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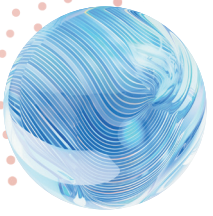
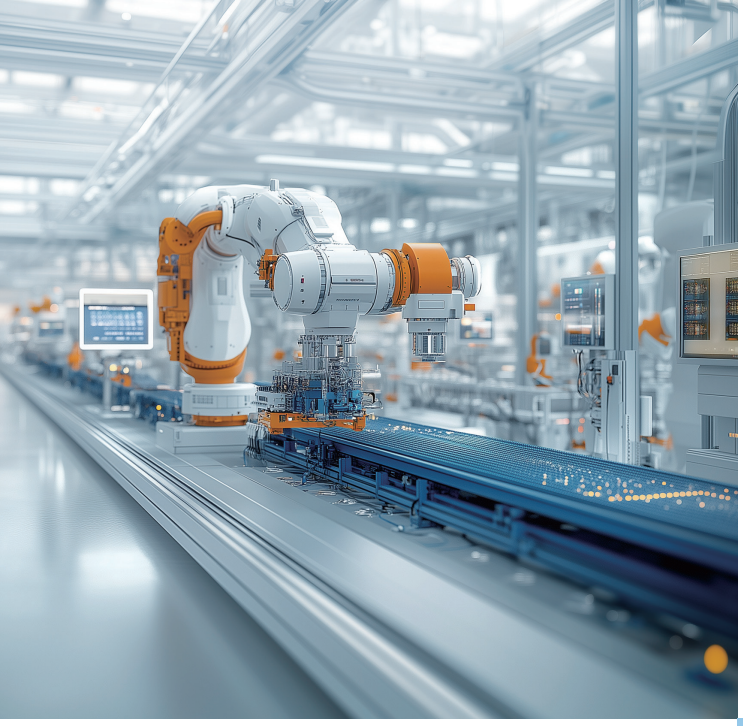
IDC

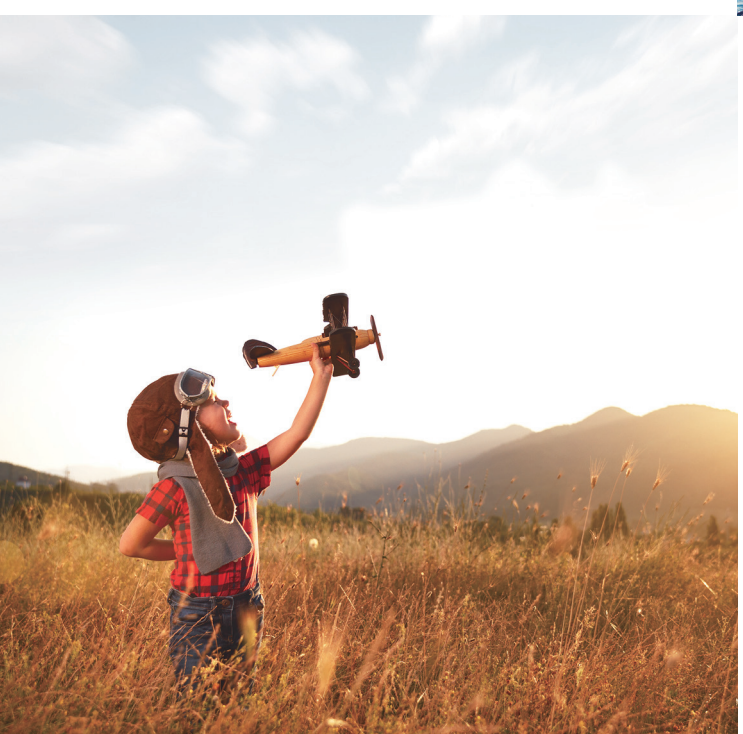
Global Digitalization Index 2024



Building a Fully Connected, Intelligent World

gdi Global Digitalization Index





Contents

Foreword

David Wang

We are moving ever faster towards the intelligent world. The Fourth Industrial Revolution is being catalyzed by digital technologies, like AI, 5G, 5G-A, and green energy.

Every industrial revolution of the past has taken technology to new heights, driven productivity improvement, and fueled leapfrog development around the world. Today, digital and intelligent transformation is ramping up, revolutionizing production by helping us advance from simple automation to intelligence.

As the physical world continues to intertwine with the digital world, the digital economy has truly taken off. Over the next five years, 70% of global economic growth will be driven by digitalization and intelligence[1]. The digital economy is also growing at a CAGR of 9.2%[2], much faster than the traditional economy.

Digital and intelligent transformation is creating tremendous opportunities. To seize these opportunities, more than 170 countries have released national strategies for digital and intelligent transformation. However, every country is struggling with the same core questions:

- How do we measure the ROI of investment into digital infrastructure?
- How do we plan the best roadmap and pace for ICT development?
- How do we evaluate the readiness of an ICT industry ecosystem?

Huawei started searching for the answers to these questions in 2014. That research resulted in the release of the Global Connectivity Index (GCI). The GCI is designed to assess the maturity of a country's connectivity infrastructure and quantify the value of connectivity and its impact on the digital economy. This research has already been widely recognized and cited by over 60 governments and more than 120 think tanks.

But now, we also want to measure the even bigger impact of digital transformation on the digital economy. And so, we have upgraded the GCI, and created the GDI – the Global Digitalization Index. The GDI measures the maturity of a country's ICT industry by factoring in more indicators for digital infrastructure, including computing, storage, cloud, and green energy. It quantifies the value of each country's ICT industry and its impact on their national

[1] World Economic Forum (WEF)
[2] *Intelligent Economy*, by EY & Huawei; *Digital Spillover: Measuring the true impact of the digital economy*, by Oxford Economics & Huawei

economy to help them make more informed decisions about the digital economy.

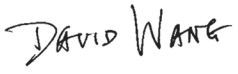
Over the past three years, Huawei's research teams have worked with the IDC to host more than 1,000 seminars that brought together over 1,200 academics, customers, and partners. Together, our experts have compiled the insights and experiences shared during these discussions into our new *Global Digitalization Index 2024* report.

This research proved just how strongly connected ICT industry development is to national economic growth. For example, a one-US-dollar investment in digital transformation results in an 8.3-US-dollar return in a country's digital economy. But the extent to which each country benefits from its ICT industry depends on how advanced that industry is. In Frontrunner countries, for example, a one-point increase in GDI score produces five times the economic value than a one-point increase in Starter countries.

Also in this report, we provide specific recommendations for countries at different stages of digital development, and look at the exact relationship between the four enablers of digital transformation: Ubiquitous Connectivity, Digital Foundation, Green Energy, and Policy & Ecosystem.

As intelligent applications are adopted more broadly, we will eventually upgrade GDI into the GDII – the Global Digitalization & Intelligence Index. The GDII will give us an even better understanding of the global digital economy.

We encourage everyone reading this report to take the future into their own hands, and join us as we continue to build this evaluation system and guide the construction of future digital and intelligent infrastructure. Only through non-stop innovation in industrial digital and intelligent applications, can we share the full benefits of the digital economy with all.



Executive Director of the Board
Chairman of the ICT Infrastructure Managing Board
Huawei

Crawford Del Prete

In today's world, where rapid technological advancements and the widespread adoption of digital tools are reshaping every aspect of our lives, understanding and measuring digitalization on a global scale is more critical than ever. The 2024 Global Digitalization Index Whitepaper is a powerful reflection of this ongoing transformation, capturing how economies, industries, and societies are becoming increasingly interconnected through digital platforms, technologies, and infrastructures.

As we journey through the fourth industrial revolution, the role of digitalization in driving economic growth, enhancing quality of life, and boosting global competitiveness is undeniable. The Global Digitalization Index (GDI) offers a comprehensive and insightful perspective on the digital landscape across regions and economies. This whitepaper doesn't just provide metrics—it dives deep into the key drivers of digitalization and the hurdles that need to be overcome.

A crucial takeaway from the 2024 GDI is the need to focus on four essential enabling dimensions: **Ubiquitous Connectivity**, **Digital Foundation**, **Green Energy**, and **Supporting Policy & Ecosystem**. These dimensions are not just abstract concepts—they are the backbone of successful digitalization, ensuring that our digital transformation is inclusive, sustainable, and resilient.

Ubiquitous Connectivity is where it all begins, enabling seamless communication and data exchange worldwide. Expanding and enhancing connectivity infrastructure is vital for bridging the digital divide and ensuring that everyone, regardless of their economic standing, can participate in the digital economy.

Digital Foundation is about deploying advanced technologies such as AI, IoT, and edge computing that drive efficiency, innovation, and adaptability. This infrastructure is the bedrock upon which smart cities, digital enterprises, and innovative solutions are built, creating a smarter, more responsive global system.

Green Energy is increasingly recognized as a cornerstone of digitalization. As digital technologies become more pervasive, their energy demands must be met sustainably. Transitioning to green energy is crucial not

only for mitigating climate change but also for ensuring that digital transformation positively contributes to global sustainability goals.

Supporting Policy & Ecosystem is the glue that holds everything together. A robust regulatory framework and a collaborative ecosystem that fosters innovation while safeguarding public interests are essential for accelerating digitalization and ensuring that its benefits are equitably distributed.

The 2024 GDI comes at a pivotal moment, capturing the shifting dynamics in a post-pandemic world. The COVID-19 pandemic accelerated digital adoption but also highlighted the stark disparities between digitally advanced nations and those still struggling with basic connectivity and digital literacy. This whitepaper sheds light on these disparities, showcasing the progress made by digital leaders and the strategies needed for others to catch up.

As you delve into the 2024 Global Digitalization Index Whitepaper, I invite you to consider the profound impact digitalization has on our global society and the importance of advancing these four enabling dimensions. The findings here are not just statistics—they represent the potential for a more connected, efficient, and equitable world. Whether you are a policymaker, business executive, or academic, this whitepaper will arm you with the knowledge and insights needed to navigate the complexities of the digital age and contribute meaningfully to the global digital ecosystem.

The Global Digitalization Index is an invaluable resource that will undoubtedly shape digital strategies and policies worldwide. I hope this whitepaper serves as a catalyst for continued innovation and collaboration as we build a digitally empowered and sustainable future.

President
International Data Corporation (IDC)

Executive Summary

Executive Summary

The rapid development of technologies, including AI, 5G, cloud, and green energy has accelerated the Fourth Industrial Revolution. Countries worldwide are racing to make the move to the digital economy. However, as these countries implement national digitalization strategies, they all need to address the following questions.

How do we measure the ROI of digital infrastructure investment?
How do we plan the best roadmap for and pace of ICT development?
How do we evaluate the readiness of an ICT industry ecosystem?

The Global Digitalization Index (GDI) is designed to quantify the digital transformation progress of each country, and help countries solve key challenges in implementing digitalization strategies and accelerate the development of their digital economies.

To achieve this goal, the GDI report has listed the key trends for 2030 and four enablers of the future intelligent world: Ubiquitous Connectivity, Digital Foundation, Green Energy, and Policy & Ecosystem. Based on these four enablers, the report has gained valuable insights into ICT supply and demand and the characteristics of the future intelligent world, and created a model to quantify the digital transformation process of each country.

The GDI 2024 report measured and scored 77 countries, representing 93% of the world's GDP and 80% of the global population, meaning it gives a good indication of the general progress in global digital transformation. The report grouped these countries into three clusters: Frontrunners, Adopters, and Starters, based on authoritative third-party data regarding each country's performance in digital transformation. It also provided each country cluster with specific recommendations on how to accelerate digital transformation.

The GDI conducted a large amount of quantitative research and developed some key findings, and these can inform the development of national digital economies.

1

The maturity of the ICT industry is strongly correlated with GDP per capita growth, but the extent of economic benefits varies by country due to their different levels of ICT development. In Frontrunner countries, for example, **a one-point increase** in GDI score produces **5.4 times** the economic value than a one-point increase in Starter countries.

2

Forward-looking digital infrastructure development serves as a new engine for economic growth. Countries around the world are currently racing to digitalization. Our research found that a **one-US-dollar investment** in digital transformation results in an **8.3-US-dollar return** in a country's digital economy.

3

The ICT industry is progressing unevenly across countries. However, **ubiquitous connectivity can bridge the digital divide**. Fixed broadband and mobile broadband can work in concert to maximize the value of the digital economy, and a **robust digital foundation and ubiquitous connectivity can reinforce each other**, creating a **multiplier effect** on economic development.

4

Countries must embrace green energy technologies to gear up for the **sustainable growth of their digital economies** and large-scale application of AI.

5

Supportive industry policies and well-paced planning create fertile ground for national digital economies to grow.

6

The proportion of STEM graduates in different countries is similar, but the conversion rate to ICT professionals varies greatly by country.

We believe that the GDI can help countries better understand the stages of their digital and intelligent transformations, identify gaps and challenges, and formulate next-step development plans, so that they can seize the huge opportunities presented by the Fourth Industrial Revolution and boost their national digital economies.

GDI Overview

GDI Overview

Countries around the world are witnessing faster adoption of digital technologies. In 2023, global ICT investment reached US$4.9 trillion. The ICT industry has grown rapidly in OECD countries, with an average growth rate of 7.6%, far outpacing the growth of other industries. China's ICT industry was worth US$539.9 billion in 2023, and this accounted for 11% of the global ICT industry. In Middle-Eastern and African countries, the market size of the ICT industry is also growing rapidly, recording a year-on-year growth rate of 11.4%[1] in 2023.

The GDI has explored what the intelligent world will need from the ICT industry by 2030, and used an economic development supply and demand model to measure the maturity of each country's ICT industry and help countries plan the best roadmaps for ICT development.

ICT industry trends toward the 2030 intelligent world

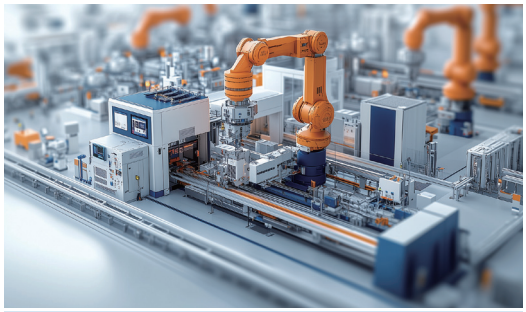
10 Gbps society is fast approaching.

Connectivity is the cornerstone of the digital economy. 10 Gbps connectivity will facilitate a world in which all things will be sensed and connected. This will eliminate information silos, and provide equal opportunities for regions at different stages of development. It is predicted that by 2030, the number of connected devices worldwide will reach 200 billion, and 25% of homes are expected to have 10 Gbps broadband access[2].

Spatial computing will boost immersive virtual reality.

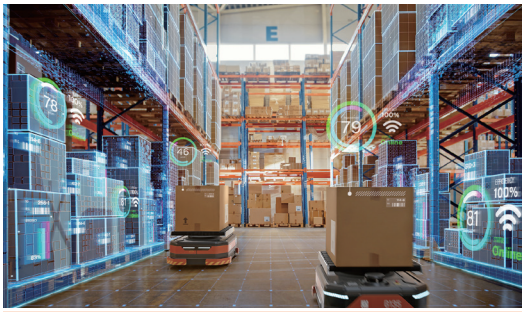
Spatial computing is a new form of computing that deeply integrates the digital and physical worlds to create intelligent experiences in extended reality environments that can be accessed equally by everyone. By 2030, the number of global AR/VR users is expected to reach 1 billion, and the "1-5-20 ms" three-tier latency ranges will be achieved[2].

[1] IDC, OECD
[2] *Intelligent World 2030*, Huawei



Data will not only be a production resource, but a source of innovation.

Ubiquitous connectivity will lead to exponential growth in data which can serve as a production resource in an intelligent world. The data can then be further translated into industry knowledge through powerful intelligent computing to help various industries go digital and significantly improve productivity. By 2030, the total amount of data generated worldwide each year is expected to reach 1 YB, while there is predicted to be 3.3 ZFLOPS of general computing power and 864 ZFLOPS of AI computing power (FP16) across the globe[2].

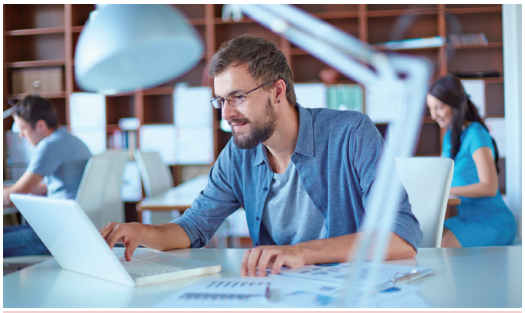


Embodied intelligence will see wide adoption.

Breakthroughs in machine vision, natural language understanding, cognition and reasoning, robotics, and other disciplines will promote the wide adoption of embodied intelligence. This will facilitate unmanned operations in scenarios like industrial production, warehousing and logistics, construction, and energy, thus greatly improving production efficiency, reducing labor costs, and enhancing work safety. By 2030, every 10,000 manufacturing workers are expected to work with 1,000 industrial robots[2].

Green and sustainable development will become the mainstream.

The large-scale application of AI consumes huge amounts of energy. For example, training a foundation model with 176 billion parameters a single time consumes 433 MWh of electricity, which is roughly equivalent to the electricity consumption of an average household over 41 years. Moving forward, as foundation models become increasingly complex, their training will consume increasingly more electricity. This means that a large amount of green and sustainable energy will be required to support the sustainable development of AI. By 2030, 80% of digital infrastructure is expected to be powered by green energy, and renewable energy is set to supply 65% of electricity worldwide[2].



Demand for ICT talent will continue to grow.

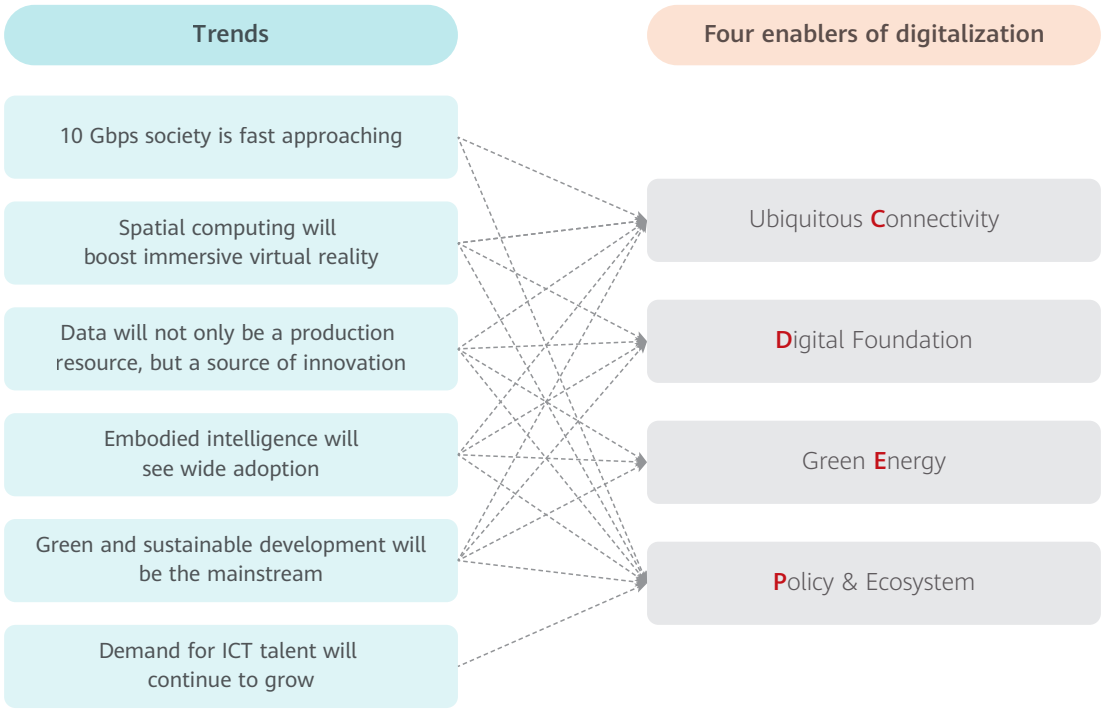
The development, convergence, and innovation of digital and intelligent technologies will cause global demand for ICT talent to soar. By 2030, these global digital jobs are estimated to grow by around 25% to over 90 million roles[3]. In particular, there will be an increasing demand for high-end talent in next-generation communications networks, generative AI, foundation model applications, cloud computing, virtual operations and collaboration, and next-generation security.

[3] World Economic Forum (WEF)

Four enablers of digitalization

Based on our insights into the ICT industry demand in the 2030 intelligent world, we have identified four enablers that influence a country's digitalization process: Ubiquitous Connectivity, Digital Foundation, Green Energy, and Policy & Ecosystem.

Four enablers of digitalization



Ubiquitous Connectivity is the foundation of an inclusive digital economy.

Access to stable and continuous network connections is a basic need and right for everyone. Ubiquitous ultra-broadband connectivity has become a reality thanks to multiple innovative technologies, such as 5G, 5G-A, fiber access, and the Internet of Things (IoT). Ubiquitous connectivity is helping more people connect with the wider world and gain equal and extensive development opportunities, and it also lays a solid foundation for the inclusive development of the digital economy.

Digital Foundation is the accelerator of a high-quality digital economy.

As data has become a new factor of production, a digital foundation needs to be established to support the storage, processing, and computing of data. This foundation will consist of data centers, future-proof computing power and storage, cloud computing, and computing networks, and serve as a catalyst for digital economy development.

Green Energy is a new driver of a sustainable digital economy.

Renewable energy, such as solar and wind, is gradually becoming a more popular alternative to traditional fossil fuels as it is clean, environment-friendly, and renewable. The global production of renewable energy is continuing to grow, and renewables contribute to an increasing proportion of electricity every year. Renewable energy has not only become one of the most competitive energy options, but it also provides new momentum for the sustainable development of the digital economy.

Policy & Ecosystem is the fertile ground for a healthy digital economy.

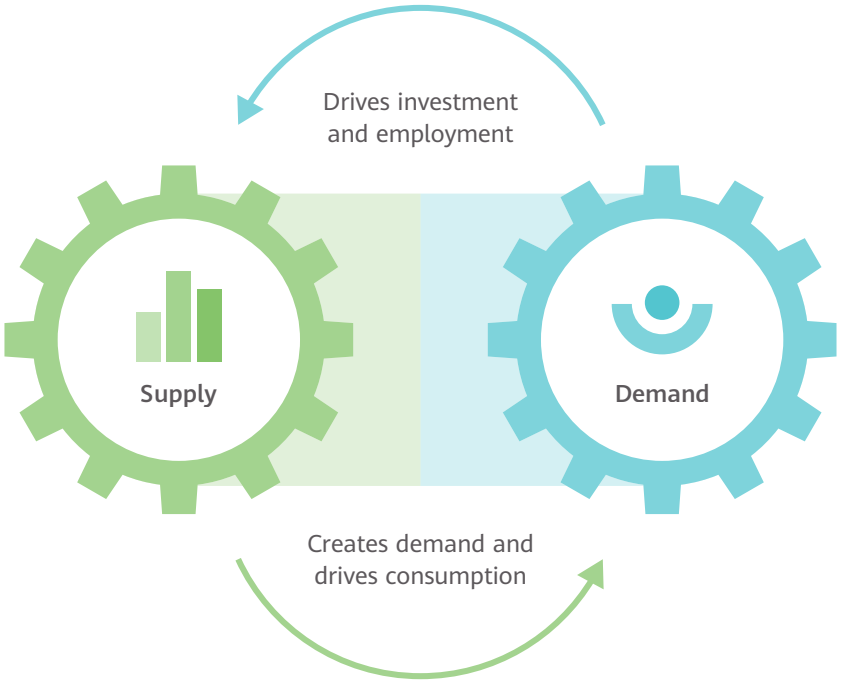
Supportive policies and regulations, a favorable environment for innovation, an adequate talent reserve, and a sustainable industry ecosystem are all essential for the development of the digital economy. Governments need to prepare the fertile ground for digital transformation, as they are uniquely positioned to provide systematic support in terms of organizations, funds, policies, and regulations.

ICT supply-demand model that impacts digital economy growth

Adequate ICT supply and demand are essential for the development of the digital economy. The ICT industry needs to provide accessible, affordable, and easy-to-use services that meet user demand to help industries go digital, improve productivity, and reduce costs, thus promoting the high-quality development of the digital economy.

From a supply perspective, the increase in production activities and the advancement of ICT boost business innovation, improve production efficiency, create market demand, and drive consumption upgrades, thus accelerating economic growth.

From a demand perspective, the increase in demand stimulates new production activities, promotes infrastructure construction, and drives investment, employment, and value creation, which in turn improves supply.



Continuous ICT supply is the bedrock of the digital economy

Adequate ICT supply is the bedrock of the digital economy, and can only be secured once complete elements are in place, including wired and wireless coverage, computing power, storage, cloud services, and green energy. ICT supply is heavily influenced by investment from governments, enterprises, telecom service providers, cloud service providers, and IoT infrastructure platforms. However, investment is not the only factor affecting ICT supply, and indicators such as wireless coverage and FTTH coverage can also be used to evaluate and quantify impacts on supply.

Overview of global digital supply in 2023[4]

Global investment in ICT

Global telecom investment and service spending

Global investment in data centers

Global investment in renewable electricity

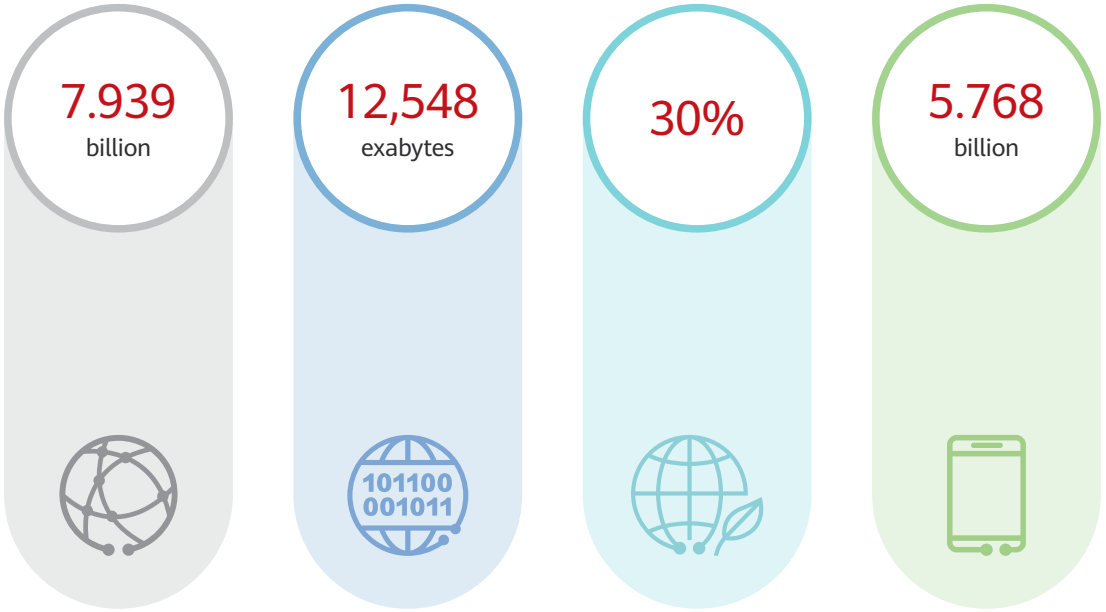
[4] IDC, IRENA, IEA

Growing ICT demand drives digital economy growth

When there is adequate supply, if it is not used, no value can be created. The growth of the digital economy requires balance between supply and demand. Therefore, ICT demand must be measured and analyzed in a timely manner, and investment in supply must be dynamically adjusted based on changes in demand.

The mobile broadband and fixed broadband user bases have been steadily increasing, pointing to growing demand for high-quality networks in a digital economy. Enterprise demand for innovation, cost reductions, and efficiency improvements are driving cloud migration. As more data centers are established around the world, the need for renewable energy development and planning is becoming increasingly prominent. The drive to satisfy key demand is promoting the sustainable development of the digital economy.

Overview of global digital demand in 2023[5]



Global mobile broadband connections

Global data volume

Share of renewable energy in the global energy mix

Global smartphones

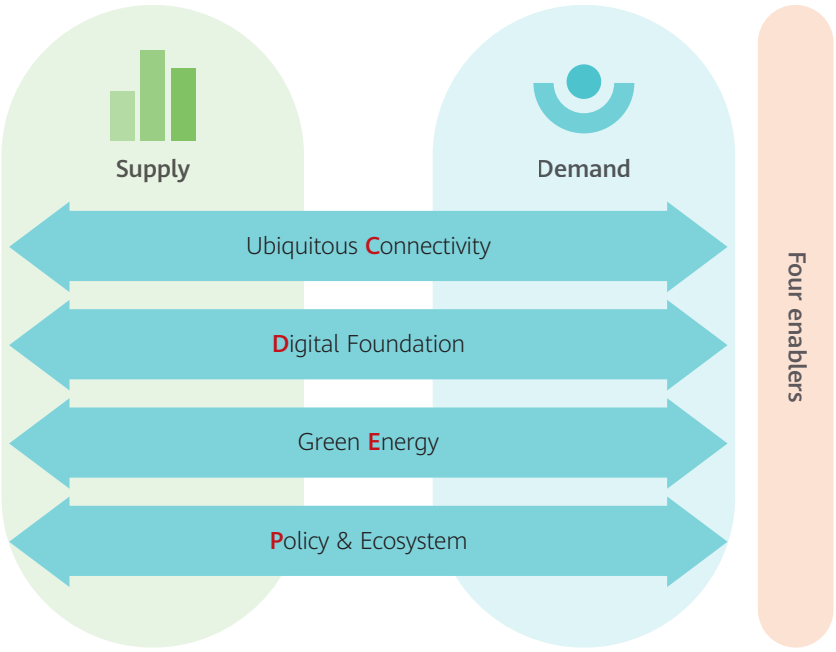
[5] IDC, GSMA, IRENA

GDI framework

The GDI is an evolution from the Global Connectivity Index (GCI). The GDI studies different countries' digital infrastructure, including connectivity, computing power, storage, and green energy, aiming to more accurately evaluate a country's digital economy development, industry development, and talent ecosystem readiness.

We designed the GDI framework by taking into account both the four enablers for the 2030 intelligent world, and the supply and demand theory for the digital economy. The framework points out the importance of striking a dynamic balance between industry supply and market demand to grow the digital economy, helps countries identify the advantages and shortcomings of specific industries, and provides a reference for the design and execution of national digitalization strategies.

GDI framework



This GDI measures the digitalization progress of 77 countries using 42 indicators under the four crucial enablers: Ubiquitous Connectivity, Digital Foundation, Green Energy, and Policy & Ecosystem. This research covers countries representing a total of 93% of the world's GDP and encompassing 80% of the global population, meaning it gives a good indication of the general progress in global digital transformation.

GDI Indicators

Enabler	Supply	Demand
Ubiquitous Connectivity	Fiber Coverage (To C) Fiber Coverage (To B) International Bandwidth 4G & 5G Coverage Mobile Broadband Experience Fixed Broadband Experience Enterprise Gigabit Campus Penetration IPv6 Deployment Rate	Fixed Broadband Subscriptions Mobile Broadband Subscriptions IoT Installed Base Mobile Broadband Affordability Fixed Broadband Affordability Mobile Data per Connection Enterprise Export Bandwidth 10 Gigabit+ Deployment Rate
Digital Foundation	Datacenter Investment Advanced Storage Investment Business Continuity and Disaster Recovery (BCDR) Adoption Computing Power Investment Cloud Investment	Cloud Migration & Cloudification Rate Data Creation E-government Index Industry Digital Transformation Spending
Green Energy	Renewable Electricity Investment Ratio Green Travel Ratio Charging Convenience	Renewable Electricity Utilization Rate Economics of Renewable Energy
Policy & Ecosystem	ICT Investment Spectrum Policy Digital transformation Policy Green Energy Policy ICT Laws and Regulations ICT Patents	Internet Participation E-commerce Volume Smart Phone Penetration Online Video Watching Time Number of Startups STEM Graduate Ratio ICT Workerforce

Country Rankings

Country Rankings

GDI 2024 examined the investment and application of digital infrastructure across 77 countries. These countries are grouped into three clusters — Starters, Adopters, and Frontrunners — based on their levels of ICT and economic development.

GDI Country Rankings

FRONTRUNNERS

RANK	COUNTRIES	SCORE
1	United States	78.8
2	Singapore	76.1
3	Sweden	74.5
4	Finland	73.0
5	Denmark	71.8
6	Switzerland	71.4
7	Netherlands	69.7
8	China	69.2
9	Ireland	68.1
10	Australia	67.6
11	United Kingdom	66.8
12	New Zealand	65.6
13	Norway	64.9
14	Germany	63.4
15	France	62.2
16	United Arab Emirates	61.4
17	Canada	61.3
18	Belgium	60.5
18	South Korea	60.5
20	Japan	58.8
21	Luxembourg	58.0
22	Austria	57.3

ADOPTERS

RANK	COUNTRIES	SCORE
23	Saudi Arabia	54.4
23	Portugal	54.4
25	Spain	54.3
26	Estonia	54.1
27	Italy	50.2
28	Malaysia	49.9
28	Greece	49.9
30	Chile	49.5
31	Czech Republic	49.1
32	Romania	49.0
33	Hungary	48.9
34	Lithuania	48.7
35	Slovenia	48.1
36	Poland	47.8
37	Thailand	47.2
38	Croatia	46.7
39	Bulgaria	46.5
40	Brazil	44.8
41	Bahrain	44.7
42	Slovakia	43.7
43	South Africa	43.4
44	Kuwait	43.0
45	Serbia	42.2
46	Oman	41.7
47	Türkiye	41.4
48	India	40.3
49	Colombia	39.9
50	Mexico	39.6
51	Peru	38.7
52	Uruguay	38.6

STARTERS

RANK	COUNTRIES	SCORE
53	Vietnam	36.7
54	Argentina	36.5
55	Costa Rica	35.4
56	Philippines	34.9
57	Morocco	34.3
58	Kazakhstan	33.2
59	Indonesia	33.1
60	Egypt	32.7
60	Uzbekistan	32.7
62	Tunisia	32.6
63	Ecuador	32.4
64	Jordan	32.2
65	Kenya	32.0
66	Azerbaijan	31.6
67	Dominican Republic	30.9
68	Pakistan	28.5
69	Algeria	28.4
70	Bolivia	28.3
71	Botswana	27.5
71	Ghana	27.5
73	Uganda	27.4
74	Nigeria	27.3
75	Namibia	27.1
76	Bangladesh	26.5
77	Tanzania	25.3

Note: The GDI ranks countries based on 42 indicators that assess their digital infrastructure maturity. The data is sourced from authoritative organizations, including the Organization for Economic Cooperation and Development (OECD), International Telecommunication Union (ITU), Global System for Mobile Communications Association (GSMA), World Economic Forum (WEF), World Bank, United Nations, Ookla, International Renewable Energy Agency (IRENA), and IDC. For a more detailed description of the model and the calculations involved, see the sections on the GDI methodology and indicator definitions.

Starters

Starters are in the early stage of ICT infrastructure build-out. Most of the 25 countries in this cluster are developing and emerging market countries. These countries face gaps in MBB coverage and fiber access, and need to enhance connectivity in every aspect and give more people access to the digital economy. Despite these challenges, we see significant potential in these countries. They tend to have abundant natural resources, and can balance digitalization with low-carbon development through supportive industry policies and forward-looking plans.

Adopters

Adopters are on the fast track of digital development thanks to widespread basic connectivity. Most of the 30 countries in this cluster are middle-income developing countries. These countries are focusing on expanding ubiquitous connectivity coverage, knowing that reliable and extensive connectivity will enable efficient digital services. Some of the countries have introduced supportive industry policies to boost connectivity benefits like higher information exchange efficiency for more people, families, and enterprises. Reliable connectivity is also crucial for the development of data centers, cloud, and storage. Adopters can leverage their basic connectivity to seize opportunities by investing in digital foundations including cloud and data storage. This will promote economic growth and digital transformation across pillar industries.

Frontrunners

Frontrunners are at the forefront of digitalization. Most of the 22 countries in this cluster are medium- and high-income countries. These countries focus on enhancing user experience with ubiquitous connectivity and investing in next-generation network technologies. They are also actively advancing the deployment of cloud, data centers, and future-proof computing power and storage. Their strengths in the ICT industry have driven transformation in other industries. They have established themselves as global role models in digital transformation, offering valuable insights for other countries. Sustainability is another key consideration for these Frontrunners. To ensure sustainable digital development, they need to align green energy planning with the construction of communications networks and future-proof computing power.

Analysis of typical countries

Singapore

Singapore is one of the top countries in the GDI Frontrunners cluster, thanks to continued government investment in digital infrastructure, comprehensive training programs, strong R&D support, up-to-date ICT industry policies and legislation, an ample pool of ICT talent, and a favorable environment for innovation. The country's GDI connectivity score is 1.6 times the global average, and its data center investment, computing power, and storage capacity are more than twice the global averages. The government will look to build seamless end-to-end 10 Gbps[1] domestic connectivity within the next five years. Currently, 98% of all homes have broadband access, with most able to access 1 Gbps speeds[1].

In 2019, Singapore unveiled its first National AI Strategy, outlining plans to deepen the use of AI to transform its economy. In 2023, the country launched the Singapore National AI Strategy 2.0 (NAIS 2.0), also known as "AI for the Public Good, for Singapore and the World", which seeks to establish Singapore as a global AI hub[2]. Additionally, the government plans to develop a roadmap for green data centers in support of the country's net-zero targets. Singapore expects around US$7.5 billion to US$9 billion in new data center investment over the next ten years.

Saudi Arabia

As part of Saudi Vision 2030, the Saudi Arabian government is ramping up its ICT investment[3]. The country ranks first in the GDI Adopters cluster. In recent years, the government has launched several key initiatives, such as the 10Gbps Society initiative. In 2023, the country rolled out commercial 5G-A networks in the Middle East[3], with a GDI connectivity score well above the global average. In addition, the government plans to invest in mega data centers with a combined capacity of 1.3 GW[4], with the aim of turning Saudi Arabia into a regional digital hub. The government has also placed significant importance on the development of AI. The AI industry is projected to contribute US$135 billion to the country's economy by 2030[1].

[1] International Trade Administration (ITA)
[2] Smart Nation Singapore
[3] Riyadh Daily
[4] Capacity Media, MCIT

Thailand

The Thai government is actively pushing the country's digital transformation. In addition to accelerating dual gigabit network development, the government is collaborating with major telecom companies such as AIS, DTAC, and True to speed up 5G network deployment in both urban and rural areas. GDI research shows that Thailand's FBB and MBB speeds have exceeded the global averages.

The Thailand 4.0 plan not only drives the development of the Eastern Economic Corridor (EEC), but facilitates investments in 5G, cloud, big data, AI, and more. Notably, progress in the National Broadband Network (NBN) initiative has expedited the nationwide deployment of high-speed Internet. Furthermore, the Thai government has reinforced its *National AI Strategy and Action Plan (2022–2027)* and launched an AI development agenda, including the creation of a national AI service platform and a Thai Large Language Model (ThaiLLM)[5].

Kenya

Kenya has made significant strides in the ICT sector, driving rapid growth in the digital economy. In recent years, the government unveiled the *ICT Authority Strategic Plan (2020–2024)* and *National ICT Master Plan*[6]. A budget of US$125 million has been allocated for the fiscal year 2024–2025 to facilitate the development of digital infrastructure[7]. Efforts include expanding mobile network coverage, building a national fiber-optic network, and digitalizing government services. Robust government support has contributed to the country's thriving e-commerce sector.

[5] Telecom Review
[6] ICT Authority
[7] Connecting Africa

Key Findings of GDI 2024

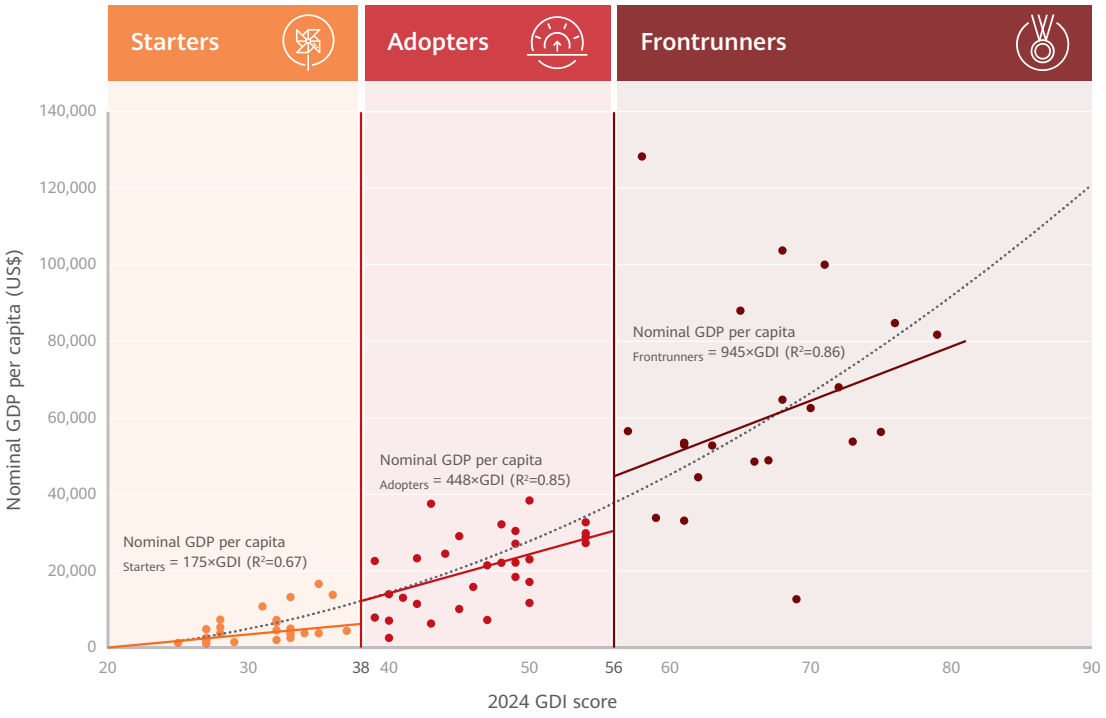
Key Findings of GDI 2024

The GDI 2024 research reveals a strong correlation between ICT industry development and digital economic growth. Countries with a more mature ICT industry tend to excel in digital economic development. However, ICT industry development varies among countries, with ubiquitous connectivity being the main cause of gaps. To bridge the digital divide, moderately advanced investment in digital infrastructure, supportive industry policies, and a robust pool of talent are essential.

Key finding 1: The maturity of the ICT industry is strongly correlated with GDP per capita growth, but the extent of economic benefits varies by country due to their different levels of ICT development. In Frontrunner countries, for example, a one-point increase in GDI score produces 5.4 times the economic value than a one-point increase in Starter countries.

The GDI examines the correlation between ICT industry maturity and digital economic growth. Our analysis shows that countries with higher GDI scores experience greater economic benefits from ICT development. Our further correlation analysis of GDI score changes and GDP growth across the three clusters reveals that each one-point increase in the GDI score of Frontrunners can boost GDP per capita by US$945, which is 2.1 times the increase observed for Adopters and 5.4 times that for Starters.

Correlation between GDI score and nominal GDP per capita



Frontrunners have adopted supportive industry policies to foster digital infrastructure investment, technological innovation, and ICT talent and ecosystem development. This has enabled them to lead both in ubiquitous connectivity and digital foundations. They have created value through a wide range of digital applications and automated production across various industries, driving the advancement of the digital economy. In China, the Port of Tianjin has undergone a digital transformation by integrating 5G, cloud, AI, and green energy technologies. It has built a smart zero-carbon terminal, achieving a 50% reduction in container transshipment, a 17% decrease in energy consumption, and a 60% reduction in personnel compared to traditional terminals of the same size. This terminal operates entirely on green power, which significantly enhances the port's economic performance.

Accelerators are benefiting from their investment in ubiquitous connectivity and digital foundations. They use digital technologies such as 5G, fiber optics, data centers, and advanced storage to facilitate data transmission and real-time computing, boost industrial production efficiency, and drive fast digital economic growth. For example, Mexico's investment in data centers is projected to generate substantial growth, with 73 new data centers expected to be established by 2029, in addition to the existing 15. This expansion is expected to boost the national GDP and create 68,198 direct and indirect jobs by 2029[1].

Some Starters have built basic connectivity networks and developed digital services such as digital payments and e-commerce. This has made their digital economies more inclusive and boosted SME productivity, thereby stimulating economic growth. According to a World Bank study, a 10% increase in FBB penetration would increase GDP growth by 1.38% in developing economies. For example, Kenya has been expanding 4G coverage to support the widespread use of mobile money platforms, giving millions of Kenyans access to banking services.

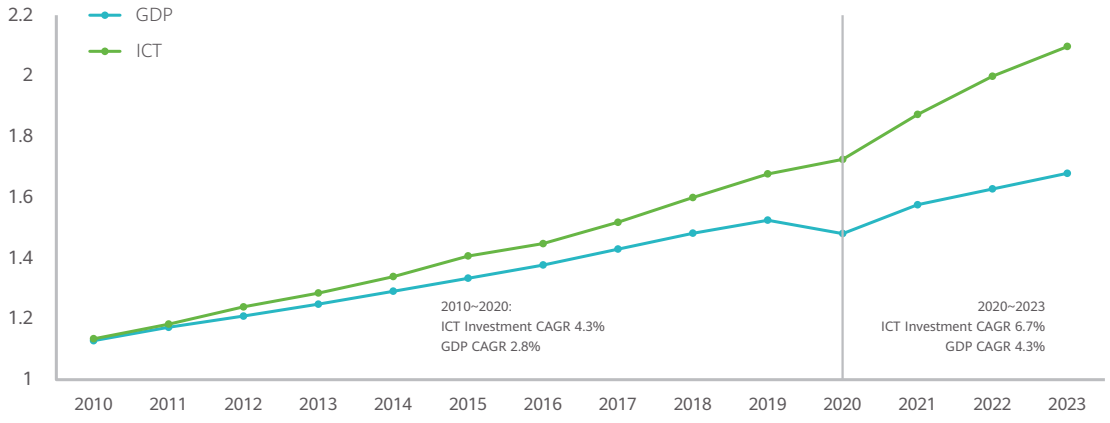
[1] Mexico Business News

Key finding 2: Forward-looking digital infrastructure development serves as a new engine for economic growth. Countries around the world are currently racing to digitalization. Our research found that a one-US-dollar investment in digital transformation results in an 8.3-US-dollar return in a country's digital economy.

The GDI has researched the trends in digital infrastructure investment and GDP growth across the 77 countries since 2010. Comparative analysis reveals that despite the countries having varying levels of ICT industry maturity, governments around the world understand the value of investing in digital infrastructure. As a result, global investment in digital infrastructure has been increasing annually, consistently outpacing GDP growth.

In the decade from 2010 to 2020, the CAGR of global ICT investment reached 4.3%, 1.5% higher than the CAGR of GDP. Despite a major slowdown in the global economy in 2020 due to the COVID-19 pandemic, global investment in digital infrastructure continued to grow, with a CAGR of 6.7%. This has helped countries improve emergency response and facilitate economic recovery. In the post-pandemic era, there has been a notable surge in digital infrastructure investment globally, which has accelerated the global economic rebound (with the CAGR of GDP increasing to 4.3%) and bolstered future economic resilience. For example, Germany increased its investment and support in the ICT sector during the pandemic, furthering the adoption and upgrade of high-speed broadband networks. This strengthened the network foundations for remote work, online education, digital healthcare, and more. The government encouraged enterprises to pursue digital transformation and adopt new technologies and business models by providing funding, tax incentives, and other supportive policies. These initiatives not only helped enterprises maintain positive growth with increased productivity and competitiveness, but played a crucial role in economic recovery.

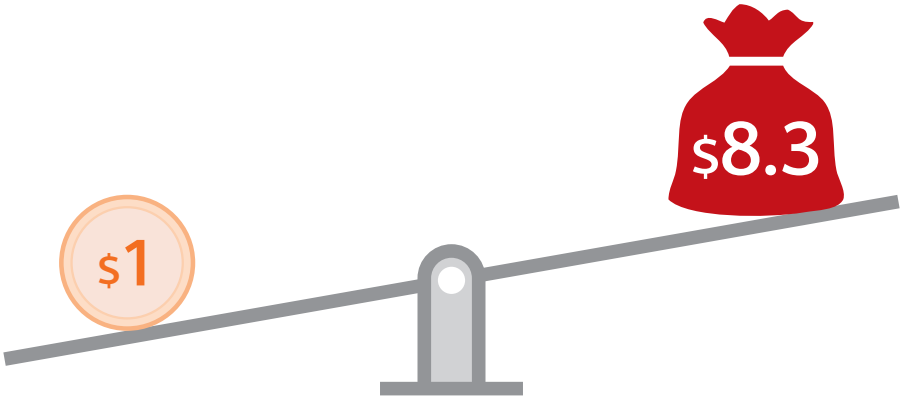
GDP growth rate vs ICT investment growth rate



Countries' investments in digital transformation will significantly increase enterprise operational efficiency, foster new service models and business models, increase demand for digital applications, and stimulate economic growth.

The GDI research examines the correlation between digital transformation spending and digital economic output, finding that **a one-US-dollar investment in digital transformation results in an 8.3-US-dollar return in a country's digital economy**. As digital transformation accelerates across industries, the digital economy is also expected to grow faster.

A one-US-dollar investment in digital transformation results in an 8.3-US-dollar return in a country's digital economy



Digital transformation spending[2]: Digital transformation is the ongoing process by which enterprises leverage their digital capabilities to innovate new business solutions, increase operational efficiency, and improve organizational performance.

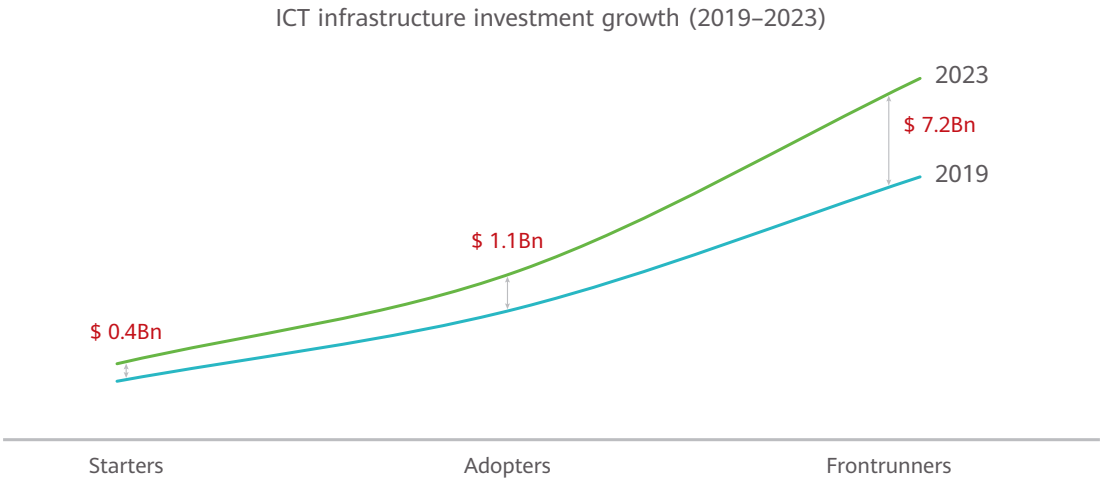
Digital economic output: The digital economy market size[3] multiplied by nominal GDP

[2] IDC's *Worldwide Digital Transformation Spending Guide Taxonomy, 2024*
[3] *Digital Spillover: Measuring the true impact of the digital economy*, by Oxford Economics & Huawei

Key finding 3: The ICT industry is progressing unevenly across countries. However, ubiquitous connectivity can bridge the digital divide. A robust digital foundation and ubiquitous connectivity can reinforce each other, creating a multiplier effect on economic development.

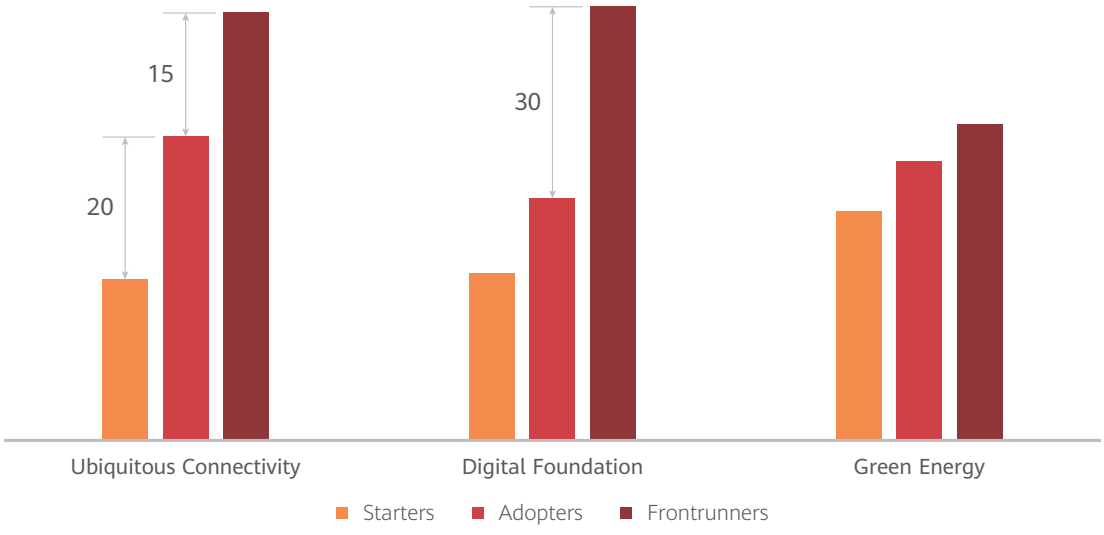
Research indicates that the gap in digital infrastructure investment growth among countries continues to widen. From 2019 to 2023, the ratio of digital infrastructure investment growth among Frontrunners, Adopters, and Starters was 18:3:1, with an annual average increase of US$7.2 billion, US$1.1 billion, and US$400 million, respectively. The ratio of 5G population coverage growth was 5:2:1, with an annual average growth rate of 5.5%, 2.5%, and 1.3%, respectively. In addition, investments in computing, storage, and data centers further widened the gap between Frontrunners and Adopters. From 2021 to 2023, Frontrunners saw a US$1.46 billion increase in data center investment, 13 times higher than Adopters.

Annual investment growth in the three clusters (2019–2023)



To find ways to bridge the digital divide, the GDI research analyzed the performance of the three clusters in three technology enablers (as shown below), revealing that the biggest gap is in ubiquitous connectivity. Frontrunners lead Adopters by 15 points and Starters by 35 points in ubiquitous connectivity. In digital foundations, Frontrunners lead Adopters by 30 points, while the difference between Adopters and Starters is relatively small.

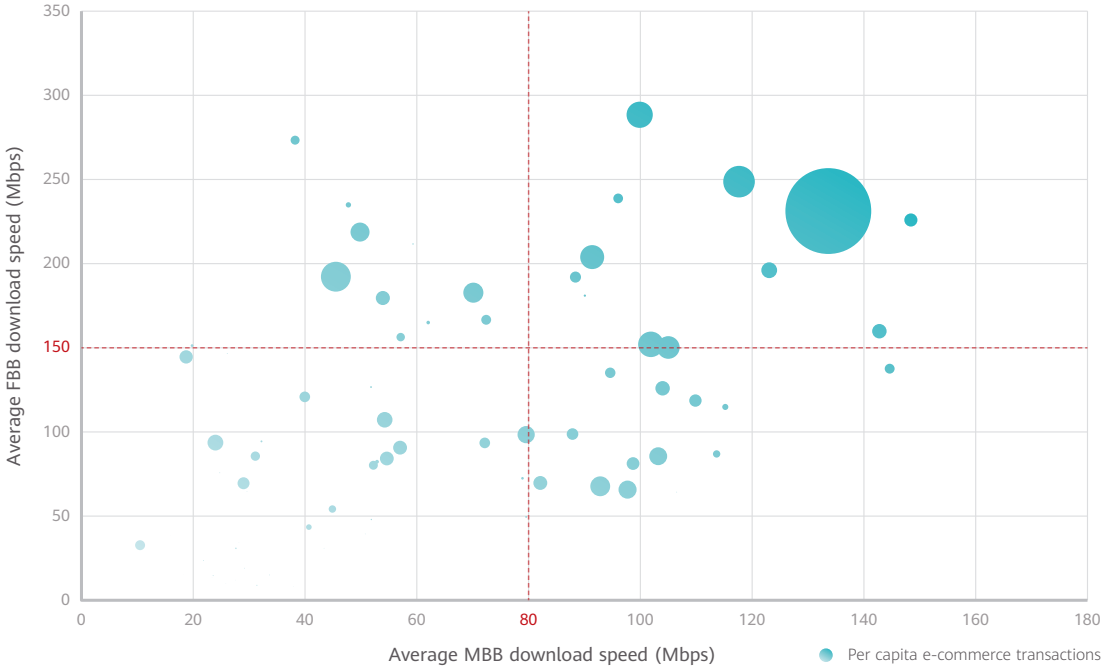
Scores of the three clusters in the three major technology enablers of the GDI



Therefore, countries should tailor their digital infrastructure investment strategies to their specific conditions, identify the underlying issues, and develop an optimal investment portfolio.

For Starters, prioritizing basic connectivity is crucial. Research demonstrates that the coordinated development of FBB and MBB can maximize the potential of the digital economy. Countries that excel in both FBB (download speeds > 150 Mbps) and MBB (download speeds > 80 Mbps) see higher per capita e-commerce transactions, thereby unlocking greater digital economic potential.

Relationship between connectivity networks and e-commerce (77 countries)



In 2019, Indonesia completed its national optical fiber development initiative, Palapa Ring. 12,000 kilometers of fiber-optic cables were laid to provide Internet access to nearly 6 million people across 57 cities and districts. Later, the country launched Palapa Ring Integration, aiming to lay an additional 11,000 kilometers of fiber-optic cables. This project is expected to cover 16.4 million people. Indonesia has built more than 100,000 4G base stations, covering more than 94% of cities and villages. The country's Internet penetration rate stands at 79.5%[4]. The coordinated development of FBB and MBB has enabled Indonesia to become the largest e-commerce market in Southeast Asia. In 2023, its digital economy reached US$82 billion, and over 15 unicorn companies were created. By 2030, the country's digital economy is projected to exceed US$210 billion[5].

Adopters need to focus on both ubiquitous connectivity and digital foundations. Some of the Adopters have started building private mobile networks and data centers to improve industry productivity and foster digital economic growth. For instance, Greece has implemented a private mobile network at the Piraeus Container Terminal (PCT). This network, which supports 4G/LTE and NB-IoT technologies, facilitates real-time data transmission and sensor installation for digital applications, thereby making maritime operations more efficient through digitalization[6].

Frontrunners score high in both ubiquitous connectivity and digital foundations. Research shows that when the scores for both ubiquitous connectivity and digital foundations exceed 50 points, they reinforce each other more and create a multiplier effect on digital economic growth. Countries that score high in ubiquitous connectivity alone may struggle to further boost productivity and innovation due to inadequate investment in digital foundations such as the computing power and storage needed to handle large volumes of data and digital applications.

Relationship between Ubiquitous Connectivity, Digital Foundation, and per capita GDP (77 countries)

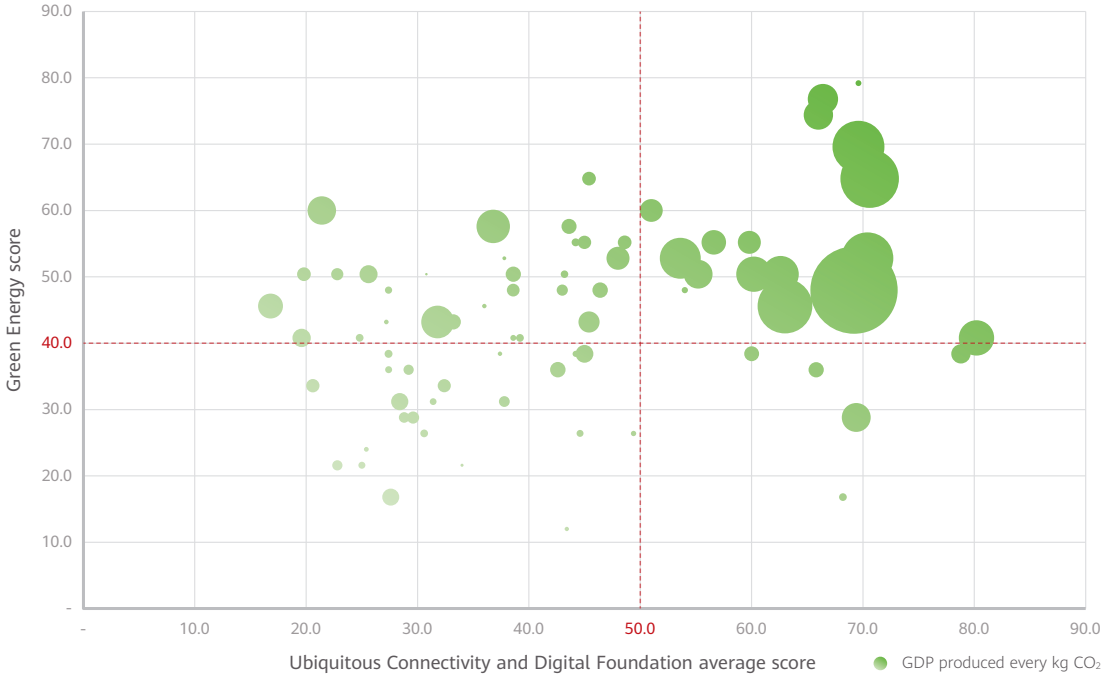
[4] People's Daily Online (April 19, 2024, 16th edition; April 18, Jakarta)
[5] Economic and Commercial Office of the Mission of the People's Republic of China to the Association of Southeast Asian Nations (Source: Antara News Agency), Bain Analysis
[6] Porttechnology.org

Key finding 4: Countries must embrace green energy technologies to gear up for the sustainable growth of their digital economies and large-scale application of AI.

The ICT industry is creating new tools that can be used to drive sustainability. For example, digital technologies can be used to predict climate change and help us better prepare for natural disasters and mitigate risks. However, the swift development of the digital economy is accompanied by issues such as rapid increases in energy consumption and carbon emissions. Data centers consume huge amounts of energy, which increases carbon emissions and puts immense pressure on energy supply. It is therefore essential that digital economies are also low-carbon economies, in order to grow sustainably and with high quality.

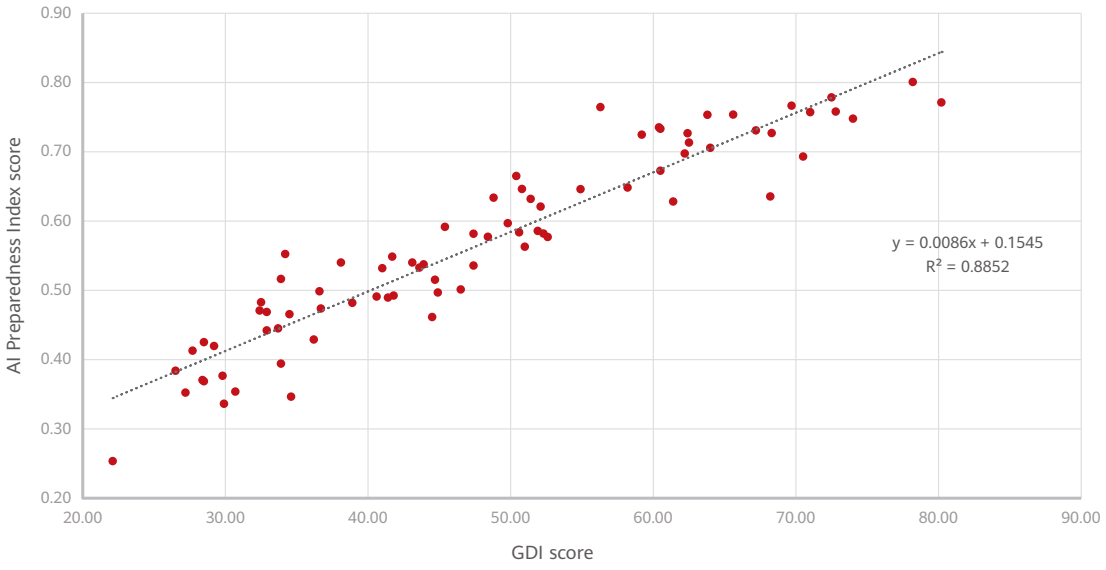
GDI research shows that countries scoring high in Green Energy, Ubiquitous Connectivity, and Digital Foundation achieve higher GDP per kilogram of carbon emissions. According to the *SMARTer2030* report released by the Global e-Sustainability Initiative (GeSI), applying digital technologies that integrate green energy can contribute to 20% of global carbon emission reductions by enabling various industries by 2030.

Relationship between digital technology and low-carbon development (77 countries)



Research also shows that the GDI strongly correlates to the AI Preparedness Index of the International Monetary Fund (IMF). Countries with high GDI scores are better prepared for AI. This makes sense, as the three technology enablers of the GDI – Ubiquitous Connectivity, Digital Foundation, and Green Energy – are also the foundations for the development, application, and widespread adoption of AI. High-speed, low-latency network connections are a prerequisite for AI development and provide the basis for all things to sense, connect, and be intelligent. In addition, future-proof computing power and storage are key to AI development. The analysis, learning, and inference of massive amounts of data requires strong computing power in order to quickly complete tasks. In turn, industries' growing demand for real-time and efficient AI boosts demand for advanced computing power and storage capacity. Furthermore, AI development will lead to a sharp increase in the energy consumption of infrastructure such as data centers. We can no longer rely on traditional energy, as this would only exacerbate carbon emissions and environmental problems. Therefore, green and affordable energy is the only way forward. For countries with AI strategies in place, forward-looking investment in the three major technology enablers will accelerate progress towards an intelligent world.

Correlation between GDI and AI Preparedness Index (77 countries)



Key finding 5: Supportive industry policies and well-paced planning create fertile ground for national digital economies to grow.

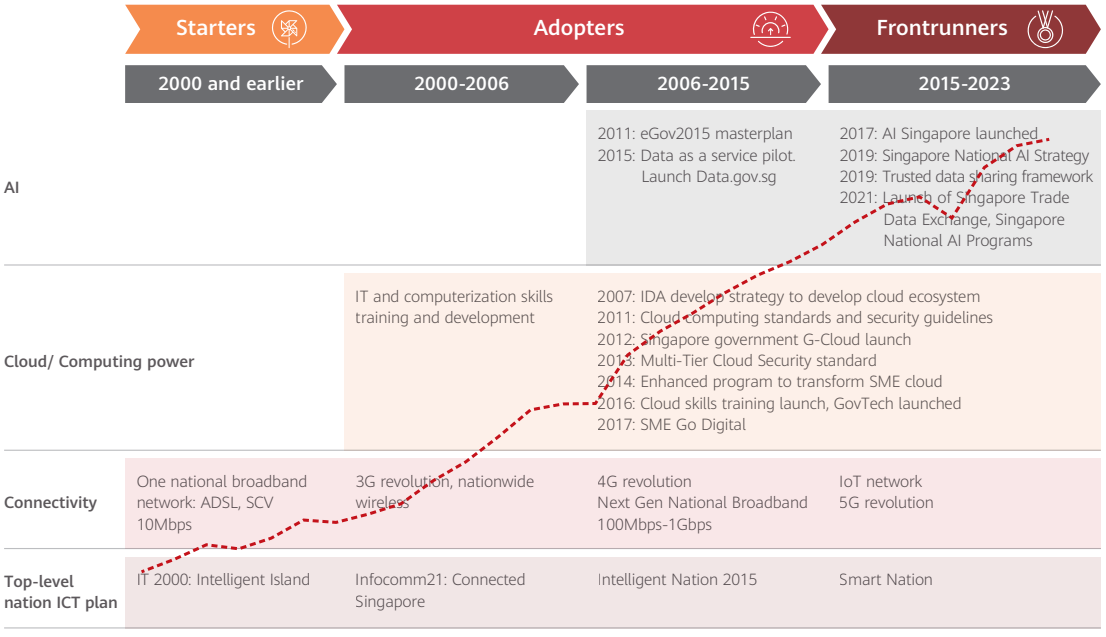
Governments have come to realize the pivotal role of digital infrastructure in driving social, economic, and technological development, and improving national competitiveness. Compared with more traditional infrastructure like roads, digital infrastructure brings higher returns on investment (ROI). According to the *Digital Spillover* report[7], the long-term return on digital infrastructure investment is 6.7 times that of investment in other types of infrastructure. Some countries among the first to enjoy the dividends of digital infrastructure have introduced digital economy strategies and policies or mid- and long-term ICT plans. They are thus already making forward-looking ICT investment, creating fertile ground for the digital economy to grow.

Take Singapore as an example. Its government has introduced appropriate digital strategies and industry policies at different stages of the country's development. In the 1990s, the government announced *IT2000: A Vision of an Intelligent Island* to focus on building national broadband and providing online services for the public 24/7. In 2000, *Infocomm 21 (Information and Communications Technology for the 21st Century)* was launched, focusing on building ICT industry clusters and hubs and creating an environment in which citizens and enterprises could easily access information technologies. In 2006, the government unveiled *Intelligent Nation 2015 (iN2015)*, aiming to make Singapore an information-powered intelligent nation by upgrading connectivity infrastructure and building a cloud computing ecosystem. Then, in 2015, the country introduced *Smart Nation 2025* to enable data connections across the country and serve citizens' personalized data requirements. GDI research shows that Singapore has grown from a Starter in 2000 to a Frontrunner, now taking second spot globally with a flourishing digital economy.

Singapore's experience shows that the digital economy develops incrementally. Governments should take a long-term perspective and ensure practical execution when developing ICT investment and development plans. Investment portfolios that can be adapted to the different stages of industry development will maximize returns.

[7] *Digital Spillover: Measuring the true impact of the digital economy*, by Oxford Economics & Huawei

Singapore's digital transformation journey



(Sources: Desk Research, IDC Analysis)

Singapore's GDP growth (1996–2023)

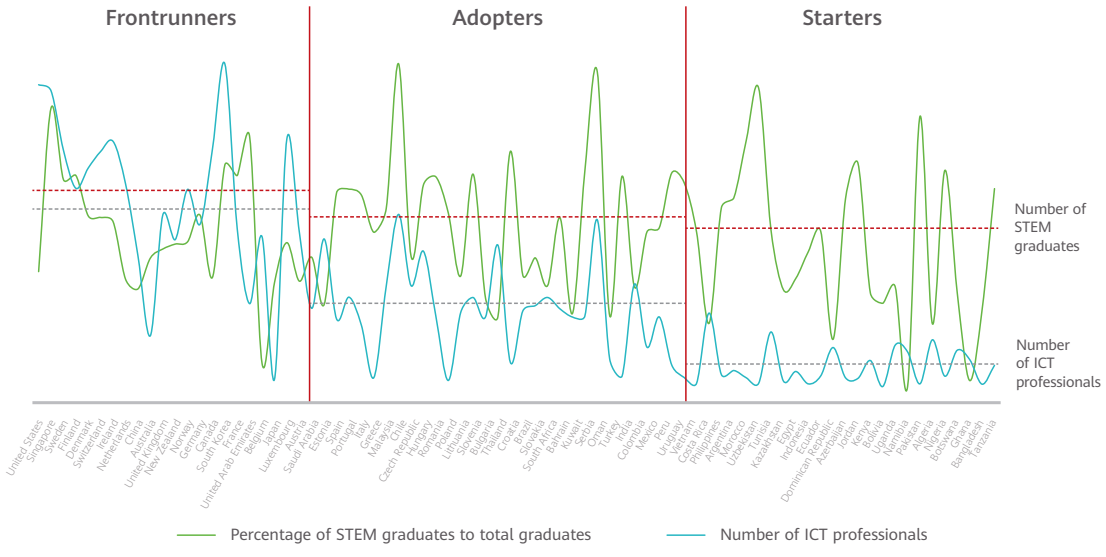
Key finding 6: The proportion of STEM graduates in different countries is similar, but the conversion rate to ICT professionals varies greatly by country.

STEM graduates are a major source of the ICT workforce. Research shows that the proportion of STEM graduates in the three clusters of countries is similar at about 25%. However, the conversion rate to ICT professionals varies greatly by country due to the discrepancies in local ICT industry development, which directly impacts available ICT jobs. 95% of STEM graduates can find jobs in ICT-related fields in Frontrunners. However, in Adopters and Starters, this number drops to 50% and 15%, respectively.

There are several reasons for this. First, Frontrunners have better-developed ICT industries, meaning more ICT job opportunities for STEM graduates. Second, Frontrunners have more sound mechanisms and policies for ICT talent identification, certification, and mapping, as well as international talent attraction than Adopters and Starters. With more advanced ICT ecosystems, Frontrunners are better positioned to facilitate the transition from STEM graduates to ICT professionals, thus supporting the sustainable growth of their digital economies.

In this sense, both Starters and Adopters are suffering from brain drain to some extent. Therefore, to enable sustainable digital economy growth, they will need to ramp up investment in their local ICT industries, provide more ICT jobs, and refine ICT talent policies to help covert more STEM graduates into ICT professionals.

ICT talent development and job opportunities in the three clusters



Sources: Desk Research, IDC Analysis

Recommendations

Recommendations

Compiled from extensive data research and analysis, the GDI highlights how countries can seize opportunities and accelerate their digital economies by comprehensively advancing their ICT industries, even amid economic uncertainty and intense competition. Policy makers should make mid- and long-term plans for ICT investment and rollout, and develop clear development strategies and feasible action plans.

- **Ramping up forward-looking digital infrastructure development:** Governments should prioritize digital infrastructure to the same level as transportation and electricity, increasing both investment and policy support. Somewhat forward-looking digital infrastructure development drives economic development. Countries with a low level of connectivity can first prioritize developing connectivity infrastructure to bridge the digital gap. Countries with higher levels of connectivity can start deploying next-generation network infrastructure and strengthening their digital foundations to fully unleash digital productivity.

- **Accelerating industry digitalization:** New ICT technologies are enabling a rich array of new applications that are driving the next phase of digital transformation. Industry digitalization is a gradual process that involves selecting the right transformation paths and building intelligent ICT infrastructure using a tiered approach. Government support is essential in this process. Governments can help industries improve transformation efficiency by promoting the widespread adoption and application of information technologies to ensure that data is fully connected, interoperable, and shared.

- **Growing digital talent reserves:** In the future, comprehensive ICT laws and regulations, combined with a strong reserve of technological talent – both domestic and international – will propel the digital economy into the fast lane of development. Governments and enterprises must develop or attract required talent as soon as possible, improve citizens' digital literacy across the board, and create a relaxed innovation climate, in order to seize the historic opportunities presented by the Fourth Industrial Revolution.

After factoring in the different maturity levels of ICT industries in the three country clusters and analyzing the gaps and their root causes, recommended actions have been proposed to help countries design optical industry investment portfolios that promise the highest ROI.

Recommendations for Starters

Key Area	Recommended Actions
Ramping up forward-looking ICT infrastructure development	**Develop reliable connectivity infrastructure and increase connectivity supply** • Invest in the development of reliable broadband networks to ensure widespread Internet access, especially in underserved, rural areas. • Expand and enhance mobile network coverage and capacity, focusing on upgrading to 4G and planning 5G deployment. • Ensure stable and reliable power supply, especially for ICT infrastructure, to avoid disconnections and service interruption. • Develop and implement disaster relief and business continuity plans to improve the resilience of ICT infrastructure against natural disasters and other emergencies.
Accelerating industry digitalization	**Provide inclusive digital services like e-commerce and digital banking across key industries to integrate more people into the digital economy** • Encourage governments and the private sector to work together and share resources, expertise, and funds in digital infrastructure projects. • Provide digital services in key industries, such as government and finance, to improve citizen satisfaction. • Provide universal coverage to enable digital education, remote healthcare, and more to address key challenges in people's lives.
Growing digital talent reserves	**Provide inclusive ICT education and improve people's digital skills** • Develop and implement comprehensive digital literacy programs for all age groups to ensure citizens are equipped with the skills needed to effectively use digital tools and services. • Incorporate ICT education into national curricula to ensure students acquire necessary digital skills from a young age.

Recommendations for Adopters

Key Area	Recommended Actions
Ramping up forward-looking ICT infrastructure development	**Comprehensively upgrade digital infrastructure and improve service quality, or supply high-quality digital infrastructure** • Ensure that ICT infrastructure is both usable and useful. • Direct investments towards technologies like 5G, cloud computing, and advanced data storage to enable ubiquitous connectivity and establish a robust digital foundation. • Develop energy-efficient and sustainable data centers to meet fast-growing demands. • Develop new, more reliable and energy-efficient power infrastructure.
Accelerating industry digitalization	**Increase adoption of digital applications in industries and create new production models** • Encourage industries to migrate applications to the cloud at scale and use digital technologies to improve efficiency and user experience. • Encourage enterprises to develop data awareness, unlock the value of data, and improve decision-making efficiency. • Emphasize data protection and privacy security and standardize data governance practices.
Growing digital talent reserves	**Develop professionals with ICT and innovation skills** • Invest in specialized ICT training programs and services to improve citizens' digital skills across the board and develop more ICT professionals. • Introduce incentive measures, such as preferential individual income tax policies and talent subsidies, to attract and retain top talent with emerging technical skills.

Recommendations for Frontrunners

Key Area	Recommended Actions
Ramping up forward-looking ICT infrastructure development	**Invest in next-generation ICT infrastructure to accommodate new business scenarios and maintain a competitive advantage in digital economy development** • Provide ubiquitous, quality connectivity, such as 5G-A, all-optical networks, and computing networks, for all business scenarios in preparation for a digital leap forward. • Develop green and intensive data centers to meet the growing demands for cloud services, big data analytics, and AI workloads. • Invest in AI technologies and ecosystems to support AI applications in industries. • Invest heavily in renewable energy and develop new power infrastructure to meet the electricity demands of growing computing facilities.
Accelerating industry digitalization	**Build a unified data foundation to help industries go from digital to intelligent** • Eliminate data silos and build a unified data foundation. • Develop advanced large-capacity storage while ensuring data security and cost effectiveness. • Build intelligent platforms and integrate AI into core business processes, enabling automatic decision-making and resolution for minor issues and assisted analysis and decision-making for bigger issues.
Growing digital talent reserves	**Nurture the innovative talent of tomorrow** • Maintain a high level of R&D investment to sustain innovation. • Create and engage in collaborative innovation ecosystems, including building partnerships with startups, academia, and other industry players. • Provide ongoing training and development programs to equip the workforce with skills regarding emerging technologies. • Develop strategies to attract and retain top talent.

Appendix

GDI Methodology 2024

Note: The Global Digital Index (GDI) was jointly developed by Huawei and IDC. It is based on the Global Connectivity Index (GCI). The study covers 77 countries, which together represent 93% of the world's GDP and 80% of the global population. The research team worked closely with industry scholars, customers, and partners; referred to data, methods, and insight reports from the United Nations, GSMA, and consulting companies; and developed a unique methodology that combines both technical and economic elements. IDC collected and collated the GDI data, scored and ranked countries based on the data of their performance, and is responsible for the authenticity and scientific interpretation of the data.

Research Framework

The GDI evaluates the performance of 78 economies through 43 indicators that gauge the digitalization progress of these economies and correlates the impact of digitalization on economic growth, competitiveness, and sustainability. Collectively, these nations account for 93.3% of the global economy in 2023, encompassing 82% of the world's population.

When building the GDI, we reviewed public reports, existing literature and indices, technology trends and gathered feedback from IDC's technology analysts. We noted several key digital trends and identified the driving technologies behind them. We developed the GDI based on these technologies grouped into four CDEP enablers.

The Four Pillars - CDEP

The Global Digital Index (GDI) offers a comprehensive framework for evaluating the digital landscape through an examination of four crucial technology enablers: Ubiquitous Connectivity, Digital Platform, Green Energy, and Policy & Ecosystem.

- **Ubiquitous Connectivity (C)** is where it all begins, enabling seamless communication and data exchange worldwide. Expanding and enhancing connectivity infrastructure is vital for bridging the digital divide and ensuring that everyone, regardless of their economic standing, can participate in the digital economy.

- **Digital Foundation (D)** is about deploying advanced technologies such as AI, IoT, and edge computing that drive efficiency, innovation, and adaptability. This infrastructure is the bedrock upon which smart cities, digital enterprises, and innovative solutions are built, creating a smarter, more responsive global system.

- **Green Energy (E)** is increasingly recognized as a cornerstone of digitalization. As digital technologies become more pervasive, their energy demands must be met sustainably. Transitioning to green energy is crucial not only for mitigating climate change but also for ensuring that digital transformation positively contributes to global sustainability goals.

- **Supporting Policy & Ecosystem (P)** is the glue that holds everything together. A robust regulatory framework and a collaborative ecosystem that fosters innovation while safeguarding public interests are essential for accelerating digitalization and ensuring that its benefits are equitably distributed.

The two fundamental pillars of the digitalized economy are Supply and Demand. The Supply pillar encompasses the entire ICT development and digital transformation chain, building the capabilities that enable the Demand pillar's technology adoption. This synergy drives innovation, productivity, and economic growth, making both pillars critical to the progress and realization of economic benefits in the digital landscape.

The analysis is conducted from both the CDEP enablers and Supply and Demand perspectives, allowing for a vertical and horizontal assessment of the economies. This approach provides in-depth insights into the relative strengths, weaknesses, opportunities, and challenges facing individual economies, guiding strategic investment decisions to enhance digitalization and economic benefits. Furthermore, the GDI measures the sustainable growth of each economy, from renewable energy utilization to cost of ownership, revealing the most successful development pathways and identifying areas where leapfrog technology adoption has proven more effective. This rich dataset serves as a blueprint for organizations and individuals to analyze a wide range of factors pertaining to digital transformation, ICT development, and the economic advantages of digitalization. The comprehensive index rankings offer a clear snapshot of the current state of global digital connectivity, establishing a leading indicator for the next decade of ICT expansion and evolution.

GDI Indicators

Enabler	Supply	Demand
Ubiquitous Connectivity	Fiber Coverage (To C) Fiber Coverage (To B) International Bandwidth 4G & 5G Coverage Mobile Broadband Experience Fixed Broadband Experience Enterprise Gigabit Campus Penetration IPv6 Deployment Rate	Fixed Broadband Subscriptions Mobile Broadband Subscriptions IoT Installed Base Mobile Broadband Affordability Fixed Broadband Affordability Mobile Data per Connection Enterprise Export Bandwidth 10 Gigabit+ Deployment Rate
Digital Foundation	Datacenter Investment Advanced Storage Investment Business Continuity and Disaster Recovery (BCDR) Adoption Computing Power Investment Cloud Investment	Cloud Migration & Cloudification Rate Data Creation E-government Index Industry Digital Transformation Spending
Green Energy	Renewable Electricity Investment Ratio Green Travel Ratio Charging Convenience	Renewable Electricity Utilization Rate Economics of Renewable Energy
Policy & Ecosystem	ICT Investment Spectrum Policy Digital transformation Policy Green Energy Policy ICT Laws and Regulations ICT Patents	Internet Participation E-commerce Volume Smart Phone Penetration Online Video Watching Time Number of Startups STEM Graduate Ratio ICT Workerforce

Scoring and Aggregation

For each variable, an economy 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 2030, 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 economies, historical market performance, and expert analyst's forecasts. Each economy'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)	GDI 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

These indicator scores are then aggregated to form a total score for each of the four GDI CDEP enablers: Ubiquitous Connectivity, Digital Platform, Green Energy, and Policy & Ecosystem.

The enabler's weights are determined through factor analysis, which derives an index variable from an optimally weighted linear combination of the items, known as Factor Scores. The weight assigned to each item is based on its factor loading, reflecting the strength of its relation to the factor (GDI). Consequently, GDI allocates 30% to Ubiquitous Connectivity, Digital Foundation, and Policy & Ecosystem, and 10% to Green Energy.

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

$$\text{GDI} = \sum_{i=1}^{4} \left(\frac{\alpha_i}{n_i} \times \sum_{j=1}^{n_i} \boldsymbol{Score}_j \right)$$, where

i: The CDEP pillars;
ni: number of indicators within the i-th pillars
j: Indicators within each CDEP pillars
αi: Weight assigned for the i-th pillars
See "GDI 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-economy 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.

GDI Indicators Definition

Ubiquitous Connectivity

Fiber Coverage (To C)

A direct fiber-based internet solution extends to the premises, providing a fiber or standard Ethernet LAN connection without relying on additional technologies like DSL or cable modems. This category encompasses passive optical network (PON) and P2P Ethernet connections. Dedicated internet access-based connections offering uncontended, symmetrical bandwidth are excluded and classified under the dedicated internet access segment. This includes connections in which the bill is paid for by the household or residential user.

Calculation: per capita

Fiber Coverage (To B)

A direct fiber-based internet solution extends to the premises, providing a fiber or standard Ethernet LAN connection without relying on additional technologies like DSL or cable modems. This category encompasses passive optical network (PON) and P2P Ethernet connections. Dedicated internet access-based connections offering uncontended, symmetrical bandwidth are excluded and classified under the dedicated internet access segment. This includes connections in which the bill is paid for by a company or government organization.

Calculation: % of GDP

International Internet Bandwidth

International Internet bandwidth refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbit/s). Used international Internet bandwidth refers to the average traffic load of international fiber-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 (bit/s) 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

4G & 5G Coverage

A weighted score of the percentage of mobile device connections which use a 5G connection (accounting for 80% of the score) and the percentage of mobile device connections which use a 4G connection but do not use a 5G connection (accounting for 20% of the score).

Calculation: 4G and 5G connections per total connections

Fixed Broadband Experience

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

Calculation: n/a

Mobile Broadband Experience

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

Calculation: n/a

IPV6 Deployment

The percentage of users able to access internet using IPv6 in the country.
Internet Protocol version 6 (IPv6) is the next generation of the Internet protocol. It was developed to succeed version 4 (IPv4) as IPv4 addresses have almost run out globally. While there are only 3.7 billion unique IPv4 addresses available for use on the Internet, the theoretical IPv6 address pool size is 340 trillion trillion trillion addresses (or 340 undecillion addresses). IPv6 addresses comprise 128 bits and they are usually shown as sequences of hexadecimal digits, separated by a colon character (:).
IPv6 example address: 2001:0db8:85a3:0000:0000:8a2e:0370:7334

Calculation: n/a

Enterprise Gigabit Campus Penetration

Enterprise-grade access devices are WLAN access devices designed for use in multi-access point (AP) systems and typically have a rich and upgradeable feature set. There are two types of enterprise-class access point devices: independent (traditional) and dependent. Deployments are either indoor or outdoor. This indicator refers to the ratio of the unit shipments of Wi-Fi 6 to the total unit shipments supporting the WLAN networks.

Calculation: total unit shipments supporting the WLAN networks

Fixed Broadband Subscriptions

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

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

IoT Installed Base

An IoT connection is defined as an intelligent end point device that has a unique identifier, such as an IP address that enables it to be remotely accessed from a public cellular network or a private IP network/internet, xDSL line, wireless (LPWAN), NFC, microwave radio, or satellite DVB-S2X connection. As an example, transportation systems such as trains, trucks, and buses can have multiple devices such as sensors and IP Cameras that can be addressed remotely and each of these are counted as IoT endpoint connections.

Calculation: per capita

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

Mobile data per Connection

This is the total data traffic transferred over the mobile network, per connection per month in the period. Expressed in megabytes (MB).

Calculation: per connection

Enterprise Export Bandwidth 10 Gigabit+ Deployment Rate

Measuring the wireless network bandwidth of a country enterprise network is an important consideration indicator for enterprise digitization. IDC classifies Ethernet switches by form factor (fixed and modular) and speed (100Mb, 1,000Mb, 2.5GbE, 5GbE, 10GbE,25GbE, 40GbE, 50GbE, 100GbE, 200GbE, and 400GbE). This indicator refers to the ratio of 10G+ ethernet switches shipments to the total ethernet switches shipments in the country.

Calculation: per total ethernet switches shipment

Digital Foundation

Datacenter investments

The total investment in IT infrastructures for all datacenters, encompassing both on-premises and off-premises environments. This includes the cost of servers and storage systems, covering all components such as processors, memory, disk storage, and bundled operating systems and software.

Calculation: per GDP

Advanced Storage Investment

This indicator evaluates the investment in enterprise storage systems, which are crucial for processing, managing, and storing digital data. It includes components like power supplies, cooling systems, storage controllers, and media such as hard disk drives (HDDs) and flash. The focus is on the proportion of advanced storage solutions, like full-flash systems and high-performance AI storage, relative to the total data storage capacity. This reflects a country's capability to support advanced productivity in data management, measured in Terabytes (TB).

Calculations: scaled per GDP and total storage size.

Business Continuity and Disaster Recovery (BCDR) Adoption

Data replication and protection software includes revenue from both software and cloud services that provide data movement, protection, and/or replication (aka online backup or backup as a service [BaaS]) licensed in a subscription fashion. This indicator measures the investment in such functionality to the investment in software.

Calculation: per software investment

Computing Power Investment

We define a server system as a multiuser computing device that accesses and delivers services via a network. A typical server system entails one or more processors, a motherboard, memory, internal disk or flash storage, a bundled operating system (OS), power supply units, and network interfaces. The computing power is measured by the total investment in server system market of the country.

Calculation: per GDP

Cloud Investment

The total expenditure by end-users on public cloud services, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), and System Infrastructure Software as a Service (SIaaS), which encompasses all compute, storage and software application resources in the cloud environment. This metric directly reflects the end-user demand for cloud services provided by cloud service providers. It is evaluated relative to GDP.

Calculation: per GDP

Cloud Migration & Cloudification Rate

This measures the rate at which enterprises are transitioning their infrastructure to cloud environments compared to non-cloud (on-premises) deployments. It also reflects the percentage of enterprise infrastructure hosted in cloud environments (public and private) versus traditional datacenters.

Calculation: n/a

Data Creation

Based on the estimated availability of target-rich, actionable data which 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: per capita

E-Government Service

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

Industry digital transformation spending

Digital transformation is the ongoing process by which enterprises adapt to or drive disruptions in their markets, leveraging digital capabilities to innovate new business solutions that integrate digital and physical experiences, enhancing operational efficiency and organizational performance.

Calculation: per GDP

Green Energy

Renewable Electricity Investment

This indicator measures Total spending on installation cost per kw/mw of Renewable Energy technology in a country (e.g. labor costs, materials costs (purchase price of materials, including feeder materials for biogas/biomass), land costs, BPL costs and FX of local currency to USD, excludes cost of manufacturing parts)

Calculation: per GDP

Green Travel Ratio

The proportion between the number of electric vehicles on the road and the number of all vehicles on the road nationwide within a certain statistical period

Calculation: n/a

Charging Convenience

This indicator measures the number of charging points versus the number of electric vehicles on roads in the country.

Calculation: per number of electric vehicles.

Renewable Electricity Utilization Rate

This indicator is a ratio of absolute value of power generation by renewable energy to the absolute value of total national power generation weighted by electrification rate.

Calculation: n/a

Economics of Renewable Electricity

It refers to the cost per kilowatt hour of electricity for photovoltaic, wind within a certain area with respect to the cost of local coal-fired power (or oil or natural gas power generation)

Calculation: n/a

Policy & Ecosystem

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: per GDP

Spectrum Policy

A composite score based on the total amount of spectrum assigned to operators in each country, rather than the average spectrum per operator. This includes the spectrum in bands below 1 GHz, 1-3 GHz, 3-6 GHz and in mmWave bands.

Calculation: n/a

Digital Transformation Policy

A composite score referring to the ITU G5 Benchmark Pillar IV: Digital economic policy agenda, which covers country policies and interventions for promoting the digital economy, entrepreneurship and investment.

Calculation: n/a

Green energy Policy

This indicator quantifies the power policies and green policies, including net zero target, renewable energy target, feed-in tariff/ premium payment and net metering/billing.

Calculation: n/a

ICT Laws & Regulations

The ITU ICT Regulatory Tracker traces countries' ICT regulatory environment. It facilitates benchmarking and the identification of trends in ICT legal and regulatory frameworks.

Calculation: n/a

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

Internet Participations

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-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

Smartphone Penetration

Smartphone penetration is 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: per total connections

Online Video Streaming

The average amount of time each day that internet users aged 16 and above spend on watching video, both broadcast and streaming.

Calculation: n/a

Number of Startups

Number of startups in the country, startup is defined as any business that applies an innovative, technology-enabled solution with the potential to achieve scalability.

Calculation: per 1000 people

STEM Graduates Ratio

The proportion of STEM (Science, Technology, Engineering and Mathematics) graduates to all graduates

Calculation: n/a

ICT Workforce

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

Calculation: per capita