HUAWEI

2019 | Huawei

ICT Sustainable Development Goals Benchmark

Contents

Foreword : ITU

By Malcolm Johnson,

Deputy Secretary General of the International Telecommunication Union (ITU)

By Malcolm Johnson, Deputy Secretary-General, International Telecommunication Union (ITU)

We are living in a time of extraordinary advances at the intersection of various fields of innovation. Industries are entering new shared space. New technologies are emerging – from the Internet of Things to artificial intelligence to 5G. As the United Nations specialized agency for information and communication technologies (ICTs), ITU is at the forefront of this digital revolution.

These new technologies hold great potential for human progress, enabling innovations in areas such as health, financial services, energy and transport, in smart cities and communities. They will be essential for the realization of every single one of the United Nations Sustainable Development Goals (SDGs).

The Huawei 2019 ICT SDG Benchmark Report shows a strong relationship between ICT maturity and the level of progress on the SDGs. It helps measure progress towards the vision of a more equitable, sustainable world driven by digital technologies.

This report comes at a time when more than half the world's population now uses the Internet for the first time in history. It also comes at a critical time for the 2030 Agenda for Sustainable Development as UN Secretary-General Guterres warned recently that on current trends, we will only be halfway towards achieving the SDGs by the target date of 2030.

The only way we can achieve the SDGs by 2030 is through multi-stakeholder partnerships – public-private partnerships – and good governance. We all need to bring our specific competencies to the table, avoid duplication, pool our resources and work to the common good. The analysis and benchmarking of the state of ICT development as well as the policy and regulatory initiatives undertaken in the countries featured in this report offer good practices that could benefit policy-makers and stakeholders everywhere in their effort to leverage ICTs for the SDGs.

I thank Huawei and the contributors to this year's report for their analysis and insights. I recommend taking these good practice recommendations into account when formulating national ICT strategies for sustainable development. And I urge all stakeholders to join forces together to use the power of tech to move the SDGs from vision to action and transform today's digital revolution into a development revolution.

Foreword : GSMA

By Mats Granryd

Director General of GSMA

Since the first mobile networks launched nearly three decades ago, the mobile industry has connected billions of individuals around the world, providing access to essential communications and a vast array of services that improve lives on a daily basis.

The world's mobile operators have now unified behind one common industry purpose: to Intelligently Connect Everyone and Everything to a Better Future. This purpose highlights our industry's commitment to the UN's Sustainable Development Goals (SDGs).

In 2016, the mobile industry became the first sector in the world to commit to the SDGs – pledging to leverage the power of the networks that mobile operators have built and the services they are delivering for social good. More than three years on, we can point to real-world evidence that shows the positive impact mobile technology is making across all 17 of the SDGs. It is important that we continue to monitor our impact, identifying the areas where we are making a difference and the areas where we can do more.

Huawei's ICT SDG benchmark report therefore provides us with a useful tool to measure the degree to which ICT development can enable and accelerate progress on achieving the goals.

More than 5 billion people are now connected to a mobile network, equivalent to roughly two-thirds of the world's population. This number continues to grow as mobile operators and their partners develop solutions to extend affordable service to some of the lowest income and remotest populations. This has, in turn, created a platform of opportunity for people to use their devices to access the internet for the first time, providing them with access to a range of life-enhancing services.

And yet even as we celebrate the strong progress we have made against the SDGs over the past three years, we recognise that we must also do more, faster, if we are to achieve the Goals. We need to extend mobile connectivity to those that remain offline, and deliver and scale the mobile-enabled solutions that will truly accelerate our achievement of the SDGs.

The 2030 deadline to meet the SDGs may seem a distant horizon today, but we cannot afford any delay in addressing the monumental issues facing our world – poverty, climate change, conflict, inequality and so many others. Together, across the private and public sectors, we must work hand-in-hand to preserve our planet and ensure a peaceful and prosperous future for its citizens.

Foreword : GeSI

Luis Neves

Managing Director of the Global e-Sustainability Initiative (GeSI)

In 2018, GeSI produced a report "Enabling the Global Goals" on the role of Information and Communications Technology (ICT) and SDG achievement and together with it the #DigitalAcessIndex which is part of a robust methodology for measuring the digital industry's contribution to SDG achievement. The index, comprising 21 Digital Indicators, is unique because it includes indicators relevant to the entire digital industry, and considers cross-cutting technologies and digital solutions. The report shares new compelling evidence that the digital industry is positively linked to achieving most of the 17 UN Sustainable Development Goals (SDGs).

For 65% of SDGs, there is a clear positive correlation with digital access at every level of analysis, across the world. Only 1 negative link – between digital access and the environmental SDG 12 – is apparent. This report goes well beyond observing a coincidental link between digital access and SDG achievement, and gets closer to causation. That's important because it allows for more confident estimates of the quantitative impact of digital access on SDG achievement., The clear message is that the increase in digital access, such as connecting more people and devices, or higher network coverage, is related to the increased implementation of SDGs.

We also found that digital technology has a positive relationship with SDGs, at all levels of development (developed regions, developing regions and least developed countries) and all regions (Africa, Asia, Europe, Latin America, the Caribbean, North America and the Ocean Interestingly, the link between digital access and SDG achievements in Africa is the strongest.

I am very pleased to see that GeSI member Huawei is publishing a new report, showing obvious leadership in this area, and setting the example as a role model to other digital companies.

In this ICT SDG Benchmark report, based on current and previous analysis, we can clearly see how digital technologies can promote the exchange of ideas and how connectivity, provides information and services to people equally, stimulates innovation, and improves process efficiency, thus promoting the SDGs achievement. Furthermore the direction of the country benchmarking provides clear evidence of national performance and allows GeSI member companies and other stakeholders to use a large amount of data to better understand how and why a country is low performer and how performance levels move to the highest level.

Although done at different times and with different methodologies both the Huawei ICT Benchmark Report and the GeSI Enabling the Global Goals Report strongly and clearly demonstrate that digital technologies will be the key and fundamental driver of SDG's achievements in 2030.

As Managing Director of GeSI I can only be proud of having our member Huawei being a role model and congratulate Huawei and its Leadership for continuing to innovate and develop breathtaking technologies which will be supporting this world to become a better and more sustainable place for all through SDG achievment. I encourage Huawei to continue to work closely with industry partners such as GESI to better promote the relevance of digital technologies to sustainable development towards decision makers and other relevant stakeholders.

Foreword : Huawei

By Tao Jingwen

Chairman of Huawei's Corporate Sustainable Development Committee

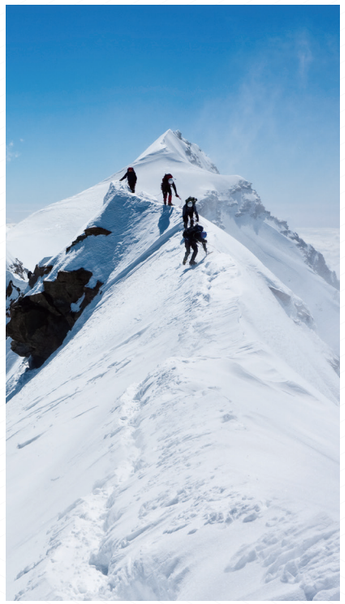
The ICT industry is quickly transforming our lives. According to the 2019 Huawei ICT Sustainable Development Goals Benchmark report, technologies like broadband, cloud, IoT, AI and 5G strongly correlate with social and economic progress. Huawei, as the world's leading supplier of ICT infrastructure and smart devices, believes that ICT will play a vital role in the attainment of UN's SDGs, thus benefiting human society.

Through our ongoing efforts in the areas of ICT Access, ICT Use and ICT Skills, more people will be able to enjoy access to ICT, make the most of it, and become equipped with relevant skills. The increased adoption of digital technology will promote the inclusive development of our society and economy. This will further digital inclusion and bring the benefits of digital technology to every person, home and organization.

I appreciate the enormous support provided by our industrial partners when compiling this report. I am also glad to see that we all recognize the role ICT plays in driving the attainment of SDGs. Although ICT is not the only tool available to us in the pursuit of SDGs, it promises innovative solutions to some of the world's most urgent and complex challenges.

This report provides an in-depth analysis into ICT solutions for countries at different stages of digitalization. We hope that the tailored suggestions provided within will act as a good reference for countries and regions that are considering how to develop their ICT capabilities. However, in order to better achieve SDGs, we should consider other indexes, beyond those in this report, when determining the areas to focus on improvement. I believe that by joining hands to leverage the full potential of ICT and promote digital inclusion, we can attain SDGs far more quickly. We will build an intelligent world where all things are connected, and bring the social and economic benefits of digital technologies to every person, home and organization.

01/02



Executive Summary

Information and communications technology (ICT), deployed strategically and used responsibly, is a force for good and a powerful lever by which to drive progress on the Sustainable Development Goals (SDGs). Fundamentally, ICT provides access to information, and if that access is provided equitably, it can drive societal progress and efficiency, ultimately building a more sustainable world.

| Purpose of the ICT Sustainable Development Goals Benchmark

The ICT Sustainable Development Goals Benchmark 2019 (ICT SDG Benchmark) allows us to measure progress toward the vision of a more equitable, sustainable world. Specifically, the Benchmark seeks to explore the relationship between ICT and sustainable development, and to understand how countries can leverage digital technology to accelerate progress on social, environmental and economic issues. The aim of the report is to:

- Examine the degree to which ICT development enables progress on the SDGs
- Provide global insight by analyzing 55 countries
- Assess annual progress of countries included in the Benchmark and identify what enabled this progress
- Identify technologies and best practices that could benefit other countries

| Methodology

This is the third annual ICT SDG Benchmark report and it is now part of Huawei's Global Connectivity Index series. In 2019 we introduced some changes:

- We analyzed 55 countries, adding six additional countries to the 49 analyzed in the 2018 report. The countries were added in an effort to move closer to covering the full scope of countries included in Huawei's Global Connectivity Index, bringing consistency to the country set across both studies. The countries added are:

Ecuador	Finland	Greece	Ireland	Jordan	Uruguay

- We updated the titles of the three country performance categories for increased clarity. The definitions of the three categories remain the same, making them comparable to those in the 2018 report. The three categories we now use for countries based on their ICT SDG Benchmark performance are Leaders, Contenders and Improvers.

The ICT data used in the Benchmark is drawn from the ITU ICT Development Index. The Index was not updated in 2019, so the ICT data for this report is the same as the data used in the 2018 report. As such, any year-over-year changes in Benchmark performance are solely the result of changes in SDG progress scores and not reflective of changes in ICT development scores. While this means that changes for ICT were not tracked in this report, we are still able to investigate in detail the overall correlations between SDGs and ICT. In future iterations of the report, updated ICT data will allow us to conduct additional analysis to track and compare ICT progress with SDG progress.

As in previous years, this country set represents a range of developed and developing economies, different geographies, and different phases of ICT and sustainable development maturity. The report focuses on six of the SDGs:

We evaluated SDG and ICT performance across four indicators for each of the six SDGs, as well as the 11 ICT indicators included in the ITU's ICT Development Index, which are spread across the categories of ICT Use, Access and Skills. We reviewed ICT and SDG performance separately to test correlation, and then combined the data to form the ICT SDG Benchmark.

A more in-depth explanation of the methodology can be found in the Appendix.

| Benchmark results

The analysis shows that ICT development is highly correlated (R^2=0.86) with progress on the SDGs, suggesting a strong relationship between ICT maturity and level of progress on sustainable development. The ICT SDG Benchmark average score increased slightly from 65.5 in 2018 to 66.7 in 2019 (out of a possible 100 point) with individual country scores ranging from 31.4 to 84.4.

Based on their combined performance on ICT and SDGs, we have grouped the 55 countries into three clusters: Leaders (top performers), Contenders (mid-level performers), and Improvers (low-level performers). In 2019, South Korea was again the top scoring country in the ICT SDG Benchmark, scoring 84.4 points on the Benchmark out of a possible 100, followed by the UK and Denmark as the second and third highest scoring countries, respectively.

The 2019 Benchmark reveals that there is still a significant gap to close between Leaders and Improvers. And compared to the previous year, the gap between the top and bottom performers has grown from 50 points in 2018 to 53 in 2019. This suggests continuing challenges for both ICT development and SDG progress for many countries.

Comparison between 2018 and 2019 results also reveals that the largest score increase for any country over the year was 1.8 points, highlighting that progress takes place over long time periods. Our analysis suggests that ICT development can have an accelerating effect on SDG progress, although we are not able to make a definitive conclusion based on this data alone.

Of the 49 countries for which we have year-over-year data, all but four increased their scores over the year, highlighting overall global progress on the SDGs covered in this report and ICT more broadly. The magnitude of score changes, both positive and negative, are largest in the improver group.

Leaders continue to show equally high performance in both ICT development and SDG progress, suggesting that improvements in ICT and sustainable development are complementary. Leaders still have the opportunity to improve by further strengthening their performance in SDG 9 (Industry, Innovation and Infrastructure), SDG 7 (Affordable and Clean Energy), and ICT Use.

SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education) showed the highest level of correlation with ICT, signaling the areas where digital technology has the highest potential to accelerate country performance. This is especially true for improver and contender countries, where small investments in ICT are coupled with significant SDG gains.

Across the Benchmark, countries tend to perform better on ICT Access and ICT Skills than on ICT Use. Solutions that encourage greater Internet use, as well as fixed and mobile broadband adoption, will help drive increased ICT Use.

| Next steps

- All countries should focus on removing barriers to ICT Use, perhaps leveraging the progress made in Access and Skills to do so, which can in turn accelerate SDG progress.
- Improvers should look for ways to leverage ICT to improve on aspects of SDGs 3 (Good Health and Well-Being), 4 (Quality Education), and 5 (Gender Equality).
- Contenders should look for ways to leverage ICT to improve on SDGs 5 (Gender Equality), 9 (Industry, Innovation and Infrastructure), and 11 (Sustainable Cities and Communities).
- Leaders should look for ways to leverage ICT to improve on SDGs 7 (Affordable and Clean Energy) and 9 (Industry, Innovation and Infrastructure).
- Stakeholders across sectors should look to collaborate and identify the ways that their skills and influence can uniquely drive impact on both ICT development and SDG progress.

| Conclusion

We encourage policymakers, business leaders, intergovernmental organizations and NGOs to seek to introduce ICT policies, products, and initiatives that focus on society, the environment, and economy development. Engaging in partnerships and multi-stakeholder initiatives to leverage the power of numerous stakeholders will be critical to harnessing ICT to achieve the SDGs by 2030. Although ICT is not the only tool available to us in the pursuit for a sustainable and just world, it promises greater speed and efficiency for progress on the world's most urgent and complex challenges.

03/04

Benchmark Results

The 2019 ICT Sustainable Development Goals Benchmark indicates a country's combined performance on ICT development and its progress toward sustainable development.

This is the third iteration of the ICT SDG Benchmark report, jointly produced by Huawei and SustainAbility.

Benchmark Categories*

Leaders: Countries scoring 75 and above (out of 100) on the Benchmark. These are mainly developed economies that are advanced in terms of both SDGs and ICT. They have greater resources available to them due to maturity of their economies and currently lead the world in implementing targeted ICT solutions to develop a smarter and more equitable society.

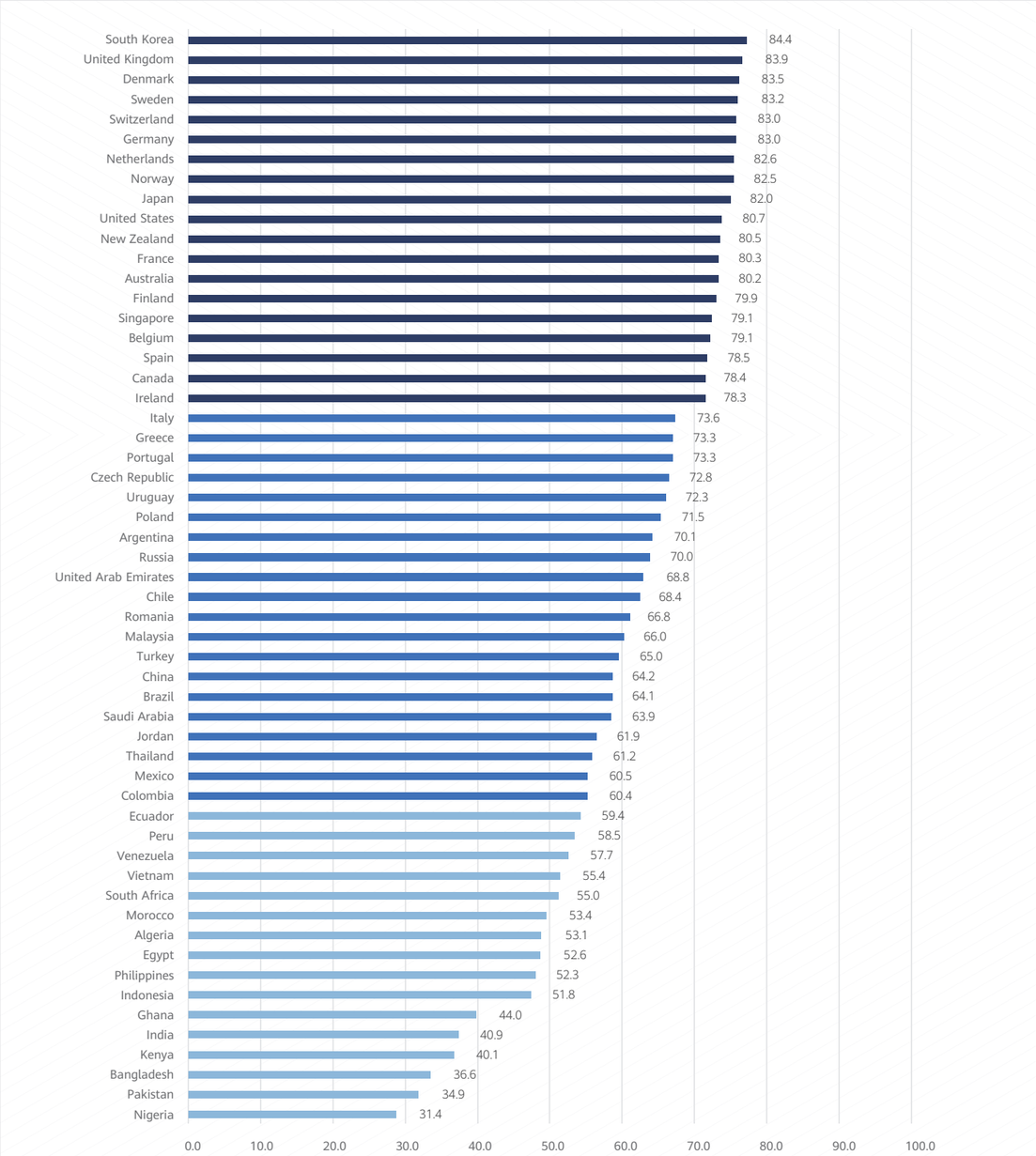
Contenders: Countries scoring between 60 and 74 (out of 100) on the Benchmark. These countries represent the medium range of combined SDG and ICT achievement and are seeing economic development along with growing ICT infrastructure investments, though targeted solutions on the SDGs are less mature. Their main focus is on increasing ICT demand to facilitate industry digitization and economic growth.

Improvers: Countries scoring below 60 (out of 100) on the Benchmark. These countries are in the early stages of ICT infrastructure build-out and have lower levels of targeted ICT investment focused on areas relevant to the SDGs. Their focus is on increasing ICT supply to give more people access to the Digital Economy.

*Note that the titles of these categories have been updated this year for increased clarity; however, the definitions of the three categories remain the same, making them comparable to those in the 2018 report.

| 55 countries and how they rank in a digitally-enabled sustainable world

Figure 1. 2019 ICT SDG Benchmark



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| Leading countries remain consistent

South Korea received the highest rank of the 2019 ICT SDG Benchmark, with a score of 84.4, maintaining its position from 2018. Its high rank points to a strong overall performance across all the indicators of SDGs and ICT. This year, we have included South Korea as a country case study in the section The Impact of Digital where we dive deeper to explore the country's successful initiatives in ICT and SDGs, as well as the key policies that have contributed to its leadership.

European countries account for seven of the ten top countries on the Benchmark – namely, the United Kingdom, Denmark, Sweden, Switzerland, Germany, Netherlands, and Norway. This is reflective of the broad international recognition that European countries have performed well and are leaders in both ICT infrastructure and sustainable development. Also telling of this trend is that almost all the European countries rank in the upper half of the Benchmark.

| The gap between the highest and lowest ranking countries has grown

The Benchmark results show that there is a significant gap to close between Leaders and Improvers. With the highest-ranking country receiving an 84.4 and the lowest ranking country receiving a 31.4, there is a gap of 53 points – a significant distance to cover considering the largest change seen in any country score between 2018 and 2019 is an increase of 1.8 points by both Kenya and Turkey. Compared to the results of the 2018 Benchmark, this gap between the top and bottom performers has grown from a gap of 50 points in 2018 to 53 in 2019, suggesting some continuing challenges for both ICT development and SDG progress for many countries.

| Countries leading the Benchmark don't necessarily lead in both SDG progress and ICT development

Table 1. Highest ranked countries for SDG Scores and ICT Scores

Top ranking for SDGs	Top ranking for ICT*	Top ranking for ICT SDG Benchmark
#1: Sweden	#1: South Korea	#1: South Korea
#2: Germany	#2: Switzerland	#2: United Kingdom
#3: United Kingdom	#3: Denmark	#3: Denmark

*Note that the ITU did not release updated ICT data in 2019, so these ranks remain the same as in the 2018 report.

When considering SDG progress and ICT development separately, we get a slightly different picture of how each of the countries are performing in these areas. The countries that rank the highest on SDGs are Sweden, Germany and the United Kingdom; for ICTs, the highest-ranking countries are South Korea, Switzerland and Denmark.

Between the 2018 and 2019 Benchmarks, some movement has occurred in the top-ranking countries on SDGs. In 2018, Germany scored highest on SDGs progress, followed by the United Kingdom and Sweden, but in 2019, Sweden leapt ahead to claim the top rank.

| Columbia and Mexico advance into Contenders category

Comparing the 2019 Benchmark results to 2018, a couple of countries moved upwards across the performance categories of Improvers, Contenders, Leaders. While almost all the countries stayed within the same category, Colombia and Mexico improved their scores enough to move from Improvers to Contenders. While the two countries did not demonstrate drastic changes in their ICT SDG Benchmark scores, the movement is similar to the upward movement seen in many of the countries over the year and suggests that Mexico and Columbia are improving their performance and are in a good position to accelerate that even further.

| Comparison of scoring and ranking changes between 2018 and 2019

To get a better idea of how country performance changed between the 2018 and 2019 Benchmarks, we calculated score changes for each country, plotted in Figure 2 below. The countries that increased their scores by the most are Turkey (+1.8), Kenya (+1.8) and Philippines (+1.5).

| The biggest year-over-year score changes were seen in Turkey, Kenya and Nigeria

Turkey's increased Benchmark score was driven mainly by improvements on SDG 4 (Quality Education) and SDG 5 (Gender Equality). Improvements on SDG 4 are the result of increased scores for "Expected years of schooling" and "Pupil teacher ratio in primary schools."

Unlike Turkey, where improvements were limited to only a few areas, Kenya's increased Benchmark score can be attributed to moderate increases in four of the SDGs. In SDG 3 (Good Health and Well-Being), improvement was due to a decrease in "Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease. In SDG 4 (Quality Education), Kenya's score for "Expected years of schooling" increased. In SDG 5 (Gender Equality) drove and increased score. Finally, in SDG 7 (Affordable and Clean Energy) where Kenya's scores improved the most, this was almost solely due to a significant increase in the percent of the population with "Access to electricity."

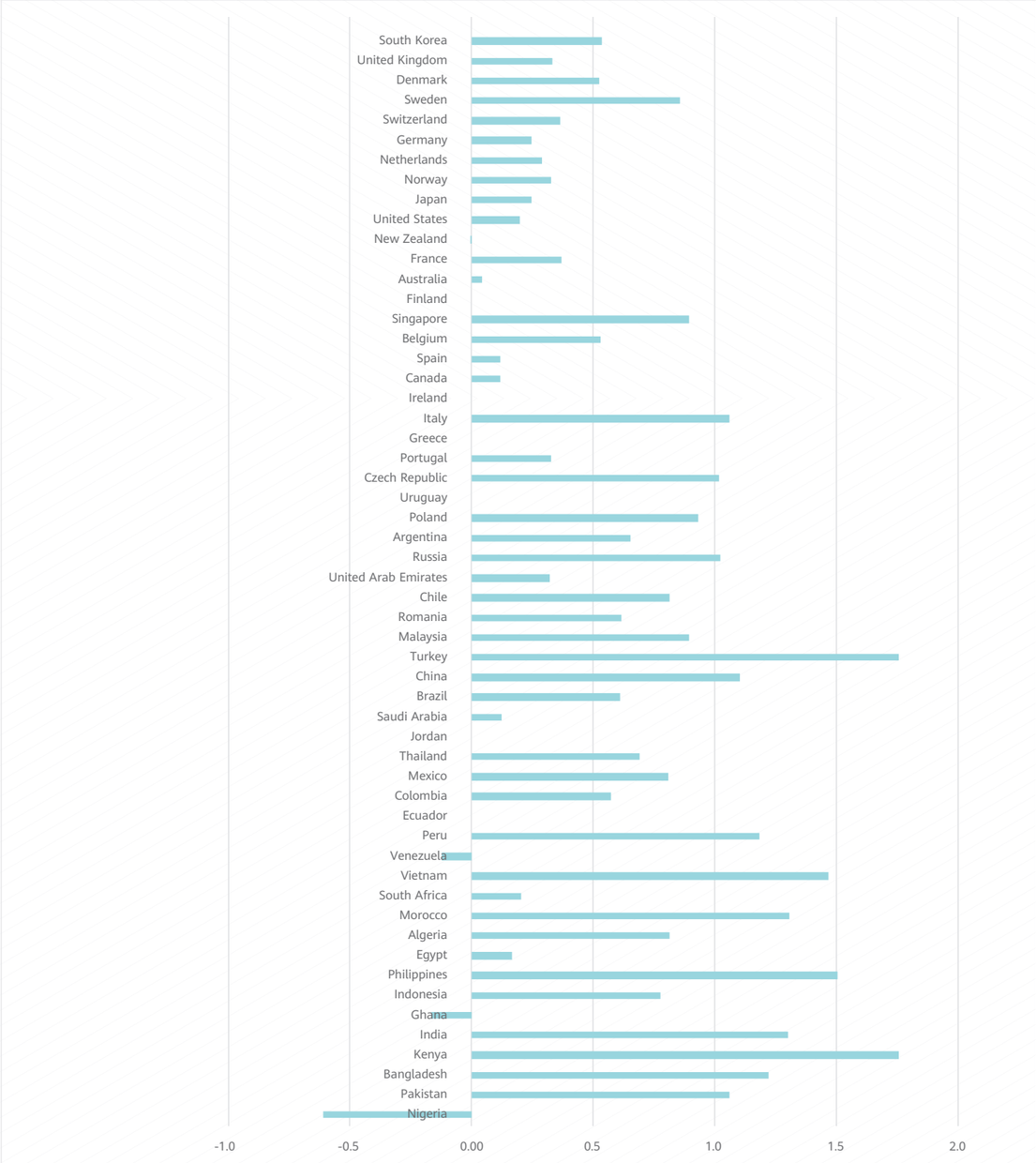
Nigeria was the country with the largest decrease in score, though the decrease is still small at less than one point. Though Nigeria improved on a number of SDGs, these were not enough to outweigh a significant decrease on SDG 11 (Sustainable Cities and Communities) where Nigeria's score on "Mean annual exposure to air pollution" fell significantly.

| The majority of countries increased Benchmark scores with Improvers exhibiting the most dynamic changes

Almost all countries improved their scores between 2018 and 2019, which suggests a positive outlook in terms of progress on the SDGs. In fact, the average Benchmark score increased from 65.5 in 2018 to 66.7 in 2019, highlighting the SDG progress that was made over the year.

Secondly, low-ranking countries displayed greater magnitudes of score changes – in upward and downward directions – which suggests two things: that lower-ranking countries are more volatile in terms of their progress on sustainable development; or that sustainable development projects in many lower-ranking countries are successful, leading the countries to progress at greater rates than higher-ranking countries (this is also aided by the fact that there is more room for improvement).

Figure 2. Changes in ICT SDG Benchmark score by country between 2018 and 2019



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| Changes in rank demonstrate relative performance shifts

In addition to looking at year-over-year changes in country scores, looking at ranking changes can provide additional insight into how countries are shifting in relation to one another. Comparing rank highlights an alternative set of countries than only looking at scores. Countries that saw increases in rank (of more than one spot) between 2018 and 2019 – not counting the newly added countries – are Singapore (↑ 3), Sweden (↑ 2), Italy (↑ 2), Turkey (↑ 2), China (↑ 2) and Morocco (↑ 2). Countries that saw decreases in rank (of more than one spot) are Saudi Arabia (↓ 3), Egypt (↓ 2), Portugal (↓ 2) and Germany (↓ 2).

Particularly noteworthy is that for the countries with the greatest decreases in rank, none of them saw decreases in their actual scores on the Benchmark – suggesting that other countries ranking close to them have accelerated on their performance relative to these countries.

Figure 3. Changes in average scores of each country group from 2018-2019

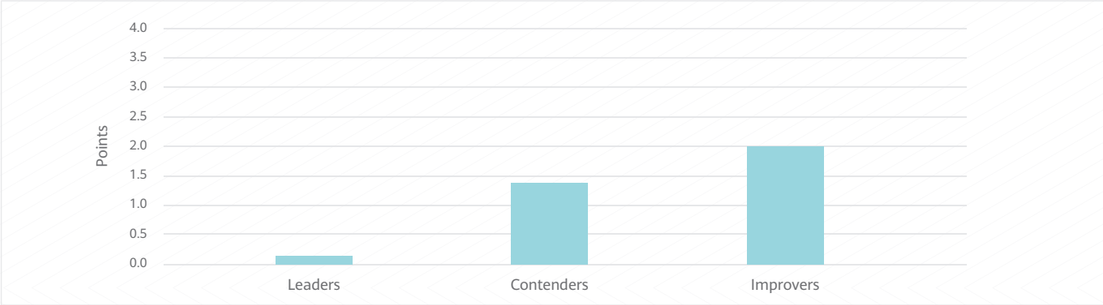


Table 2. Largest rank changes from 2018 to 2019

Greatest ranking increases (more than rank increase of 1)						Greatest ranking decreases (more than rank decrease of 1)			
Singapore	Sweden	Italy	Turkey	China	Morocco	Saudi Arabia	Egypt	Portugal	Germany
↑3	↑2	↑2	↑2	↑2	↑2	↓3	↓2	↓2	↓2

| Strong correlation between ICT and sustainable development

Correlation between ICT and sustainable development continues to be strong in the 2019 Benchmark, with an 86% correlation value (measured using a coefficient of determination, or R-squared, calculation, described in more detail in the Appendix section). While not signifying causation, the high value highlights the interconnectivity of the two and suggests that ICT can act as an enabler for countries to improve performance on the SDGs. The correlation for 2019 can be seen visually in Figures 4 and 5 below.

A pattern we've continued to see is the larger gap between Leaders and Improvers on the ICT performance than on SDG performance. The particular correlations of each SDG with ICT will be explored later on in the report to give deeper insight into the underlying relationship between ICT and SDGs.

Figure 4. 2019 SDG scores and ICT scores by country

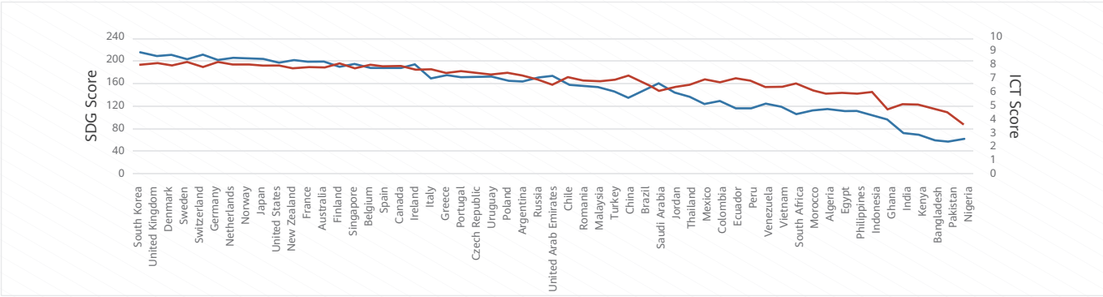
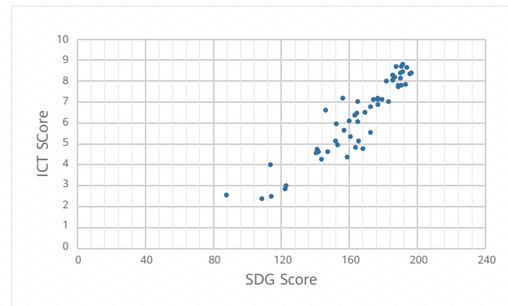


Figure 5. 2019 SDG scores and ICT scores by country - Scatterplot



Correlation between ICT and SDGs remains largely unchanged between 2018 and 2019. In 2018 we saw a correlation of 91% with a set of 49 countries, compared to the 86% we are seeing in 2019 for 55 countries. The slight change in correlation can partially be explained by the addition of six countries to the Benchmark – the 2019 correlation for the original 49 countries is slightly higher at 88%. The change in correlation can also likely be explained by the greater increase in Benchmark scores by Improvers compared to Leaders, as well as by some natural fluctuation of country SDG scores leading to some variation in the correlation number. Regardless, the change in correlation between 2018 and 2019 was very small and thus was not considered to be a significant indication of changing dynamics between ICT and SDGs. In future iterations of the Benchmark, we will continue to monitor the correlation changes over longer time periods, and we will also have more comparable annual data from which to pull insights about growth trends and inter-linkages between ICT and SDGs.

| The ICT SDG Benchmark correlates with other indices

To get a better idea of how the ICT SDG Benchmark compares to the global context, we compared the Benchmark with other indices:

| Gross Domestic Product (GDP)

A relatively low correlation of 63% suggests that GDP is not the only determining factor that leads to a country scoring high on the ICT SDG Benchmark. While GDP will always be one factor dictating the speed and effectiveness of a country's development, it is important to measure the effect of underlying economic and policy factors that contribute to how the country performs on ICT and SDGs, rather than just tracking the amount of resources that a country has available to it.

| Global Connectivity Index (GCI)

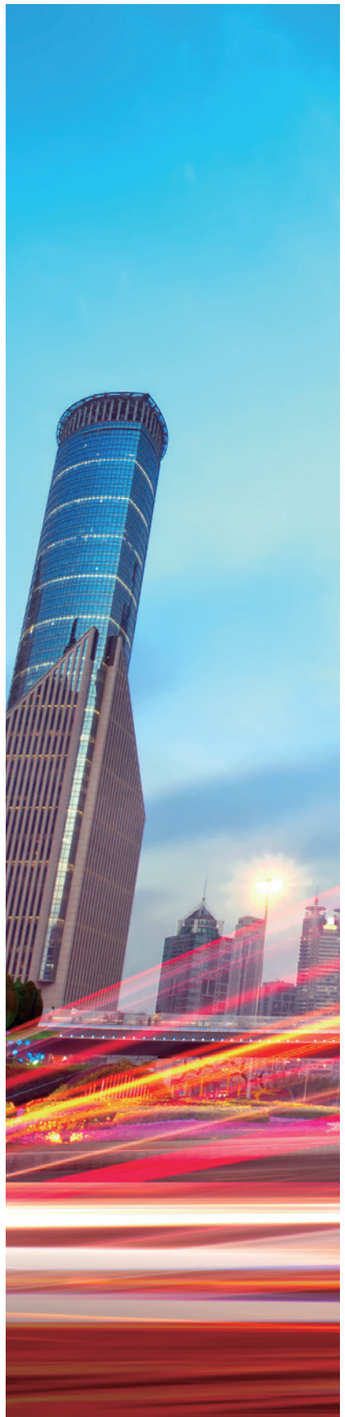
The ICT SDG Benchmark is highly correlated with Huawei's Global Connectivity Index (GCI), one of the world's leading holistic measures of a country's progress towards the digitally powered society of the future. The ICT Sustainable Development Goals Benchmark has a high correlation with the GCI (82%), although with some significant deviations, suggesting that some countries are over- or under- performing on ICT. This high degree of correlation is not unexpected, since country scores on both indices are heavily influenced by their ICT performance.

| Human Development Index

The high correlation between the ICT SDG Benchmark and the Human Development Index (HDI) remains consistent with the 2018 findings at 95% correlation. The Human Development Index, developed by the United Nations Development Programme, assesses country development across a broad range of areas (such as economic development, health, life expectancy, education) and provides a broad assessment of a country's level of development beyond pure economic growth. There is some overlap between the indicators in the HDI and the indicators used to measure country performance on the SDGs in the Benchmark, especially in SDGs 3 (Good Health and Well-Being), and SDG 4 (Quality Education), so the high degree of correlation between these two indices is not surprising.

| Environmental Performance Index

The correlation between the ICT SDG Benchmark and the Environmental Performance Index (EPI) in 2019 is 73%, slightly lower (though not significantly) than the 77% in 2018. The EPI, developed by Yale and Columbia University, provides an assessment of how well countries perform on top environmental issues and policies, such as the protection of human health from environmental harm and the protection of ecosystems. The index does not include economic factors in its measurements. The high correlation suggests that countries that perform well on environmental policies also tend to perform well in other areas of sustainable development.



Breakthrough Opportunities

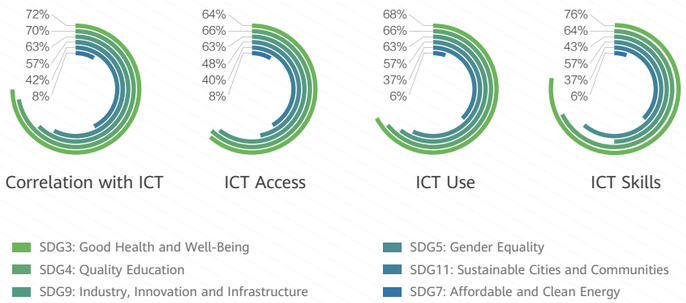
| Areas where ICT can make the most difference

Considering ICT and its correlation with SDGs broadly, we see that all three ICT sub-indices – Access, Use and Skills (details can be found in the Appendix) – demonstrate high correlation with the SDGs, indicating that all are similarly important for achieving the SDGs.

Table 3. Correlations between country scores on individual ICT Sub-Indices and total SDG scores

Deeper assessment of individual SDGs and their correlation with ICT reveals which of the SDGs have the strongest links with ICT. Analysis shows that SDG 4 (Quality Education) and SDG 3 (Good Health and Well-Being) have the highest correlation with ICT in the 2019 assessment, consistent with 2018 results. To a lesser extent, with slightly lower correlations, SDG 9 (Industry, Innovation and Infrastructure) and SDG 5 (Gender Equality) also show correlations with ICT. These appear to be the areas where ICT development can have the greatest impact on SDGs and where there are opportunities for policymakers who are focused on improving these SDGs in their countries.

Table 4. Correlations between country scores on individual SDGs and ICT scores, in order of decreasing correlation



SDG 4 (Quality Education) has the highest correlation with ICT development at 72%. The correlation with ICT skills is particularly high at 76%, the highest of any ICT sub-indices in correlation to SDGs. SDG 4 is also highly correlated with ICT Access and ICT Use, at 64% and 68%, respectively. The high correlation between SDG 4 and ICT Skills demonstrates the strong linkage between education and training on ICTs with a country's broader performance on education, and perhaps highlights the double benefit to countries of focusing on educating its population on ICT skills. ICT can contribute significantly to education outcomes, especially for people living in rural and low-income populations, by providing an effective and low-cost solution to access information to support learning and educational resources through mobile or Internet services.

SDG 3 (Good Health and Well-Being) has the next highest correlation with ICTs at 70%, which is evenly spread across its sub-indices of Access (66%), Use (66%), and Skills (64%). The high correlation, which was also seen in the 2018 Benchmark, is not surprising due to the significant efforts that countries and technology companies are already conducting to improve healthcare systems, solutions and their delivery around the world, in both the developed and developing countries. ICT is seeing rapid growth in this area, spurring breakthrough solutions to address some of the most pressing health issues on a large scale. We expect healthcare services to continue to be a main area of growth and innovation for ICTs as countries and companies find new and more efficient and effective ways to deliver and improve healthcare solutions.

At a lower level of correlation, but still relatively high, is SDG 9 (Industry, Innovation and Infrastructure) at 63%. For SDG 9, correlation with ICT Access and ICT Use are high, at 63% for both, but we found a much lower correlation with ICT Skills at 43%. This is a surprising result, particularly because it would be logical to infer that skills contribute greatest to success in a country's economic and innovative abilities (though 43% still suggests that some correlation exists). However, this simply highlights Access and Use as areas where the greatest correlation occurs with ICT, suggesting that even if the education and skills exist for ICT, a greater contribution to the economy may be through people and organizations having the ability to access and use ICT services.

SDG 5 (Gender Equality) shows a lower correlation with ICT as well, at 57%, still showing that there are significant benefits to be gained from investment in ICT focused on this area. For SDG 5, the highest correlations are with ICT Use and Skills, at 57% for both, pointing to the opportunity that exists for more women to gain education and training in ICT and the opportunity to use the technology.

At lower levels of correlation are SDG 11 (Sustainable Cities and Communities) at 42% and SDG 7 (Affordable and Clean Energy) at 8%, which show less of a linkage between ICT development and SDG progress. This result does not necessarily suggest that these SDGs are not linked to ICT development, but the low numbers here may be due to the fact that ICT solutions and national policy around these goals are relatively under-developed and will need more time to show the details of its relationship.

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| Analysis broken down by Leaders, Contenders, Improvers

Leaders

Leaders tend to perform fairly evenly across the six SDGs and the three ICT categories, suggesting an even distribution of investment across all areas of SDGs and ICTs. On average, Leaders score highest on SDGs 3 (Good Health and Well-Being) and 4 (Quality Education), like in 2018. However, year-over year comparison reveals that the greatest improvement made was on SDG 5 (Gender Equality) (Figure 6). The Leader group of countries posted improvements in all SDGs except SDG 9 (Industry, Innovation and Infrastructure), where the average dropped slightly in 2019 as compared to 2018 due to drops in three of the four indicators for that SDG.

The greatest difference between maximum and minimum country scores among the Leaders are seen in SDG 9 (Industry, Innovation and Infrastructure) with a gap of 15.8 points, and SDG 5 (Gender Equality) with a gap of 12 points, signifying areas where there are challenges for countries in this category, but also highlighting that some countries have been able to excel much farther ahead of their peers in these areas of sustainable development. For ICT, the greatest gap between high and low scoring countries is for ICT Access, followed closely by ICT Use, which tells us that some countries are far exceeding others in these two areas of ICT.

Recommendations for Leaders

Countries in this category perform well across SDGs and ICTs, but those looking to further increase performance can benefit by focusing national policies on innovation and infrastructure (SDG 9) and gender equality (SDG 5) that, both areas that correlate highly with ICTs (63% and 57%, respectively) as well as orient ICT policies towards bringing access to more citizens and getting them to engage with technology.

Figure 6. 2019 Leader country scores on each SDG

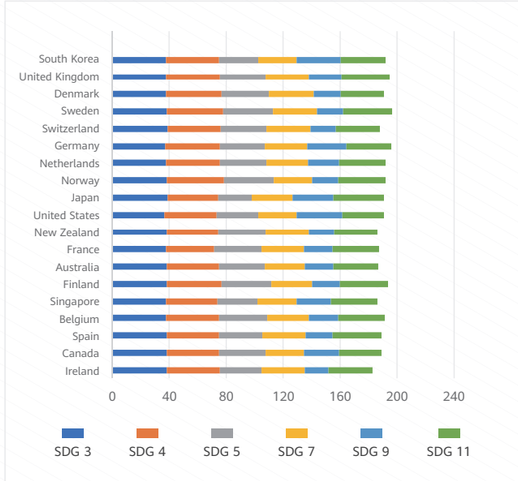


Figure 7. 2019 Leader country scores on each ICT sub-index

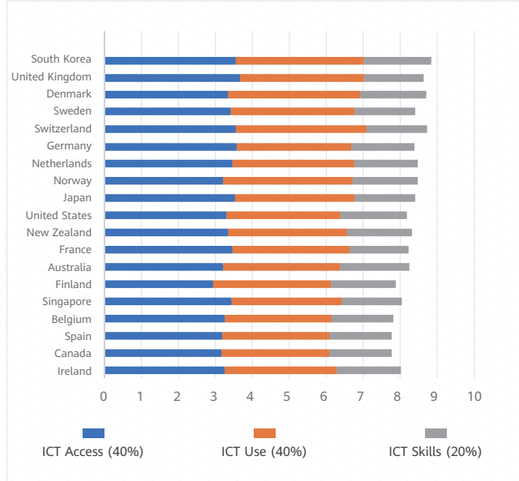


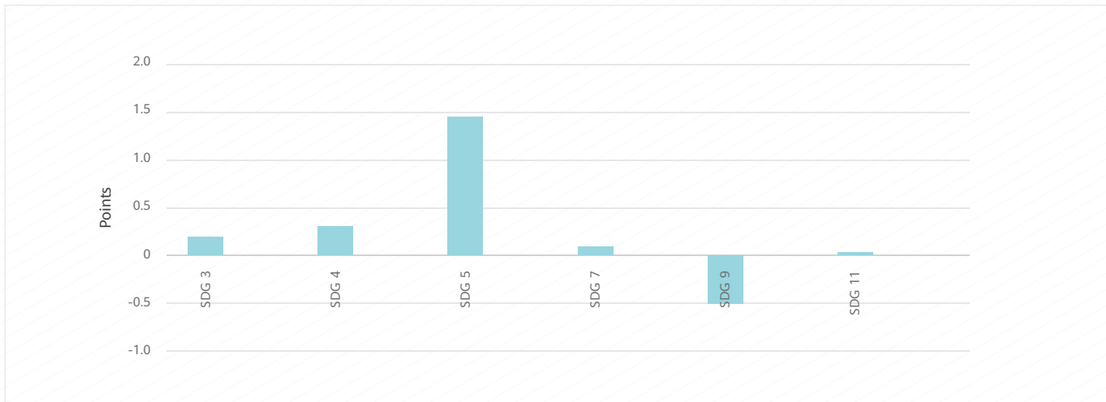
Table 5. Gap between highest and lowest Leader country scores on each SDG in 2019

Leaders	SDG 3	SDG 4	SDG 5	SDG 7	SDG 9	SDG 11
Gap between highest and lowest scores	2.4	6	12	5.2	15.8	6.4

Table 6. Gap between highest and lowest Leader country scores on each ICT sub-index in 2019

Leaders	ICT Access	ICT Use	ICT Skills
Gap between highest and lowest scores	1.8	1.7	1.2

Figure 8. Leader group's change in average SDG scores from 2018-2019



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Contenders

Like the leader group, Contenders score highest on SDGs 3 (Good Health and Well-Being) and SDG 4 (Quality Education). However, on average the contender group scores increased year-over-year on most of the SDGs to a larger degree compared to the Leader group, and on the overall ICT SDG Benchmark score as well. The average Contender scores on SDG 5 (Gender Equality) increased the most of all SDGs. The only SDG on which the average Contender score slightly declined is SDG 9 (Industry, Innovation and Infrastructure), but to a lesser degree than the Leader countries.

Contenders show a large gap for countries in the category in SDG 9 (Industry, Innovation and Infrastructure) with a gap of 17.8 points, SDG 5 (Gender Equality) with a gap in 16.8 points, and SDG 11 (Sustainable Cities and Communities) as well with a gap of 15.8 points. In ICT, similarly we see large gaps between the higher and lower scoring countries in the category, with the largest gap for ICT Skills. The large gaps across almost all the SDGs and ICTs in this category suggest a dynamic space for the countries; the large gap in performance between the top countries in the contender category and the bottom countries reflects many of them performing close to the Leader level while others have only just crossed into the Contender category from the improver level.

Recommendations for Contenders

Countries in the Contender category can find the greatest gains by focusing policy efforts on integrating ICT into industry and infrastructure (SDG 9), addressing gender equality (SDG 5) and by using ICT to improve cities and communities (SDG 11). The first two show high correlations with ICTs (63% and 57%, respectively); SDG 11 shows a lower correlation (42%), but the large gap for countries in this category shows that there is an opportunity to progress in this area relative to peers. On ICTs, the most important area for Contenders is to improve skills in ICT.

Figure 9. 2019 Contender country scores on each SDG

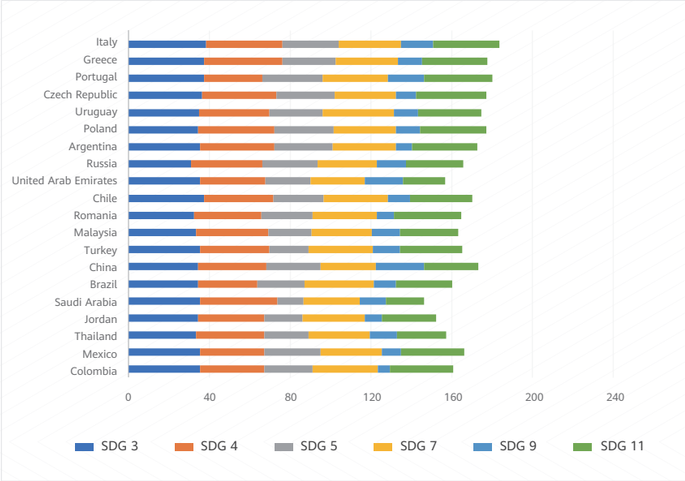


Figure 10. 2019 Contender country scores on each ICT sub-index

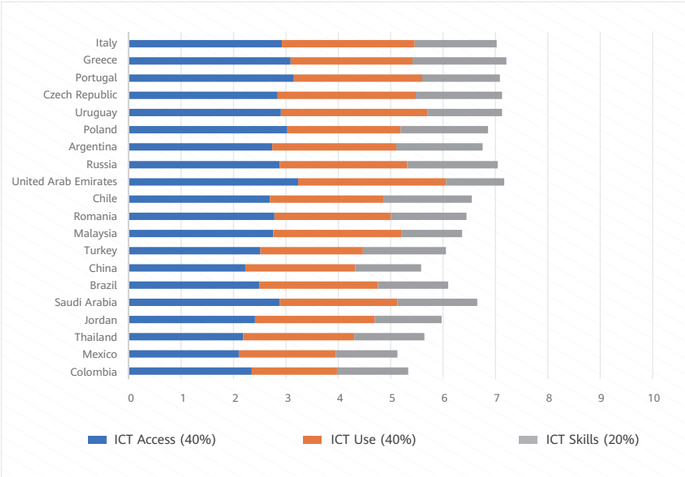


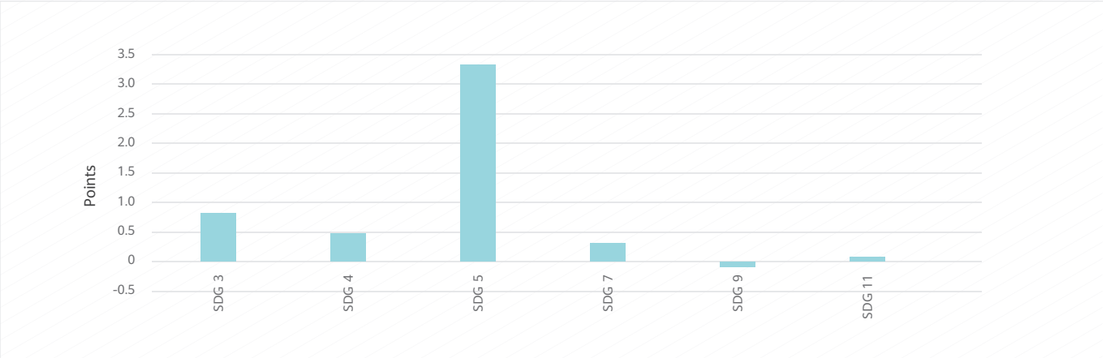
Table 7. Gap between highest and lowest Contender country scores on each SDG in 2019

Contenders	SDG 3	SDG 4	SDG 5	SDG 7	SDG 9	SDG 11
Gap between highest and lowest scores	7.4	10.2	16.8	8.6	17.8	15.8

Table 8. Gap between highest and lowest Contender country scores on each ICT sub-index in 2019

Contenders	ICT Access	ICT Use	ICT Skills
Gap between highest and lowest scores	2.8	3.0	3.4

Figure 11. Contender group's change in average scores from 2018-2019



Improvers

The improver country group's average ICT SDG Benchmark score improved more than both Contenders and Leaders from 2018 to 2019, a commendable outcome given the improvements needed by 2030. Significant improvements were made in the average improver scores on all SDGs except SDG 9 (Industry, Innovation and Infrastructure), which only increased slightly, and SDG 11 (Sustainable Cities and Communities), which decreased. The highest improvement in the average score for Improvers is in SDG 5 (Gender Equality), driven by improvements in "Mean years of schooling" etc. Unlike the Leader and Contender groups, the only SDG where the average improver score declined in 2019 is SDG 11 (Sustainable Cities and Communities), not due to significant decline in any one indicator but small declines in all indicators.

Improvers, like Contenders, also demonstrate a large gap of scores across all SDGs and ICTs between the highest and lowest performers in the group. In particular, the largest gaps between high and low scoring countries are for SDG 4 (Quality Education) with a gap of 21.4 (by far the largest gap for any SDG in each of the categories), SDG 5 (Gender Equality) with a gap of 19.8, and SDG 3 (Good Health and Well-Being) with a gap of 17.2. In ICT, we see the largest gap for ICT Skills, with a gap of 4.7, also the largest gap for any ICT in each of the categories. This represents an even larger divide between the countries at the top of this category and those at the bottom compared to Contenders and Leaders, which highlights the challenge for countries in this category but also points to the opportunities it has to make great strides on both SDGs and ICT if it is able to direct resources in the right way.

Recommendations for Improvers

Countries in the improver category can benefit the most by implementing policies that address education (SDG 4) and gender equality (SDG 5), both of which show high correlations with ICT (72% and 57%, respectively). This finding aligns closely with the large gap we see for ICT Skills, demonstrating the large potential cross-indicator gains that can be realized by focusing policies in this area.

Figure 12. 2019 Improver country scores on each SDG

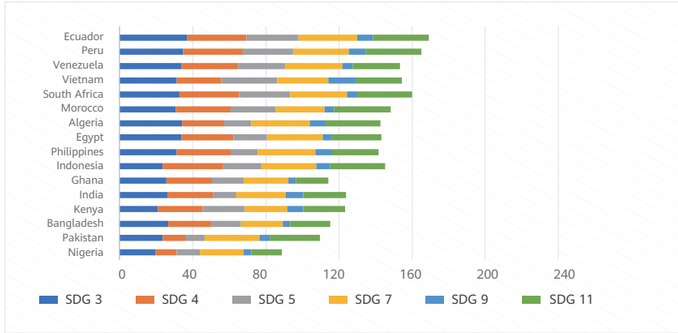


Figure 13. 2019 Improver country scores on each ICT sub-index

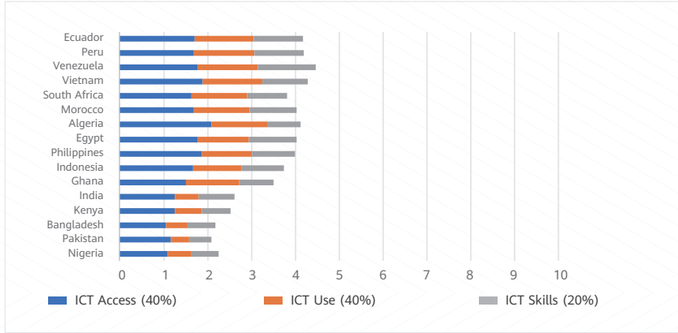


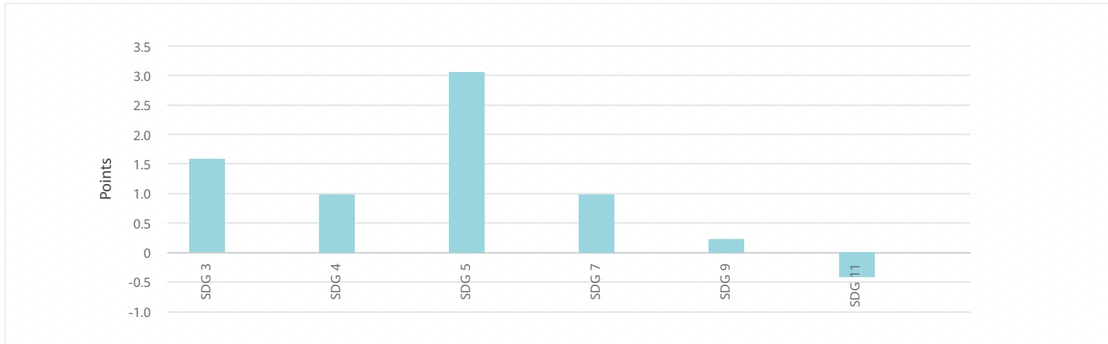
Table 9. Gap between highest and lowest improver country scores on each SDG in 2019

Improvers	SDG 3	SDG 4	SDG 5	SDG 7	SDG 9	SDG 11
Gap between highest and lowest scores	17.2	21.4	19.8	9.2	10.8	14.6

Table 10. Gap between highest and lowest Contender country scores on each ICT sub-index in 2019

Improvers	ICT Access	ICT Use	ICT Skills
Gap between highest and lowest scores	3.0	2.7	4.7

Figure 14. Improver group's change in average SDG scores from 2018-2019



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Digital Solutions

| Three critical pathways for ICT to drive sustainable development

Digital technologies accelerate human progress toward the SDGs by facilitating connections and exchange of ideas, providing more equitable access to information and services, spurring innovation, and creating vastly more efficient processes.

The three critical pathways for ICT to drive sustainable development that were identified in the 2018 report remain relevant:

1. Increase access to information and services

ICT infrastructure, the connectivity it provides, and availability of devices such as mobile phones, tablets, and computers play a major role in enabling access to information and services for individuals and organizations in both developed and developing nations, which can form a basis for progress on almost all SDGs in some way. Inequitable access to resources, information, education, and services of all kinds exacerbates disparities worldwide.

2. Increase connectivity between people and organizations

Increased access leads to better connectivity and communication between people, homes, intelligent devices, IoT nodes, and the companies and organizations people interface with at an instantaneous or near-instantaneous speed. This can increase productivity and innovation for a broad range of sectors and communities, and provide the real-time communications needed for rapid scaling of critical human-oriented services.

3. Increase productivity and resource efficiency

The access to information and communication ICT provides holds immense potential to raise the productivity and efficiency of many human activities. Digital technologies provide solutions for more efficient ways to collect and analyze large sets of data with the help of big data analytical tools, which has wide-ranging implications for SDG progress.

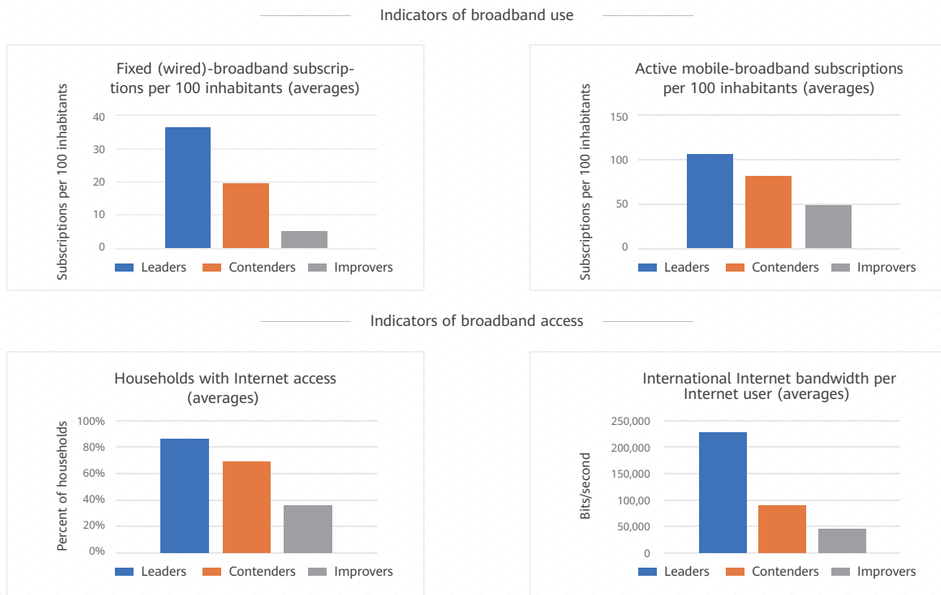
| Digital infrastructure can open these pathways and accelerate sustainable development

Digital technologies need to be deployed to open these pathways; however, Leaders, Contenders, and Improvers each face different constraints on how they expand their ICT infrastructure. We offer insights below on some of the key components of ICT infrastructure: broadband, cloud, IoT, artificial intelligence, and 5G.

Broadband: Broadband provides people with a wider range of digital services, making digital life possible. Broadband is also the prerequisite for the large-scale, rapid, and effective deployment of digital solutions. It enriches interactions between people, homes, and organizations, and helps improve local education, healthcare, and living conditions. In addition, broadband could promoting economic development and boosting efficiency in our society.

- Improvers: Many improver countries still lack adequate infrastructure to provide universal access to high-speed Internet. While urban areas usually have better connectivity levels, rural inhabitants are often disadvantaged. Increasing investment in ICT infrastructure that would give more people to access high-speed Internet is a major priority for policymakers of improver countries as multiple studies have shown that broadband is one of the most effective technologies when it comes to advancing SDGs. With proliferation of mobile phones, where fixed broadband is not available, mobile broadband is increasingly becoming a go-to solution. Policymakers, businesses and entrepreneurs should look for ways to more effectively harness this technology to address the most critical societal needs.
- Contenders: Most countries scoring in the middle range of the Benchmark have relatively well-developed ICT infrastructure that covers the majority of the population, but connectivity levels and Internet use are lower than in the case of Leaders. Policymakers should focus on bridging the divide between those connected to high-speed Internet and those that either don't have the resources or skills to become regular Internet users. Expanding the use of e-government services is another area where action by policymakers is likely to deliver noticeable improvements in key SDG areas.
- Leaders: Policymakers in these most advanced countries should focus on increasing bandwidth and speed through updates to fiber-optic broadband networks. While most countries in this category have advanced infrastructure, there are still major improvements to be made in terms of increasing speed and readiness for next-generation technologies (i.e. 5G). Despite maturity of their ICT infrastructure, some European countries are still lagging on connectivity levels compared to the United States or South Korea. Digital skills and uptake of high-speed Internet by government and

Figure 15. Country group performance on indicators of broadband access and use



Data source: ITU Development Index 2017

Cloud: Cloud services enable data acquisition. By pooling computing resources together, people will be able to access computing services at affordable prices, without needing to invest in data centers, hardware, and software. Flexible cloud services boost the speed and efficiency of data processing, driving sustainable development in many fields.

- Improvers: The ICT infrastructure of improver countries tend to not be advanced enough to take full advantage of multiple benefits offered by cloud technologies. By focusing on ICT infrastructure needed to increase access to high-speed Internet, policymakers can pave the way for and accelerate adoption of cloud by private and public sectors. In particular, the cloud has a vast potential to improve healthcare, education and delivery of public services – the key areas for growth for Improvers.
- Contenders: Targeted policies and business initiatives will be needed to achieve greater adoption of the cloud in Contender countries. Among other benefits, the cloud could increase opportunities for innovation and collaboration by businesses and entrepreneurs, which is key to advancing SDG 9: Industry, Innovation and Infrastructure, one of several areas where this country group needs to increase performance.
- Leaders: Greater adoption of cloud technologies by Leader governments could deliver multiple benefits for the public sector including reducing costs, increasing efficiency and enabling greater innovation. Adoption of the cloud by companies in Leader countries has been accelerating but still has much room for growth. Some studies have shown that in addition to other benefits, by moving their operations to the cloud, companies may be able to reduce their energy footprint by as much as 87%, in addition to other efficiency benefits.

Internet of Things: All things will be connected thanks to the development of broadband, big data, and cloud. With computing devices embedded into everything, new products and services will emerge, driving new business models. We will also be able to further tap into the value of data. In the future, IoT solutions will better serve people's needs, driving sustainable development in multiple fields, from healthcare, to energy, to environmental protection.

- Improvers: Similar to the cloud, successful deployment of IoT solutions is dependent on access to high-speed Internet. Targeted investment in infrastructure to increase connectivity levels will be key for improver countries to take full advantage of not only IoT but most other ICT solutions for addressing societal needs. Emerging research shows that even small-scale IoT projects can have substantial positive impact on sustainable development, indicating that even countries with less mature infrastructure are in a good position to benefit by starting to deploy this rapidly developing technology.
- Contenders: According to one recent study, a majority (84%) of existing IoT deployments can be used to advance the SDGs. Moreover, the majority of IoT deployments are medium or small scale, which makes it possible even for less developed countries like Contenders with less advanced infrastructure to successfully implement IoT solutions to address social and environmental needs. However, targeted policies and participation of business, which is responsible for developing the majority of IoT solutions, is a necessary prerequisite for achieving good results.
- Leaders: It is estimated that by 2025, the IoT's economic impact will reach $11.1 trillion, most of which will be felt by Leaders and Contenders (especially China). The sustainable development areas that are best placed to benefit from IoT deployment align with the SDGs where Leaders also need to make the greatest progress to meet UN targets. For instance, cities are likely to feel the economic impact of $0.9-$1.7 trillion from IoT deployment, putting Leader countries in a strong position to make progress on SDG 11 (Sustainable Cities and Communities). Clean energy is another area, where Leaders are currently underperforming and where with targeted policies and involvement of business, with the help of IoT countries can improve performance through smart grids, lighting, homes, etc.

Artificial Intelligence: Artificial intelligence (AI) enables computer systems to perform complex tasks normally associated with human intelligence. Increasingly, AI is used by governments, businesses and other organizations to improve efficiency, reduce costs, extract deep learning insights with the help of complex data analysis, and in many other ways. While research into application of AI for sustainable development is still nascent, emerging analysis shows that in addition to many other areas, AI could be especially effective at improving human health and well-being.

- Improvers: Examples of AI application suggest that advanced ICT infrastructure is not necessarily required for countries to take advantage of emerging AI solutions. In particular, Improvers are in a good position to benefit from application and scaling of already existing and emerging AI solutions (some of which, for instance, offered by Microsoft or Google, are free to use) to improve health outcomes (e.g., through AI solutions to diagnose disease, improve the lives of people with visual impairment), an area where Improvers in particular need to demonstrate faster progress.
- Contenders: The Contender countries have variable ICT capabilities when it comes to development and application of AI. China, for example, is among the world's leaders on AI development and whether emerging AI solutions will be used to support the country's progress on sustainable development will depend largely on the effectiveness of government policies. Contender countries can benefit by balancing the implementation and scaling of existing AI solutions and investment in new infrastructure that would enable development of AI.
- Leaders: Due to the maturity of their economies and volume of investment in ICT, Leaders are in a position to shape the role that AI will play in society for decades to come. The United States and EU countries, most of which are in the Leaders category are the key players shaping emerging AI technologies. Most major technology companies are already investing billions of dollars in AI solutions but governments have a major role to play shaping this emerging space and making sure that AI initiatives end up helping to address some of the most critical social and environmental needs.

5G: 5G greatly increases the speed of mobile broadband. Its high reliability, low latency, and support for massive numbers of connections will drive the development of more ICT solutions. These solutions will provide invaluable services in areas such as education, healthcare, and environmental protection, and help address many of society's challenges.

- Improvers: Most improver countries are unlikely to see large scale deployment of 5G networks before 2025. However, even with gradual deployment, 5G is likely to dramatically increase opportunities for Improvers to advance progress in many sustainable development areas through 100x faster Internet speed, deployment of IoT, the cloud and other technologies. For improver countries, with the help of targeted policies and effective public-private partnerships, the greatest benefits of 5G are likely to be in education and health. For instance, 5G will significantly expand opportunities for remote learning, reducing the need for investment in brick-and-mortar schools and helping to address the shortage of teachers, especially in rural and remote areas.
- Contenders: By 2024, more than 40% of the world's population is expected to be covered by 5G networks. While not all of the Contender country populations will have access to 5G, most of them are likely to be covered by this new generation network. According to one recent study, fast mobile broadband connection is likely to have the biggest impact on SDG 9 (Industry, Innovation and Infrastructure), SDG 4 (Quality Education) and SDG 13 (Climate Action).
- Leaders: Most of the Leader country inhabitants are likely to have access to 5G in the next five years, putting them in an advantageous position to advance some of the most critical pressing social and environmental issues. South Korea, the leader of this Benchmark, is also a leader in deploying 5G, but European countries are somewhat behind both South Korea and the United States in their efforts. With 5G becoming ubiquitous in Leader countries in the next decade, it will be up to both the public and private sector decisionmakers to ensure that 5G not only brings commercial gains but is also harnessed to address key societal needs and improve the well-being of all.

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| Digital solutions that help drive human progress

Below we outline the digital solutions enabled by ICT infrastructure that can drive progress on the six SDGs in the Benchmark. We show how digital solutions open up the ICT pathways, described above.

Table 11. Role of ICT in achieving SDGs and examples of digital solutions

SDG	Examples of digital solutions	Key ICT pathways
3 GOOD HEALTH AND WELL-BEING Ensure healthy lives and promote well-being for all at all ages	Cloud-enabled access to digital medical records and communication between medical professionals and between patients and doctors Public digital platforms, such as e-government healthcare services Video-enabled telemedicine and mobile health solutions	Access: Greater access to health-related ICT-based information and services will overcome traditional constraints that affect access to medical services, a key target of SDG 3.
	Connected wearable medical devices and remote patient monitoring Use of virtual reality and augmented reality for medical procedure practice and training Remote patient monitoring Online or mobile learning and training solutions for medical professionals AI's vast benefits for both doctors and patients such as faster drug recovery, reduced radiation doses, and increased patient engagement	Connectivity: Health workers and patients alike can be more connected with each other in order to provide and receive healthcare, including diagnostic services and emergency response.
	Digitalized medical records and management AI solutions and machine learning for diagnostic services and patient monitoring AI used to digest mass amounts of clinical material that can then be accessed by AI-powered devices and instruments for various uses	Efficiency: ICT provides productivity gains by unlocking efficiencies in supply chain logistics, particularly for the distribution of medicine and medical equipment; and in publicizing emerging health issues, such as disease outbreaks, and supporting large-scale data collection and analysis.
4 QUALITY EDUCATION Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Infrastructure solutions that bring Internet access or access to downloadable digital content to rural and remote areas Remote learning programs for children and adults including live streaming and live chat capabilities 5G network for enhanced support of the above programs	Access: Students and teachers, including those that are underserved and remote, can increasingly access information to support learning, online certification, and student advisory services, etc.
	Connected classrooms Use of mobile devices and tablets to enhance learning environment Augmented reality and virtual reality solutions for greater hands-on learning options	Connectivity: Students, teachers, and institutions can interact and communicate with each other in order to learn together, collaborate on projects, and develop new learning models and innovations.
	Massive open online courses (MOOCs) Big data analytics and AI solutions to support efficiency and individualized learning Digital platforms that allow teachers to reach more students without increasing the amount of physical resources required	Efficiency: Access to more people and instant communication through email, texting, and online learning platforms can increase teachers' productivity and reach. Big data analytics will enable the offering of more tailored learning curricula (e.g., smart systems can analyze patterns of student learning and help prescribe learning plans to improve results).
5 GENDER EQUALITY Achieve gender equality and empower all women and girls	Digital education platforms focused on women and girls Mobile-enabled micro lending that gives access to financial resources	Access: ICT provides increased access to information related to healthcare and nutrition, training and education, employment, markets, financial services and entrepreneurship opportunities. This information can help to support and empower women and girls.
	Mobile apps and social media Online forums or educational resources that connect women with each other to share resources, educational materials, discuss issues, tackle challenges, mobilize resources, etc. Enhanced opportunities for adult literacy and vocational training required to gain employment Advanced data collection and analytics to gain better information on trafficking and violence against women	Connectivity: Increased connectivity helps women and girls communicate with other women and communities and increases economic and social opportunities. This can give women more influence at the community, government, and global level and support mobilization efforts.
	Training for women in web skills, coding, and other digital literacy skills Advanced data collection and analytics to enable gender-sensitive and gender-specific solutions	Efficiency: Connecting women to online markets and services can increase economic productivity as a result of both women's market offerings and purchasing power. In addition, leveraging analytics to understand the needs of women and create specific solutions to support their participation and capabilities can lead to improved societal development overall.
7 AFFORDABLE AND CLEAN ENERGY Ensure access to affordable, reliable, sustainable and modern energy for all	Advanced data analytics for determining viability of renewable energy sources in a specific area Online resources for residents and businesses interested in procuring clean energy	Access: ICT solutions provide opportunities for businesses, households and individuals to improve energy management and efficiency, reducing risk exposure to increasing costs and energy shortages.
	Smart grid solutions allow for the integration of distributed energy resources, increase renewable sources, and demand response programs 5G network connectivity properly enables the IoT aspects of the smart grid Online and mobile platforms that can connect businesses or communities interested in pursuing a renewables project to sources of funding and potential partners Blockchain facilitates distributed energy systems and enables consumers to buy and sell energy, engaging in peer to peer trading Advanced systems modeling and open source data sharing that advances use of energy storage	Connectivity: Connectivity between organizations through ICT can lead to greater effectiveness of collaboration and innovation in reducing energy use and identifying opportunities for smart grid connections.
	Smart meters and online portals for home and office to see meter data and tools for maximizing efficiency of energy use and enhance tailored solutions Big data analytics for modelling and scenario planning 3D printing, robotics, and other ICT-enabled manufacturing developments helps ensure supply of wind turbines and solar panels AI for enabling more efficient energy storage by informing when and how energy should be stored	Efficiency: Increased efficiency by improving ICT infrastructure can greatly reduce energy consumption, performing the same tasks better while saving energy and reducing costs.

SDG	Examples of digital solutions	Key ICT pathways
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE Build resilient Infrastructure, promote inclusive and sustainable Industrialization and foster innovation	Online crowdsourcing solutions that give innovators access to companies that are looking for solutions to challenges, and vice versa Online educational resources that give members of a given labor force access to courses and training to re-skill for the jobs of the future	Access: ICT helps provide access to information that can support the management and optimization of important global and local infrastructure, such as power, water, communication networks, and transportation systems
	Industrial Internet of things (IIoT) solutions for manufacturing, warehousing, transportation, and logistics, etc. 5G network connectivity properly enables the IIoT Cross-team collaboration opportunities enabled by digital platforms and 5G networks Edge computing infrastructure and cellular IoT gateways that will facilitate the connectivity of IoT devices Augmented reality for spurring innovation in product and process design	Connectivity: Connectivity between individuals and organizations is often an essential enabler for innovation, frequently fostered through ICT platforms such as online collaborations or resources (e.g., crowd sourced data collection and data products, and the creation of new business models, such as peer-to-peer or sharing economy models).
	Smart meter networks that can monitor major power, water and communication infrastructure for early warning signs of issues or failure, increasing resilience Data analytics and AI solutions to increased productivity and efficiency Smart IoT manufacturing solutions and 3D printing that drives innovation for more efficient manufacturing 5G to enable industrial automation and the associated efficiency gains Smart building management systems	Efficiency: Increased productivity and efficient use of resources in industry can be improved through ICT infrastructure and services (e.g., industrial Internet of things, smart water and energy grids, and advanced traffic management systems).
11 SUSTAINABLE CITIES AND COMMUNITIES Make cities and human settlements inclusive, safe, resilient and sustainable	Safe city solutions including emergency services IP networks that give residents access to warnings and information in case of emergency E-government initiatives that increase access and ease of use for public services Greater access to public transportation and improved mobility enabled by apps and other online information	Access: In dense cities, access to information via SMS alerts, online, or through media broadcasting, is essential to the provision and use of basic city systems, such as transport, emergency response, housing, education, and healthcare.
	Intelligent traffic control systems that include connected CCTV (closed-circuit television) camera networks and advanced controls on traffic lights Connected sensor and smart meter networks for utilities and pollution and waste management AI-powered solutions that help local governments and municipalities track and manage various issues, such as illegal dumping of waste 5G deployed in edge applications to reduce latency and increase bandwidth	Connectivity: ICT-enabled connectivity between individuals and organizations can improve productivity, management, and the economic activity of cities. It can also increase civic awareness among residents and opportunities to participate in policy and decision-making processes.
	Smart mobility solutions Deep learning video analytics applied to video surveillance systems Smart street lighting Big data analytics for modelling and scenario planning Big data and AI solutions to improve public transportation coverage and accessibility	Efficiency: ICT can support resource-efficient building and the management of sustainable cities through smart building applications, smart water and energy grids, intelligent transport systems and safety systems. Cities that have efficient resource and transport systems also improve the productivity of their residents.

| Role of national, city and local policy for using ICT to drive progress on SDGs

Political commitments and policy mechanisms are important for promoting and implementing effective policies for sustainable development. As such, national, city and local governments have a crucial role to play in creating economic conditions that support greater ICT development and SDG progress.

A first critical step in developing policies and strategies around SDG progress is taking stock of existing policies, regulations, strategies, and plans to illuminate which SDG targets these are (or are not) supporting. This can help policymakers identify where current policies are driving progress on the SDGs and where gaps may exist.

Through this review, it's possible that governments will realize they may not have the data necessary to measure progress and identify areas for improvement, and this highlights one of the initial ways governments can begin to contribute to SDG progress. This is actually covered in SDG 17 target 17.19 which addresses statistical capacity building and the need for countries to "develop measurements of progress on sustainable development."

SDG 17 target 17.14 is to "enhance policy coherence for sustainable development," and the World Resources Institute has defined this in terms of three dimensions:

1. Here and now: The efficacy of domestic policies, and whether domestic policies related to one issue area reinforce or undermine those related to other important issue areas; whether domestic policies spread the gained benefits equitably.
2. Elsewhere: The spillover effects domestic policies have on other countries' development and the degree to which they are aligned with internationally agreed objectives.
3. Later: The impact of today's policies on the well-being of future generations and long-term sustainable development.

After reviewing existing policies and regulations – taking into account the dimensions of policy coherence, identifying gaps and opportunities, and identifying data needs – policymakers can focus on developing ICT and progressing toward the SDGs in their areas of jurisdiction through a number of ways:

Systems thinking approach

As part of this systems approach, policymakers should consider:

Interlinkages between SDGs: For example, policies designed to advance SDG 7 (Affordable and Clean Energy) could also affect progress toward SDG 5 (Gender Equality) and SDG 11 (Sustainable Cities and Communities). Policymakers should understand and consider these interlinkages so that all consequences are clearly understood. The full spectrum of direct and indirect consequences of a policy should be understood to ensure that policies meant to drive progress on one SDG, do not undermine progress on another.

Systemic efficiencies: Proposed policies should leverage efficiencies where possible, i.e. opportunities for a single policy to drive progress on multiple SDGs. For example, a certain ICT solution could potentially drive progress on multiple SDGs in different ways, leading to an amplified return on investment.

The concept of equity: One of the underlying concepts of the SDGs is "leaving no one behind," and policymakers must consider how policies, regulations or strategies may negatively affect the various groups, paying close attention to disadvantaged populations, regardless of the ICT solutions or SDGs the policy is meant to address.

Targeted policies

Targeted action by policymakers will be required to harness the opportunities presented by ICTs to advance sustainable development.

National, city and local governments can take stock of the datasets at their disposal and how those data sets align to SDG progress. For example, does the country already collect data points on educational progress or health statistics? Governments can look to the trends in these data sets to identify specific areas for improvement. Once areas for improvement are identified, lawmakers can engage with experts in the ICT sector to seek out ways the sector can contribute to improvements in the priority areas. Then, governments should create policies that either directly enable this progress or create an environment that incentivizes progress on the country's priorities. These targeted policies on priority areas should of course take into account the systems thinking concepts outlined above as well.

As an example, the European Parliament's Directorate-General for External Policies suggests the following steps to creating a national approach to targeted policies that support sustainable development:

- Have a national sustainable development strategy
- Identify target areas for the country that are aligned with SDGs but also with the country's needs and priorities
- Tie targets to the national budget
- Measure progress against specific targets

Public-private partnerships and multi-stakeholder coalitions

SDGs cannot be achieved without collaborative efforts, particularly between the public and private sectors. Partnerships between governments, policymakers, regulators and businesses will be critical to ensuring that ICT develops with a focus on SDGs and does not exacerbate inequalities or leave groups of people behind. Partnerships that can be looked to as effective examples include:

Virtual University of Pakistan: Established by the government of Pakistan to provide high quality, affordable education to students all over the country, the university runs as a non-profit institution and is completely based on ICT. The government partners with the private sector to run the over 200 campuses across Pakistan (30 of those are run by the public sector and the rest by private partners). Students can enroll and access courses regardless of location because the university delivers all courses and content using free-to-air satellite television broadcasts and Internet. For other examples of public-private partnerships that increase the use of ICT in education as well as best practices, see this study commissioned by the Asian Development Bank.

2030 Vision Technology Cooperation Project: This multi-stakeholder partnership involving private sector, intergovernmental organizations, NGOs, and a university undertakes projects to connect organizations and the technology solutions that can support progress on the SDGs. Projects include a wide range of initiatives; for example, Urban Tech Bets: Smart Water Metering is a project, currently in pilot stage, to develop IoT networks for city water systems. Connected sensors and smart meters monitor water flow and quality, detect leakages, and improvement water management practices leading to greater access and affordability.

Huawei ICT Academy: Through this initiative, Huawei has partnered with Universities (such as Open University) to provide information communication technology training and certification opportunities to students, ultimately increasing the pipeline of workers with the proper skills and training for the tech jobs of the future. The initiative started in Europe and has since spread to other regions, including ICT competitions held in numerous countries.

Prioritizing connectivity and digital skills

When it comes to progress on sustainable development and improving people's lives, few technologies hold more promise than broadband. Therefore, increasing connectivity and the level of digital skills among the general population area paramount to making progress on the SDGs. Fostering STEM education and focusing on equal access should be a major priority for policymakers and businesses.

Additional resources are available to guide policymakers with this task; for example, the World Bank's Systems Assessment for Better Education Results (SABER) documents national educational policies around the world and the SABER-ICT Framework Paper for Policy Analysis helps policymakers benchmark their own policies on ICT use in education against others around the world and ultimately draft better ICT and education policies.

Ghana

The Impact of Digital

Although Ghana ranks quite low on the Benchmark, there is much evidence that Ghana is well-positioned to accelerate stronger development on ICTs, and in the process, drive greater performance on the SDGs.

Ghana is recognized as one of the more politically stable countries in West Africa, which has led to some investor confidence; however the country's economic dependence on commodities has dampened enthusiasm, and from 2015-2016 foreign direct investment fell by 11%, or $300 million. While the country has one of the highest rates of mobile phone penetration in the region at 137% of the population in 2016 (meaning there are more subscriptions than people), there remains significant room for progress in providing Internet services through home broadband connections. Just 0.3 out of 100 people had a home broadband connection in 2016, particularly because the majority of users access broadband through Internet cafes.

In 2017 Ghana experienced the largest year-on-year improvement in average peak broadband connection speeds out of 141 countries analyzed in Akamai's State of the Internet report, a 120% increase to 26 Mbps. This rate of growth is partly due to a low baseline, but it also reflects Ghana's focus on ICT as a priority industry for stimulating broader development, an approach which is echoed in the priorities of the government-funded Ghana Investment Promotion Centre.

Sustainable development progress in Ghana echoes its performance in ICT infrastructure investment. Although Ghana has a rich recent history of initiatives created to address socio-economic development, these have largely failed to achieve their objectives, such as the Ghana Shared Growth and Development Agenda of 2015 and the Ghana Vision 2020. Likewise, the future of the more recent 40-year National Development Plan, has been called into question by the competing priorities between the country's two main political parties.

Ghana's ICT SDG Benchmark performance

Ghana ranks 50th out of 55 countries on the ICT SDG Benchmark, scoring 44 out of a possible 100 points, placing it in the bottom half of the countries in the improver category. Its SDG and ICT scores contribute almost evenly to its total – it has a higher SDG score compared to ICT score, although relative to other countries, it receives a slightly higher rank on ICT compared to SDGs (#50 for ICT vs. #53 for SDGs). Between the 2018 and 2019 Benchmarks, Ghana had a very slight decrease in score from 44.2 to 44.0, and relative to other countries in the Benchmark it fell in rank by one spot from #49 to #50.

Table 12. Ghana's year-over-year change in scores and rank

Ghana	2018	2019	Change
Ranking on the ICT SDG Benchmark	#49	#50	↓ 1
Score on the ICT SDG Benchmark	44.2	44.0	– 0.2
Ranking on SDG progress	#50	#53	↓ 3
Score on SDG progress	114.8	114.0	– 0.8
Ranking on ICT development	#50	#50	-
Score on ICT development	4.1	4.1	-

* Note ICT development scores which come from the ITU's ICT Development Index, did not change because the ITU database skipped an update year and will not publish new data until the end of 2019.

Ghana scores significantly below average on all the SDGs, suggesting a continuing urgent need to direct focus towards the SDGs. Of the six SDGs, Ghana demonstrates strongest performance on SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education), which are the two SDGs with strongest correlation with ICT and are the SDGs identified as having the largest gaps in the Leaner category of countries.

For SDG 3 (Good Health and Well-Being), Ghana receives a relatively high score on "neonatal mortality rate" but performs poorly on the other indicators that address mortality rate metrics and incidence of tuberculosis. For SDG 4 (Quality Education), Ghana receives the highest score on "primary school repeaters" (the number of students enrolled in the same grade as in the previous year) but falls behind on other metrics related to literacy rate, years of schooling and pupil-teacher ratio.

Between the 2018 and 2019 Benchmarks, Ghana saw an overall decrease in SDG score, from 114.8 to 114.0, and also dropped 3 spots in SDG ranking. Still, Ghana was able to increase its indicator scores on SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education) and SDG 5 (Gender Equality), suggesting a step in the right direction in those areas. However, the country received decreases in scores on SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities), which suggests that the country is falling behind in these areas.

Ghana's most notable area for improvement is in SDG 9 (Industry, Innovation and Infrastructure). This is the lowest of its SDG scores. Across all four of the indicators included in SDG 9, Ghana tied with Bangladesh to receive the lowest scores of all countries included in the Benchmark. This is an area of opportunity in which Ghana can quickly increase its performance if it is able to effectively direct policies and resources towards bolstering the country's ability to succeed.

Figure 16. Ghana's 2019 SDG scores, each out of a possible 40 points

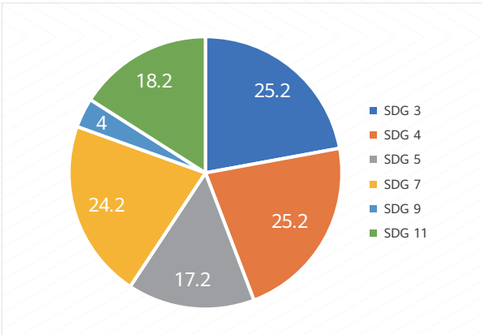


Figure 17. Ghana's 2019 SDG scores compared to the Benchmark average

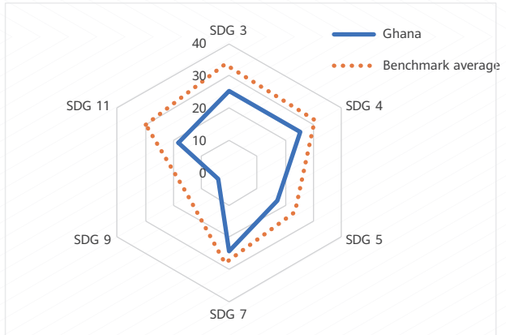
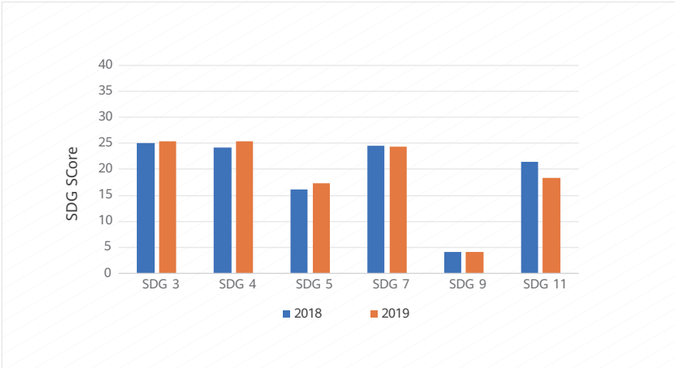


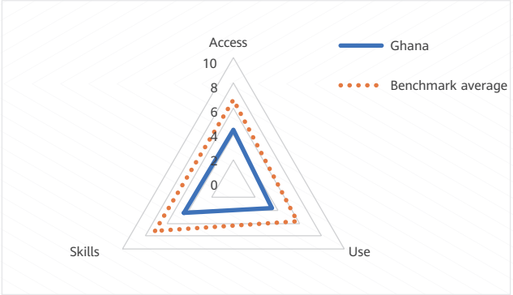
Figure 18. Ghana's 2018-2019 year-over-year change in SDG progress



Ghana scores significantly below average on each of the three ICT sub-indices of Access, Use and Skills. Each of these are areas of opportunity for Ghana to focus on, however it falls the most behind in Skills compared to the Benchmark average, suggesting that this is one particular area that Ghana could focus on to produce gains in its ICT performance.

While Ghana performs well below average on almost all of the indicators across Access, Use and Skills, the one indicator that Ghana performs above average on is for "mobile-cellular telephone subscriptions per 100 inhabitants" in Access, which points to an area of strength that Ghana can leverage to build up its capabilities in other areas of ICT.

Figure 19. Ghana's 2019 ICT scores compared to the Benchmark average



Key initiatives that support progress on the SDGs

ICT for Accelerated Development:

Presently in place is the ICT for Accelerated Development (ICT4AD) Policy which is a long-term strategy for developing the ICT Sector and expanding its role in the Ghanaian economy. The ICT4AD vision for Ghana is: "To improve the quality of life of the people of Ghana by significantly enriching their social, economic and cultural well-being through the rapid development and modernization of the economy and society using information and communication technologies as the main engine for accelerated and sustainable economic and social development."

Despite a clear recognition of the correlated benefits of ICT and wider socio-economic development, evident in its ICT for Accelerated Development policy launched in 2003, many of the initiative's aims unfortunately remain unrealized. This is due to a lack of satisfactory progress in other more basic infrastructure services, such as transport and energy, which are currently stifling opportunities to leverage ICT for sustainable development.

Mobile Technology for Community Health:

The Mobile Technology for Community Health (MOTECH) initiative was launched in 2010 as a partnership between the Grameen Foundation, Columbia University's Mailman School of Public Health, and the Ghana Health Service with grant funding from the Bill and Melinda Gates Foundation. The aim of the initiative is to "increase the quantity and quality of prenatal and neonatal care in rural Ghana" through the use of mobile phone applications. Two main applications are used:

- One is Mobile Midwife that provides timely information (such as alerts and reminders, actionable advice) to pregnant women and their families throughout their pregnancy via SMS text or voice message.
- The second is the Client Data application for nurses and health workers that enables them to better track patient care and health in these rural areas.

A recent study looked at the implications of expanding the program to 170 districts in Ghana. Both the costs to scale the program and the potential health effects were modeled. The study found that over the next ten years, MOTECH could save close to 60,000 lives at a cost of US$32 million, which is deemed completely cost-effective.

Solutions that can further Ghana's SDG progress

SDG 9 (Industry, Innovation and Infrastructure) is Ghana's largest and most pressing area of opportunity for improvement. Other pressing areas of focus are SDGs 3 (Good Health and Well-Being), 4 (Quality Education) and 5 (Gender Equality), for which Ghana scores significantly below average and have high correlations with ICT. ICT can further enable Ghana's contribution to these SDGs in the following ways:

- Focus on basic infrastructure services from a policy perspective to unlock the capabilities of ICT and enable services that improve the lives of Ghanaians.
- Bolster the country's approach of making it easier to do business in the country, particularly for companies investing in infrastructure.
- Focus on enabling access to ICT education for more Ghanaians to drive more high-quality employment and create a pipeline of new innovators.
- Focus the skills of Ghanaians towards making smart infrastructure that leads to greater safety and efficiency in communities.
- Leverage Ghana's high mobile phone penetration rates to make it easier for citizens and foreign investors to do business, but also to boost access for Ghanaians to healthcare, education, and providing greater opportunities for women.

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India

Less than one fifth of users have access to average Internet connection (IPv4) speeds greater than 10 Mbps, and despite the average connection speed of 6.5 Mbps being among the slowest in the world, it is the result of an 87% increase in speed from 2016, according to Akamai's State of the Internet 2017 report. Although the government released its National Digital Communication Policy in 2018, the industry still has concerns about the government's high levies on 5G infrastructure stifling market adoption and a lack of clarity on financial incentives for fiber infrastructure slowing the potential speed of rollout.

Sustainable development in India strongly parallels its performance in ICT. The Indian government is firmly committed to the sustainable development agenda and has recognized that its national development goals are mirrored in the SDGs. It has participated in the UN's Voluntary National Review process and reported on its sustainable development progress in 2017. India has achieved recent improvement on sustainable development, particularly through anti-poverty programs such as the Mahatma Gandhi Rural Employment Guarantee Act which created two billion days of employment in 2016 by guaranteeing all households a minimum of 100 days of wage work every year.

India's ICT SDG Benchmark performance

India ranks 51st out of 55 countries, scoring 40.9 out of a possible 100 points on the Benchmark. India's SDG score contributes much more to its total score than does its ICT score – it also ranks slightly higher on SDGs compared to ICT (#50 for SDGs, #51 for ICT). Between the 2018 and 2019 Benchmarks, India demonstrated an increase of three points in score, from 37.9 to 40.9, while also increasing its rank by one spot from #52 to #51.

Table 13. India's year-over-year change in scores and rank

India	2018	2019	Change
Ranking on the ICT SDG Benchmark	52	51	↑ 1
Score on the ICT SDG Benchmark	37.9	40.9	+ 3.0
Ranking on SDG progress	52	50	↑ 2
Score on SDG progress	109	123.6	+ 14.6
Ranking on ICT development	51	51	-
Score on ICT development	3.0	3.0	-

* Note ICT development scores which come from the ITU's ICT Development Index, did not change because the ITU database skipped an update year and will not publish new data until the end of 2019.

India scores below average on each of the six SDGs included in the benchmark but demonstrates the strongest performance on SDG 7 (Affordable and Clean Energy), for which it scores just 3.0 points below Benchmark average. India also scores relatively well on SDG 9 (Industry, Innovation and Infrastructure), for which it scores 4.4 points below average.

For SDG 7 (Affordable and Clean Energy), India receives a high score on "electric power consumption (kWh per capita)." This is a complex indicator to unpack because while it's seemingly good to have low energy consumption, in India's case, this may be more reflective of the population's low level of access to electricity as opposed to highly efficient energy use. This will be an important indicator to track as India continues to develop in the coming years to determine how sustainably India is able to provide greater access to energy services. On SDG 9 (Industry, Innovation and Infrastructure), India does not score very high, but as the Benchmark average for SDG 9 is quite low, it performs close to average relative to other countries in the Benchmark. Of the indicators for SDG 9, India performs best on the indicator related to "logistics performance index" which measures quality of trade and transport-related infrastructure, but poorly on the others.

Between the 2018 and 2019 Benchmarks, India was able to increase its scores on SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education), SDG 5 (Gender Equality) and SDG 7 (Affordable and Clean Energy), with none of the SDGs showing a decrease in score, leading to an increase in overall SDG score from 109.0 to 123.6, and achieving a rank increase from #52 to #50. This is a good sign for the country, suggesting that its past efforts on SDGs are paying off, particularly in the area of health, and that it is not backsliding in any of SDG areas included in the assessment.

While SDG 7 (Affordable and Clean Energy) and SDG 9 (Industry, Innovation and Infrastructure) are areas where India can continue to focus and make further progress, it has the most benefit to gain from focusing on the SDGs on which it falls furthest behind average – particularly SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education) and SDG 5 (Gender Equality). These SDGs also represent the areas with highest correlation to ICT, which means that by focusing ICT solutions on these areas, India has the greatest opportunity for success in development.

Figure 20. India's 2019 SDG scores, each out of a possible 40 points

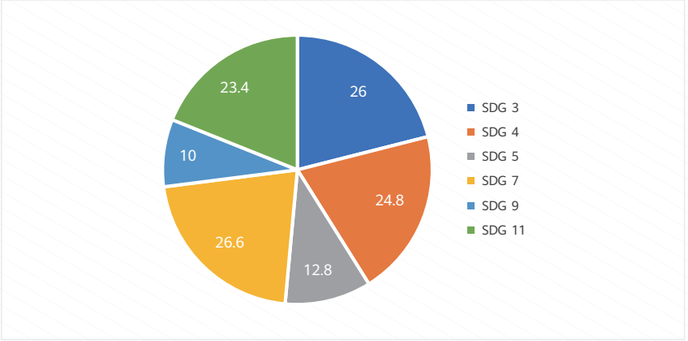


Figure 21. India's 2019 SDG scores compared to the Benchmark average

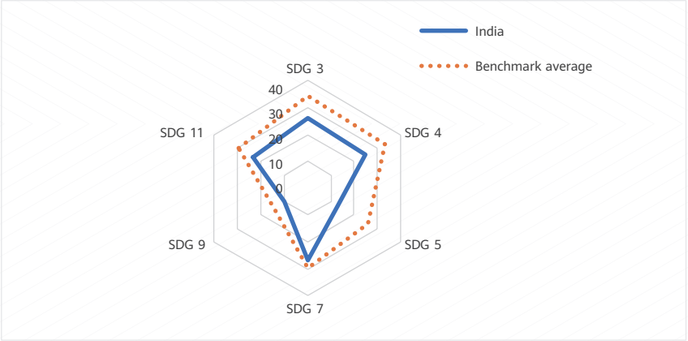
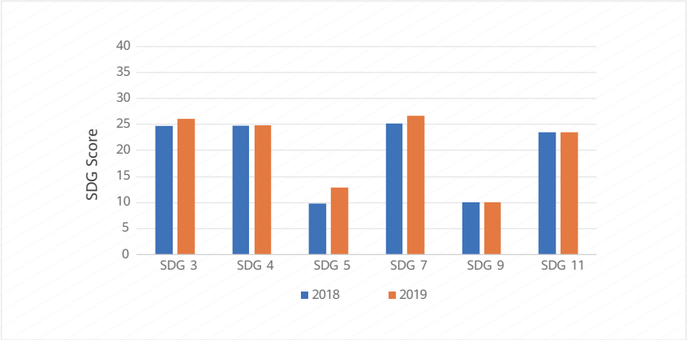


Figure 22. India's 2018-2019 year-over-year change in SDG progress



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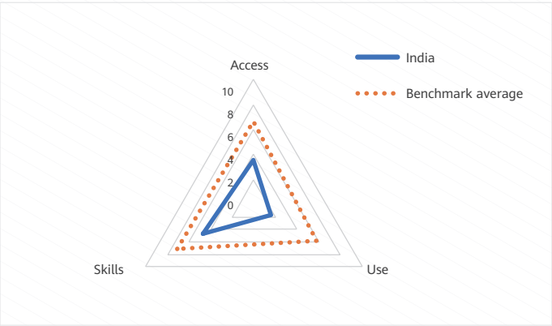
India scores below average on each of the three ICT sub-indices of Access, Use and Skills. India's low scores on all three Use indicators – "percentage of individuals using the Internet," "fixed broadband subscriptions" and "active mobile-broadband subscriptions" – are the primary reasons for this yet-to-be improved performance.

India has the greatest opportunity for improvement by focusing on Use – greater uptake and use of ICT systems can help drive progress in other areas of sustainable development.

Figure 23. India's 2019 ICT scores compared to the Benchmark average



Key initiatives that support progress on the SDGs

National Digital Communication Policy 2018:

Although India has disadvantages in ICT development, the newly published National Digital Communication Policy 2018 details a clear vision with a five-year plan to be completed by 2022. Notably, Telecom Optic Fiber has been awarded the status of public utility and some of the key goals set within the policy are to:

- Provide access to universal broadband at 50 Mbps for every citizen
- Enable access to high speed broadband at 1 Gbps for all village councils
- Create 4 million additional jobs
- Propel India to the Top 50 Nations in the ICT Development Index of ITU, from 134 in 2017
- Enable deployment of public Wi-Fi Hotspots; to reach 5 million by 2020 and 10 million by 2022

Public-private partnerships:

At a sub-national level, state governments have established public-private partnerships to advance sustainable development and ICT performance. IBM announced this year that it will collaborate with three states (Karnataka, Telengana and Andhra Pradesh) to support at least 200,000 women in India advance their skills and careers in STEM subjects. IBM hopes to expand these collaborative programs with other states.

Solutions that can further India's SDG progress

India can see the greatest gains by focusing on SDGs 3 (Good Health and Well-Being), 4 (Quality Education) and 5 (Gender Equality). ICT can be a powerful tool to help India achieve progress in these areas:

- Harness the momentum of India's year-on-year progress on SDGs 3 (Good Health and Well-Being) and SDG 5 (Gender Equality) by expanding government initiatives in these areas that have been successful.
- Focus on enhancing use of ICT services; greater uptake and use of ICT systems by Indian citizens can in turn drive greater progress in other areas of sustainable development.
- Ensure that policies and standards are in place as the country develops its energy grid so that progress in this area will lead to decreased carbon emissions, greater efficiency and equitable access to clean energy sources.
- Reassess policies that may be preventing improved ICT services from being adopted in the country, such as the high levies in place on 5G and the lack of policy clarity on fiber infrastructure. Unlocking these technologies strategically may be the key to greater progress in many areas of the SDGs.

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South Korea

South Korea has ranked the highest of all countries in the ICT SDG Benchmark since it was first included in the assessment in 2018, retaining this rank for the second year in a row. Its high rank is primarily driven by its ICT performance – the Asian country ranked highest out of ITU's list of 176 countries in 2015 and 2016, and ranked second only to Iceland in 2017. South Korea has some of the world's fastest Internet speeds – first in a recent report by Akamai, with an average connection speed of 28.6 Mbps (global average is 7.2 Mbps; second is Norway at 23.5 Mbps). It is also in the running to be the first country to launch its 5G network sometime in 2019; a 2019 5G Country Leadership Index report benchmarking 40 countries identified South Korea as the clear leader in rolling out the technology, ahead of the United States.

Linked to its strength in ICT, South Korea was recognized in the 2017 Bloomberg Index as the highest ranking of "Most Innovative Economies," based on research and development spending and the concentration of high-tech public companies. According to the ITU, the three major factors that have formed the basis for growth of South Korea's digital economy: the advanced educational system, a cultural characteristic to move quickly, and key government support for ICT beginning as early as the 1990's. ICT policies in South Korea continue to play a role in driving the country ahead, such as its three-phased roadmap for the fourth industrial revolution.

South Korea has also made significant progress on the SDGs, focusing in recent decades particularly on reduction of poverty and inequality and transition to democracy. A number of policies have been implemented that further drive sustainable development, particularly the Standard Guideline for the Management and Support for Implementing Organization of Local Agenda 21(2004), and the Framework Act on Sustainable Development (FASD) (2007). The South Korean government has also been implementing the Three Year Plan for Economic Innovation which, in addition to reforming the public sector, promoting a creative economy and boosting domestic demand, is targeting SDGs that are mainly associated with social and economic development, such as fair and efficient economy, growth through innovation, and the balance between exports and domestic consumption.

The South Korean government is also paying particular attention to gender equality – the Framework Act on Gender Equality (2015) and a prior Act on Promotion of Economic Activities of Career-Interrupted Women (2010) are in effect, although Korea still has a ways to go in regards to gender equality, as reported in the recent Glass-ceiling index which shows Korea as the lowest ranking of OECD countries. Nonetheless, across the SDGs Korea's government has shown dedication to achieving various areas of sustainable development; the Office for Government Policy Coordination (OGPC), MOFA, and MOE together with Statistics Korea are playing a main role in mainstreaming the SDGs, have recently begun mapping exercises to identify existing laws, rules, regulations and policies conducive to achieving the SDGs.

South Korea's ICT SDG Benchmark performance

South Korea ranks first out of the 55 countries on the ICT SDG Benchmark, scoring

84.4 out of a possible 100. Its overall score is driven by its ICT score, which is a similar pattern to other Leaders in the Benchmark. The country increased its score by 0.6 points from the 2018 Benchmark, in which it also ranked the highest of the countries included in that assessment (49 countries).

Table 14. South Korea's year-over-year change in scores and rank

South Korea	2018	2019	Change
Ranking on the ICT SDG Benchmark	1	1	-
Score on the ICT SDG Benchmark	83.8	84.4	+ 0.6
Ranking on SDG progress	9	6	↑ 3
Score on SDG progress	190	192.6	+ 2.6
Ranking on ICT development	1	1	-
Score on ICT development	8.9	8.9	-

* Note ICT development scores which come from the ITU's ICT Development Index, did not change because the ITU database skipped an update year and will not publish new data until the end of 2019.

Figure 24. South Korea's 2019 SDG scores, each out of a possible 40 points

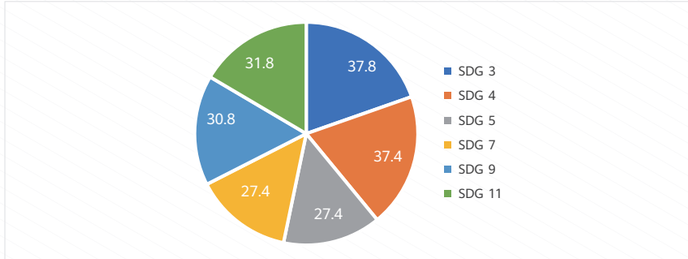


Figure 25. South Korea's 2019 SDG scores compared to the Benchmark average

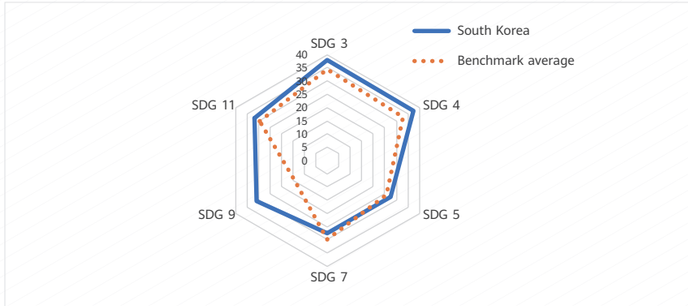
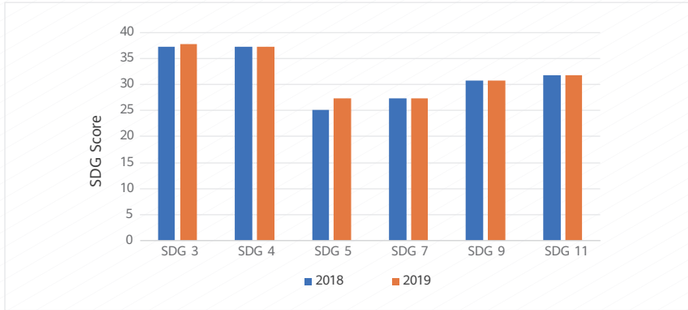


Figure 26. South Korea's 2018-2019 year-over-year change in SDG progress



South Korea performs close to or above average on all SDGs, but on SDG 9 (Industry, Innovation and Infrastructure) it performs significantly higher than average, with a score of 30.8 compared to the Benchmark average of 14.5. This is a direct result of South Korea's innovation-focused economy, a characteristic that led it to receive recognition as the world's most "Most Innovative Economy."

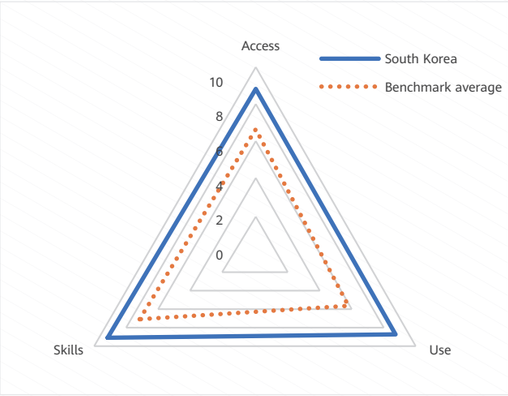
SDG 7 (Affordable and Clean Energy) is the only SDG on which South Korea performs slightly below average, with a score of 27.4 compared to the Benchmark average of 29.2. This represents an opportunity for improvement of efficient and low-carbon energy for the country, which it likely has to balance against expanding reliance on technology and digitization.

Between the 2018 and 2019 Benchmarks, South Korea increased its indicator scores on SDG 3 (Good Health and Well-Being) and SDG 5 (Gender Equality), with the other SDG scores staying the same, driving an increase in overall SDG score from 190 to 192.6 and leading it to an increase in SDG rank from 9 to 6. This is a strong sign for South Korea of continuing to make year on year progress on sustainable development, particularly on the topic of gender equality (SDG 5) for which South Korea receives the lowest score of the SDGs (tied with its score on SDG 7).

Within ICT indicators, South Korea performs well across all three indicators of Access, Use and Skills. Compared to Benchmark average, it scores the highest above average on Use, followed by Access and then Skills.

While South Korea performs above average on almost all the indicators across Access, Use and Skills, one indicator on which South Korea performs below average is "International Internet bandwidth per Internet user." This is an area on which South Korea can focus future efforts.

Figure 27. South Korea's 2019 ICT scores compared to the Benchmark average



Key Initiatives that support progress on the SDGs

Smart City of Busan:

Busan Metropolitan City is being reimagined as a Smart City of the future as part of the South Korean government's plan to develop smart cities over the next five years. The city is the second most-populated city in South Korea and is economically important as South Korea's largest shipping port and one of the world's Top Ten Largest Container Ports. The government-led smart city project in Busan aims to be human-centered, with a focus on applying innovative technologies, such as autonomous driving, artificial intelligence, smart energy management and virtual reality, to ensure a connected and safe city for residents.

In Busan, open data projects and data monitoring systems are already being implemented to monitor traffic flows and working with emergency services on real-time communications flows. To improve resident safety, the city plans to use connected sensors in surrounding buildings to alert people in the neighborhood if a fire breaks out, while fire engines can be guided by a disaster control tower in the region to optimize the fastest route to the scene.

This test case, along with Sejong city, are part of the South Korean government's push toward the fourth industrial revolution, which has become an economic focus of the country's government.

Government for Citizens:

The Government for Citizens (G4C) system was established to connect South Korea's government database networks – such as resident registration, real estate, vehicle registration, etc. – with citizens, and streamline government processes in the delivery of services to citizens. By 2003, up to 97% of documents were accessible through an e-approval system in the government agencies, compared to a paltry 21.2% in 1998. The online-based Home Tax Service (HTS) allows taxpayers to file tax returns, receive e-Bills, and process e-Payments from their homes via the Internet. With the establishment of the Government e-Procurement Service (GePS), procurement processes involving bidding, contract agreements, and payment for services or supplies take place online in real-time. A study conducted following the initiative found that 47,000 public institutions and 138,000 private businesses had used this e-procurement system, achieving savings of US$ 4.5 billion. The initiative also enabled database networks for health insurance, pension insurance, industrial accident compensation insurance, and unemployment insurance policies, to be integrated into the seamless network.

Korean Ministry Blockchain Initiative:

The Korean Ministry of Information and Communication recently implemented efforts to expand and develop blockchain pilot solutions. The Ministry of Information and Communication announced that South Korea "will establish a roadmap for developing a block chain technology and plan to secure 90% of the technology level by 2022 compared to the world's top countries." As part of this effort, the Ministry introduced an initiative to expand and develop six existing blockchain pilot projects focused on developing solutions that address various areas of economic and sustainable development, including the management of livestock records for target spread of foodborne illnesses, authenticated online voting, and improved logistics and trade management systems.

Solutions that can further South Korea's SDG progress

South Korea excels in many aspects of Benchmark, but notably ranks lower in SDGs compared to ICT. Within the SDGs, South Korea has the greatest opportunity for improvement in SDGs 5 (Gender Equality) and SDG 7 (Affordable and Clean Energy). With its leading position in ICT, South Korea can further its contribution in these areas in the following ways:

- Focus ICT on empowering women and providing them with more access to economic opportunities, such as by enabling flexible work arrangements and providing greater access to financial services.
- Harness ICT solutions to drive improvement of efficient and low-carbon energy use for the country, particularly as the country's reliance on technology and digitization continues to expand.
- Focus on boosting the country's metric for "International Internet bandwidth per Internet user" which is one area in which South Korea has room for improvement in terms of ICT development.

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Turkey

Turkey has significant opportunity to speed ahead on ICT progress. Turkey's economy and ICT sector has shown strong growth. Turkey's ICT sector grew 18.2% year-on-year in 2017, with another 10-15% forecasted for 2018. The size of the Turkish ICT sector has almost doubled by growing at an annual average rate of 15% since 2012. Digitization has gained momentum in Turkey's business sector – the share of firms with a website and of firms present in digital social media is very high compared with peer countries in Europe. However, use of core digital applications in businesses, such as use of enterprise resource planning and customer relationship management software, is lower than in other countries in Europe, possibly reflecting an opportunity of skills improvement. There is significant appetite from the Turkish government to advance in ICT capabilities.

Turkey has demonstrated great effort on progressing on sustainable development in recent decades. Prior to the SDGs, Turkey made significant progress on the Millennium Development Goals (the United Nations' goals for international development for 2015, also considered a precursor to the SDGs) and was considered among the top ten performers by annual rates of relative progress, particularly on topics such as eradicating extreme poverty, reducing child mortality, improving maternal health, and focusing on environmental sustainability. Turkey was able to achieve this through a long-term focus on implementing broad and ambitious reforms, including government programs that have targeted vulnerable groups and disadvantaged regions. Through these programs, poverty incidence more than halved over 2002-2015, with extreme poverty dropping even faster. During this time, Turkey urbanized dramatically and harmonized many laws and regulations with the European Union standards. The country's response to the influx of approximately 3.6 million Syrian refugees has been exemplary, according to the World Bank, and provides a model to other countries hosting refugees. Although it has come a long way, the country continues to face certain challenges: the labor market continues to be too rigid; women's labor force participation is significantly below peer countries; and educational performance has weakened.

Turkey's ICT SDG Benchmark performance

Turkey ranks 32nd out of 55 countries, scoring 65 out of a possible 100 points on the Benchmark. Turkey ranks close to the middle of the countries included in the Contender category. Its SDG score contributes more to its total score than does its ICT score – it also ranks higher on the SDGs compared to ICT (#32 for SDGs, #34 for ICT). Between the 2018 and 2019 Benchmarks, Turkey demonstrated an increase of 1.8 points in score, from 63.2 to 65, while also increasing its rank by two spots from #34 to #32.

Table 15. Turkey's year-over-year change in scores and rank

Turkey	2018	2019	Change
Ranking on the ICT SDG Benchmark	34	32	↑ 2
Score on the ICT SDG Benchmark	63.2	65.0	+ 1.8
Ranking on SDG progress	37	32	↑ 5
Score on SDG progress	157.4	166	+ 8.6
Ranking on ICT development	34	34	-
Score on ICT development*	6.1	6.1	-

* Note ICT development scores which come from the ITU's ICT Development Index, did not change because the ITU database skipped an update year and will not publish new data until the end of 2019.

Turkey scores slightly above average on many of the SDGs, but notably below average on SDGs 5 (Gender Equality) by 6.5 points and SDG 9 (Industry, Innovation and Infrastructure) by 0.6 points. For its higher performing SDGs, Turkey performs above average by 1.3 points for SDG 3 and 4, and by 1.5 points for SDG 11.

For the indicators of SDG 5, Turkey performs poorly on "proportion of seats held by women in national parliaments" and "Ratio of female to male labor force participation rate," two areas that could be holding the country back from making greater progress in this area (and likely in ICT development as well).

Between the 2018 and 2019 Benchmarks, Turkey was able to increase its scores on almost all the SDGs (aside from SDG 11 which remained the same), giving the country an increase in overall SDG score from 157.4 to 166 and an SDG rank increase from #37 to #32. The greatest increase for Turkey was seen in SDG 5, which demonstrates that while this is an area of weakness for the country, it is also making strong strides to address these issues. Overall, the increases in score and rank across the SDGs is a good sign for the country showing continued progress.

Figure 28. Turkey's 2019 SDG scores, each out of a possible 40 points

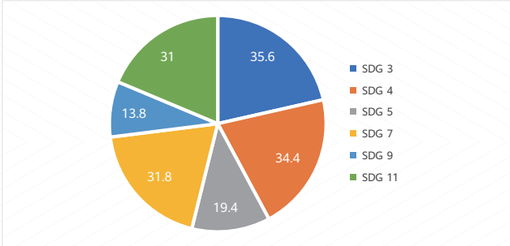


Figure 29. Turkey's 2019 SDG scores compared to the Benchmark average

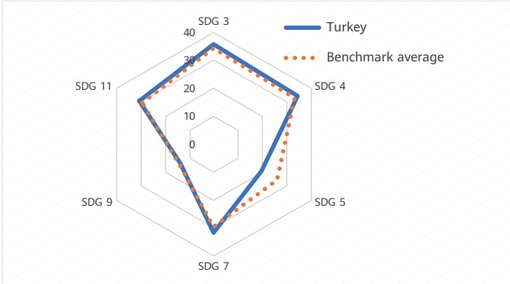
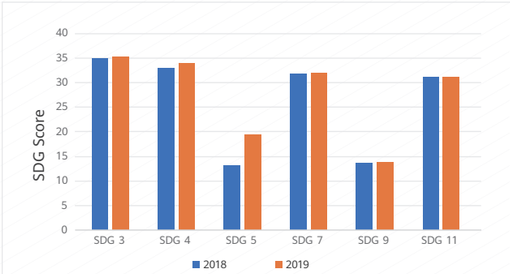


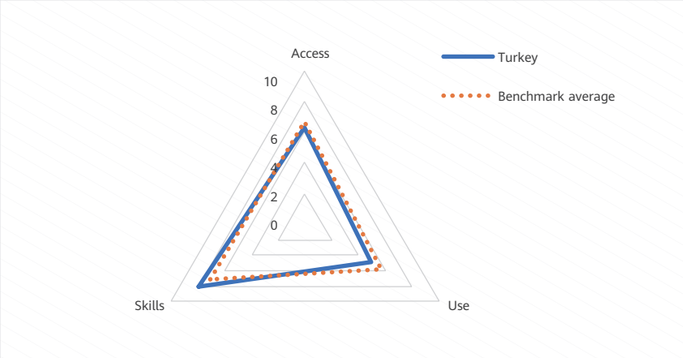
Figure 30. Turkey's 2018-2019 year-over-year change in SDG progress



Turkey scores very close to average on all three of the ICT sub-indices; it scores just above average on Skills, but just below average on Access and Use. Most notably, Turkey exceeds the average by a large amount for the Skills indicator "tertiary gross enrollment ratio," demonstrating an area of strength for Turkey which can be valuable for improving its performance in other areas of ICT.

Turkey has the greatest opportunity to focus on improving issues related to Access and Use, both of which risk limiting Turkey's successes on Skills. Within the Access indicators, Turkey exceeds the average in terms of "percentage of households with Internet access" but falls behind on each of the other indicators. Turkey also lags behind average on each of the Use indicators. By focusing policies on these areas of ICT Turkey can improve its strength in ICT and also help drive progress on other areas of sustainable development.

Figure 31. Turkey's 2019 ICT scores compared to the Benchmark average



Key Initiatives that support progress on the SDGs

TEYDEB 1515 -Frontier R&D Laboratories Support Program:

The stated aim of this government initiative in Turkey is to increase the research qualifications of Turkish scientists and ensure that the country is a center of attraction for fields of science and technology. The first research laboratory established for the ICT sector under the TÜBİTAK's program was Ericsson Research, which will enable Turkish researchers to contribute to international projects and produce new articles, papers and patents, while directly contributing to worldwide standards. As part of this move, the Deputy Turkey Ministry of Industry and Technology has stated that he is "Well aware that human capital is the most important component of sustainable development," highlighting his recognition of the linkage between ICT growth and sustainable development in Turkey.

Education Information Network (EBA):

EBA is recognized as the most important online platform in Turkey. Developed under the FATIH project, EBA allows teachers and students to create, share and exchange digital content. It also provides free access to tools to create multimedia resources (ideaLStudio, EBA Sunum, Eutdyo and Xerte). EBA is also a gateway to other online platforms such as Khan Academy, Da Vinci Learning and Lingus. Common criticisms suggest that there are no agreed standards for digital content in general, and that resources for vocational subjects in particular as well as interactions among users are relatively limited, so there is room for further improvement of this important tool.

Solutions that can further Turkey's SDG progress

While Turkey performs at a mid-level compared to other countries in the Benchmark, it has opportunities to advance on SDG 5 (Gender Equality) and 9 (Industry, Innovation and Infrastructure) as these are Turkey's most pressing areas for improvement. ICT can drive Turkey's contributions to these SDGs in the following ways:

- Focus on educating the workforce on the use of digital applications in business (such as enterprise resource planning and customer relationship management software) to close the skills gap and boost use and capability of ICT in the business sector.
- Harness ICT tools to enable greater participation from women in the workforce, such as tools allowing for greater flexibility during maternity. Encourage and enable women to participate more actively in government by engaging with them through web content and online mentorship programs.
- Harness Turkey's strength in tertiary education by embedding more ICT programs and encouraging students to pursue fields in ICT. Incentivize the use of ICT towards creating social and environmental solutions.

Next Steps

| Recommendations for Contenders and Improvers

In terms of ICT development, Improvers and Contenders lag the most behind Leaders in the area of Use, whereas the performance gap for Access and Skills is less pronounced. This finding emphasizes the importance of leveraging capabilities in both Access and Skills to drive increased Use, particularly to improve country performance on indicators relating to percentage of individuals using the Internet and fixed and mobile broadband subscriptions. The barriers to Use associated with these technologies can involve affordability, awareness, as well as whether users have personal vs. public access to devices. As such, governments, policymakers and the private sector should determine which of these factors are the main inhibitors of progress on ICT Use the most and follow up by targeting policies, initiatives and partnerships to solving those issues.

It remains evident based on both the 2018 and 2019 Benchmark results that digital solutions related to health (SDG 3) and education (SDG 4) can provide the greatest return on investment for Contender and improver countries due to strong correlations between these SDGs and ICT development.

Improvers made measurable progress on SDGs 3 (Good Health and Well-Being) and 5 (Gender Equality) in 2019, in addition to a focus on SDG 4 (Quality Education), and should look to continue this trend so that performance on these foundational societal needs can eventually reach the performance levels seen in Contender and Leader countries. Significant improvements in health, education and gender equality can then further enable these countries to pursue higher levels of progress on other SDGs that build upon this foundation. Though specific areas of greatest need will vary by country, the areas that need the most focus include:

- Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease
- Incidence of tuberculosis
- Expected years of schooling
- Primary school pupil-teacher ratio
- The proportion of seats held by women in national governments (and other areas of leadership)
- Female labor force participation rate
- Average years of schooling for females

On average, Contenders are not far behind Leaders on SDGs 3 (Good Health and Well-Being) and 4 (Quality Education), and actually exceed the Leaders' average score on SDG 7 (Affordable and Clean Energy). Contenders made significant progress on SDG 5 (Gender Equality) in 2019, but this remains an area for the country group to focus improvements, along with SDGs 9 (Industry, Innovation and Infrastructure) and 11 (Sustainable Cities and Communities). Though areas of greatest need will vary depending on country context, the areas in need of focus include:

- The proportion of seats held by women in national governments (and other areas of leadership)
- Female labor force participation rate
- The quality of trade and transport-related infrastructure, including port infrastructure
- Innovation and developing new patents
- The availability of automated banking services
- Waste generation per capita
- Making roads and transportation safer, as indicated by traffic deaths rate

While these are the areas most in need of improvement for Contenders and Improvers based on assessment of the indicators in this study, it is important to keep in mind that this is a narrow subset compared to the vast number of indicators that could be considered for measuring progress on the SDGs. It is therefore also important for government officials and policymakers to seek out the appropriate indicators to best determine the focus areas for their countries and the specific policies and initiatives that will best propel it forward.

| Recommendations for Leaders

Though Leader countries are performing well on the Benchmark, they can still benefit by investing in ICT solutions that drive improvements all six of the SDGs studied here in pursuit of a balanced approach to progress. Most Leader countries have ample opportunity to deploy and make use of the more advanced digital solutions available such as 5G, fiber-optic broadband, cloud applications, artificial intelligence, blockchain and more, as discussed in the Digital Solutions section of this report.

Specifically, ICT can be leveraged by Leader countries to focus on improvements toward SDGs 7 (Affordable and Clean Energy) and 9 (Industry, Innovation and Infrastructure). SDG 7 is the only SDG on which Leader countries score below Contender countries on average; SDG 9 represents the Leader group's lowest average score, and is also the only SDG on which the average Leader score decreased in 2019 compared to 2018. Though areas of greatest need within the Leader group will vary, countries can benefit the most by focusing on:

- Percentage of energy consumed that's from renewable resources
- Efficient use of electricity (i.e. decreasing per capita electric power consumption)
- The quality of trade and transport-related infrastructure, including port infrastructure
- Innovation and developing new patents
- The availability of automated banking services
- Waste generation per capita

As mentioned previously, there are many other indicators beyond those included in this study that government officials and policymakers should take into account when determining the areas of focus for improvement and how to leverage ICT to their greatest advantage.

| Final conclusions

Countries can benefit most from focused investment on the use of ICTs. While all three sub-indices of ICT (Use, Access and Skills) show high correlations with SDGs and all are important for driving progress on sustainable development, Use emerges as a particular area of need of improvement for most countries, perhaps because it is somewhat dependent upon both Access and Skills. Not only do Leader countries score the lowest on Use on average compared to Access and Skills, Use is also the indicator with the largest gap between Leaders and Improvers, signaling this as an area where many countries have room for progress.

Alongside these recommendations, we encourage national decision-makers to seek to design and implement targeted policies that harness digital technologies to address the most important social and environmental issues for their countries, taking into account the policy recommendations made in the Digital Solutions chapter of this report.

ICT will continue growing exponentially around the world, especially with the myriad sensor networks crucial for building the IoT and the 5G networks required to connect it all. But in order for digital technologies to deliver the highest benefit to society, their deployment has to be targeted, thoughtful, and cautious with particular attention paid to ensuring equitable access for all populations and addressing both positive and negative impacts on society and the environment.

It will be particularly important for countries to have strategic policies for the fastest growing technologies: cloud, IoT, big data, artificial intelligence, augmented and virtual reality, blockchain, 5G networks, and others. South Korea, the highest ranking country in the Benchmark, remains a leader in both the development of ICT infrastructure (e.g. 5G) and the application of its digital capabilities for social good (e.g. e-government, customized welfare services). It provides a strong example of effective national policies for other countries to look towards.

In addition to local and national governments, the private sector, NGOs, intergovernmental organizations and other stakeholders have crucial roles to play in mobilizing ICT to drive SDG progress as well. Multi-stakeholder partnerships will be critical to this objective which involves complex interdependencies among various environmental, social, cultural, and technological issues.

ICT is not the only tool for achieving the SDGs; however, ICT shows great promise for accelerating our progress on some of the world's most pressing global problems through creative and innovative solutions.

Appendix Methodology

| Objectives

The ICT Sustainable Development Goals Benchmark measures the combined performance of countries on information and communication technology (ICT) and the Sustainable Development Goals (SDGs or Global Goals). The goal of this study is to establish a credible Benchmark that will enable progress to be tracked over time and will inform deeper analysis of the impact that ICT has on sustainable development. The underlying hypothesis is that ICT development and sustainable development have a causal relationship: By increasing investment in ICT and being more targeted in its application, countries can increase their contribution to and performance on the SDGs.

| Research Framework

The 2019 ICT Sustainable Development Goals Benchmark ranks 55 countries on their combined performance on ICT development and performance on the SDGs, assigning equal weight (50% of the benchmark value) to each. Each country is assigned a score on a 0-100 scale and ranked.

Country Selection

Countries included in the Benchmark were selected to align with and move closer to covering the full scope of countries included in Huawei's Global Connectivity Index (GCI). These 55 countries represent a range of developed and developing economies, different geographies, and different phases of ICT development to provide a broad view of how countries are performing and enable comparison and identification of opportunities for countries.

SDG Indicators

The selection of indicators (Table 16) was guided by the following principles:

- We selected SDG targets with the strongest link to ICT and where data was available, and chose indicators to track those targets that have been officially recommended by the UN
- Where possible, we collected data on the broadest possible range of targets for each SDG
- We prioritised indicators measuring policy outputs rather than policy inputs
- We only used recent data from reputable sources, primarily UN agencies, the World Bank, OECD and academic institutions

Table 16. Chosen indicators and data sources

SDG	Indicator	Data Source
SDG 3: Good Health and Well-Being	Maternal mortality ratio	WHO 2015
	Neonatal mortality rate (per 1000 live births)	WHO 2017
	Incidence of tuberculosis (per 100 000 population per year)	WHO 2016
	Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	WHO 2016
SDG 4: Quality Education	Literacy rate of 15-24 year olds, both sexes (%)	UNESCO 2016, or most recent available data
	Expected years of schooling	UNDP 2017
	Pupil-teacher ratio, primary	UNESCO 2016-2017
	Repeaters, primary, total (% of total enrolment)	UNESCO 2016-2017
SDG 5: Gender Equality	Unmet demand for contraceptives (% of women married or in union, ages 15-49)	Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2018): SDG Index and Dashboards Report 2018. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN)
	Proportion of seats held by women in national parliaments (%)	IPU 2018
	Labour force participation rate, female (% of female population ages 15+)	ILO 2017
	Mean years of schooling (females aged 25 years and above) (years)	UNESCO 2017
SDG 7: Affordable and Clean Energy	Access to electricity (% population)	World Bank, Sustainable Energy for All, 2016
	Renewable energy consumption (% of total final energy consumption)	World Bank, Sustainable Energy for All, 2015
	Proportion of population with primary reliance on clean fuels and technology	WHO Household energy database, 2016
	Electric power consumption (kWh per capita)	OECD/IEA 2014
SDG 9: Industry, Innovation and Infrastructure	Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high)	World Bank 2016
	Quality of port infrastructure, WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards)	WEF 2017
	Patent applications, residents per million population	World Intellectual Property Organisation, 2016
	Automated teller machines (ATMs per 100,000 adults)	IMF Financial Access Survey 2016-2017
SDG 11: Sustainable Cities and Communities	Waste Generation per capita (kg/yr)	Waste Atlas, accessed Jan 2019
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	Brauer, M. et al. 2016, for the Global Burden of Disease Study 2016
	Traffic deaths rate (per 100,000 people)	WHO 2013
	Access to improved sanitation facilities (% of urban population)	WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation 2015

ICT Indicators

To gauge country performance in ICT, we used the ratings of the ICT Development Index 2017 published by the ITU, a specialised agency of the United Nations. It is a highly reputable global composite index that combines 11 indicators in three areas: Access (readiness and infrastructure), Use (intensity and subscriptions) and Skills (capabilities and education) (Table 17).

Table 17. Chosen Indicators to Measure ICT Performance

ITU Category	Benchmark ICT Indicators
ICT Access: measure of the level of networked infrastructure and access to the ICTs	• Fixed-telephone subscriptions per 100 habitants • Mobile-cellular telephone subscriptions per 100 inhabitants • International Internet bandwidth per Internet user (Bit/s) • Percentage of households with a computer • Percentage of households with Internet access
ICT Use measures the willingness or interest of people to use the services provided by the Internet	• Percentage of individuals using the Internet • Fixed (wired)-broadband subscriptions per 100 inhabitants • Active mobile-broadband subscriptions per 100 inhabitants
ICT Skills refer to the capabilities and knowledge relating to ICT	• Mean years of schooling • Secondary gross enrolment ratio • Tertiary gross enrolment ratio

Measurement, Normalization and Scoring

Data from various indicators was normalised by assigning a score from 1 to 10. The top threshold of the ranking (10) for each indicator was the SDG target. If this target is achieved, the country will have fulfilled its commitment towards the 2030 Agenda for Sustainable Development. For instance, the top threshold for Target 3.1 "reduce the global maternal mortality ratio to less than 70 per 100,000 live births" is <70. For SDG targets that do not have inherent thresholds, we used a high-performance Benchmark through an analysis of the best-performing countries globally, depending on the scope of the data set used. For example, some of our indicators set Benchmarks at the top 2% of the data range. In some cases, the target is defined by established scientific consensus, as with the World Health Organisation's recommended average exposure to fine particulate matter (PM2.5). Scores are then converted to a scale of 1 to 10, with a value of 1 being the farthest from the target and a value of 10 being the closest.

The ranking values for each indicator were added to compile an individual SDG sum, and the sums for all six SDGs were added to create a total country SDG sub Benchmark. This sum was then weighted equally against the country's 2017 ITU Development Index score to create a total country score that was then fitted on a 0-100 scale to create a country's ICT Sustainable Development Goals Benchmark score.

Determining Correlations

The correlation calculation used in this report, called the coefficient of determination (or R-squared), depicts how related two variables are. It is usually expressed in percentages, so the closer the value is to 100%, the more accurately one variable predicts the other, and therefore the more correlated the indicators are. However, it is important to note that no matter how high the correlation value, it should not be interpreted as proof of causation.

Changes between 2018 and 2019 Benchmarks

Compared to previous year's Benchmark, we analyzed 55 countries, adding six additional countries to the 49 analyzed in the 2018 report. This is in an effort to move this report closer to covering the full scope of countries in Huawei's Global Connectivity Index, bringing consistency to the country set across both studies. The countries added are:

Ecuador	Finland	Greece	Ireland	Jordan	Uruguay

We also updated the titles of the three country performance categories for increased clarity, now titled as Leaders, Contenders and Improvers. The definitions of the three categories remain the same, making them comparable to those in the 2018 report.

There is also one notable, and unplanned, consistency between the 2018 and 2019 reports, which is that the International Telecommunication Union (ITU) did not update the data in its ICT Development Index in 2019, so all ICT data feeding into this year's Benchmark results is the same as the data used in the 2018 report. This means that any year-over-year changes in Benchmark performance are solely the result of changes in SDG progress scores, and not reflective of any changes in ICT development scores. In future iterations of the report, new ICT data will allow us to track and compare ICT progress with SDG

Data Chart

| Correlation between ICT Sustainable Development Benchmark scores and external indices

Figure 32. ICT Sustainable Development Goals Benchmark vs. GDP per Capita (measured as Purchasing Power Parity)

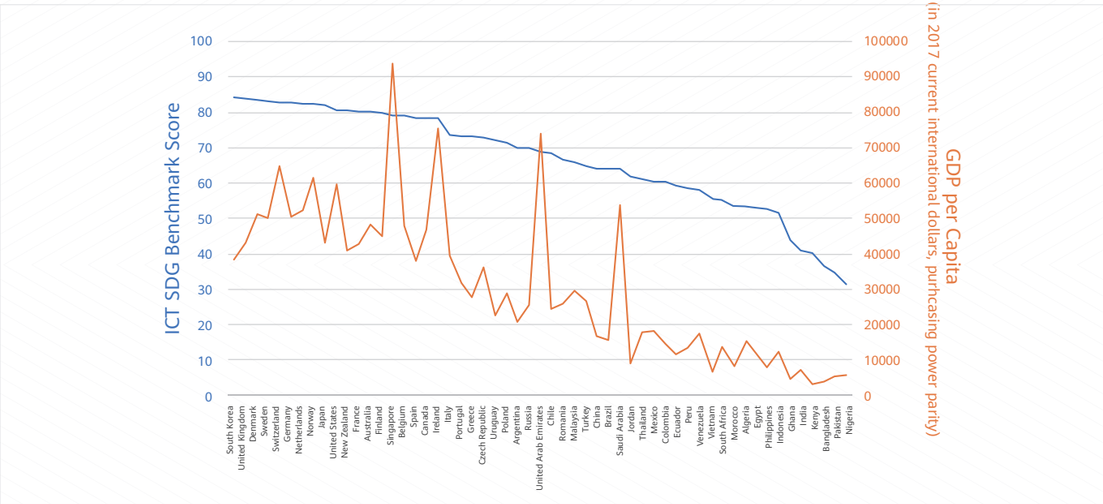


Figure 33. ICT Sustainable Development Goals Benchmark vs. Human Development Index (HDI)

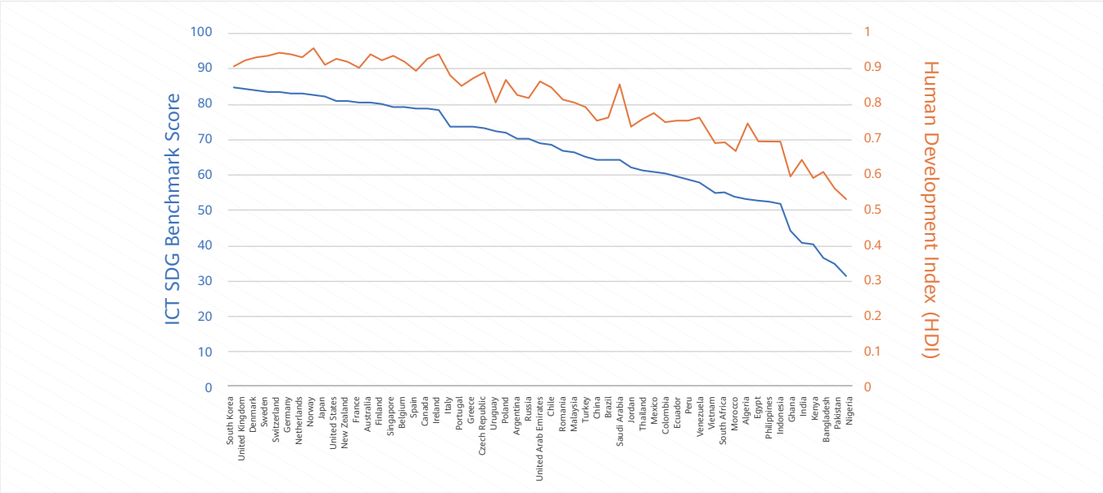


Figure 34. ICT Sustainable Development Goals Benchmark vs. Environmental Performance Index (EPI)

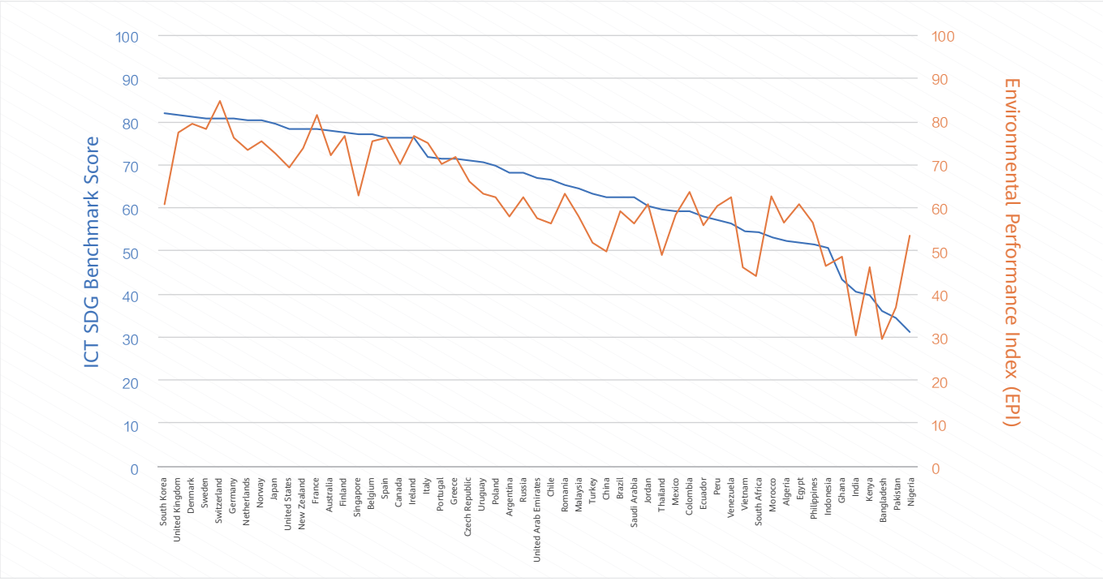
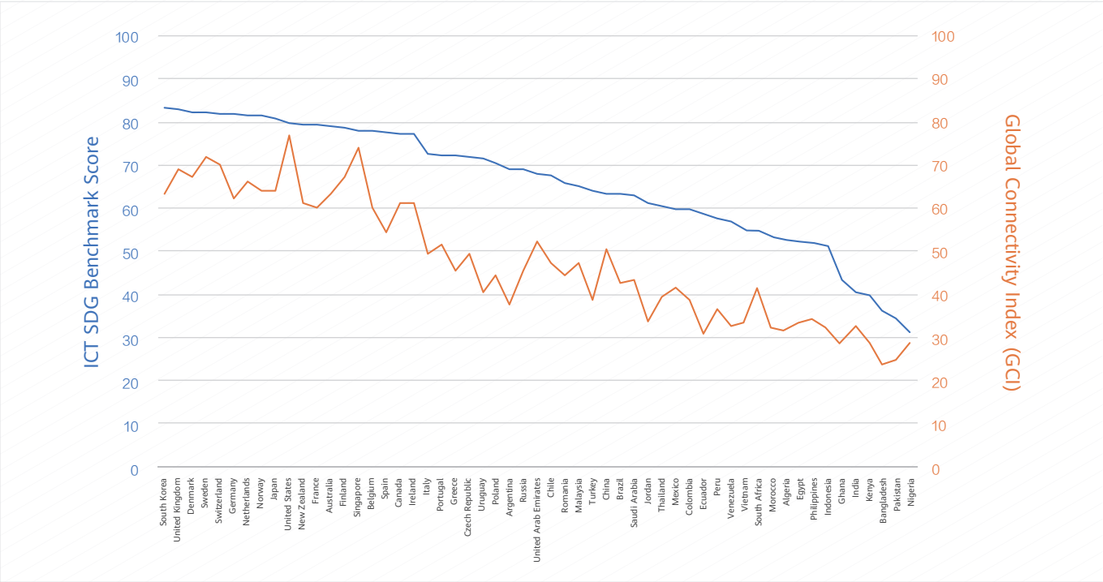
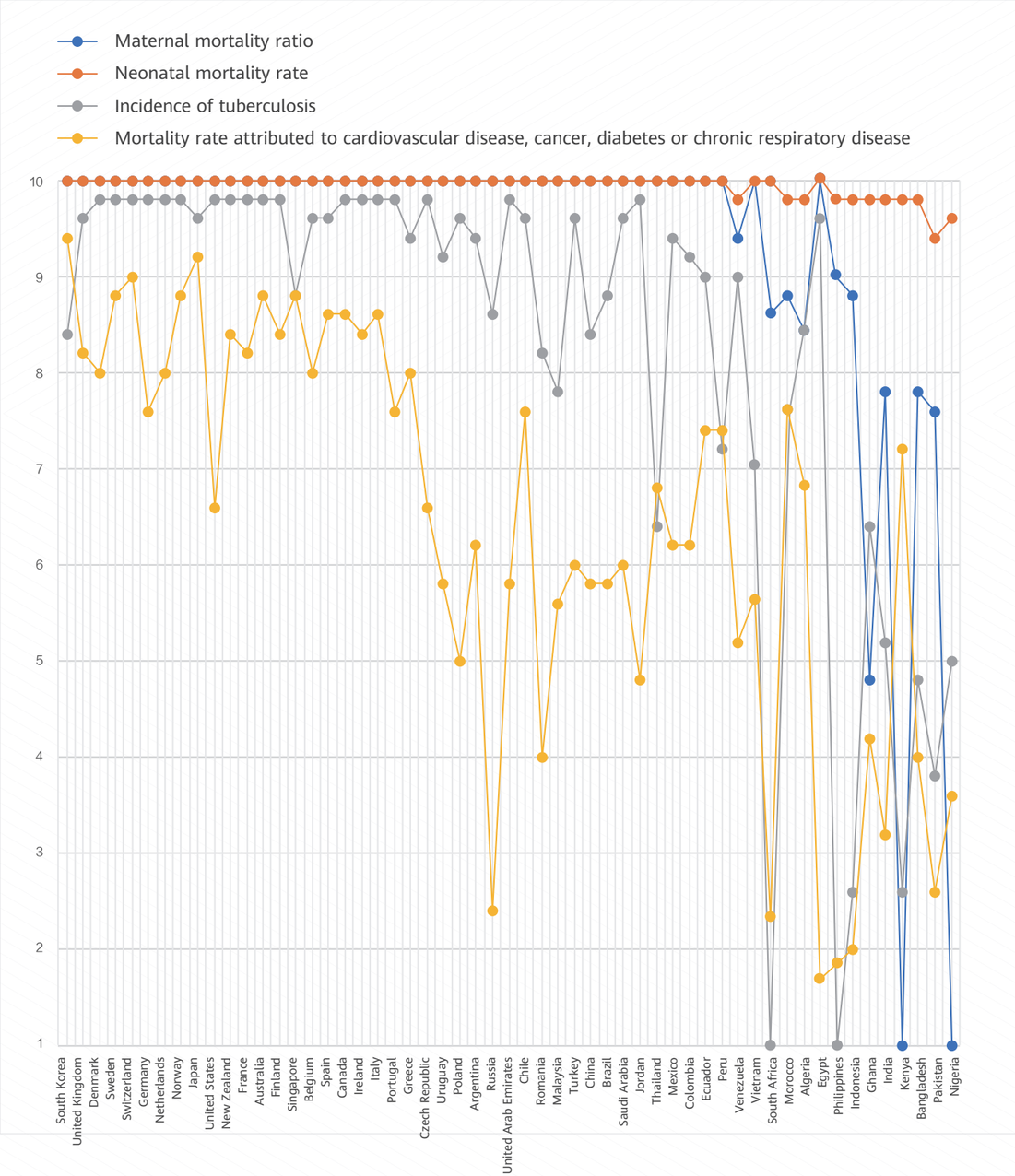


Figure 35. ICT Sustainable Development Goals Benchmark vs. Global Connectivity Index (GCI)



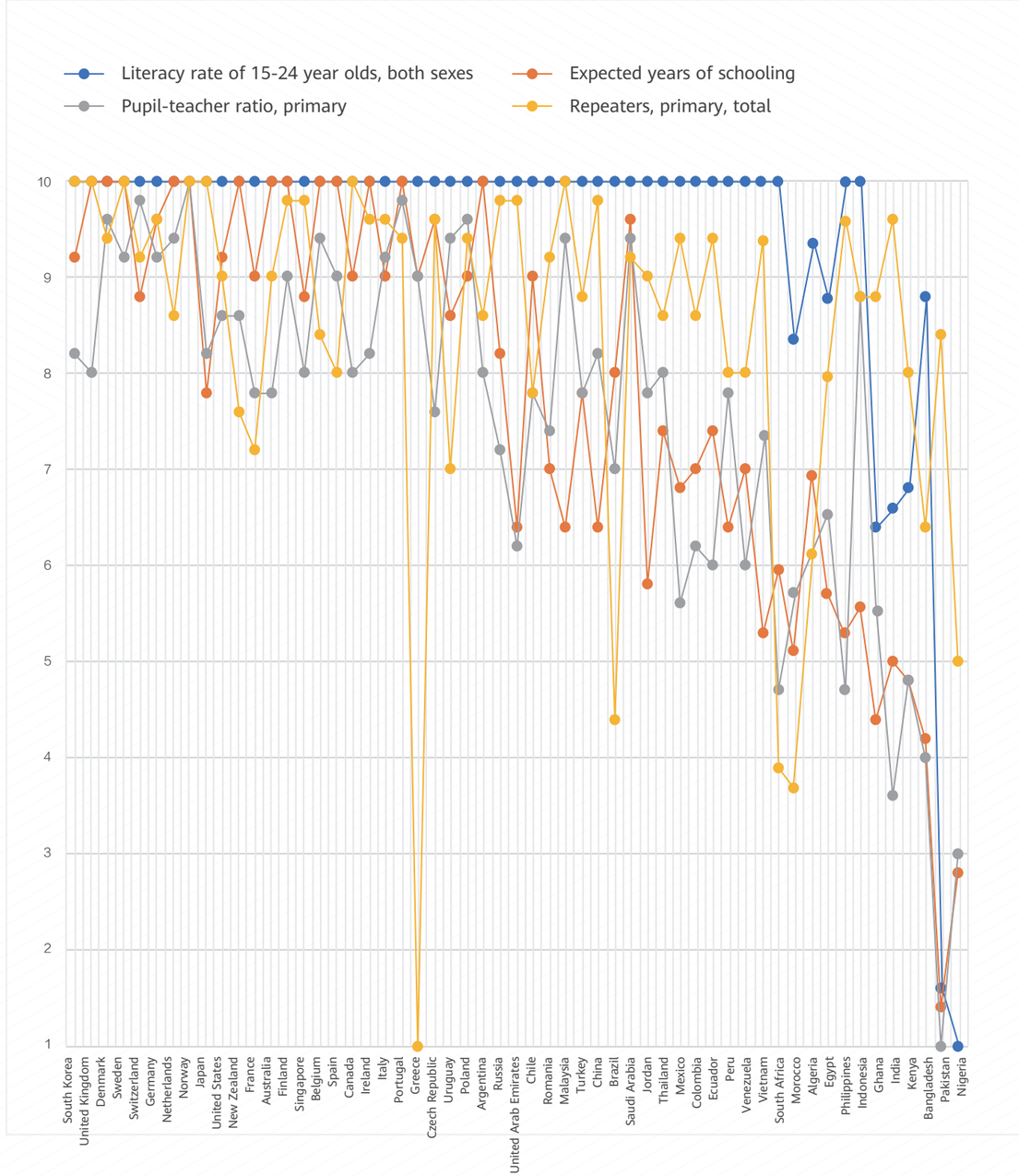
| SDG 3 Indicator Scores

Figure 36. SDG 3 Indicators



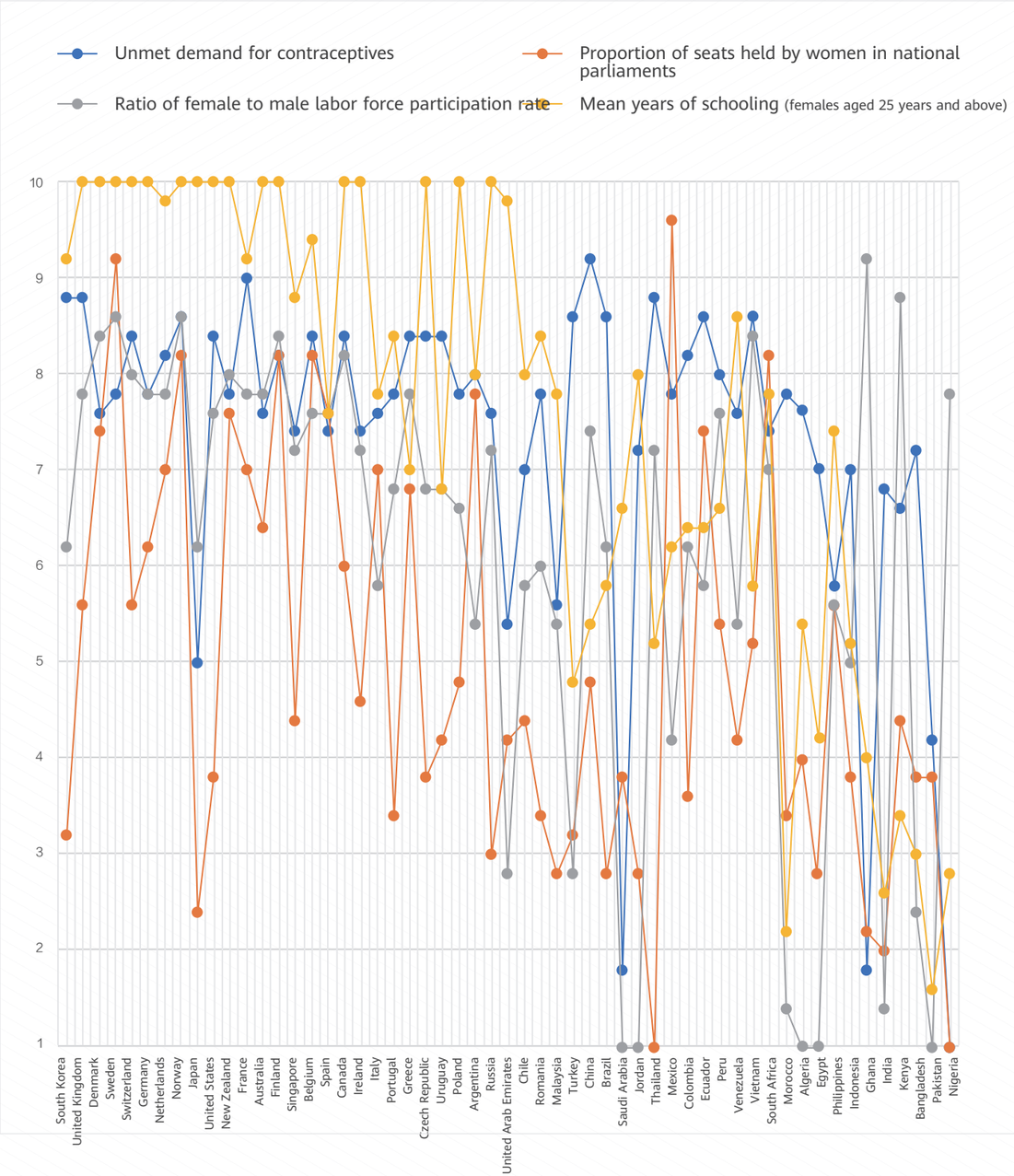
| SDG 4 Indicator Scores

Figure 37. SDG 4 Indicators



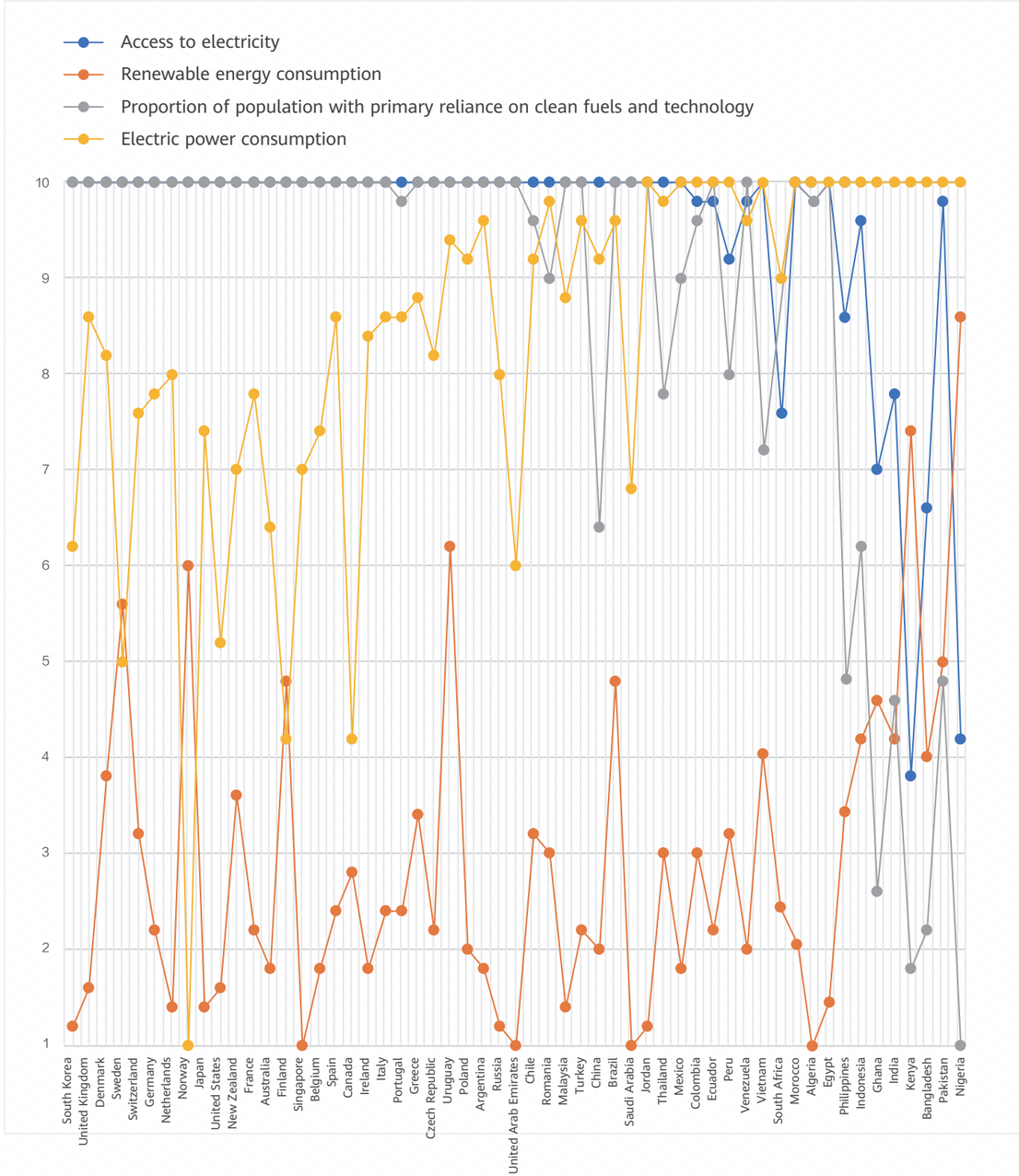
| SDG 5 Indicator Scores

Figure 38. SDG 5 Indicators



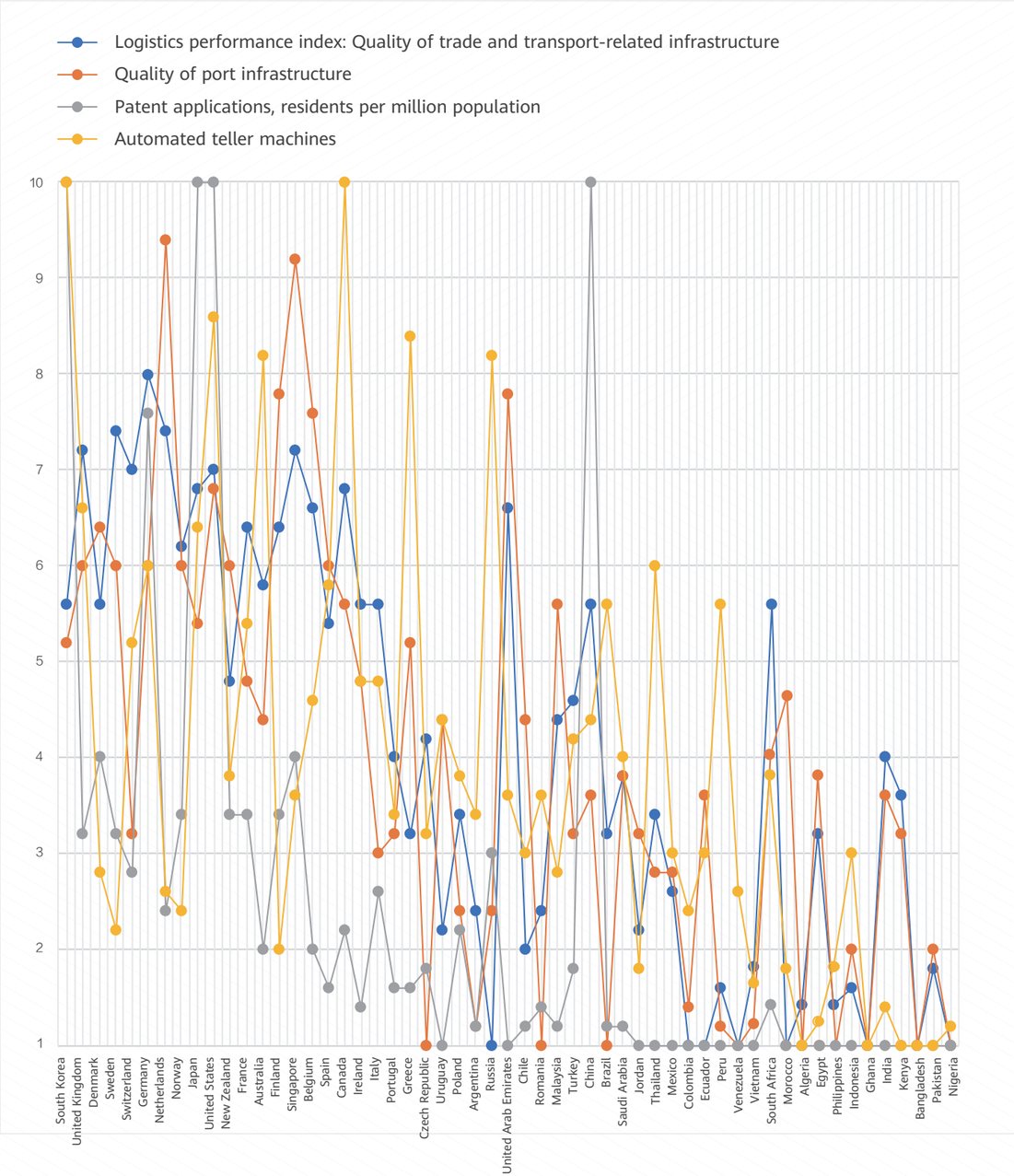
| SDG 7 Indicator Scores

Figure 39. SDG 7 Indicators



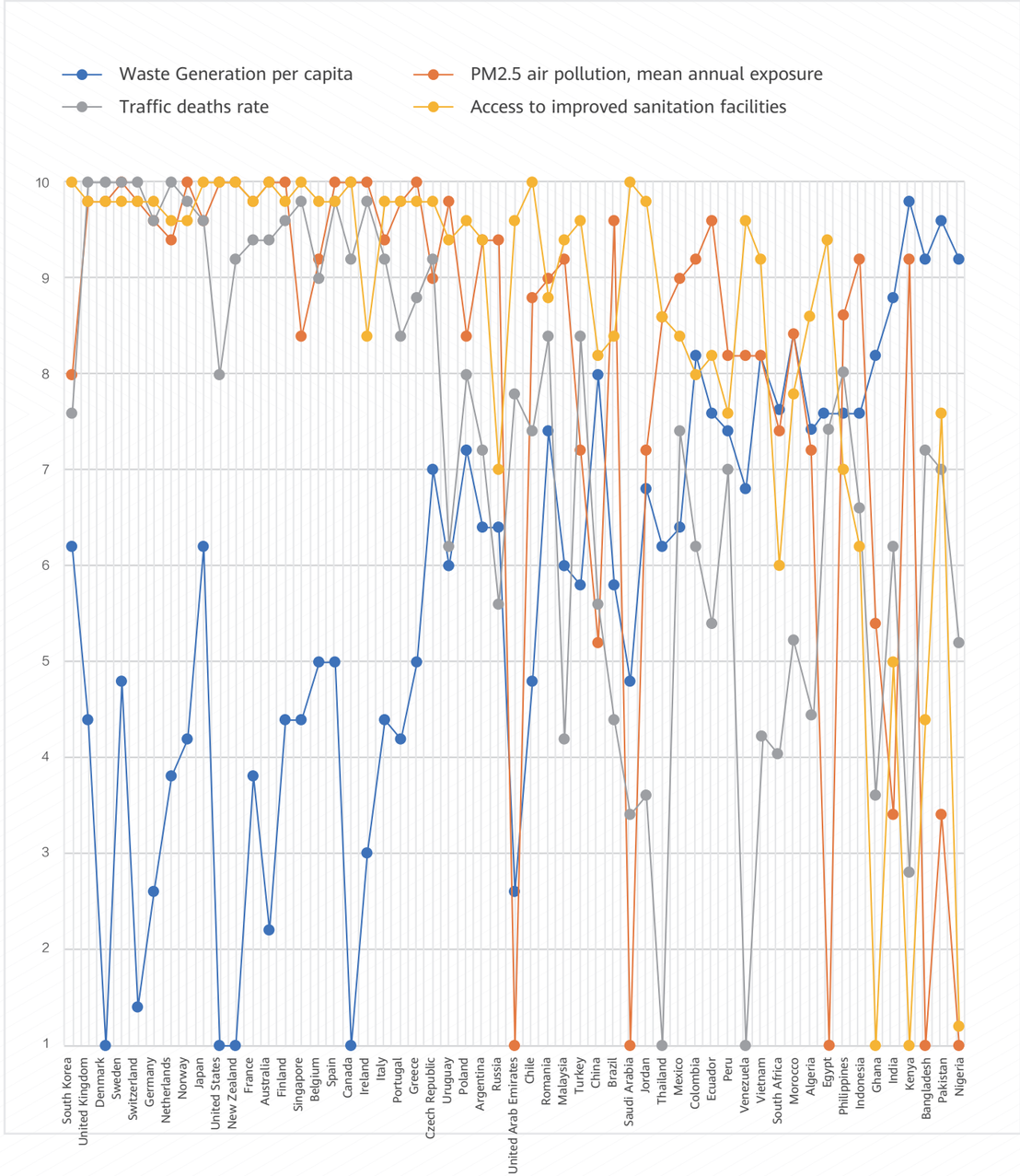
| SDG 9 Indicator Scores

Figure 40. SDG 9 Indicators



| SDG 11 Indicator Scores

Figure 41. SDG 11 Indicators



Accelerating Sustainable Development Goals through ICT

gci global connectivity index

The 2019 Huawei ICT SDG Benchmark is part of Huawei's GCI series of reports and shows where a country stands on their digitally-enabled journey towards meeting the 2030 Agenda for Sustainable Development – only 11 years away. It shows that the digital pathway to achieving the SDGs is more rapid than business as normal.
