen the participation of local communities in improving water and sanitation management.	e-government; mobile applications
8	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Online information and services
8	8.8 Protect labor rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment.	Online services
8	8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all.	m-banking, micro credit
9	9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.	ICT solutions, smart cities
10	10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.	e-government / online services; mobile applications; e-learning; e-health
10	10.c By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent.	e-banking, m-banking
11	11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.	e-government / online information and services; e-health
11	11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.	e-government / e-participation; smart cities
11	11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage	Open data; digital information and repositories

SDG	Goal	ICT Review
11	11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.	Open data; smart cities
11	11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.	Smart cities
12	12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.	Mobile applications; smart cities
12	12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities.	e-government
13	13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.	Online information, open government data
16	16.3 Promote the rule of law at the national and international levels and ensure equal access to justice for all.	e-government
16	16.5 Considerably reduce corruption and bribery in all forms	e-government / government data
16	16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels.	e-government / open data / e-participation
16	16.9 By 2030, provide legal identity for all, including birth registration	Online services
16	16.b Promote and apply nondiscriminatory laws and policies to promote sustainable development	e-government / online information

Source: Prepared by Cetic.br with data from Cetic.br; ITU, OECD; UN DESA; WSIS.

4. RECOMMENDATIONS FOR ICT PUBLIC POLICIES ALIGNED WITH SUSTAINABLE DEVELOPMENT

1. **Design, assess and implement comprehensive ICT public policies consistent with the principles of sustainable development**, providing them with sufficient budgets and the necessary coordination and participatory bodies, to ensure their maximum potential is harnessed for achieving solutions aimed at sustainable development, in addition to having indicators for appropriate measurement. These digital transformation policies should be **integrated into national or local development plans and strategies aligned with the 2030 Agenda.**

2. Fully use **advances in science, technology and innovation in the economic, social, environmental and cultural spheres that foster sustainable development**, in coordination and communication with other academic, civil society, business and multi-level (international, state, regional and local) actors. At the national level, it is crucial to promote interrelationships among the ministries with various competencies, such as science, technology, industry, economics, finance, trade, labor, health, and culture or education, among others. It is also necessary to perform diagnoses with specialized teams and decision-makers that will enable coherent use of ICT for sustainable development, in order to visualize their economic, social, environmental and cultural impact.

3. Have **human rights-focused ICT public policies**, and guarantee the principle of applicability of human rights to cyberspace and the R.O.A.M. principles that should guide Internet development (based on human rights, openness and access by all people, and supported by the participation of multi-stakeholders). This means having appropriate mechanisms to protect the principles of access of all people to the Internet (in reference to Internet universality, UNESCO developed an indicator framework to define and assess national environments), open access to information resources, protection of personal privacy, surveillance/control of government by citizens, and freedom of expression.

4. **Ensure that the State's use of the Internet is efficient, transparent, uncensored, equitable and participatory** in relation to the provision of services and also in regard to citizenship through open government and the expansion of democratic venues.

5. Incorporate different aspects related to **equity in regulatory frameworks, access policies and safeguarding of rights to ensure that ICT contribute to development in terms of sustainability and social justice**. Such policies should also reduce the digital divide within and among countries, and between rural and urban populations, older and younger people, those with and without disabilities, and men and women. This must be linked with other measures aimed at comprehensively reducing inequalities and implementing universalization strategies, focused on population groups more susceptible to the digital divide. In the specific case of the gender digital divide, this requires working with all government institutions, and with regional and local governments, to address the multidimensional nature of the factors that have an impact on the digital divide.

6. Collaborate in the **definition of Internet governance and regulation, based on the principle of shared responsibility** in the international realm, for better development of digital agendas that incorporate multi-stakeholder partnerships and seek balances that securely ensure the privacy and needs of users, as well as approaches focused on users, collaborative mechanisms to improve security and open web platforms consistent with the Open Stand principles (Internet Society, 2015). This could include: anticipating risks associated with violation of data on the Internet; the use of big data or other

data derived from more recent innovations, such as those linked to the ecosystems of the Internet of Things; data management through artificial intelligence; robotics; and blockchain.

7. Develop **national development strategies or plans based on ICT** that respond to the potential for social and economic innovations made possible by the proper use of ICT. Such strategies or plans should focus, not only on infrastructure (broadband extension, mobility for improving ICT access, and technical standards), but also on reduction of inequality, incorporation of ICT in policy areas such as health, agriculture and environmental protection, and ethical concerns regarding the use of social communication, among others.

8. Monitor the **transition from traditional economies to digital economies**, reducing social and environmental costs to a minimum and tackling the challenges that arise in matters of jurisdiction, oversight, privacy, security and equity in terms of access to what are already key resources of new economies, nationally and globally.

9. Exercise **digital leadership based on a deep understanding of how ICT interact with other complementary factors**, such as economic policies, government institutions, management capabilities and organizational structures and business practices. Align ICT investments with policies and complementary investments in the sectors and organizations to be transformed.

10. Incorporate to **the definition of access to information public policies**: infrastructure for access to information and communications; the necessary skills of people and all social actors; a positive social context for its use; and a favorable legal and political context (Garrido & Wyber, 2017). It is also recommended to transversally incorporate policies for open data, open solutions, digital agendas or development programs, media and information literacy and universal access, universal service and access funds into development plans and/or digital agendas

11. Regarding the use of **ICT solutions,** incorporate measures into national development plans, digital agendas and sectoral policies that guarantee: a) **Compatibility of ICT solutions with existing infrastructure** (whether fixed and mobile broadband are available) and **physical equipment** (hardware) in use locally and among more vulnerable populations and in more remote areas, ensuring public access to this infrastructure and equipment (through Internet cafés and/or mobile libraries); b)**Availability of relevant ICT solutions** and applications in local languages and user-friendly formats that are accessible from all devices, which ensures access to and management by all individuals and social actors; c) **Affordable connectivity** and access to devices and applications by all segments of the population that require them; d) **Necessary skills** for accessing and managing available devices and applications, especially to ensure that people with fewer resources are not negatively affected; and e) **Regulations** that make access to data and ICT solutions foreseeable.

12. Generate **national policies to strengthen** digital, communication and information **skills in public administration** (at all levels and in all sectors), **companies and civil society organizations**, to promote significant participation in multi-actor, multi-level and multi-sector partnerships; along with national policies to **promote innovative ICT solutions in business, educational and scientific systems**, as well digital policies aimed at promoting ICT solutions and applications in different sectors (e-business, e-health, e-banking, e-learning, e-science, e-environment, etc.) through public-private partnerships, if necessary, and with the participation of the social actors involved in each context.

13. Define **ICT promotion policies that guide applications and the development of local content, based on local needs**. This requires that the people responsible for policies pay attention to aspects of transformation, such as change management, skills, incentives and culture.

14. To use **ICT to efficiently measure development**, national governments must: a) foster and promote innovative solutions with respect to the availability and use of ICT devices, platforms and applications to generate and analyze data, and create data ecosystems that help overcome lacks, reduce costs and increase the potential of ICT as providers of data for public policies; b) incorporate specific transversal/shared actions in national development plans, digital agendas and national statistical systems, such as : i) mobilization of national and international technical and financial resources, ii) development of national skills to use ICT for measuring development at all levels and in all involved sectors, iii) formation of solid and strategic partnerships between governments, research centers and companies for the production of data, methodologies and standards linked to national statistical systems; and iv) participation in and contribution to international initiative and pilot tests for this purpose.

15. Develop needed skills, particularly in national statistical institutes, in order to have accurate, reliable and clear indicators linked to ICT and/or the Internet that provide input for evidence-based policymaking. Apart from breaking down data by income, sex, race and population groups, it is also useful to have indicators at the local and municipal levels to try to incorporate all the realities that national averages obscure from view and thereby fulfill the mandate to **leave no one behind**.

16. Comply with the recommendations of the Statistical Commission of the United Nations to establish **mechanisms for the coordination, homogenization and homologation of national statistical efforts** to achieve a complete and functional global indicator system. It will be necessary to develop and use tools and standards that make it possible to automate data exchange, such as the Statistical Data and Metadata eXchange and application program interfaces through online means.

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