

GCI Methodology 2019

The GCI analyzes the full spectrum of measurements for intelligent connectivity and provides a detailed map of the global digital economy.

The index benchmarks 79 countries according to their performance in 40 indicators that track the impact of ICT on a nation's economy, digital competitiveness and future growth. Combined, these countries account for 95 percent of global GDP.

Research Framework

The GCI analyzes digital transformation from basic levels of connectivity to supplementary, advanced technologies. The GCI has adapted its methodology over time to capture how technology evolves and to better evaluate the correlation of ICT investment with GDP growth. In 2019, the GCI's methodology has been expanded again to highlight Intelligent Connectivity's role in boosting the digital economy. We consolidated Intelligent

Connectivity's four enabling technologies into four: Broadband, Cloud, Internet of Things, and Artificial Intelligence. Two notable changes we made were to merge the Data Centers perimeter into Cloud and incorporate Big Data into a newly-created AI perimeter. Please refer to the diagram below for details.

These advanced technologies are built on a foundation layer of technologies such as telecom infrastructure, e-Commerce, and the overall adoption of computers, smartphones, and the Internet - all of which have been key determiners of the growth and development of digital economies over the past two decades. The GCI also includes forward-looking factors such as ICT patents, R&D and the outlook for each technology's compound annual growth rate.

The research framework thus covers a complete combination of advanced and fundamental technologies, enabling us to analyze how yesterday, today, and tomorrow intersect.

Four Pillars

Four Technology Enablers		SUPPLY  Measures current levels of supply for ICT products and services used for digital transformation.	DEMAND  Gauges demand for connectivity in the context of users and activities relating to digital transformation initiatives.	EXPERIENCE  Comprises variables for analyzing the experience of connectivity for end users and organizations in today's digital economy.	POTENTIAL  Comprises a forward looking set of indicators that point towards the future development of the digital economy.
	FOUNDATION	ICT Investment Telecom Investment ICT Laws International Internet Bandwidth Security Software Investment	App Downloads Smartphone Penetration eCommerce Transactions Computer Households Secure Internet Servers	E-Government Services Telecom Customer Services Internet Participation Broadband Download Speed Cybersecurity Awareness	R&D Expenditure ICT Patents IT Workforce Software Developers ICT Influencing New Business Models
	BROADBAND	Fiber Optic 4G Connections	Fixed Broadband Subscriptions Mobile Broadband Subscriptions	Fixed Broadband Affordability Mobile Broadband Affordability	Broadband Potential Mobile Potential
	CLOUD	Cloud Investment	Cloud Migration	Cloud Experience	Cloud Potential
	INTERNET OF THINGS	IoT Investment	IoT Installed Base	IoT Analytics	IoT Potential
	ARTIFICIAL INTELLIGENCE	AI Investment	AI-enabled Robotics	Data Creation	AI Potential

The Four Pillars: SDEP

The four pillars encompass the entire chain of ICT development and digital transformation to provide a 360-degree view of the digital economy. Each pillar has a set of 10 data indicators.

The Four Technology Enablers

The index allows the horizontal analysis of four technology enablers that are crucial signposts to help benchmark the relative strengths, weaknesses, opportunities, and challenges facing digital economies: Broadband, Cloud, IoT, and AI

Each horizontal layer includes at least one variable from each of the four pillars: supply, demand, experience and potential.

Thus, the GCI can be analyzed both vertically (supply, demand, experience, potential) and horizontally (Broadband, Cloud, IoT, and AI).

This allows an extremely detailed analysis on the relative strengths and weaknesses of individual countries to pinpoint the areas in which additional investment is needed to advance connectivity and economic benefits.

Additionally, this structure enables the detailed analysis of correlations between advanced connectivity services like IoT and the key areas of supply, demand, experience, and potential. This reveals the most successful roadmaps for growth and development, and possible areas where leapfrog technology adoption has proved more successful than others.

The GCI is a rich and deep dataset that serves as a blueprint for individuals and organizations to analyze a wide range of factors relating to digital transformation, ICT development, and the economic benefits of connectivity. The overall index rankings provide a snapshot of the current state of connectivity across the global digital economy, forming a leading indicator for the next decade of ICT expansion and evolution.

The ICT Fundamentals

The four technology enablers need to function on a platform of robust core measurements of ICT fundamentals for a nation to transform into a digital economy and build upon these fundamentals in a self-reinforcing loop.

Examples of these fundamentals and their functions are as follows:

ICT laws are essential for Supply: They set down regulatory boundaries that govern privacy, confidentiality, and safe and legal use. The digital IP, digital assets, identities, and privacy of businesses and consumers must be protected against abuse and misuse, ICT laws make it feasible for the public and private sectors to invest in supplying ICT products and services to the mass market safely and under regulations.

Applications drive demand. Delivered on broadband networks, stored in data centers, and distributed via cloud services for mass consumption, they enable technology to produce outcomes. Applications feed data to analytics solutions for processing into information that can effect changes through IoT devices.

Customer experience is driven by quality of service (QoS). It ensures that ICT services meet the expectations and requirements of businesses and consumers in a way that encourages greater use and investment. For example, a country could have strong investment in cloud solutions but poor network performance or reliability, which will hinder the ability of end users to derive economic benefits.

Patents lead to potential. They form the basis that stimulate the innovation of new products and services. High demand coupled with a good experience builds strong future potential to accelerate digital transformation and make economic gains. The four technology enablers require patents for innovation.

A strong IT workforce ensures that a skilled and technology-literate population is available to drive future digital transformation through innovation based on real-world use. A shortage of skilled workers can be a significant inhibitor to a country's potential transformation. Equally an educated workforce is needed to make the most of digital technology.

Other fundamental layer measurements include telecom infrastructure investment, Internet bandwidth, e-Commerce, smartphone and computer penetration, e-government, Internet participation, average download speed, R&D expenditure, and number of software developers.

Measurement and normalization

The variables are measured against factors such as GDP PPP, number of households, and total population.

These factors assess the full picture of connectivity for each country, including measurements like app downloads per person or fiber optic penetration against total households.

In emerging economies, connectivity levels in major metropolitan areas tend to be much higher than their national scores, because these nations are still in the early stages of ICT adoption. This provides an important metric for understanding the potential of the increased economic benefits that these emerging economies will probably see over the next decade and beyond, as they close the digital divide through rapid investment and adoption programs.

In all cases, the data inputs are first measured against a normalizing variable like population size, so the index can benchmark countries according to relative levels of connectivity rather than absolute market size, which would be more reflective of economy size.

Scoring and Aggregation

For each variable, a country receives a rating of 1 (low) to 10 (high), depending on the data input.

Each indicator has a scale based on a realistic target value for 2025, and beyond with a score of “10” indicating that the target value has been reached.

These target values are extrapolated from market penetration projections based on the highest ranked countries, historical market performance, and expert opinions. Each country’s score is then determined by its normalized raw data value in relation to this scale. In most baseline cases, a value that is less than 10% of the target value will be allocated a score of 1. A value of between 10% and 20% of the target value is allocated a score of 2, and so on. This is shown in the table:

VALUE (% of target value)	GCI SCORE
1-10 %	1
11-20 %	2
21-30 %	3
31-40 %	4
41-50 %	5
51-60 %	6
61-70 %	7
71-80 %	8
81-90%	9
91-100%	10

Where the average values are significantly lower than the median, the formula is adjusted to include meaningful differentiation at the lower end of the scale and avoid excessive clustering of countries with equal (low) GCI scores.

For example, for Fiber Optics, we use a formula that differentiates between a value of 1% to 5% of the Target (GCI Score=1) and a value of 6% to 10% of the Target (GCI Score=2). This reflects the fact that average Fiber Optics penetration rates are much lower than the median value.

These indicator scores are then aggregated to form a total score for each of the four GCI pillars: Supply, Demand, Experience and Potential. These run from a scale of 10 to 100 (where 10 is the lowest possible total score, equivalent to a score of 1 for each of the 10 indicators within a segment).

The final index score is then calculated by aggregating the four segments:

GCI Total = (Supply + Demand + Experience + Potential) / 4

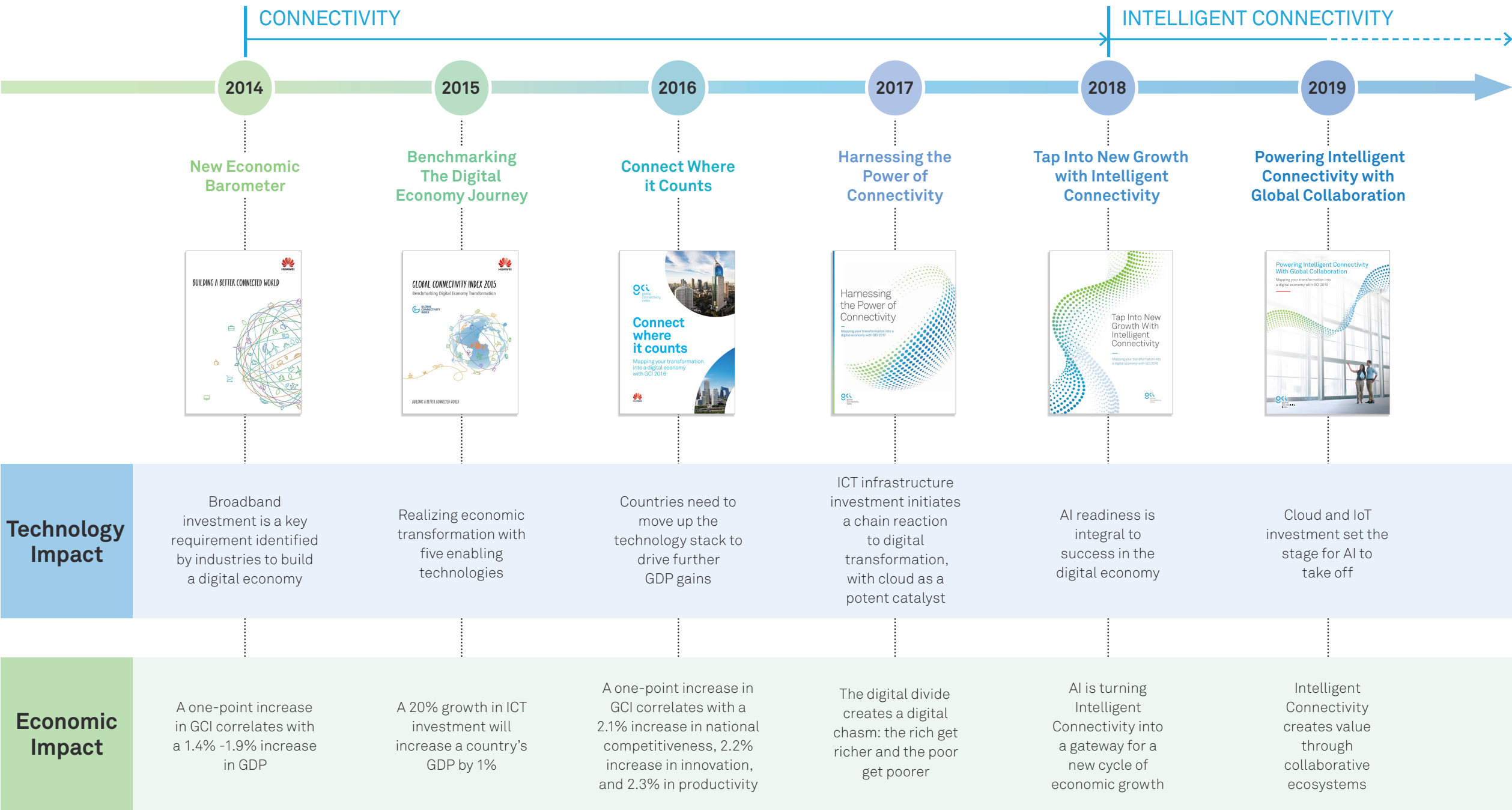
See “GCI Definitions” for a full list of data category definitions and sources.

Additional Notes

For variables weighted against GDP, we use the GDP at Purchasing Power Parity (PPP) calculation. This is generally the best way to calculate in-country purchasing power after it has been adjusted for the cost of living. This measures the relative wealth of a nation in terms of its ability to purchase goods and services within the national economy.

The data is always the most recent that is available, depending on the source. Data sources include: OECD, ITU, GSMA, WEF, World Bank, United Nations, Ookla, IDC, and Huawei. We’ve estimated the data for missing values based on geographical cohorts. Numbers in the charts might appear different from direct calculation due to rounding adjustments. Historical data shown in GCI 2018 may be different from data used in GCI reports of previous years, as it has been updated with the most recent actual data to improve accuracy.

The Evolution of the GCI: Benchmarking the Digital Economy Journey



GCI Definitions

SUPPLY

International Internet Bandwidth

International Internet bandwidth refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbps). Used international Internet bandwidth refers to the average traffic load of international fibre optic cables and radio links for carrying Internet traffic. The average is calculated over the 12-month period of the reference year and takes into consideration the traffic of all international Internet links. International Internet bandwidth (bps) per Internet user is then calculated by converting to bits per second and dividing by the total number of Internet users, and this is used to calculate the index scores.

Calculation: per internet user

Telecom Investment

Telecom Service Provider investment in modern network infrastructure over an aggregated five-year period. This focuses on key carrier network technologies that are integral to the delivery of cloud, mobile, and high-speed data services including service provider routers, service provider switches, and wireless infrastructure (including 3G, 4G, and 5G). Aggregate spending over the most recent five-year period is used to provide a more holistic measurement of Telco infrastructure deployments in the context of carrier investment cycles and economic wild cards.

Calculation: % of GDP

ICT Laws

A World Economic Forum survey on how developed a nation's ICT laws are (e.g. electronic commerce, digital signatures, and consumer protection).

Calculation: N/A

IoT Investment

Spending on IoT solutions and deployment including systems, sensors, modules, infrastructure, networks, specialized devices, security, software, connectivity services, IT and installation services, content services, OT (operational technology), and ongoing services (including consumer services). Weighed against the size of the population (IoT per capita).

Calculation: per capita

ICT Investment

The overall size of the traditional ICT market in each country, as defined by the total amount of end-user spending on IT hardware (servers, storage, PCs, devices, peripherals, network equipment), software,

IT services, and telecom services. The total market size is measured against the overall size of the economy (GDP), which provides a measurement of market supply maturity.

Calculation: % of GDP

4G Connections

The percentage of mobile device connections that access a 4G/LTE network. This measurement is not based on geographic landmass, and is therefore a more accurate measurement of the actual supply of 4G services to individuals and organizations. Users who haven't subscribed to 4G services but who use a 4G phone aren't counted.

Calculation: % of mobile data connections

Fiber Optic

The number of Fiber to the Home (FTTH) subscriptions, measured against the total number of households in each nation. "Fiber to the Home" is defined as a communications architecture in which the final connection to the subscriber's property is Optical Fiber. The fiber optic communications path is terminated on or in the premise for the purpose of carrying communications to the subscriber.

Calculation: % of total households

Security Software Investment

Investment in software relating to the security of ICT resources and data. These security products may be deployed in data centers, on networks, and on devices. Spending by all end-user segments is included (private and public sector). The data is weighted by the total size of population.

Calculation: per capita

AI Investment

The sum of investments for the deployment of artificial intelligence (AI) solutions by private and public institutions. This includes AI-related investments in hardware systems, software platforms, and professional services.

Calculation: % of GDP

Cloud Investment

Overall investment in cloud infrastructure services (Infrastructure as a Service), leveraged for the supply of server (compute) and storage infrastructure resources in a cloud environment. This provides a direct measurement of the supply of services from cloud infrastructure deployments to and end users. It is weighted against GDP.

Calculation: % of GDP

DEMAND

Fixed Broadband Subscriptions

Total number of subscriptions that access the Internet through a wireline (including satellite) broadband Internet connections.

Calculation: per capita

Mobile Broadband Subscriptions

Total number of mobile broadband services subscribers measured in relation to the overall size of the population.

Calculation: per capita

Smartphone Penetration

Smartphone penetration expressed as a percentage of total connections (excluding M2M). A smartphone is defined as a mobile handset with advanced access to Internet-based services and computing functions.

Calculation: share of total connections

App Downloads

The total number of new mobile application downloads in the calendar year on all major mobile platforms (Android and iOS). This is measured against the overall size of the population, and refers to new app downloads, not the existing installed base.

Calculation: per capita

E-commerce Transactions

E-commerce involves orders placed on the internet (i.e., the buyer clicks an order button on the Internet) in a commitment for paid goods or services. Total e-commerce measures the volume of all e-commerce transactions, both B2B and B2C (including volume purchases).

Calculation: per capita

Cloud Migration

An index based on the percentage of traditional software budgets that have migrated from traditional on-premise licensing to 'as a service' cloud deployments, thus measuring demand for advanced Public Cloud Services in relation to overall ICT spending.

Calculation: % of total annual software investment

AI-enabled Robotics

Total annual investment in robotics deployments partly enabled by artificial intelligence for advanced use cases across multiple vertical end-user industries. Example use cases include customer service, medical surgery/therapy, autonomous vehicles, and advanced inspection/diagnosis.

Calculation: per capita

IoT Installed Base

Total installed base of IoT devices and systems (including Intelligent Systems).

Calculation: per capita

Secure Internet Servers

Secure Internet Servers (per 1 million people) refers to the number of distinct, publicly-trusted TLS/SSL certificates according to the Netcraft Secure Server Survey.

Calculation: per capita

Computer Households

The number of households with access to a computer – a fixed desktop computer, laptop, or tablet (or similar handheld computer). Excludes smartphones.

Calculation: % of total households

EXPERIENCE

Fixed Broadband Affordability

The price of a monthly subscription to an entry-level fixed-broadband plan. These entry-level plans may include a variety of data and download speed allowances. The calculation is a percentage of a nation's average monthly GNI per capita.

Calculation: per GNI

Mobile Broadband Affordability

The price of a monthly subscription to postpaid handset-based data services with a minimum of 500 MB data allowance. This is calculated as a percentage of a nation's average monthly GNI per capita.

Calculation: per GNI

Broadband Download Speed

Average download speed for each country. These metrics leverage billions of Internet and mobile network tests to provide a current view and analysis of global Internet access speeds.

Calculation: n/a

Cybersecurity Awareness

The Global Cybersecurity Index is a trusted reference that measures the commitment of countries to cybersecurity at a global level. As cybersecurity has a broad field of application, cutting across many industries and various sectors, each country's level of development or engagement is assessed along five categories: Legal Measures, Technical Measures, Organizational Measures, Capacity Building, and Cooperation. It is then aggregated into an overall score. Scores are derived from an online survey, which also allows for the collection of supporting evidence. Through consultation with experts, these survey responses are then weighted, giving the final index scores.

Calculation: n/a

Telecom Customer Services

Current service levels provided by telecom operators based on previous research and surveys conducted within each nation.

Calculation: n/a

Internet Participation

The total number of individuals accessing the internet at least once during the 12-month period via wireline and/or mobile Internet access.

Calculation: per capita

E-Government Services

These scores are sourced directly from the United Nations E-Government Survey, which benchmarks countries according to ratings derived from a survey to assess the e-government development status of all UN member states.

Calculation: n/a

IoT Analytics

Total spending on analytics software relating to IoT data analysis. These software tools extract value from the mass of data being created via IoT to improve the experience of a nation or organization with an IoT platform that transforms IoT data into actionable information.

Calculation: per capita

Data Creation

Based on the estimated availability of target-rich, actionable data (TB) that can be leveraged by Artificial Intelligence (AI) platform and analytics tools to enhance the experience and ROI of organizations investing in the deployment of AI solutions. To improve the experience of this technology, the scalability of created data needs to be considered.

Calculation: TB per capita

Cloud Experience

An index that measures the quality of service available to customers of public cloud service providers in each nation. This is calculated on the basis of Broadband Affordability and Average Download Speed.

Calculation: n/a

POTENTIAL

ICT Patents

The total number of patents filed under the PCT within the ICT technology domain in the inventor's country of residence, as measured and tracked by the OECD (stats.oecd.org).

Calculation: per capita

IT Workforce

Total employment in the supply and management of IT for each nation. This includes workers employed directly in the IT industry (hardware manufacturers, software vendors, service providers, and channel organizations), and IT staff employed by end users in IT departments for the management, deployment, support, and strategic implementation of technology solutions.

Calculation: per capita

R&D Expenditure

Expenditure on R&D means current public and private capital expenditure on creative work to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development.

Calculation: % of GDP

Software Developers

The total number of software developers in each nation. Professional software developers are engaged in employment where the primary activity is constructing software or supervising its construction.

Calculation: per capita

ICT Market Potential

An index derived from local nation survey data on the potential for market development and the economic benefits to be derived from adopting Cloud, AI, IoT and Broadband solutions. To assess future potential for development, the five-year forecast for CAGR (compound annual growth rate) is used for the time period through 2022. This CAGR accounts for current market assumptions relating to technological development, penetration rates, macroeconomic growth and the ability of customers in each country to invest in these ICT markets.

Calculation: n/a

ICT Influencing New Business Models

Based on a survey conducted by the World Economic Forum where respondents were asked to evaluate the extent to which ICT enables new business models.

Calculation: n/a

REFERENCES

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