G20 BRASIL 2024
BUILDING A JUST WORLD AND A SUSTAINABLE PLANET

Universal and meaningful connectivity: A framework for indicators and metrics

Digital inclusion, universal and meaningful connectivity

Digital Economy Working Group

Report prepared under the Brazilian Presidency of the G20

Knowledge partner

ITU

Universal and meaningful connectivity: A framework for indicators and metrics

Digital inclusion, universal and meaningful connectivity

Digital Economy Working Group

Report prepared under the Brazilian Presidency of the G20

MINISTRY OF COMMUNICATION

BRAZILIAN GOVERNMENT

UNITING AND REBUILDING

Brazilian Network information Center

Brazilian Internet Steering Committee

August 2024

Acknowledgments

This report has been developed, under the auspices of the Brazilian Presidency of the G20, by the Digital Economy Working Group, in collaboration with the Ministry of Communication (MCOM), ITU and the Brazilian Network Information Center (NIC.br)/ Brazilian Internet Steering Committee (CGI.br).

The report was coordinated by the Ministry of Communication (MCOM), with contributions from Daniel Brandão Cavalcanti, Hermano Barros Tercius, Juliano Stanzani, Renato Gomes Alves de Oliveira and William Ivo Koshevnikoff Zambelli.

The report was also co-authored by ITU – with contributions from José Luis Cervera-Ferri, Fredrik Eriksson, Thierry Geiger, Esperanza Magpantay, and Martin Schaaper – and by the Brazilian Network Information Center (NIC.br)/ Brazilian Internet Steering Committee (CGI.br), with contributions from Alexandre Barbosa, Graziela Castello, Fabio Senne and Fabio Storino.

The authors also thanks the members of the G20 DEWG for their inputs and guidance during the development of this report.

Table of contents

Boxes

Charts

Tables

Figures

Introduction

In the Issue Note for the Digital Economy Working Group (DEWG), the Brazil Presidency of the G20 listed as one of the DEWG's deliverables a set of "proposed guidelines for indicators and metrics for universal and meaningful connectivity, compiled with the support of the ITU."

As the saying goes, one cannot achieve what one cannot measure. Incorporating measurement into a national digital development strategy is essential for accelerating progress towards universal and meaningful connectivity (UMC). Without measurement, it is impossible to know where one stands or where to go. Policymakers equipped with timely, accurate data can make more informed decisions, design more effective policies and interventions, and ultimately achieve better outcomes. Sustained upstream investment in measurement generates significant returns down the line.

These Guidelines is neither exhaustive nor definitive as it proposes a framework for measuring the various dimensions of UMC. They do not provide a statistical assessment of the state of connectivity of any specific geography, economy, region, demographic group, or country group. Instead, the Guidelines offer guidance on how to conduct such statistical assessments.

For countries with limited statistical capacity, these Guidelines offer practical advice. For those with more advanced capacity, they provide pointers to improve the accuracy, timeliness, and granularity of their assessments. For countries which substantial capacity, they illustrate how data science, new data sources and tools can further enhance measurement.

It is hoped that these Guidelines will promote and improve collaboration among stakeholders concerned with improving digital connectivity, particularly among the producers and users of statistics.

The remainder of the document is organised as follows: Section 2 presents the concept of universal and meaningful connectivity and its policy relevance. Section 3 shows the significant benefits of investing in measurement and introduces a framework for measuring UMC and potential indicators. Section 4 makes recommendations to improve the statistical capacity of G20 economies. Section 5 shows how new statistical methods and new data sources can complement and, in some cases, replace traditional methods. Section 6 concludes and makes general recommendations.

Embracing universal and meaningful connectivity

In 1999, when the G20 was established, only 5% of the world's population was online. At that time, there were about 900 million mobile phone subscriptions, but these were limited to calls and short text messages. Smartphones didn't exist, and the Internet was accessible only from computers. Fast forward twenty-five years, and the Internet is now woven into our daily lives, used by two-thirds of the world's population, with over seven billion mobile broadband subscriptions.[1]

Yet, a third of humanity[2] remains offline, and many users only experience basic connectivity. In least developed countries (LDCs), two-thirds of the population has never used the Internet and many don't know what the Internet is. Digital divides persist and, in some cases, are widening or newly emerging — across countries, between genders, generations, urban and rural areas, and between users with ultra-fast fiber connections and those relying on spotty 3G access.

The Internet offers significant economic benefits and enhances welfare throughout individuals' lives. It enables new forms of communication, entertainment, expression, and collaboration, and provides access to services where traditional ones are lacking. Additionally, it offers an enormous amount of knowledge, learning resources, and job opportunities.

Connectivity plays an evident role in artificial intelligence (AI) development. High-speed internet and widespread connectivity are essential for the vast data exchanges that AI systems need to learn and improve, and for cloud computing, on which AI critically relies.

The benefits of connectivity are considerable for everyone, including marginalized, vulnerable, and remote communities. Depriving vast segments of humanity of the Internet's potential is unacceptable and costly, hindering economic development and deepening inequalities.

1. Internet use statistics are derived from household surveys where the related question asks if the individual has used the Internet in the past three months. All figures cited in this section are estimates for 2023 sourced from ITU 2023.

2. https://www.itu.int/itu-d/reports/statistics/2023/10/10/ff23-internet-use/

The catalytic role of digital connectivity in sustainable development has been acknowledged in several recent G20 declarations (see Box 1) and is recognized in the Sustainable Development Goals framework (see Box 2).

Box 1. Digital connectivity in previous G20 declarations

The importance of digital connectivity has been acknowledged by several G20 declarations in recent years.

- **G20 Osaka Summit 2019**: The Declaration mentions facilitating data free flow and strengthening consumer and business trust, and efforts to bridge the digital divide and close the digital gender gap. The G20 also emphasized support for the UN's Sustainable Development Goals and 2030 Agenda for Sustainable Development, which include targets for significantly increasing access to information and communications technology.
- **G20 Riyadh Summit 2020**: The Declaration focused on recovering from the COVID-19 pandemic and building an inclusive, sustainable, and resilient future. The Leaders' Declaration acknowledges universal, secure and affordable connectivity as a fundamental enabler for the digital economy, as well as a catalyst for inclusive growth, innovation and sustainable development advancing. The summit also reaffirmed the role of data for development, as well as addressing the challenges related to privacy, data protection, intellectual property rights and security.
- **G20 Rome Summit 2021**: The Declaration addressed the issue of digitalization in several sections, reiterating the need to bridge the digital divide. The G20 recognized the responsibility of digital service providers and the need for future work towards enhancing confidence in the digital environment by improving internet safety, committing to protect the most vulnerable. The G20 also recognized universal, secure, affordable, advanced and well-functioning digital infrastructure as an important driver for the economic recovery and the contribution of sustainable investment in quality digital infrastructure.
- **G20 Bali Summit 2022**: The Declaration acknowledged that affordable and high quality digital connectivity is essential for digital inclusion and digital transformation, particularly considering the digital acceleration caused by the COVID-19 pandemic.

Source: adapted from various G20 Declarations.

Box 2. Connectivity in the SDGs

Digital connectivity features prominently in multiple initiatives led by the United Nations, including the Sustainable Development Goals.

Sustainable Development Goals

The Global SDG Indicator Framework includes seven ICT indicators covering six targets under Goals 4, 5, 9, and 17. ITU is the custodian for all these indicators except 4.a.1 (UNESCO Institute for Statistics is co-custodian for Indicator 4.4.1).

- Indicator 4.4.1: Proportion of youth and adults with ICT skills, by type of skills
- Indicator 4.a.1: Proportion of schools offering basic services, by type of service, includes 'Internet' and 'computers' among the services
- Indicator 5.b.1: Proportion of individuals who own a mobile telephone, by sex
- Indicator 9.c.1: Proportion of population covered by a mobile network, by technology
- Indicator 17.6.1: Fixed Internet broadband subscriptions per 100 inhabitants, by speed
- Indicator 17.8.1: Proportion of individuals using the Internet

In the 2000s, as the benefits of the Internet became evident, connecting everyone became a global objective. The SDGs introduced in 2015 called for universal and affordable Internet access in LDCs by 2020. Today, 95% of the world's population is covered by a mobile-broadband network (3G or better), but in LDCs, only 80% of the population has access, falling short of the 2020 target.

However, supplying infrastructure alone is insufficient. While global universal access is nearly achieved, only 67% of the population uses the Internet. This usage gap of almost 30 percentage points indicates that universal access is necessary but not sufficient for universal adoption. Adoption depends on other factors such as affordability, devices, skills, connection quality and reliability, and content availability. These factors not only influence adoption levels but also the quality of the Internet experience for users, fundamentally redefining policy objectives and creating new challenges as universal access becomes achievable.

In 2018, the United Nations Secretary-General convened a High-level Panel on Digital Cooperation. In 2020, based on the Panel's report and following further multistakeholder consultations, the Secretary-General issued his report

Roadmap for Digital Cooperation, which includes, at its core, a commitment to "connect" all people to the Internet.

In 2021, as part of the implementation of the Roadmap, a multi-stakeholder group was tasked with proposing a baseline and targets for digital connectivity (see Box 3). In the process, the group developed the concept of *universal and meaningful connectivity* (UMC), defined as the possibility for everyone to enjoy a safe, satisfying, enriching, productive online experience at an affordable cost.

Box 3. The genesis of universal and meaningful connectivity

The Roadmap for Digital Cooperation details specific actions that the United Nations will undertake "to ensure that every person has safe and affordable access to the Internet by 2030, including meaningful use of digitally enabled services, in line with the Sustainable Development Goals", including specifically supporting efforts to establish a baseline of digital connectivity that individuals need in order to access the online space, as well as a definition of "affordability", including universal targets and metrics.

The multistakeholder Roundtable on Global Connectivity, co-chaired by the United Nations Children's Fund (UNICEF) and ITU, with the support of the Office of the Secretary-General's Envoy on Technology (OSET), works to follow up on the Roadmap by implementing its recommendations.

Within this Roundtable, a sub-working group (SWG) led by ITU was convened and tasked with developing a baseline and formulating targets for digital connectivity. The SWG was guided by two questions: (1) What is the level of connectivity of countries today? and (2) Where should countries be in 2030? The baseline aims to answer the former, the targets the latter. The expectation was that such tools would serve monitoring, prioritization, and advocacy efforts, thus contributing to the Roadmap's overall objectives.

The first task of the SWG was to determine the scope of the baseline for connectivity, and by corollary what was out of scope. It quickly became clear that such baseline and associated targets could not be limited to the quantity of connectivity. The quality of connectivity was essential. To capture this duality, the SWG coined the term "universal and meaningful connectivity" and developed a conceptual framework.

Equipped with the definition and framework, the SWG set out to identify indicators and set aspirational targets. The baseline and aspirational targets proposed by the SWG were released by OSET and ITU in 2022. This first version was based on existing indicators and evidence available at the time. But the baseline is meant to be a flexible tool that can be regularly revisited to incorporate new concepts and new indicators and ensure continued relevance through 2030.

UMC does not mean everyone must be connected all the time. Instead, UMC is a situation where everyone can access the Internet optimally and affordably whenever and wherever needed. It is up to individuals to choose how to use this opportunity.

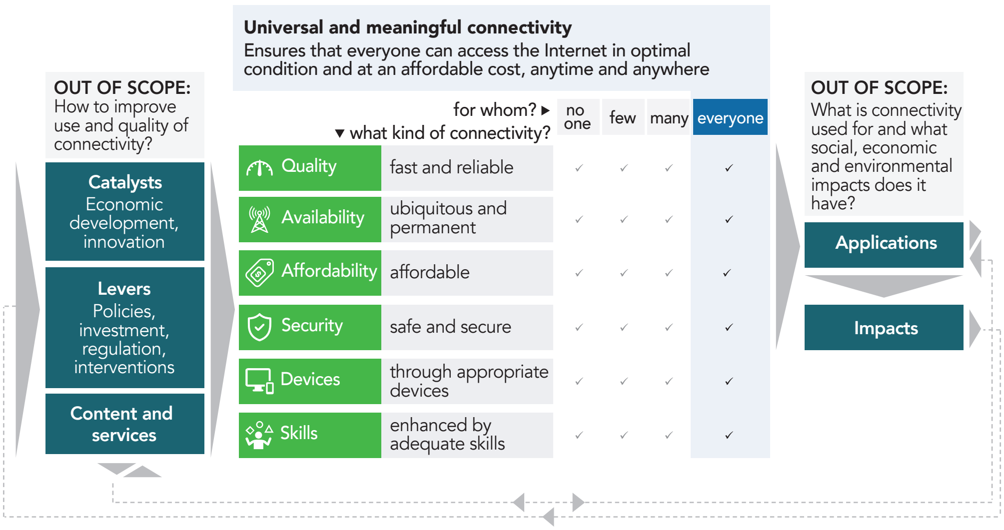
The UMC definition reflects the multidimensionality of connectivity and has important policy implications: aiming for universal access or use is not enough. Achieving UMC calls for holistic strategies that extend well beyond digital infrastructure.

The UMC concept has important implications for measurement too: Measuring access (e.g., by counting the number of people covered by broadband) or measuring usage (e.g., by counting the number of people using the Internet) is not enough.

Since 2021, UMC has garnered much attention. It is now one of the strategic goals of ITU. The concept is expected to be one of the objectives of the future Global Digital Compact (see Box 4). It ought to be a policy objective for any economy aiming to fully leverage the potential of connectivity for social and economic development.

Building on the original UMC, the framework in Figure 1 operationalises the concept of UMC for the purpose of these Guidelines. The framework lists the main dimensions of UMC and delineates its scope. The dimensions are quality (of connection); availability (for use); affordability; devices; digital skills; and security. There is no compensability across the dimensions. A robust performance in one dimension cannot make up for shortcomings in another.

Figure 1. Universal and meaningful connectivity framework



UMC only focuses on the *state* of connectivity. It is therefore deliberately agnostic about the following aspects:

- **Levers:** Policymakers and other stakeholders can improve the quality of the dimensions through "levers": investment, policies, and regulation (left hand-side of Figure 1). UMC is agnostic about these, as there is no single pathway and no one-size-fits-all strategy.
- **Catalysts:** UMC does not include broader factors and trends – or "catalysts" –, such as economic development and technological innovation, that contribute to UMC. By corollary, the definition excludes determinants of economic development, such as education or infrastructure, even though they are prerequisites for connectivity.
- **Content and services:** The availability and quality of online content and services are treated as a lever: the more content and services are available, accessible, and relevant, the more likely people are to connect. The relationship goes both ways, though: as usage grows, content creators and service providers are incentivized to deliver more content and services.
- **Applications:** The framework is agnostic about what people use connectivity for, its applications.[3] The neutrality of use cases is paramount: it is impossible to prescribe an ideal digital behaviour. This does not mean that promoting certain applications is not desirable, but this depends on circumstances.
- **Impacts:** The societal, environmental, and economic impacts – positive and negative – of the applications of connectivity are also excluded from the definition.

3. Although applications and content and services are closely related, and indeed influence each other, they are distinct because the former represent the purpose, whereas the latter are the means.

Box 4. UMC in the future Digital Compact

The Digital Compact that is scheduled to be launched at the Summit of the Future in 2024, calls for closing all digital divides, referring to UMC.

> "**Objective 1. Closing all digital divides and accelerating progress across the Sustainable Development Goals**
>
> Connectivity […]
>
> 10. We acknowledge the pivotal role of universal, reliable and meaningful connectivity and affordable access in unlocking the full potential of digital and emerging technologies. We commit to connect all people to the Internet. We recognize that this will require strong partnerships and increased financial investments in developing countries from governments and other relevant stakeholders, in particular the private sector. We recognize that innovative solutions can help deliver high-speed connectivity to remote and rural areas.
>
> 11. We commit by 2030 to:
>
> (a) Develop targets, indicators, and metrics for universal meaningful and affordable connectivity, building on the work of the ITU, and integrate these into international, regional and national development strategies (SDG 9);
>
> (b) Develop innovative and blended financing mechanisms and incentives, including in collaboration with multilateral development banks, relevant international organizations and the private sector, to connect the remaining 2.6 billion people to the Internet and to improve the quality and affordability of connectivity. We will aim for entry-level broadband subscription costs at less than 2 percent of average income of the bottom 40 percent of national populations (SDGs 1 & 9);
>
> (c) Invest in and deploy resilient digital infrastructure, including satellites and community networks, that provides safe and secure network coverage to all areas, including rural, remote and 'hard-to-reach' areas. We will aim for universal access at sufficient speeds and reliability to enable meaningful use of the Internet (SDGs 9 & 11);
>
> (d) Map and connect all schools and hospitals to the Internet, building on the Giga initiative of ITU and UNICEF (SDGs 3 & 4);"

Source: adapted from *Global Digital Compact – Second Revision* (26 June 2024), Office of the Secretary-General's Envoy on Technology.

Measuring universal and meaningful connectivity

Data is critical for assessing challenges, customizing solutions, and monitoring progress in achieving universal and meaningful connectivity and the future Global Digital Compact. This section argues for the necessity of improved data to inform evidence-based policies, emphasizing the importance of understanding the quality of Internet connections and access conditions for individuals and groups. It illustrates, with an example from Brazil, how investing in data collection can be largely recouped by optimizing resource allocation and pinpointing areas most in need of intervention. Moreover, a measurement framework is proposed for these Guidelines using the definition of universal and meaningful connectivity.

From this framework, a list of suggested, core and comparable indicators for assessing progress towards universal and meaningful connectivity across and within countries is presented. The aim of this list is to encourage countries to allocate adequate resources to measure key connectivity concepts as part of their journey towards universal and meaningful connectivity, with a particular focus on an approach to measurement at the individual level. This section also highlights the definitions needed to construct the suggested indicators, such as periodicity of production and alternative methods for data collection. Furthermore, the need to incorporate the cultural, social, and economic characteristics of each context is emphasized, serving as a starting point for refining and potentially adapting the suggested indicators.

Advocating for effective and multidimensional measurement

In recent years, the debate around the impact of digital technologies in society has intensified and expanded. In this scenario, the use of the Internet and digital devices has grown exponentially, driven by the development of new applications and services, an advance that has brought about significant changes in people's lifestyles. In this horizon of accelerated transformations, Artificial Intelligence (AI), the Internet of Things (IoT) and a new digital economy driven by the constant and massive production of data are phenomena that demand

(and will demand) increasing connectivity from individuals. This connectivity is necessary so that they can take advantage of the opportunities created by these changes and, at the same time, manage and mitigate the potential risks associated with them. Taking advantage of these opportunities, safely and for the benefit of human development, depends initially on the conditions in which the population has access to this whole horizon of possibilities. In this scenario, data is critical for assessing challenges, customizing solutions, and monitoring progress in achieving universal and meaningful connectivity. The Global Digital Compact advocates for the strengthening of the collection and use of data to inform decision making and address gaps and needs in digital transformation.

For a comprehensive understanding of the population's connectivity conditions, it is necessary to adopt a multidimensional perspective. This perspective should encompass various aspects, such as simple access to the Internet, to the devices used, the quality of connections, the financial feasibility of acquiring the necessary resources for smooth navigation, as well as the opportunity of use in different environments and with the desired intensity. In other words, it should consider the possibility for individuals to access the Internet where, when, and how they want.

It is also crucial to note that a multidimensional approach helps in understanding various connectivity constraints. For instance, the quality of the available connection or the types of access devices represent distinct dimensions. The absence of either of these factors creates significant obstacles for satisfactory connectivity, while the absence of both exacerbates the problem.

However, the effective formulation of policies that address these complex needs requires considering social, economic, and environmental factors to which different individuals are exposed.

In this sense, understanding the actual access conditions of individuals and different social groups is a crucial element for effective policy planning, the adjustment of already implemented action routes, and the accurate allocation of invested resources. Strategies that overlook certain social groups, besides having a lower chance of achieving their goals, can exacerbate existing exclusion situations. In some cases, rather than alleviating them, they may generate new social and economic problems.

Here, the importance of focusing on individuals is underscored. While institutional and infrastructural data are essential, measurements that illuminate connectivity conditions from the perspective of individuals are strongly recommended. They are more effective for designing and implementing scalable policies that respect the specificities of social groups and particular communities, moving towards universal connectivity while leaving no one behind.

Dimensioning the problem based on individual access indicators is a promising approach for more substantive analyses. In addition to portraying real connectivity conditions, this approach enables more accurate monitoring of changes in social dynamics and the assessment of possible positive and negative impacts of connectivity conditions on economic development and individuals' well-being.

In summary, a multidimensional and human-centric approach – rather than country-level composite indicators that hide trade-offs between dimensions and disparities within countries – to understanding connectivity is critical for developing effective policies. This approach ensures that no one is left behind in the digital era, optimizing resource allocation, and addressing the specific needs of diverse social groups. **Box 5** presents a study analyzing the levels of meaningful connectivity in Brazil's population. This study exemplifies the benefits and potential for policy development using this kind of measurement approach.

Box 5. Disclosing hidden gaps. A case of a multidimensional individual approach for measuring meaningful connectivity

In 2024, the Regional Center for Studies on the Development of the Informational Society (Cetic.br), department of the Brazilian Network Informational Center (Nic.br), released the publication 'Meaningful connectivity: measurement proposals and the portrait of the population in Brazil', that offers insights into how we can measure meaningful connectivity. In this box some key elements of 'Chapter 3 - Meaningful connectivity in Brazil: the portrait of the population' will be presented to emphasize the benefits of a multidimensional individual perspective for measurement.

The study aimed to present an initial portrait of the Brazilian population in terms of meaningful connectivity, based on the reprocessing of quantitative indicators from the Brazilian ICT Household survey[1]. The survey provides indicators for both individuals and households, enabling various controlled analytical approaches through its microdata sets. Based on international methodological frameworks and a long historical series, the indicators can be analyzed retrospectively to gauge the country's progress and ensure ongoing future monitoring. Moreover, it ensures a

1. More information available at: https://cetic.br/en/pesquisa/domicilios/

CONTINUES ►

▸ CONTINUES

more precise understanding of the individuals' situation across their social, economic, and territorial diversity, allowing a deeper understanding of the phenomenon.

According to the 2023 ICT Household survey, 84% of Brazilians aged 10 and above are Internet users, with nearly all of those (95%) using the Internet daily. While this suggests that Brazil is well-connected, this aggregate result does not reveal the true conditions of connectivity even among current Internet users.

To develop this study, based on existing literature (A4AI, 2021 and ITU, 2022), data from the Brazilian ICT Household survey were analyzed and an analytical and conceptual framework was developed for measuring meaningful connectivity among the population.

Nine indicators across four dimensions (affordability, access to equipment, quality of connections and connectivity environment) were identified to assess the levels of meaningful connectivity among Brazilians. Those indicators generated a scale from zero to nine, in which everyone received a score, ranging from having none of the attributes measured (score 0) to having all of them measured by the nine indicators (score 9). Those who had at least 7 of the 9 conditions measured, were understood as meaningfully connected.

Using this scale, in 2023, just 22% of Brazilians were considered meaningfully connected, scoring between 7 and 9 points. Unfortunately, the largest group observed performed poorly, with scores up to 2 points, representing a third (33%) of the Brazilian population. This presented a more challenging scenario than when solely considering the 84% of Internet users.

The analysis also explored connectivity gaps by examining data across territorial, sociodemographic, and socioeconomic dimensions. The graphs below reveal inequalities in Brazil that were hidden or underestimated when considering connectivity solely by Internet access. Some key results include:

- **Hidden gender gaps:** According to the ICT Household 2023 survey, 83% of males and 86% of females in Brazil were Internet users. At first glance, it might seem that females are better positioned than males. However, a closer look at meaningful connectivity reveals a significant gender gap: 28% of men were meaningfully connected compared to only 17% of women. The poorer connectivity conditions among women worsen existing barriers to their productive inclusion, income equality, public presence, and participation in social, political, and economic life.
- **Age is a barrier to connectivity, not just for older people:** Age has historically been a barrier to digital inclusion, even in economically developed countries (Helsper, 2009; Mubarak & Suomi, 2022). This is also true in Brazil. In 2023, only 51% of Brazilian residents aged 60 and over were Internet users, compared to 84% of the overall population. However, when examining

▸ CONTINUES

meaningful connectivity across different age groups, a different trend emerges. Unlike general Internet usage, where younger people are the majority, only 16% of those aged 10 to 15 and 24% of those aged 16 to 24 were meaningfully connected. This highlights a significant issue: while older individuals face greater exclusion, a large proportion of young Brazilians also experience poor connectivity. This puts them at numerous disadvantages in both their personal and professional development.

- **Infrastructure gaps remain in the smaller municipalities:** Differences in simple Internet access based on the population size of municipalities are minimal. In municipalities with up to 50,000 residents, 81% of the population are Internet users, compared to 86% in municipalities with over 500,000 residents. However, when it comes to meaningful connectivity, there is a direct correlation: the larger the municipality, the higher the proportion of individuals meaningfully connected.
- **Economic gap is much more challenging:** There are significant differences in Internet usage between economically advantaged and disadvantaged groups in Brazil. While 97% of the wealthiest Brazilians use the Internet, only 69% of the poorest do. The gap is even more pronounced when considering meaningful connectivity: 83% of the wealthiest have meaningful connectivity, compared to just 1% of the poorest. This extreme inequality directly impacts the opportunities available to different segments of society in the virtual environment, further disadvantaging those who are already vulnerable.

Chart 1. Internet users and meaningfully connected individuals in Brazil (2023)

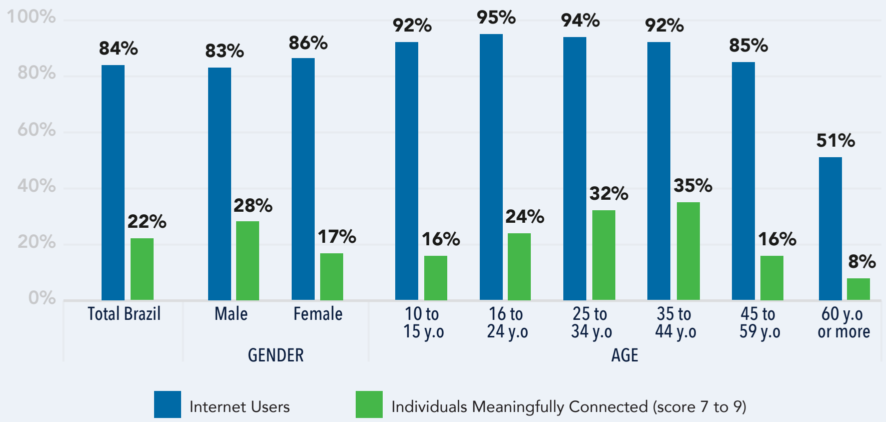
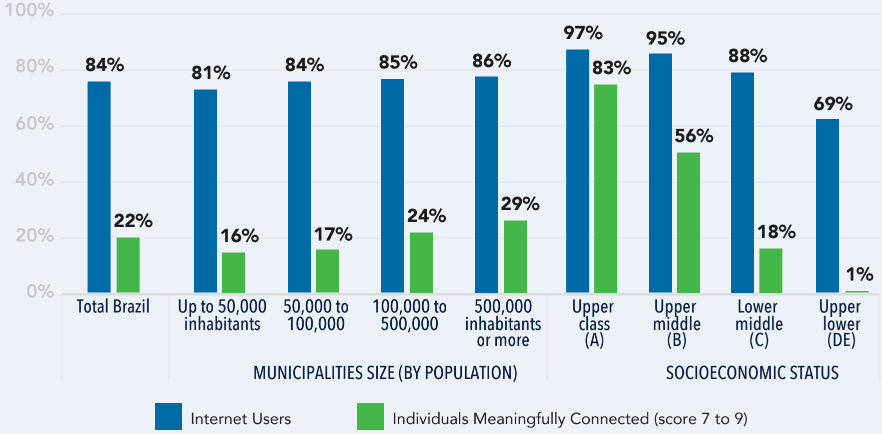


Chart 2. Internet users and meaningfully connected individuals in Brazil (2023)



Measurement framework for assessing UMC

From the perspective of individuals, meaningful connectivity is a multifaceted concept that encompasses several fundamental dimensions necessary to understand the interaction between individuals and the online world. These dimensions incorporate crucial concepts for a comprehensive and in-depth analysis of the dynamics of Internet access and usage.

Accurate, timely, and granular data are essential for understanding current circumstances, designing effective interventions, efficiently allocating resources, and monitoring progress. This is true across all domains, including information and communication technologies (ICTs) and digital connectivity. To comprehensively understand universal and meaningful connectivity from an individual's perspective, it is crucial to consider the necessary conditions for its effectiveness, including social, economic, and territorial constraints. The Global Digital Compact advocates for effective measurement, which can guide policies, correct actions, and mitigate exclusion, relies on collecting and analyzing digital connectivity conditions influenced by the social, economic, and geographical characteristics of the population.

A measurement framework is proposed for these guidelines using the definition of universal and meaningful connectivity (Figure 2). The framework includes six dimensions: quality of connectivity, availability, affordability, devices, digital skills, and safety and security. For each dimension, it outlines key policy questions and measurement concepts.

A key feature of the proposed framework is its granularity. National averages can conceal vast differences, particularly in large and diverse economies. Ignoring these differences can lead to misguided conclusions and inefficient policies. Therefore, instead of a country-level assessment, the framework proposes measuring the situation for specific demographic groups and locations. Conceptual questions for socioeconomic dimensions are included, suggesting ways to improve capabilities for a deeper understanding within countries, ensuring visibility for all individuals.

Figure 2. Proposed framework for measuring UMC

DIMENSIONS	CONCEPTUAL QUESTIONS	MEASUREMENT OBJECTIVES
CONNECTION QUALITY	Do people have access to high-speed, stable Internet connections suitable for their specific needs and activities online?	Assessing the speed, reliability, and stability of Internet connections.
AVAILABILITY FOR USE	Are people able to use the Internet as frequently and intensively as they wish? Can people access the Internet in different locations, wherever and whenever they want?	Measuring the regularity and intensity of Internet use among individuals. Evaluating the accessibility and convenience of Internet use in various contexts and locations.
AFFORDABILITY	Are Internet access, devices, and data plans affordable and sufficient relative to people's incomes, allowing for flexible and desired quality of use?	Evaluating the affordability, adequacy, and flexibility of Internet services relative to individual incomes.
DEVICES	Do people have access to the appropriate devices necessary to fully engage with and benefit from digital opportunities?	Evaluating the availability, variety, and suitability of devices used to access the Internet.
DIGITAL SKILLS	Do people possess the necessary skills to leverage digital opportunities and manage potential risks effectively?	Assessing individuals' competency and confidence in using the Internet effectively.
SAFETY AND SECURITY	Do people have access to secure Internet connections, can they navigate online safely, and do they feel secure in their online interactions and activities?	Assessing the safety and security of user online experience including concerns and exposure to harmful content and to-enabled crime.

SOCIOECONOMIC DIMENSIONS

Demographic: Do people from various groups and stages of life have equal opportunities to access and benefit from the digital environment with the quality they need?

Economic: Do individuals across diverse socioeconomic backgrounds have equitable opportunities to access and fully utilize the digital environment?

Location: Do people in different regions and territories have equal chances to access and utilize the digital environment with the necessary quality?

Figure 3 proposes a list of indicators for each dimension, mostly derivable from household survey data. Each indicator should be measured with the greatest granularity possible, systematically collecting information on survey respondents' socio-economic backgrounds and locations.

The proposed indicators draw on ongoing efforts in ICT statistics. An international community of statisticians and ICT experts from academia, national statistical offices, regulators, ministries, and international organizations (IOs) defines ICT indicators and develops standards and methodologies. IOs produce manuals, toolkits, and courses to facilitate their adoption and provide technical assistance. They collect data from countries to produce internationally comparable statistics. For ICT statistics, the Partnership on Measuring ICT for Development, a consortium of 14 IOs, coordinates this effort. It maintains a Core list of 67 ICT indicators, including 23 indicators on ICT access and use by households and individuals, which are particularly relevant for measuring UMC. The proposed indicators in Figure 3 mostly comprises indicators from the Partnership's core list.

Figure 3. Proposed indicators for measuring UMC

DIMENSIONS	PROPOSED INDICATORS
CONNECTION QUALITY	Households with broadband connections; Household broadband connections by technology and speed; Mobile connection by technology (e.g., 4G or 5G)
AVAILABILITY FOR USE	Frequency of Internet use; Perception that the use intensity meets their needs; Internet use by type of location (e.g., home, workplace, educational institution, public areas, community centers, on the move)
AFFORDABILITY	Cost of fixed-household Internet connection; Cost of a data-only mobile broadbandbasket; Cost of mobile and fixed devices; Availability of unlimited data package
DEVICES	Ownership of a smartphone; Availability of devices in the household (number and type); Diversified use of devices (e.g., smartphones, computers)
DIGITAL SKILLS	Information and data literacy; Communication and collaboration; Digital content creation; Problem solving
SAFETY AND SECURITY	Adopting security measures; Adopting privacy procedures; Perception of online safety

Demographic Indicators
Priority: Age; Gender; Household size (number of residents)
Additional: Ethnicity or race; Migration status; Belonging to traditional communities or groups

Location Indicators
Priority: Rural/Urban; Location (the more disaggregated the better, e.g., region, state, city, district)
Additional: Municipality size (number of inhabitants); Hard-to-reach territories

Economic Indicators
Priority: Education Level; Household income
Additional: Individual income; Workforce status (employed, unemployed, student, retired)

The list is neither exhaustive nor definitive. Additional data should be used to capture specific cultural, economic, and social features and refine the assessment. As digital technologies and behaviours evolve rapidly, the list will need to evolve to ensure continued relevance, with indicators added, adapted, or dropped as necessary.

Table 1 presents more details about the suggested indicators for assessing the connectivity dimensions. For each indicator, it includes: (a) the locus of measurement (the unit of observation, such as the individual or the household in which the individual lives); (b) the time frame (the period the indicator should refer at the time of collection); (c) the most appropriate method for data collection; (d) possible alternative sources for data collection; and (e) the recommended frequency for collecting the indicators.

It is important to note that the socioeconomic dimensions considered here (Figure 2) are oriented towards the adult population, as are the proposed indicators for assessing the connectivity dimensions. For observing the conditions of children, it is necessary to adapt to the reality of this population group. Hence, the markers for children should also consider other dimensions, such as the appropriation of technology in educational programs, recommended dynamics for the use of specific technologies for children, suitable devices for activities, parental mediation, and appropriate places for use and non-use.

Although the proposed indicators are applicable to the adult population, the connectivity environment, in the case of household indicators, should also consider the presence of children in the household to more accurately assess metrics.

Table 1. Proposed indicators for measuring UMC and relevant characteristics

Connectivity Dimensions	Proposed Indicators	Unit of measurement	Time frame	Data source* (better option)	Data source (alternative options)	Periodicity
Connection quality	Households with broadband connection	Household	Current	HH survey	Providers or administrative data	Once a year
	Type of household broadband connection by technology and speed	Household	Current	HH survey	Providers or administrative data	Once a year
	Mobile connection by technology (e.g., 4G, 5G)	Individual	Current	HH survey	Providers or administrative data	Once a year
Availability for use	Frequency of Internet use	Individual	Current	HH survey	Online panel survey	Once a year
	Perception that the use intensity meets their needs	Individual	Last month	HH survey	Online panel survey	Once a year
	Internet use by type of location (e.g., home, workplace, educational institution, public areas, community centers, on the move)	Individual	Current	HH survey	Online panel survey	Once a year
Affordability	Cost of fixed-household Internet connection	Household	Last month	Market data	HH survey	Once a year
	Cost of a data-only mobile broadband basket	Individual	Last month	Market data	HH survey	Once a year
	Cost of mobile and fixed devices	Individual	Annually	Market data	HH survey	Twice a year
	Availability of unlimited data package	Individual	Last month	HH survey	Online panel survey	Once a year

CONTINUES ▸

Connectivity Dimensions	Proposed Indicators	Unit of measurement	Time frame	Data source* (better option)	Data source (alternative options)	Periodicity
Devices	Ownership of a smartphone	Individual	Current	HH survey	Providers or administrative data	Once a year
	Availability of devices in the household (number and type)	Household	Current	HH survey	NA	Once a year
	Diversified use of devices (e.g., smartphones, computers)	Individual	Current	HH survey	NA	Once a year
Digital skills	Information and data literacy	Individual	Last three months	HH survey	Online panel survey	Once a year
	Communication and collaboration	Individual	Current	HH survey	Online panel survey	Once a year
	Digital content creation	Individual	Last three months	HH survey	Online panel survey	Once a year
	Problem solving	Individual	Last three months	HH survey	Online panel survey	Once a year
Security	Adopting security measures (as strong passwords or two-factor authentication)	Individual	Last three months	HH survey	Online panel survey	Once a year
	Adopting privacy procedures (as changing privacy settings)	Individual	Last three months	HH survey	Online panel survey	Once a year
	Perception of online safety: feel safe on their online experiences	Individual	Current	HH survey	Online panel survey	Once a year

* Note: this is the source recommended; HH survey = household survey

Assessing current statistical capacity to monitor progress towards UMC

The Global Digital Compact, proposed by the United Nations, aims to establish shared principles for an open, free, and secure digital future for all. It addresses key areas such as digital inclusion, data protection, and the responsible use of technology. Developing robust statistics is crucial to monitor the implementation of this Compact as well as its call for UMC.

This section offers an overview of the global state of statistical capacity of the G20 countries to measure universal and meaningful connectivity and highlights the need for enhanced prioritization and increased investment to upgrade the relevant data ecosystems.

The ITU, as the UNs specialized agency for ICTs, works extensively to assess the digital divide through its global and regional reports. As most ITU data are compiled from national institutions (national statistical offices, regulators, ICT ministries and other), national statistical capacity is crucial to effectively contribute to collect high-quality data, develop data services and products and use of these global datasets for the design of digital inclusion policies. As the horizontal role of ICT to achieve SDGs has been recognised, the capacity to compile data on the complex topic of ICT (see Box 6) becomes an imperative not only to monitor progress towards UMC, but also to support the monitoring of the SDGs.

Box 6. Why are ICT statistics complex?

ICT statistics are relatively new in the official statistics landscape, being collected by NSOs only from the early 2000s (compared to older statistical domains such as industrial or labour statistics, or even older ones such as demographic or agricultural statistics), so that not all countries have the same experience and capacity to compile them. The ICT domain has not only specificities related to difficult concepts and evolving technologies (e.g. types of fixed and mobile connection, new devices, emerging tools and uses such as AI) but also present a challenge as it requires information from different sources to have a general perspective (supply and demand side). The following table summarizes the diversity of data sources covering the areas of ICT infrastructure, prices, access and use of ICT by people, businesses, schools and communities, etc.

	SOURCE	COLLECTED BY
Demand-side data	Household Survey Budget/ Expenditure Surveys Labor Surveys ICT Surveys	National Statistical Office Digital Agency
Supply-side data	Administrative Data on Telecommunications Big Data from Telecom Operators/ ISPs	Ministry of Telecommunications Regulatory Authority

Despite data's significant role in decision-making, national data ecosystems often face a chronic lack of resources, leading to a self-perpetuating cycle where limited demand for data results in an even weaker supply. The Global Digital Compact promotes an increased financing for data and statistics and efforts to build capacity in data and related skills.

Assessment frameworks

In the field of ICT statistics, needed to monitor the progress towards UMC, the assessment of national statistical capacity has not yet taken a formalised, regular approach (see Box 7).

Box 7. Statistical capacity assessment frameworks

Assessing the statistical capacity and compliance to codes of practice represents a fundamental aspect of ensuring the reliability and comparability of data across countries. No wonder that several initiatives led by international organisations – whose databases are populated with countries' data - have been established to evaluate these capacities systematically.

The World Bank has put in place systems to assess the statistical capacity of countries. Replacing the previous Statistical Capacity indicator (established in 2004), the WB's Statistical Performance Indicators[1], (SPI) is a comprehensive framework designed to identify strengths and weaknesses of national statistical systems (NSS), assessing various dimensions such as institutional aspects (legal and organizational structures governing the NSS), the performance of statistical processes, the output quality and the data accessibility. A battery of 51 indicators, which are also combined into a composite indicator, allow for comparisons across countries and over time. The SPI is strongly correlated with common development indicators such as GDP per capita.

The International Monetary Fund's (IMF) Data Quality Assessment Framework (DQAF) also provides a structured approach to assessing the quality of a country's statistical system, considering data integrity, methodology, and data dissemination practices. The IMF Dissemination Standards[2] are a set of guidelines established to promote the transparency, accessibility, and quality of economic and financial data disseminated by member countries. These standards place particular emphasis on improving metadata transparency and data accessibility, enabling users to better understand the methodologies and sources underlying the data. The SDDS represents the highest tier of the IMF Dissemination Standards, targeting countries with more developed statistical systems. It requires participating countries to meet stringent criteria for data coverage, periodicity, and timeliness across a broader range of economic and financial indicators.

Eurostat, the statistical office of the European Union, has implemented mechanisms such as Sector Reviews and Peer Reviews to assess the institutional aspects of statistical systems and compliance with statistical standards in specific domains across EU Member States as well as in countries that are EU candidates or members of the European Neighborhood Partnership. Sector and Peer Reviews are conducted by teams comprising representatives from other NSOs, Eurostat, and sometimes external experts. The review process involves a prior, comprehensive self-assessment by the NSOs, followed by site visits, interviews, and consultations with a wide range of stakeholders within the national statistical system. Additionally, Eurostat carries out user satisfaction surveys to fine-tune the statistical production and dissemination activities.

1. https://www.worldbank.org/en/programs/statistical-performance-indicators/Framework

2. https://dsbb.imf.org/

A stocktaking exercise (Partnership on Measuring ICT for Development, 2005) carried out in 2004-2005 showed the scarcity of indicators Almost two decades ago, few countries except OECD member states had implemented specific household surveys on the access to and use of ICT. The level of harmonization was low, and there were few mechanisms to consult the users of ICT data in a structured manner. The results highlighted the lack of metadata from several economies relevant at regional levels but served as a starting point for further work on the harmonization of ICT statistics internationally - the initial list of Core ICT indicators and the establishment of standards such as the ITU "Manual on Measuring ICT access and use by households and individuals" (ITU, 2020) - as well as for the identification of capacity building needs in developing countries.

The capacity for monitoring UMC in G20 countries

Strong progress has been made since this seminal stocktaking exercise, proved by the rich statistical databases maintained by ITU from data provided by the countries[4]. ITU databases allow for a preliminary assessment of the capacity of national statistical systems of the G20 countries to monitor UMC.

G20 countries have strong statistical systems: the average of SPI for G20 has steadily increased since 2016 (from 75.6 to 84.4 on a scale 0-100), while the range has decreased over time from [46.4 – 90.3] to [59.6 – 92.9], and all G20 countries subscribe to SDDS, while 8 of them are in the highest category SDDS Plus. However, ICT statistics are relatively new in the landscape of official statistics, starting in the early 2000s, and the availability and timeliness of ICT statistics varies significantly across indicators and countries.

Data quality: coverage, frequency and timeliness of ICT statistics

From the databases maintained by the ITU it is possible to calculate indicators on data availability, frequency, time lag, and detail (breakdowns available).

While administrative data (collected from telecom operators) are more frequently updated, survey data often lag behind. While EU Member States collect ICT statistics with annual frequency, complying a strong legal basis[5], some G20 countries have discontinued their household surveys on ICT access and

4. The stocktaking exercise has been updated in Spring 2024, with the results expected to be available by August 2024.

5. https://ec.europa.eu/eurostat/web/digital-economy-and-society/legislation

use, despite the large digital gaps that may exist across regions or population groups. While all countries can provide gender-disaggregated figures (but only 74% less than 2 year old), 84% can measure gaps by urban/rural location (63% less than 2 years old), by age and by household composition, 74% by level of education and labour force status (53% less than 2 years old), and only 53% by occupation (only 37% less than 2 years old) (see Table 2). Socio-economic breakdowns, including double disaggregation (e.g. by age and gender) are extremely relevant to ensure that indicators do not hide divides among population groups. However, ITU databases do not include such disaggregation for one-third to one-half of G20 countries.

Table 2. Availability and timeliness of indicator breakdowns

	Nr of countries submitting data	Nr of countries submitting data not older than 2 years (i.e. since 2021)	Proportion of countries submitting data	Proportion of countries submitting data not older than 2 years (i.e. since 2021)	Average time lag (WRT 2023)
Gender	19	14	100%	74%	1,4
Urban Rural	16	12	84%	63%	2,7
Household composition	16	11	84%	58%	3,1
Age	16	12	84%	63%	2,1
Age / Gender	15	12	79%	63%	1,7
Level of education	14	10	74%	53%	2,3
Level of education / Gender	13	10	68%	53%	1,8
Labour force status	14	10	74%	53%	2,3
Occupation	10	7	53%	37%	2,6

Out of the 23 core indicators on ICT access and use by households and individuals (see Annex 1), the availability of data on household expenditure on ICT goods and services (HH16), barriers to the use of Internet (HH14) and indicators on e-commerce (HH20 to HH23) is much lower (see).

Table 3. Availability and timeliness of indicators on ICT access and use by households and individuals

	Nr of countries submitting data	Nr of countries submitting data not older than 2 years (i.e. since 2021)	Proportion of countries submitting data	Proportion of countries submitting data not older than 2 years (i.e. since 2021)	Average time lag (WRT 2023)
HH1	4	3	21%	16%	4,0
HH2	14	6	74%	32%	9,6
HH3	16	10	84%	53%	5,0
HH4	18	11	95%	58%	2,2
HH5	16	10	84%	53%	3,2
HH6	19	14	100%	74%	1,3
HH7	18	14	95%	74%	1,1
HH8	15	7	79%	37%	4,3
HH9	16	12	84%	63%	1,5
HH10	13	11	68%	58%	2,6
HH11	15	9	79%	47%	3,4
HH12	13	10	68%	53%	3,0
HH13	6	3	32%	16%	4,0
HH14	12	4	63%	21%	4,7
HH15	15	12	79%	63%	1,1
HH16	6	3	32%	16%	3,8
HH17	11	11	58%	58%	1,0
HH18	12	9	63%	47%	1,7
HH19	7	6	37%	32%	1,6
HH20	10	8	53%	42%	1,4
HH21	6	5	32%	26%	1,7
HH22	3	3	16%	16%	1,0
HH23	8	7	42%	37%	1,9

Time lags in G20 countries are on average 2 years for basic indicators such as internet use by gender/age, and up to 3 years for more complex breakdowns such as by household composition. With the fast pace of technological developments and efforts by G20 governments, and especially after the impact of COVID-19, time lags of more than 2 years may decrease the relevance of official statistics for policymaking.

In the developing world, many of the challenges in the production of ICT indicators identified more than a decade ago (Teltscher and Cervera, 2011) are still present: weak coordination mechanisms between statistical producers, holders of administrative data and users; irregular planning of household surveys on the access and use of ICT; inadequate or outdated household and business sampling frames; difficulties in collecting data and poor dissemination.

Institutional framework for ICT statistics

The legal and regulatory framework governing the collection and dissemination programs on ICT statistics is crucial for a strong national statistical system. It requires the autonomy and authority of the national statistical office (NSO) and relevant agencies in ICT data collection (Ministries, Regulatory Authority), and the coordination among different government entities involved in ICT statistics, including the cooperation with international agencies (e.g. the timely provision of data to ITU). While the coordinating role of NSOs must be ensured[6], including in federal countries, a distribution of responsibilities in the compilation of ICT statistics should be institutionally agreed, and duplication of statistical operations - leading to different results for a country, strictly avoided. For example, ICT infrastructure data may be collected by the ministry responsible for telecommunication or the national regulatory agencies of the telecommunication sector, use of ICT in businesses may be collected by the NSO in the framework of business surveys, use of ICT in schools may be collected by the ministry of education, and access and use of ICT by households may also be collected by the NSO. Because of the variety of existing data sources and the cross-cutting nature of ICT, coordination and cooperation among data producers are fundamental to the production of high-quality official ICT statistics.

6. As recommended by the UN Handbook on Management and Organization of National Statistical Systems (https://unstats.un.org/capacity-development/handbook/html/topic.htm#t=Handbook%2FC4%2FCoordination_of_the_national_statistical_system.htm).

Human resources

Due to the high demand of quantitative skills in the private sector, NSOs frequently lack adequate human the production of official statistics. ICT statistics require additional expertise on technologies and policy issues, including how data are used for digital policies, which may not be available in NSOs. The collaboration between subject-matter experts in regulators and ministries, with specialized international organizations such as ITU, as well as with users from the private sector, is crucial to develop and adapt data collection instruments, elaborate and disseminate analytical studies.

Statistical programs and methodology

This dimension of statistical capacity assesses the range and scope of ICT statistics produced, the methodologies used for data collection (surveys, administrative data, etc.), and the adherence to international standards (e.g. ITU, UNCTAD, UIS) and best practices in ICT statistics. 8 out of the 19 G20 countries have specific surveys on ICT access and use by households and individuals, which allow in general collecting more ICT indicators. Other 10 countries insert questions on the topic in multi-purpose surveys, allowing less room for specific questions, but more insights by cross-tabulating them against other socio-economic variables. Two countries have discontinued the collection of household ICT data.

Dissemination and accessibility, user engagement and feedback

This involves examining the mechanisms in place for disseminating ICT statistics, including the availability of data to users, the use of digital platforms for data sharing, and the transparency and clarity of statistical releases.

Measuring the capacity for dissemination and accessibility would require examining websites and publications of NSOs and other institutions. Some information is provided by the countries at the time of the submission of ICT data to ITU, but it would require developing a system – not yet in place at ITU – to assess aspects such as user-friendliness, availability of tailor-made tabulations, download options, existence of metadata and methodological reports, etc. Note that the International Household Survey Network[7] may be used to list household surveys including questions on ICT access and use.

7. https://catalog.ihsn.org/catalog/?page=1&ps=15

Assessing how well the statistical system engages with users of ICT data, including mechanisms for gathering user feedback, consultations with stakeholders on data needs, and responsiveness to new and emerging data requirements may require asking the countries for additional information, as this is not already collected by the ITU.

Recommendations to increase the statistical capacity for monitoring UMC

Considering the importance of mainstreaming the concept of UMC in digital policies, several actions are recommended to enhance the statistical monitoring of progress towards UMC at the national and international levels:

Developing the legal basis for collecting ICT statistics

Legislation should be established[8] to ensure the sustainable, regular and systematic collection of ICT statistics through household surveys by national statistical offices, as well as through administrative data collected from operators by the regulators. As the topic of ICT statistics is relatively new compared with other domains, this can involve amending existing statistical laws (e.g. ensuring the presence of ministries for digital development in the established fora for official statistics) or creating new regulations specifically for ICT data, especially in the case of sensitive data for the analysis of the telecommunication market.

The legal framework should clearly define the roles and responsibilities of various stakeholders, including national statistical offices (NSOs), telecom regulators, and other relevant institutions. Institutionalizing collaboration between them and avoiding duplication of efforts or provision of different figures by official institutions. This may involve setting up formal agreements and mechanisms for data sharing (including access for statistical purposes to privately-held operator data), standardizing data collection methods, and ensuring consistent application of statistical standards.

The legal framework for ICT statistics should be grounded on the UN Fundamental Principles of Official Statistics[9] (UN FPOS) and may refer to the international agreements such as relevant ITU Resolutions.

8. EU Member States already have a strong legal basis for annual statistics on ICT (https://ec.europa.eu/eurostat/web/digital-economy-and-society/legislation).

9. https://unstats.un.org/unsd/dnss/gp/fundprinciples.aspx

Investing in data infrastructure and statistical operations

Investment in modern data infrastructure is essential for the efficient collection, storage, and analysis of ICT statistics. This includes upgrading IT systems, adopting cloud-based solutions, and ensuring robust data security measures. Enhanced IT infrastructure supports the scalability and reliability of statistical operations.

Governments of G20 countries should guarantee that their national statistical systems are adequately funded, to ensure regular monitoring of the future Global Digital Compact, and more comprehensively, the progress towards achieving the SDGs.

Household surveys are financed in many developing countries by development partners, in general lacking sustainability. Aligned with the Global Digital Compact, governments may consider allocating national resources from Universal Service Funds to finance data collection operations that will provide the necessary evidence for digital inclusion policies. International development partners, including multilateral and bilateral agencies, should consider the possibility of financially supporting surveys on ICT access and use by households and individuals, considering the lessons learnt in other experiences[10]. To efficiently allocate financial resources to countries for the improvement of their ICT statistical system, independent assessments of their capacity should be made on the basis of available data and metadata in ITU databases.

Building technical expertise at the national level

Continuous professional development programs should be established to keep statisticians and data scientists abreast of the latest methodologies and tools for collecting and analyzing digital divide data. The availability of new data sources such as mobile phone data (see Section 5) require creating new data science skills for the staff of NSOs, strengthened through the cooperation with the private data source holders.

Training can cover areas such as big data analytics, and the application of machine learning in statistics, the integration of statistical data from surveys and administrative registers, and with geospatial data.

10. Experiences on supporting domain-specific statistical systems such as the Global Strategy for Agricultural and Rural Statistics, led by FAO, the Multiple Indicator Cluster Surveys, led by UNICEF, or the Living Standards Measurement Study (LSMS) by the World Bank, can provide relevant lessons on how to implement large-scale, multi-country statistical operations.

At the same time, policymakers from ICT ministries and telecom regulators and other data users should be trained on how to interpret and effectively use ICT statistics for evidence-based decision-making in the field of digital policies.

Improving data collection methods

Household surveys are the main source of data on Internet use. However, it is important that individuals can respond by themselves. Proxy interviews are not adequate for household surveys on the use of technology, especially when the head of household or interviewed person is less likely to be connected than younger family members.

To complement traditional surveys and censuses, new data sources such as big data and mobile phone data should be integrated into the statistical system. This can provide more timely and granular insights into ICT usage patterns and trends. The collaboration of public and private entities to grant access to such sources is necessary.

Making data and metadata available in accessible formats and more detail

ICT statistics should be disseminated in formats that are easily accessible to a wide range of users, including policymakers, researchers, and civil society. Open data initiatives as well as AI tools can be promoted to facilitate the dissemination and use of ICT statistics in various sectors.

More granular and disaggregated data should be made available to enable a deeper understanding of digital gaps across different demographics and regions. The integration of geospatial and statistical information can enhance the use of evidence for deployment of connectivity infrastructure and for the identification of hard-to-reach populations. Disseminating anonymised microdata, in a way like that used by EU Member States would contribute to the analysis of digital gaps.[11]

Metadata on the statistical operations should be provided routinely, preferably using international standards (e.g. SDMX). This would enhance the transparency of methodology of national data sources, facilitate the production of estimates when data are not available, and align with the good practices promoted by the UN FPOS.

11. See https://ec.europa.eu/eurostat/web/microdata/community-statistics-on-information-society. Tools such as the International Household Survey Network https://www.ihsn.org/ can help countries anonymize microdata, catalogue surveys and provide easier access to researchers.

Engaging in international efforts to harmonize data collection on UMC

Active participation in international meetings and working groups, such as those organized by the ITU (Expert Group on Household Indicators (EGH) and the Expert Group on Telecommunication/ICT Indicators [EGTI], can help align national practices with global standards. The provision of data to regional and international organisations increases the efficiency of data dissemination. While G20 countries may have other forums to discuss statistical methodology (such as those organised in the European Statistical System and OECD working parties), the international constituency of EGH and EGTI provide a unique global forum on ICT statistics.

In parallel, international organisations such as ITU should continue to advocate for measurement, define international standards and promote their adoption, develop manuals and training materials; provide technical assistance, and strengthen the capacity of the statistical community.

Addressing data scarcity with innovative approaches

In an era where the volume of data is expanding exponentially, new data sources, innovative technologies, and advanced statistical methods can revolutionize the way data is produced, analysed, and used. However, realising this potential requires new skills, robust infrastructure, effective coordination among stakeholders, and the application of rigorous statistical methodologies to mitigate potential biases.

This section delves into some of the most promising methodologies and provides guidance on how to harness their potential and integrate them into mainstream practices.

New data sources

Big data analytics offer near real-time insights that typically exceed the capabilities of traditional data sources. By leveraging big data from satellite imagery, social media and other online activities, and the digital traces from everyday use of mobile phones, policymakers can get new insights and make more informed decisions and design timelier and targeted interventions. The use of these new sources of data can significantly improve the measurement of the various dimensions of universal and meaningful connectivity:

- ***Satellite imagery:*** Satellite data play a crucial role in monitoring urban development, helping policymakers identify areas that need new or upgraded infrastructure. For UMC, this data, combined with demographic statistics, can pinpoint populated areas with limited ICT infrastructure, monitor network capacity, and help determine the most optimal technologies for connecting regions. Satellite imagery can also help identify suitable paths and locations for ICT infrastructure development and estimate mobile phone network coverage based on geographical features, such as elevation of the surrounding area. While satellite data are valuable due to their accessibility and (often) global coverage, their use in measuring UMC beyond ICT infrastructure remain unexplored.

- ***Mobile phone data:*** Data generated from mobile phone usage gained global traction during the COVID-19 pandemic when governments in over 40 countries partnered with mobile operators to monitor mobility restrictions.[12] Mobile phone data can complement traditional household surveys in measuring Internet use, and provide a reality check on network coverage compared to operators' estimates (both UMC and SDG indicators). However, access to mobile phone data from telecommunication operators is challenging. Some countries have legal framework granting access and protecting personal data confidentiality. However, other limitations, such as lack of skills and infrastructure, often prevent systematic use of mobile phone data. In other countries, access to mobile phone data from telecommunication operators has been obtained for pilot studies through financial means or short-term partnerships, using statistical capacity building as incentive for data access. In most countries, data access remains the biggest challenge where legal framework needs to be set-up to allow sustainable access to operators' data for statistical purposes. Box 8 presents two ITU mobile phone data pilot projects.

- ***Speed tests:*** One of the most used big data sources are speed tests generated by users or through applications. These tests measure and record upload and download speeds, as well as latency, and are available both for computers and mobile devices. Additionally, many applications run background speed tests to monitoring network experience or checking users' Internet connection to optimize the download of software updates. The data can serve as a reality-check to official estimates. In 2019, Microsoft estimated that 157 million people in the United States did not use the Internet at broadband speeds, which was more than seven times the official figures reported by the Federal Communications Commission.[13] Speed test data is a useful complementary big data source to monitor and benchmark other UMC indicators. Although this data is mostly privately owned, some companies are now releasing some of it publicly or sharing it through partnerships with national and international organisations.

12. GSMA (2021), Utilising mobile big data and AI to benefit society, available at: https://www.gsma.com/solutions-and-impact/connectivity-for-good/external-affairs/wp-content/uploads/2021/03/GSMA-AI4I-Covid-Response-Report_March2021.pdf

13. This was part of Microsoft's Airband Initiative aimed to bring broadband to people living in rural areas. For more information, see: https://blogs.microsoft.com/on-the-issues/2020/03/05/update-connecting-rural-america/

- ***User-generated content:*** User-generated content in social media is often utilized to analyze public opinion and monitor societal trends. Social media companies provide data access through APIs for marketing or research, allowing researchers to explore user profiles across platforms. The OECD has used LinkedIn data to identify trends in ICT and other skills requested in job postings. Crowdsourced big data for common goods is another valuable resource. Wikipedia and OpenStreetMap are prime examples, as is OpenCellID, which collects cell tower locations globally through user-contributed mobile data. Despite its value, most user-generated content is privately owned and not publicly accessible, not even for national statistical offices. However, the real-time nature of social media content allows for rapid feedback and policy adaptation, ensuring relevance and effectiveness.
- ***Financial transactions:*** Electronic transactions made by credit cards are a sensitive yet valuable big data source that can provide detailed insights into the digital economy. By analyzing patterns in online purchases, researchers and policymakers can track trends in e-commerce, the popularity of digital services, preferences for new payment technologies, and changes in consumer behavior. This data can complement official household surveys on e-commerce, particularly regarding the frequency and preferences of individuals' online shopping behavior. However, obtaining credit card data is challenging due to commercial and privacy protection concerns.

Box 8. Leveraging Mobile Phone Data in Brazil and Indonesia

The use of mobile phone big data to measure Universal and Meaningful Connectivity involves analysing anonymized call detail records (CDRs) and Internet Protocol Detail Records (IPDR) to gain comprehensive insights into Internet usage and network coverage in the country.

The International Telecommunication Union (ITU) plays a pivotal role in this domain by supporting countries with methodology and guidance of using mobile phone data for official statistics. In 2019, the ITU supported two pilot studies in Brazil and Indonesia, which used mobile phone data to estimate the proportion of individuals using the Internet and the proportion of individuals with mobile network coverage by technology.[1] These indicators are part of the Sustainable Development Goal (SDG) monitoring framework.

The pilots demonstrated that mobile phone data could provide reliable and detailed estimates for Internet usage and mobile network coverage, comparable to traditional survey data. The differences between mobile phone data and survey estimates were generally minimal, highlighting the robustness of mobile phone data as a supplementary source for information society statistics.

These studies allow for more frequent and geographically disaggregated data, supporting better-informed policy decisions aimed at enhancing digital inclusion and telecommunications infrastructure in Brazil and Indonesia. The success of the pilots underscores the potential of leveraging big data for national statistical offices to meet the increasing demands for timely and detailed information.

1. The pilots were conducted in collaboration with the Brazilian Institute of Geography and Statistics (IBGE) and CETIC in Brazil, and the National Statistics Office of Indonesia (BPS).

New methods and technologies

The advent of machine learning, generative AI, and large language models is providing powerful tools to enhance the production and dissemination of official statistics. These technologies can detect trends and outliers, automate repetitive tasks, and synthesize information from surveys, social media, and other textual sources to extract valuable insights.

Machine learning

Machine learning, a component of artificial intelligence, leverages algorithms and statistical models to analyze and infer patterns in data. It can play a significant role in official statistics by aiding the processing and analysis of big data sources and improving efficiency in traditional data collection methods, such as surveys and censuses.

For example, missing or incomplete data is a common challenge in statistical analysis. Machine learning models can analyse relationships within datasets and predict missing data based on patterns identified in the existing data. Additionally, anomaly detection algorithms can identify and correct errors in the data, ensuring accuracy and reliability of statistical outputs. Machine learning models can also forecast future trends and outcomes based on historical and recent data.

The accuracy of official statistics can be further improved by integrating administrative, geospatial, and survey data. In most cases, survey samples are not large enough to produce reliable estimates for small areas. Statistical models which rely on auxiliary information and relationships from larger areas or more comprehensive datasets can help address this challenge. This approach, known as small area estimation, enables more precise and effective local interventions.

Generative AI

Generative AI, particularly large language models (LLMs) such as ChatGPT, has the potential to enhance productivity within statistical organizations by automating routine tasks and supporting statistical production processes. These models can assist with communication and project management tasks, freeing up human resources for more strategic activities. Additionally, LLMs can help translate documents between languages, making information accessible to a broader audience.

In statistical production processes, LLMs can aid in survey design by suggesting wording and formats that enhance user understanding, leading to more accurate responses. They can also organize survey responses, classify textual data into different categories, support code development, and identify data errors, including missing values and outliers.

However, the greatest potential of LLMs may lie in enhancing the production of communication materials for statistical products. Through interactive queries in plain language, LLMs can improve the experience of users and help them find the information they need. They can also support the production of statistical reports and tailored content for different audiences.

Any use of generative AI must be supervised, and outputs from LLMs must be rigorously checked and verified. It is important to consider the potential risks associated with LLMs, including the dissemination of misinformation from misinterpretation or hallucination, privacy and ethical concerns, and potential legal implications. To mitigate these risks, a robust governance structure and human oversight, including strict verification protocols, are necessary to ensure the responsible use of LLMs.

Making statistical organisations fit for the future

The evolving technological and data landscapes present opportunities and challenges for NSOs and other organizations engaged in the production of official statistics. These must adapt and harness the potential of new data sources and new method and technologies

A critical area is the improvement of access to private sector data. Establishing long-term partnerships with the private sector is essential to secure sustained access to new data sources that complement traditional data sources. However, this may require expanding the statistical mandate of NSOs and upgrading the legal framework to allow NSOs to access private sector data for producing public and official statistics, while ensuring individual privacy and commercial confidentiality of the data.

This in turn requires an enhanced data governance system, which includes decision rights and accountabilities for the management of data and information. It encompasses the plans, practices, concepts, programs, and range of systems that contribute to the organization and maintenance of data processes. Adopting principles of data stewardship, as proposed by a Task Force of European Statisticians within the United Nations Economic Commission for Europe (UNECE), can guide NSOs in managing data responsibly. This approach ensures that data are not only collected and stored securely but are also used in ways that maximize their value and ensure public trust. Data stewardship includes a range of responsibilities from data quality assurance to ethical considerations in data usage.

In parallel, leveraging new data sources require upgrading infrastructure. Managing big data - collecting, cleaning, processing, and analysing potentially trillions of data points from unstructured environments – is quite different from managing traditional statistical production cycles. It requires robust, scalable platforms that can manage the volume, velocity, and variety of big data. Many cloud providers offer off-the-shelf services to process big data, either in public or private cloud computing platforms, but it is essential to consult data legislations and consider internal human, technical and financial resources to ensure appropriate data governance practices are established within the cloud environment.

Additionally, the technological shift necessitates an upskilling of staff within NSOs and other public institutions, as recalled in Section 4. The competition for talent with the private sector, which often offers more attractive compensation packages, poses a substantial challenge in retaining skilled staff. Alongside providing ongoing training in big data analytics and new technologies, organisations must focus on building a strong data culture that attracts and retains talent.

Several initiatives within the UN system aim to modernize official statistics. In Europe, for instance, UNECE's High-Level Group for the Modernisation of Official Statistics (HLG-MOS) provides a platform for statistical organizations to develop strategies and solutions. This includes "The Blue Skies Thinking Network," which serves as an "ideas factory" for the statistical community, offering a platform for sharing ideas and exploring innovative solutions to improve statistical production processes.

At the global level, the UN Committee of Experts on Big Data and Data Science for Official Statistics (UN-CEBD), established by the UN Statistical Commission in 2014, plays a key role in the modernization of statistical practices through the integration of big data and data science. Tasked with providing strategic direction, the committee works through several task teams focusing on big data sources and technologies such as mobile phone data, scanner data, privacy-enhancing technologies, and Earth observation data (see Box 9).

The committee organizes the *International Conference on Big Data for Official Statistics* and the *UN Datathon*, which serve as global platforms for collaboration and innovation in data-driven solutions. Key outputs from the different task teams include a variety of methodological guides, comprehensive training resources, and the UN Guide on Privacy-Enhancing Technologies for Official Statistics. The Data Science Leaders Network (DSLN) was established as a subgroup to UN-CEBD by the Statistical Commission in 2022. The network includes senior officials from NSOs and global and regional big data networks and aims to strengthen collaboration and leadership on big data and data science issues. These initiatives aim to help NSOs harness big data and data science.

While the United Nations actively supports the modernization of national statistical offices, it is equally crucial to embrace a parallel modernization *within* the United Nations itself, ensuring that the organization's data processes, structures, and strategies are equipped to efficiently tackle global challenges. In 2020, the UN Secretary-General launched a Data Strategy to enhance data and analytics capabilities within the United Nations to address global challenges.

Priorities include:

- Establishing new data governance structures, such as the UN Data Council, to ensure data quality and effective implementation of data strategies.
- Implementing training and capacity-building initiatives, along with creating specialized roles like Chief Data Officers and Data Scientists, to build data-driven cultures and enhance the UN's data management and analytical capabilities.
- Highlighting the importance of partnerships for accessing and integrating new data sources and setting data quality standards.
- Deploying advanced technology environments to better facilitate data sharing across the UN system and beyond.

Box 9. Mobile Phone Data Task Team

The Mobile Phone Data (MPD) Task Team, chaired by ITU, is one of the six task teams of the UN-CEBD. It has developed six methodological guides on the use mobile phone data for official statistics, focusing on indicators related to migration, tourism, ICT statistics, dynamic population, disaster-context statistics and transport statistics. These guides also cover data access, privacy, and data quality assurance of input and calculated data. In 2023, the team launched training courses, conducted webinars together with the regional hubs, and contributed to international forums to promote these methodologies. In 2024, the task team is working on developing synthetic data, training course for MPD project managers, and engages in global collaborations to enhance the use of mobile phone data in national statistical offices.

- NSOs and other producers of official statistics are at a critical juncture. To reap the benefits of new data sources, they must improve data governance practices, develop new partnerships with the private sector, focus on skills development, and upgrade technical infrastructure. Countries may need to adapt their legal frameworks, too. These changes will not only enhance the capacity of NSOs and other organisations to produce higher quality and more timely statistics but will also ensure their relevance and effectiveness in the future.

Recommendations for G20 economies

Striving for universal and meaningful connectivity

- Broaden digital strategies to encompass all dimensions of connectivity beyond just infrastructure.
- Aim for universal and meaningful connectivity (UMC), ensuring UMC is a situation where everyone can access the Internet optimally and affordably whenever and wherever needed.

Improving measurement and evidence-based decision making

- Recognize the critical role of measurement in achieving UMC.
- Adopt the proposed UMC measurement framework presented in these Guidelines.
- Collect data for as many ICT indicators as possible from the Core list maintained by the Partnership on Measuring ICT for Development, especially those related to individual use and access.
- Promote evidence-based decision-making using data to design tailored interventions for specific demographic groups and geographies.
- Provide easy, timely, and open access to ICT official statistics, including anonymized microdata for in-depth analysis of digital divides.

Strengthening national statistical systems

- Improve the legal basis for ICT statistics by adhering to the UN Fundamental Principles of Official Statistics; promoting the collaboration with the private sector and relevant agencies for improved access to anonymized private sector data; and ensuring proper data governance for the secure and ethical use of data.

- Assess national statistical capacity in ICT statistics and identify areas for improvement in coverage, accuracy, frequency, timeliness, and compliance with international standards.
- Allocate adequate resources for the collection, processing, analysis, and dissemination of ICT statistics.
- Ensure budgetary support for ICT statistics, guaranteeing efficiency and avoiding duplication in statistical efforts through inter-agency collaboration.
- Foster strong cooperation between data providers and users to ensure data supply meets demand.
- Work with national statistical offices (NSOs) to upgrade skills and data infrastructure to leverage new technologies and data sources, including AI and big data.
- Participate in international efforts to modernize statistics, define new standards, and support knowledge transfer to developing countries.

References

Alliance for Affordable Internet. (2020). *Meaningful connectivity: A new target to raise the bar for Internet access.* Available at: https://docs.google.com/document/d/1qydsmTY4hln3pP4dWJbCSRFna8SfDYAtGfacKYwhVk8/edit

Helsper, E. (2009). *The ageing Internet: Digital choice and exclusion among the elderly.* Working With Older People, 13(4), 20-33. Available at: https://www.emerald.com/insight/content/doi/10.1108/13663666200900068/full/html

International Telecommunications Union (2020). *Manual on Measuring ICT access and use by households and individuals.* Available at: https://www.itu.int/en/publications/ITU-D/pages/publications.aspx?media=electronic&parent=D-IND-ITCMEAS-2020

International Telecommunication Union. (2022). *Achieving universal and meaningful digital connectivity: Setting a baseline and targets for 2030.* Avaliable at: https://www.itu.int/itu-d/meetings/statistics/wp-content/uploads/sites/8/2022/04/UniversalMeaningfulDigitalConnectivityTargets2030_BackgroundPaper.pdf

International Telecommunication Union (2023). *Measuring digital Development: Facts and Figures 2023.* Available at: https://www.itu.int/itu-d/reports/statistics/facts-figures-2023/

Mubarak, F., & Suomi, R. (2022). *Elderly forgotten? Digital exclusion in the information age and the rising grey digital divide.* INQUIRY: The Journal of Health Care Organization, Provision, and Financing, 59. https://journals.sagepub.com/doi/10.1177/004695802 21096272

Partnership on Measuring ICT for Development (2005). Measuring ICT: the global status of ICT indicators. Available at https://www.itu.int/en/ITU-D/Statistics/Documents/partnership/MeasuringICT_2005.pdf

Teltscher, S. and J. Cervera-Ferri (2011). Producing ICT indicators in developing countries: challenges and initiatives. ESTADÍSTICA (Instituto Inter-Americano de Estadística), 63, 180, pp. 27-61

Annex 1 – List of Core ICT indicators on ICT access and use by households and individuals

Indicator	Description
HH1	Proportion of households with a radio
HH2	Proportion of households with a TV
HH3	Proportion of households with telephone
HH4	Proportion of households with a computer
HH5	Proportion of individuals using a computer
HH6	Proportion of households with Internet
HH7	Proportion of individuals using the Internet
HH8	Proportion of individuals using the Internet, by location
HH9	Proportion of individuals using the Internet, by type of activity
HH10	Proportion of individuals using a mobile cellular telephone
HH11	Proportion of households with Internet, by type of service
HH12	Proportion of individuals using the Internet, by frequency
HH13	Proportion of households with multichannel television, by type
HH14	Barriers to household Internet access
HH15	Proportion of individuals with ICT skills, by type of skills
HH16	Household expenditure on ICT
HH17	Proportion of individuals using the Internet, by type of portable device and network used to access the Internet
HH18	Proportion of individuals who own a mobile phone
HH19	Proportion of individuals not using the Internet, by type of reason
HH20	Proportion of individuals who purchased goods or services online, by type of good and service purchased
HH21	Proportion of individuals who purchased goods or services online, by type of payment channel
HH22	Proportion of individuals who purchased goods or services online, by method of delivery
HH23	Proportion of individuals who did not purchase goods or services online, by type of reason