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Accelerating SDGs through ICT

2018 Huawei
ICT Sustainable Development Goals
Benchmark

Contents

Foreword: ITU

By Malcolm Johnson

Deputy Secretary General
of the International
Telecommunications Union (ITU)

The potential of digitalization to accelerate progress towards the achievement of the 2030 Agenda for Sustainable Development is becoming ever more clear.

Information and Communication Technologies (ICTs) cut across all the Sustainable Development Goals (SDGs) and are a practical enabler for growth and development. Ensuring universal and affordable Internet access for all is therefore vital to the achievement of the SDGs.

This report offers insights into using ICTs to achieve the SDGs and also indicates the risks of being left behind. This report shows how countries use ICT infrastructure to maximize the impact of innovations that help communities and people in need. We can see the benefits of sustained efforts to extend telecommunication networks; train and equip people with new digital skills; and ensure that schools, hospitals, and cities are smarter, more energy efficient and safer.

It is clear that the full transformative potential of the digital economy can be better realized with the creation of an enabling environment with ICT regulations, standards and policies to guide countries towards more effective implementation of the SDGs. ITU's work on leveraging ICTs for sustainable development is widely recognized. As the United Nations specialized agency for ICTs, ITU is working to help push the global development agenda forward through a number of key initiatives to drive ICT adoption. It aims to advance development goals through sharing best practices, multi-stakeholder collaboration and coordination of activities. ITU works, through its membership of governments and leading players in ICTs, to advocate the opportunities for a sustainable world that ICTs can deliver, through reaching agreement on international technical standards, harmonized spectrum, and the policies which will provide the foundation for this to be achieved.

ITU's work focuses directly on deploying the infrastructure (SDG 9) upon which the implementation of the other 16 SDGs will rely. Only by expanding access to ICTs, ensuring that they are affordable and people have the necessary skills, can new technologies deliver opportunities for economic development, social progress, and environmental protection to everyone.

As the lead coordinator of the World Summit of the Information Society (WSIS) Process, ITU works closely with UN agencies and all stakeholders to ensure a strong linkage between the WSIS Process and the 2030 Agenda for Sustainable development leveraging the potential of ICTs for achieving the SDGs.

I thank Huawei and others who contributed to this report and recommend it to all those interested in using ICTs to advance sustainable development.

Foreword: GeSI

By Luis Neves

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

The United Nations' Sustainable Development Goals (SDGs) are a commitment to create a more prosperous and healthy world that eliminates poverty and protects the global environment for generations to come. The UN also recognises that ICT is key to achieving these goals. The Global e-Sustainability Initiative (GeSI) own research on the topic, the #SystemTransformation report released in 2016, found that digital solutions can directly contribute to all 17 SDGs and over 50 percent of the 169 targets.

GeSI believes that digital has tremendous potential to build a more inclusive society, to link more people to markets, to generate new opportunities to improve livelihoods, to improve the stewardship of ecological resources, and to provide access to information and services that benefit people's lives. Given the magnitude of the opportunity, slow or poor adoption would represent a failure to accelerate human progress. The challenge facing us is: how can we successfully enable digital transformation so it delivers these opportunities to everyone?

Huawei's Benchmark shows us that digital transformation is not only about economic efficiency and growth. Countries currently leading the Benchmark demonstrate that digital can also help realise the broader benefits of the SDGs. Perhaps most importantly, the differences between countries in the Benchmark remind us that digital transformation is not simply a technological fix, or a solution that can be bolted on later. Societal dividends will not be generated automatically. Digital transformation needs to be steered responsibly and in collaboration with government, industry, technology, and society to achieve optimal results.

Digital technologies are highly interdependent and constitute a dynamic ecosystem. Maximizing societal returns requires nurturing this ecosystem, identifying synergies between digital innovations and societal goals, and ensuring collaboration at the national, local, and industry levels for their effective application. GeSI is uniquely placed to contribute to this vision. We work with ICT leaders to engender a shared vision, a commitment to integrate ICT into SDG strategies, and to pursue partnerships between civil society and the private sector.

Delivering digital transformation for everyone demands leadership and collaboration between the ICT industry and society. In effect it requires a vibrant transformation ecosystem. We are delighted that Huawei, one of our members, has published its second Benchmark and continues to contribute to this effort. It is only through these types of sustained efforts that we will accelerate progress and achieve the SDGs.

Foreword: Huawei

By Kevin Tao

Chairman of Huawei's Corporate Sustainable Development Committee

Facing the future, Huawei's vision is Every Person, Home and Organization for a Fully Connected, Intelligent World. People and people, people and things, things and things will be more widely integrated, and humanity will fully enjoy a new era of prosperity and convenience. In response to this revolutionary change, Huawei has continued to innovate around customer needs and technology innovation, in cooperation with our industry partners. It is committed to building a better connected world and continues to create value for customers and society as a whole. At the same time, as responsible corporate citizens, we have an obligation to promote knowledge transfer, enhance people's understanding of ICT innovation, and encourage all countries and regions to participate in the construction of digital communities.

This study is part of Huawei's GCI series of reports and shows that digital infrastructure is key to achieving the Sustainable Development Goals (SDGs) by 2030 – only 12 years away. We have extended the scope of the report from last year and focused on whether digital connectivity is able to contribute to the sustainable development of society. For example, ICT technology may contribute to lifelong education, create greater economic value, create jobs, and reduce inequality. We analysed the progress of ICT development and SDG goals in four countries, elaborated on the role played by ICT in achieving SDG progress, in order to share relevant discoveries with everyone.

Huawei believes that stimulating the potential of digital technology will help solve society's most urgent development challenges. If a country fails to seize the opportunities brought about by digital technology, the country's economic and social development may slow down. This will pose a threat to countries that lack digital infrastructure and may gradually widen the gap between countries. At the same time, it should be noted that this is not only a major challenge faced by developing countries, but millions of people in developed countries are still affected by income, education, and gender differences.

We hope that this report will enable people to fully realize the importance of ICT and hope it provides support for relevant policy analysis, so as to create a more intelligent world with greater prosperity, tolerance, and sustainable development. We will not disappoint the historic opportunity generously endowed to us in this era. We are willing to work hand in hand with our industry partners to build a smart world in which everything is interconnected.

HUAWEI

Accelerating Sustainable Development Goals through ICT

Executive Summary

Information Communication Technology (ICT) is a force for good. By providing access to information, it makes people more effective and businesses more efficient. Access to ICT can help society build a more equitable, sustainable world.

Purpose of the ICT Sustainable Development Goals Benchmark

The ICT Sustainable Development Goals (SDGs) Benchmark 2018 allows us to measure progress towards this vision. It seeks to explore the relationship between ICT and sustainable development, and to understand how countries can leverage digital technology to accelerate their social and economic progress.

The report aims to accomplish the following:

- Examine the degree to which ICT enables the SDGs
- Provide global insight into the issue by analyzing 49 countries
- Assess annual progress and identify what enabled it
- Identify technologies and best practices that could benefit other countries

Methodology

In preparing this year's report, which is now part of Huawei's GCI series, we made some changes to our methodology. Like last year, we focused six of the 17 SDGs. But this year, we removed SDG 13 (Climate Change) and added SDG 7 (Clean Energy) to better explore the relationship between ICT and energy.

We analyzed 50 countries, including the 15 the report looked at last year. These countries represent a range of developed and developing economies, different geographies, and different phases of ICT maturity. 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 International Telecommunication Union's (ITU) most recent ICT Development Index. We reviewed ICT and SDG performance separately to test correlation, and then combined the data to form the ICT SDG Benchmark.

Benchmark Results

The analysis shows that ICT development is highly correlated (R2 = 0.91) with faster and more efficient progress on the SDGs. This suggests that ICT is a leading indicator for sustainable development.

We have grouped the 49 countries into three clusters: Leaders (top performers), Up-and-Comers (mid-level performers), and Pioneers (low-level performers). This year, South Korea was the top performing country, followed by the UK and Denmark.

Leaders show equally high performance in ICT and the SDGs, indicating that improvements in ICT and sustainable development are complementary. But Leaders still have 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, suggesting that this is where digital technology has the highest potential to accelerate country performance. This is especially true for Pioneer and Up-and-Comer countries, where small investments in ICT are coupled with significant SDG gains.

A significant gap remains between Leaders and Pioneers. Pioneers show the poorest performance on SDG 9 (Industry, Innovation and Infrastructure), SDG 5 (Gender Equality), and ICT Use.

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 fixed and mobile broadband adoption, will help drive increased ICT Use.

Next Steps – Pioneers and Up-and-Comers

The benefits of ICT use accrue disproportionally to Pioneers and Up-and-Comers. These countries will therefore benefit from prioritizing ICT infrastructure. Leaders may enjoy less dramatic gains, but can still benefit by investing in ICT solutions that improve all six of the SDGs studied here in pursuit of a balanced approach to progress.

Focusing on digital solutions related to health and education could provide the greatest return on investment, as there is a strong correlation between these SDGs and ICT adoption. These are also the SDGs where the largest gap exists between Leaders and Pioneers, signaling a promising opportunity to make strides in both areas. Because health and education can be considered foundational, it may be necessary to address them first, in order to achieve progress on other SDGs.

Next Steps – Leaders

Leaders should focus on using ICT to specifically improve performance on SDG 9 (Industry, Innovation and Infrastructure) and SDG 7 (Clean Energy), two of the SDGs on which they score lowest, on average. Leaders such as South Korea have also deployed ICT initiatives specifically aimed at providing greater access to social services such as e-government. Such investments can spur progress in both ICT and the SDGs.

Leaders can achieve additional progress by using the Benchmark to focus on SDG areas where they score poorly. These areas include waste generation per capita (from SDG 11 Sustainable Cities and Communities), proportion of renewable energy (from SDG 7 Clean Energy) and patent application (from SDG 9 Industry, Innovation and Infrastructure).

Conclusion

We encourage policymakers and business leaders to implement ICT policies focused on social and environmental issues. Engaging in partnerships to leverage the power of ICT will be critical to achieving the SDGs by 2030. Although ICT does not hold all the solutions to achieving the SDGs, it shows great promise for quickening our progress on some of the world's most pressing global problems.

Benchmark Results

The 2018 ICT Sustainable Development Goals Benchmark indicates a country's combined performance on ICT development and its progress towards sustainable development.

Glossary of terms

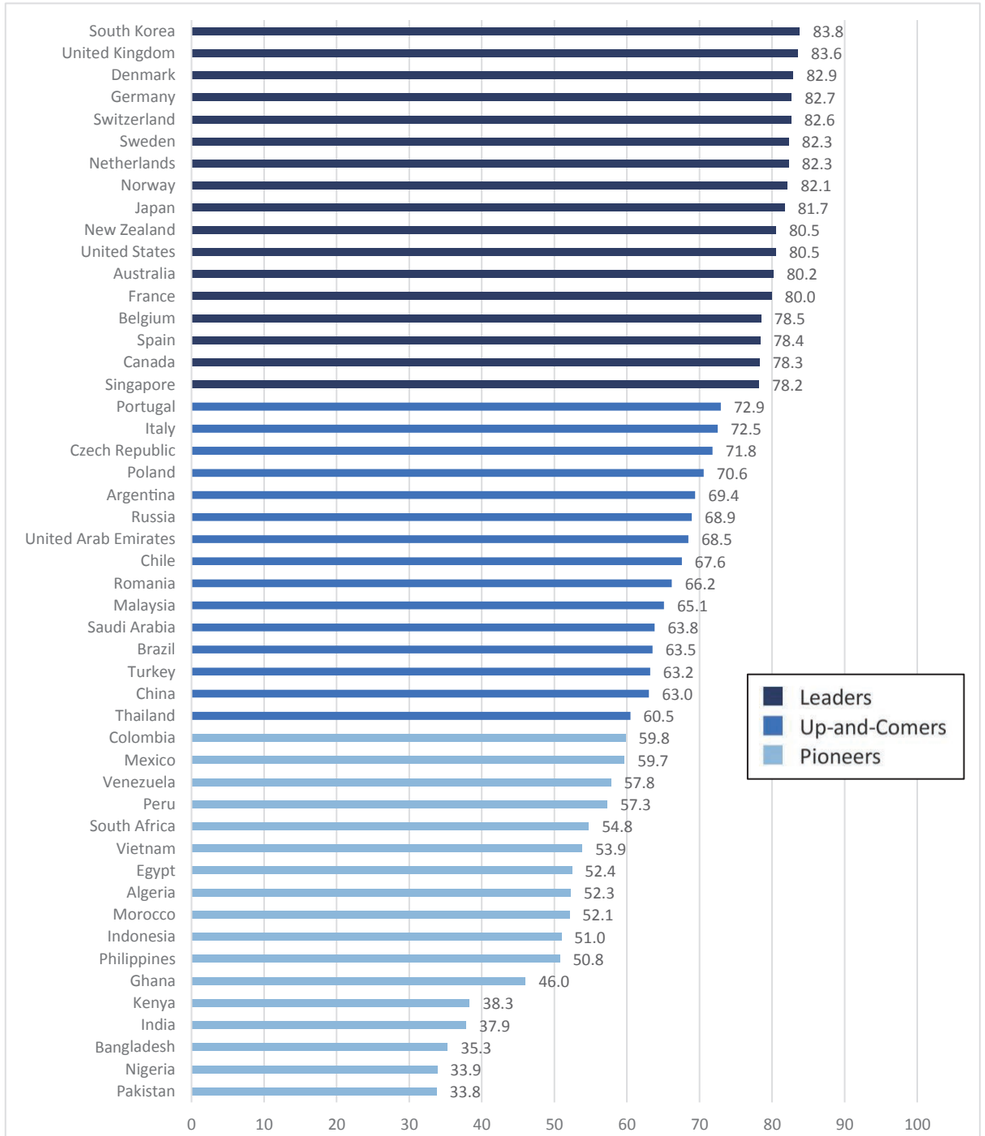
Leaders: Countries scoring 75 and above on the Benchmark. These are mainly developed economies that are advanced in terms of both SDGs and ICT. They have greater resources available to them (higher GDP) and currently lead the world in implementing targeted ICT solutions to develop a smarter and more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

Up-and-Comer: Countries scoring between 60 and 74 on the Benchmark. These represent mid-level of economic development and are seeing GDP growth 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 high-quality economic growth.

Pioneer: Countries scoring 59 and below on the Benchmark. These countries are in the early stages of ICT infrastructure build-out and with 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.

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

Figure 1 ICT Sustainable Development Goals Benchmark 2018



South Korea leads this year's Benchmark. South Korea is a surprising leader, which was not included in last year's Benchmark and is the only Asian country to rank so highly. Its high ranking indicates its strong overall performance on all the indicators of SDGs and ICTs.

South Korea: A Closer Look

South Korea ranks the highest in the Benchmark primarily due to its strong performance on ICT. It was ranked highest out of ITU's list of 176 countries in both 2015 and 2016 and ranks #2 in 2017 (behind Iceland).

The ITU cites strong promotion by South Korea's government, eager consumers, competitive markets, and strong collaboration between the nation's research community, hardware manufacturers, and service providers as some of the **main factors** driving South Korea's high performance on ICT.

Within the Benchmark's ICT components, South Korea does not take the top rank in any of the sub-indices of Access, Use or Skills but still captures the overall top rank, suggesting that the country performs very well across the three sub-indices, with strong country investment in all three areas. South Korea performs well on SDGs as well, ranking at #7, although it is its strong performance in ICT that leads South Korea to the top rank in the overall Benchmark. On SDGs, South Korea falls behind European countries particularly in SDG 5 (Gender Equality) and SDG 7 (Affordable and Clean Energy), signalling additional areas of opportunity for the country to direct its strong ICT capabilities.

South Korea's leadership in ICT is seen particularly in its focus on ICT for the government sector – South Korea's ICT Ministry aims to have **40 percent** of public organisations move to the Cloud, with the intention of driving open data initiatives, adoption of latest technologies, and customised welfare services. South Korea topped the UN's **e-government leader** list in 2014 and continues to be in the top 3 in the 2016 list.

South Korea has also recently announced a **$1.5 billion** plan to upgrade its network to 5G capability by 2020, which greatly exceeds investments pledged by Europe ($950 million) and China ($600 million). South Korea also recently gave a demonstration of its **leading 5G capabilities** at the 2018 Winter Olympics event in Pyeongchang.

Other Leaders are primarily based in Europe (United Kingdom, Denmark, Germany and Switzerland). Their presence at the top of the Benchmark is not as surprising, as European countries are collectively known to be global leaders in both ICT infrastructure and sustainable development. The strength of European countries on SDGs and ICT is also reflected when looking more closely at the separate SDG and ICT components of their scores – of the Leaders on SDGs, all three are European; and of the top-ranking countries on ICT, two out of three are European. Additionally, almost all European countries rank above the median in the Benchmark, with Romania, the lowest performing European country in the Benchmark, ranking at #26.

The Benchmark shows a significant gap to close between the Leaders and the Pioneers – with a span of 50 points between South Korea and the lowest scoring country, Pakistan. One aspect in common for Leaders is that they score almost evenly across the six SDGs included in the Benchmark and the ICT indicators (Access, Use, Skills), while Pioneer countries tend to have a more uneven score make-up. Of the SDGs, Leaders also tend to score most strongly on SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education), which can be considered building blocks for a thriving society, and potential areas of greatest priority for Pioneers and Up-and-Comers. This is also discussed in a later section of the results, as SDG 3 and SDG 4 also happen to be the SDGs that have the highest correlation with ICT.

Alternatively, Pioneer countries showed poorest performance on SDG 9 (Industry, Innovation and Infrastructure) and SDG 5 (Gender Equality). Our research also shows a strong relationship between performance in these two areas and ICT development, which means that through targeted investment and deployment countries could significantly improve their achievement on these and other SDGs.

Table 1 Highest ranked countries for SDG Scores and ICT Scores, separately

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

To get a clearer picture of which countries are performing best in each component, we considered the top three ranking countries for the separate SDG and ICT components and found that the countries that rank the highest for SDGs differ from the countries that rank the highest for ICT. The top-ranking countries for SDGs are Germany, UK and Sweden, while the top-ranking countries for ICT are South Korea, Switzerland and Denmark (Table 1). Countries that score highest on SDGs tend to be European countries, pointing to the overall high level of progress that Europe has made on sustainable development. Countries that score highest in ICT include those with high levels of ICT investment and innovation, with high levels of economic wealth, literacy, and skills to **utilise digital technology.**

Strong correlation between ICT and sustainable development

Comparing the SDG scores to ICT scores reveals a strong positive correlation between the two (91%), suggesting that ICT enables countries to improve their performance on the SDGs. The correlation is evident in the scatterplot chart (Figure 3) and is largely unchanged from last year even after expanding the analysis from 15 to 49 countries.

By looking more closely at the differences between the two scores, there is a steeper slope for ICT compared to the SDGs (Figure 2), i.e. there is a larger gap between the Leaders and Pioneers on ICT, compared to SDGs. Based on this pattern, Leaders tend to have higher ICT scores than SDG scores, while the opposite is true for Pioneers; they tend to have higher SDG scores than ICT scores. In Leaders countries, this suggests that ICT development is outpacing progress on sustainable development, or that ICT is advancing swiftly but adequate focus is not being given to societal needs. In Pioneer countries, the pattern of higher SDG scores compared to ICT scores highlights the significant opportunities for these countries to boost their ICT capability and through targeted application of ICT achieve greater progress on sustainable development. The correlation of individual SDGs and ICT later in the report should help identify those areas where new ICT capacity would have the greatest benefit.

Figure 2 SDG Scores and ICT Scores by Country

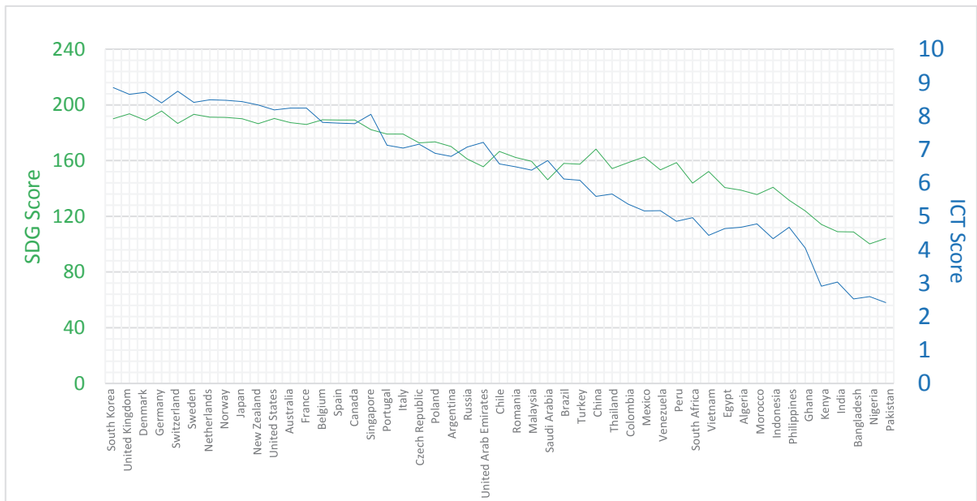
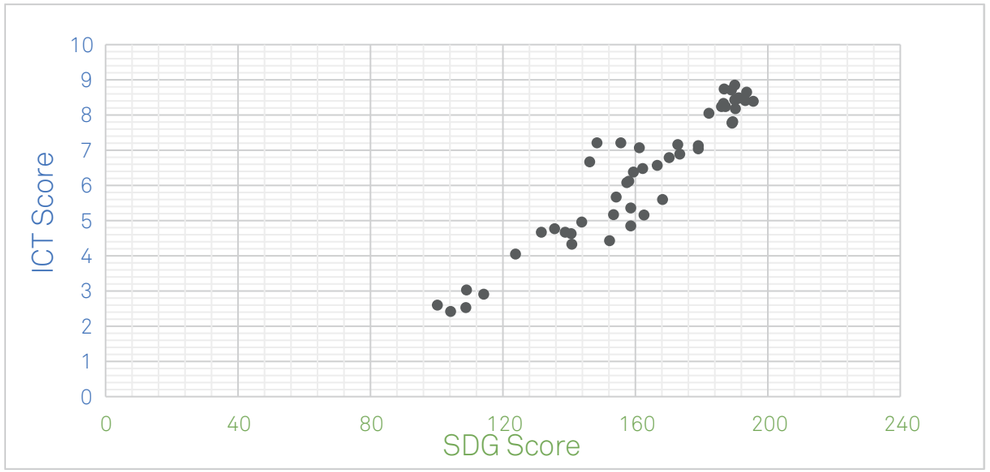


Figure 3 SDG Scores and ICT Scores by Country (Scatterplot) – Each dot represents a country



The ICT SDG Benchmark correlates with Triple Bottom Line

Gross Domestic Product (GDP)

GDP is likely a significant contributor to the country rankings, given the large role that GDP plays in determining progress on the ICT. This comparison is highlighted and described in detail in Huawei's annual GCI report. However, it is not the only determining factor for overall country ranking, noting a number of outliers that have high GDPs but relatively low scores on the ICT SDG Benchmark.

The ICT SDG Benchmark has a moderate level of correlation with GDP in this year's report, with a 66% correlation (Figure 19 in Appendix). This is lower than the correlation seen in the 2017 Benchmark, which was 82%. The primary reason for the lower correlation is the inclusion of additional countries, including some that could be considered outliers in terms of GDP relative to country ranking. By testing this and selectively removing three possible outlier countries from our sample – Saudi Arabia, United Arab Emirates, and Singapore – the analysis shows a much higher correlation between GDP and the ICT SDG Benchmark, at 82%.

Human Development Index (HDI)

A higher correlation was seen between the ICT SDG Benchmark and the Human Development Index (HDI), at 95% correlation (Figure 20 in Appendix). The Human Development Index, developed by the United Nations Development Programme (UNDP), assesses country development across a broad range of areas (such as economic development, health, life expectancy, education, etc.) and provides a broad assessment of a country's level of development on social issues. The high correlation suggests that the ICT SDG Benchmark is effective in assessing the development of a country in terms of human life and health. There is some overlap between the indicators in the HDI and the indicators selected to measure country performance on the SDGs, especially in SDGs 3, and 4, so the high degree of correlation of these two indices is not surprising. Correlation from the 2017 Benchmark was similar, at 96%.

Environmental Performance Index (EPI)

A high correlation was also seen between the ICT SDG Benchmark and the Environmental Performance Index (EPI), at 77% (Figure 21 in Appendix). The Environmental Performance Index, 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 socially-focused areas of sustainable development. Correlation from the 2017 Benchmark was higher, at 92%.

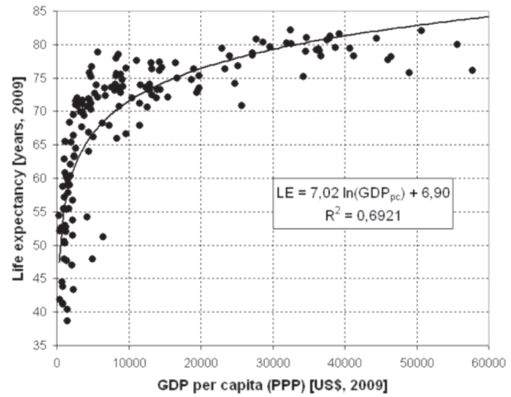
A notable finding here is that South Korea scores significantly lower on the EPI compared to other Leader countries – it scores a 70.61, which is below the average EPI score of 75.58 for all countries in the Benchmark.

Additional ICT and SDG Analysis

A Closer Look at an Evolving ICT-SDG Relationship Over Time

In order to better investigate the longitudinal relationship between ICTs and the SDGs (and across countries at different levels of ICT development) we propose an adaptation of Preston Curves – an approach we have not seen used by researchers so far. These graphical relationships between life expectancy (an important and measurable health outcome) and real per capita income were first advanced by Samuel H. Preston[Preston, S. H (1975). "The Changing Relation between Mortality and Level of Economic Development". Population Studies. 29 (2): 231–248]. Preston studied the relationship for the 1900s, 1930s and 1960s and found that it held for each of the three decades. What he discovered in essence was that at low levels of income, further increases in income lead to large gains in life expectancy but at higher levels of income, increased incomes per capita led to much smaller gains in longevity.

Chart 1 – Example of a Preston Curve



Preston's work also suggested two additional significant findings. The first was that by periodically re-examining the relationship, one could establish how the link between income and life expectancy shifted as a result of new influences or scientific breakthroughs and how it impacted countries at different levels of economic development. The second was that by testing the relationship over time one could either prove or disprove the underlying relationship.

Chart 2 – Observing the relationship over time

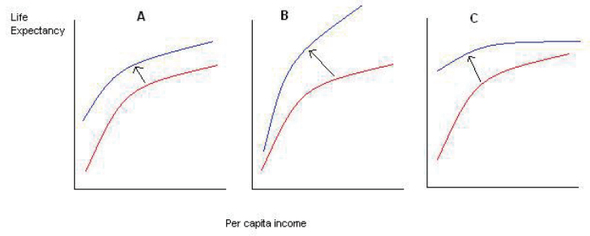
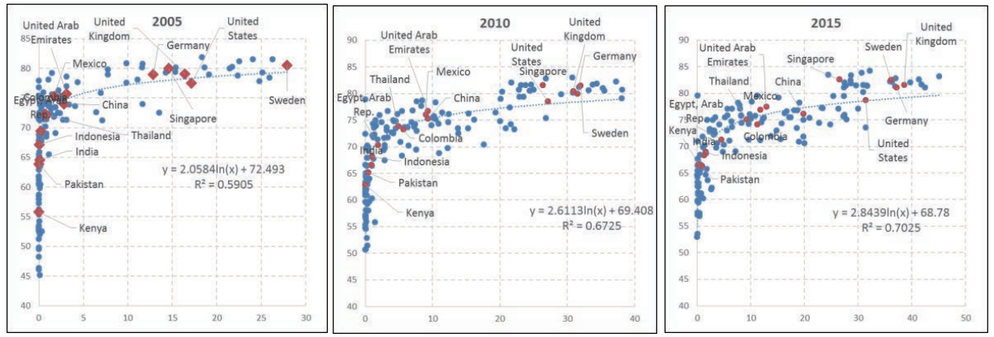


Chart 2 illustrates three potential changes in relationship between life expectancy and income over time. In box A, life expectancy improves across all countries at a given level of income over time suggesting that any new influences or technological breakthroughs on life expectancy impact equally across all countries, regardless of their level of economic development. Box B shows a change in relationship where a new influence or technology proportionately benefits richer countries. Finally, box C depicts a shift where poorer countries benefit more from exogenous changes to technology or other factors.

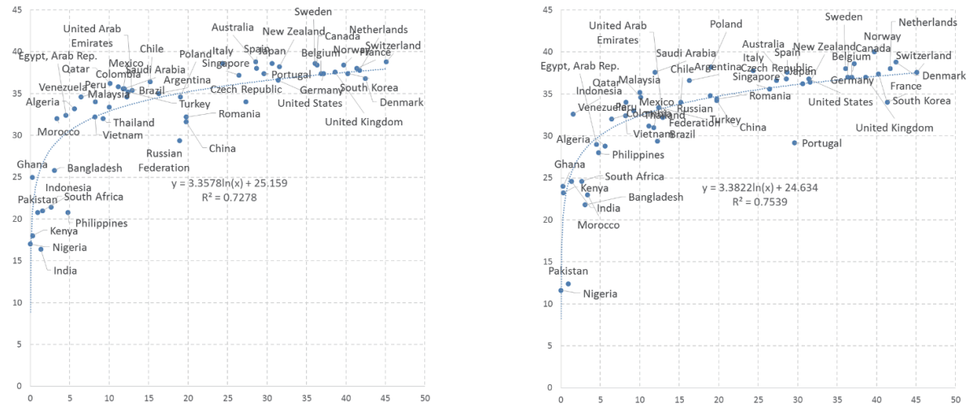
If data are indeed the new measure of **income**, as several have suggested, and given the pivotal importance ICT has been given in our ability to achieve the SDGs, we propose substituting the measure of GDP per capita with broadband subscriptions per 100 people. We observe some interesting initial findings (chart 3).

Chart 3 – Preston Curve: Broadband subscriptions per 100 people vs life expectancy



Firstly, the relationship substituting broadband diffusion is very similar to that established by Preston using real income per capita. The curve is concave, suggesting rapid returns to increases in connectivity from the lowest levels of broadband diffusion but diminishing returns towards the highest ratios. But greater connectivity to the internet does still correlate to greater levels of life expectancy. Secondly, the concave relationship holds over the years 2005, 2010 and 2015 but changes slightly, while shifting upwards. Broadly the curve holds its shape, with rapid returns for less developed countries and less increases in life expectancy for more developed countries. As with income, increases in broadband diffusion have increased in lock-step with increases in life expectancy. Moreover, the fit to the curve also grows much stronger statistically over time, showing less variance across countries as we move from 2005 to 2015.

Chart 4 – Preston Curve: Broadband subscriptions per 100 people vs SDG 3 and SDG 4



What does the current relationship look like if we substitute life expectancy for the sub-component composite indicators for each of the SDGs in our research study? Charts 4, 5, and 6 illustrate the results from our 2018 data sets and calculations. For SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education) the results appear to be very similar to the previous findings – rapid improvements in national scores for health and education coincide with small improvements in broadband subscriptions from the lowest base ratios with declining returns as we approach the higher levels of diffusion. Moreover, the fit to the curve is even stronger to our more holistic measure of health outcomes as covered in SDG 3 of our ICT Sustainable Development Goals Benchmark, than life expectancy. The same is true with our broad SDG 4 based measure of education outcomes.

Chart 5 – Preston Curve: Broadband subscriptions per 100 people vs SDG 5 and SDG 7

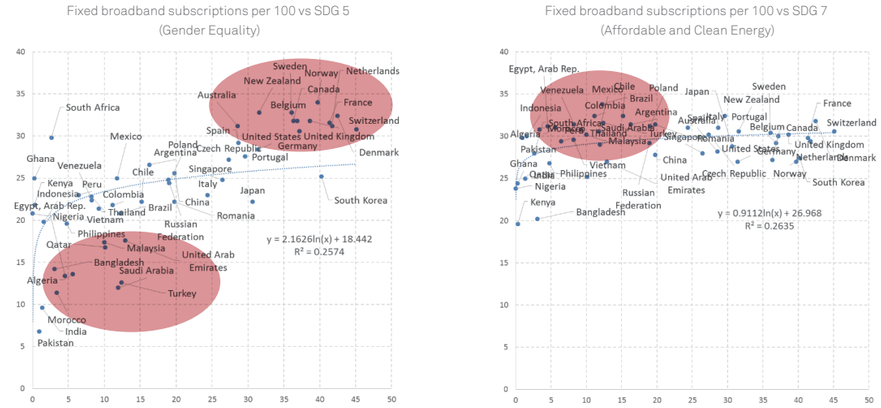
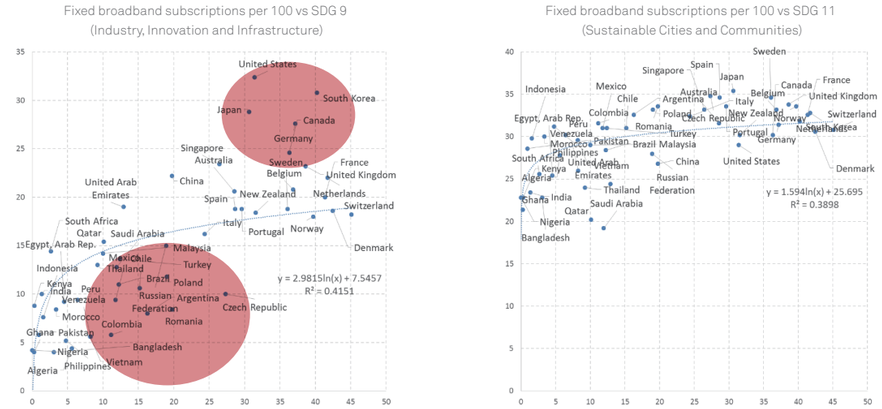


Chart 6 – Preston Curve: Broadband subscriptions per 100 people vs SDG 9 and SDG 11



The relationship for the ratio of fixed broadband subscriptions per 100 people to SDG 5 (Gender Equality) and SDG 7 (Affordable and Clean Energy) as plotted, do not exhibit the same clear concave curves as previously. The correlation is also much weaker. On gender equality there are two distinctive groups weakening the overall fit to the curve, possibly suggesting that cultural and societal norms are much more influential. The plot for SDG 11 (Sustainable Cities and Communities) suggests only a very mild relationship of increasing returns to greater internet connectivity, which may be indicative of the very early stages we are at in terms of smart energy deployment through national infrastructure.

The statistical relationship for SDG 9 (Industry, Innovation and Infrastructure) is more surprising and weakened again by two distinct groups. The first set that perform exceptionally well in our SDG 9 benchmark are composed of innovation powerhouses such as the United States, Japan, South Korea and Germany. The second are the relative laggards, countries like Russia, Romania, Argentina, and Brazil with middling levels of connectivity but low relative scores in terms of our SDG 9 benchmark. These countries are clearly not fully benefiting yet from digital dividends in terms of innovation or digitalised industry. SDG 11 exhibits some of the similar issues in the plot for SDG 7.

In future iterations of Huawei's ICT Sustainable Development Goals Benchmark assessment, we will continue to review shifts in our adapted Preston Curve analysis to better understand the underlying relationship between ICT and the SDGs and how the dynamics change over time as the benefits of greater connectivity are fully realised.

Breakthrough Opportunities

Areas where ICT can make the most difference

Analysis reveals which SDGs have the strongest links with ICT. This highlights the SDGs that may benefit the most from improvements in ICT. Those with highest correlation (Table 2) are: SDG 4 (Quality Education) (73%) and SDG 3 (Good Health and Well-being) (71%).

This is further supported by our findings through Preston Curve analysis, featured in the previous section, which suggests that small improvements in certain technology, such as broadband, can lead to rapid improvements in performance on SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education). This is especially true for Pioneer countries.

Table 2 Correlations between country scores on individual SDGs and ICT scores, in order of decreasing correlation

SDGs	Correlation with ICT
SDG 4: Quality Education	73%
SDG 3: Good Health and Well-being	71%
SDG 9: Industry, Innovation and Infrastructure	65%
SDG 5: Gender Equality	51%
SDG 11: Sustainable Cities and Communities	41%
SDG 7: Affordable and Clean Energy	16%

In terms of driving progress on SDG 3 (Good Health and Well-being), ICT is already playing a major role in helping patients gain access to more information about their health and become more knowledgeable about health conditions. As ICT capabilities continue to grow, healthcare solutions will increasingly move from reactive models to predictive healthcare models that promise even greater improved outcomes. SDG 3 is highly correlated with all three aspects of ICT: Access (68%), Use (67%) and Skills (63%).

ICT also plays a major role in education, particularly for children and adults living in rural and low-income populations. According to the United Nations , rural children are nearly twice as likely to be out of school as urban children, and children from poorer households are three times as likely to be out of school as children from wealthier backgrounds. ICT provides an effective and low-cost solution for children and adults to access information to support learning and educational resources through mobile phones and the internet. One example of ICT strengthening education systems is the International Youth Foundation's Bridgeit program , which uses cell phones to give remote schools access to locally developed educational content. The program has benefited over one million students in Philippines and Tanzania. SDG 4 is highly correlated with all three aspects of ICT, with a slightly higher correlation with ICT Skills (78%), followed by Use (69%) and Access (66%).

At a lower but still high level of correlation are SDG 9 (Industry, Innovation and Infrastructure) (65%) and SDG 5 (Gender Equality) (51%). These SDGs represent goals that do not show the highest correlation but still can have significant benefits to be gained from investment in ICT focused on these areas.

SDG 11 (Sustainable Cities and Communities) (41%) and SDG 7 (Affordable and Clean Energy) (16%) do not have as strong a correlation between SDG and ICT performance. This may be due to the fact that ICT solutions and national policy around these goals are relatively underdeveloped and will need more time to show the relationship.

Comparing the 2018 Benchmark results with 2017 to see how correlations may have changed when expanding the country list, we see that most correlations remain similar although there are a few notable changes. SDG 5 (Gender Equality) is less correlated in 2018 (51%) than in 2017 (66%), and SDG 9 (Industry, Innovation and Infrastructure) is similarly less correlated in 2018 (65%) than in 2017 (80%). In both instances, the difference is almost entirely due to the new country additions, rather than indicative of a significant finding or change in progress between the two years.

Ensuring meaningful progress for People, Society, and the Planet

Like Huawei, Orange believes that the Sustainable Development Goals cannot be achieved without digital technology and innovation. Our commitment is expressed by Stéphane Richard (Chairman and CEO of the Orange Group)

"Through our role as an operator, our history, the expertise of our teams, and our investments, we believe that we can contribute to guide current global changes in a positive way."

With our locations in 29 countries around the world, we play a direct role in the socio-economic development of those countries as a key player in their digital transformation. The central role that digital technology plays has been proven in numerous studies. According to the GSMA, the mobile industry contributed more than $3.6 trillion to the world economy in 2017, which represents 4.5% of the world's GDP.

Our approach is based on the potential to transform societies through digital technology and innovation. This starts with geographic connectivity (such as broadband undersea connections, mobile networks, and improved access for isolated regions). This is followed by services with high added social value, such as Orange Money's mobile banking solution, which helps people without bank accounts, or m-Agri which offers vital services to a huge proportion of the rural community. Thirdly, we support local entrepreneurship. One particular focus relates to SDG 5 (achieve gender equality and empower all women and girls). The Orange m-Women programme is based on mobile devices and services used to give more empowerment to the women: healthcare savings with Orange Money, medical prevention with My Health Line in Cameroon, and the promotion and support for women entrepreneurs using digital technology in Senegal, to name a few.

For each of the Sustainable Development Goals, digital technology can provide substantial added value. Orange's objective is clear: to generate, maximise, and share that added value.

BT delivers solutions that help customers reduce their carbon emissions

BT is again pleased to contribute to Huawei's 2018 Benchmark report. Our sustainability journey started in 1992 – that's over 25 years ago now when we first began to measure our corporate carbon footprint and set our first reduction target. In 2008, we set a goal to cut our carbon emissions intensity by 80% by 2020 against a 1996/97 baseline – a goal we achieved four years ahead of time in 2016. In September 2017, we therefore announced a new science-based target based on 1.5 degrees Celsius pathway. This target, which has been approved by the Science-Based Targets Initiative, is to reduce our Scope 1 and 2 carbon emissions intensity by 87% by 2030 against a 2016/17 baseline and reduce the carbon emissions associated with our supply chain by 29% in the same timeframe.

We have a Net Positive goal to demonstrate that our negative carbon impact on the world is outweighed by our positive impact. We call this our 3 to 1 goal which is to help our customers to reduce their emissions by at least three times our own end-to-end carbon footprint by 2020. Last year the revenues from our carbon abating products and services were £5.3bn, that's about 22% of BT's total revenues and up £1.7bn from the previous year. We were at a ratio of 1.8 to 1.

On SDG 7, we are a pioneer in purchasing renewable electricity which we started doing in the UK in 2012. We have an ambition to purchase 100% renewable electricity in all our operations around the world wherever markets allow by 2020.

Together with our energy provider, npower, we're encouraging our suppliers to switch to renewable electricity. The RE100 group we are part of highlighted our approach as best practice in a guide to help companies increase use of renewables in their supply chains. We're also encouraging employees and customers to make the switch. BT employees can get discounts on their energy bills when they switch to renewable power with Good Energy. And we offer customers the same deal when they contact us to let us know they're moving home.

ICT drives sustainable consumption and production patterns

We are delighted to contribute to Huawei's 2018 ICT SDG Benchmark, because we also believe that ICT is indispensable in achieving the SDGs. One of the goals we are most focused on is SDG 12: Responsible Consumption and Production. KPN is working with its suppliers, including Huawei, to make all new KPN network and customer hardware designed to last longer, produced using fewer virgin raw materials, and built in such a way that by 2025 close to 100% of the parts and resources can be reused or recycled.

Chief Procurement Officer, Michelle Baker "Within KPN we contribute to SDG 12: Responsible Consumption and Production, by setting the very ambitious goal of becoming a virtually circular company by 2025. We can only achieve this by close cooperation with our suppliers. We are happy that Huawei was amongst the first parties who decided to join us and signed our circular manifesto."

Climate change is one of the most pressing challenges in our society and it's time for action, not words. As the Netherland's largest ICT provider, we recognise that we have a leading role to play to enable the necessary transition towards a sustainable and increasingly circular economy.

We have been climate neutral since 2015 and have lowered our annual energy consumption for six consecutive years through to 2016 while absorbing an eight-fold increase in data volume during that same time. Recently recognised by the Dow Jones Sustainability Index (DJSI) as the world's most sustainable telecommunications company, KPN is on track to reduce its energy consumption by 50% by 2030, compared with 2010. This target takes into account the expected continued exponential growth in data traffic amid the increased digitization of society and the expected growth of the IoT. KPN currently accounts for approximately 0.8% of Dutch electricity consumption.

KPN believes in the potential of smart ICT solutions to significantly reduce energy consumption, CO2 emissions and the use of natural resources. We continuously seek to further reduce our own carbon footprint and those of our customers through KPN products and services while at the same time enabling the delivery of better service.

All ICT pathways are closely correlated with the SDGs

The ICT score is made up of three sub-indices: Access, Use and Skills. All three have a high correlation with the SDGs (Table 3), indicating that all are highly important for achieving the SDGs. Correlation with ICT Use is slightly higher than Access and Skills, which indicates that encouraging greater use of ICT services may play a slightly more important role in helping countries to achieve the SDGs.

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

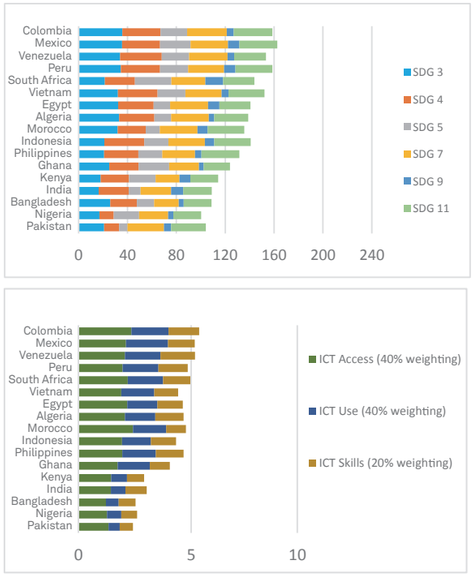
ICT Sub-Indices	Correlation with SDG
ICT Use	89%
ICT Access	86%
ICT Skills	82%

Where Pioneers can find the greatest dividends

In addition to analysing correlation between SDGs and ICTs, insight can be gleaned from differences in performance among Leaders, Up-and-Comers and Pioneers to identify areas that can provide the greatest dividends for Pioneers.

Pioneer countries score disproportionately across the SDGs when compared to Up-and-Comers and Leaders in the charts that follow (Figure 4). On average Pioneers perform poorest on SDG 9 (Industry, Innovation and Infrastructure) and SDG 5 (Gender Equality), while scoring relatively lower in other SDGs as well.

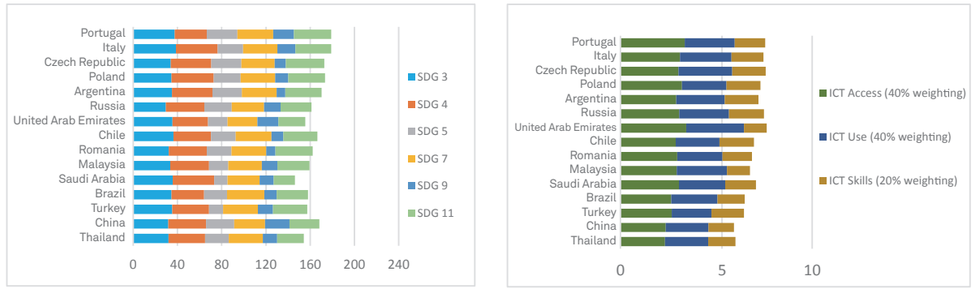
Figure 4 Performance on individual SDGs and ICT for Pioneers



Note: ITU's weightings for indicators are used in the Benchmark and their exact contribution to overall ICT score are reflected in this chart – ICT Skills with a 20% weighting compared to 40% for Access and Use.

While Up-and-Comers demonstrate higher scores generally across the SDGs and Access, Use and Skills compared to Pioneers, Up-and-Comers score notably lower than Leaders on SDG 5 (Gender Equality) and SDG 9 (Industry, Innovation and Infrastructure) (Figure 5). Up-and-Comers also show lower scores on ICT Use.

Figure 5 Performance on individual SDGs and ICT for Up-and-Comers



Leaders perform fairly evenly across the six SDGs and the three ICT categories, suggesting an even distribution of investment across all areas of SDGs and ICT (Figure 6).

Figure 6 Performance on individual SDGs and ICT for Leaders

One reason Pioneers score poorly on SDG 9 (Industry, Innovation and Infrastructure) is due to its indicators related to trade and port infrastructure (for landlocked countries – e.g. Switzerland, Czech Republic – this measures their access to port facilities, such as through trade agreements). UAE and Saudi Arabia are among the Up-and-Comer countries that excel on SDG 9 due to higher-than-average scores on quality of port and trade infrastructure, which is to be expected as they are significant energy exporters. Nevertheless, the low performance of Pioneers and high correlation with ICT (65%) suggest SDG 9 as a potential opportunity for Pioneer countries to focus their ICT efforts.

Pioneers also score relatively low on SDG 5 (Gender Equality). This **aligns with studies** that correlate levels of gender equality with economic development. Though other factors can contribute to a country's performance on gender equality, including culture and local customs, this represents a significant area of opportunity for ICT solutions – much of which could also benefit economic growth and other SDGs.

Another pattern is that Pioneer countries tend to perform well on SDG 11 (Sustainable Cities and Communities) although this is most likely due to other contributing factors such as low waste generation per capita levels. The UAE is an exception to this, having a high waste generation per capita even as an Up-and-Comer country, falling in alongside Leader countries who typically waste more per capita than Pioneer and Up-and-Comer countries.

For ICT, the largest gap between Pioneers and Leaders is for ICT Use, suggesting that this should be a priority area for Pioneers. This priority is further reflected in Use having the highest correlation with SDGs compared to Access and Skills (though they are all high in correlation), suggesting that developing nations can also improve SDG performance this way.

ICT and Digitalization support SDG attainment

Deutsche Telekom's mission is to serve our private and corporate customers with modern ICT. Providing a powerful, energy-efficient and reliable network infrastructure is the core of all our business activities. Building on this strong network, we provide our customers with state-of-the art products and services to enable sustainable businesses and lifestyles.

Thus, we strongly believe that the SDGs are an important framework to prioritise and align our business actions. This is **visualised in our Annual Report**, where we attribute our activities to the respective SDG. Over the past three years, the strong visuals and clear message of the SDGs have proven very helpful in addressing ESG topics in our multi-faceted stakeholder dialogues.

Deutsche Telekom directly contributes to SDG 8 (Decent Work and Economic Growth) by being a responsible, global employer. We not only provide decent jobs for our employees, we also demand and promote high employment standards to our suppliers. In this regard, we very much appreciate Huawei's long-term engagement as a participant of Deutsche Telekom's Supplier Development Program – providing social and business advantages for our business and our suppliers' business in a proven, successful win-win approach. Digital collaboration tools and virtual work streams play a key facilitating role in this program.

Looking at our customers, ICT and digitalization supports SDG attainment by decoupling growth from resource use, reducing our ecological footprint and mitigating global warming. Deutsche Telekom provides responsible, resource-efficient, and increasingly smart products and solutions. Digitalization connects people and machines in innovative fields such as eHealth, media literacy, as well as enabling smart solutions for cities, mobility, logistics, agriculture, and many other areas. Besides serving customer needs, we put focus on understanding and actively managing the ecological and social impact of our business on society at large.

We continuously evaluate opportunities for fruitful collaboration. By engaging globally in industry-specific, as well as cross-sector and multi-stakeholder, initiatives, we strive to scale up our common efforts for maximizing our contribution to the Agenda 2030 for Sustainable

Vodafone Future Jobs Programme

The International Labour Organisation (ILO) estimates that more than 200 million young people are either unemployed or have a job but **live in poverty**. In many of the countries in which Vodafone operates, youth unemployment is at record levels, from 38% in Italy and 39% in Spain to 47% in Greece and 53% in **South Africa**.

Paradoxically, unemployment among young people is rising just as businesses of all types and sizes are struggling to fill a wide range of digital technology roles that are critical for future growth. The European Commission estimates that around **500,000 digital jobs** across the European Union will remain unfilled by 2020.

In response, Vodafone has launched a ground-breaking international future jobs programme "What will you be?" to provide career guidance and access to training content in the digital economy for up to 10 million young people across 18 countries. The Vodafone digital skills and jobs initiative is the largest of its kind in the world. This includes the development of a smartphone-based service - called the **Future Jobs Finder** - that offers young people a simple but comprehensive gateway to new skills and opportunities for employment in the digital economy.

In parallel, Vodafone also wants to significantly increase the number of young people brought into the company to gain direct experience of the digital workplace. Vodafone will expand its existing graduate, apprenticeship, internship and work experience schemes worldwide to reach a total of up to 100,000 young people by 2022.

Digital Solutions

Three critical pathways for ICT to drive sustainable development

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

This opens three key pathways for Leaders, Up-and-Comers, and Pioneers to address the challenges seen in the earlier chapters and fast-track their sustainable development:

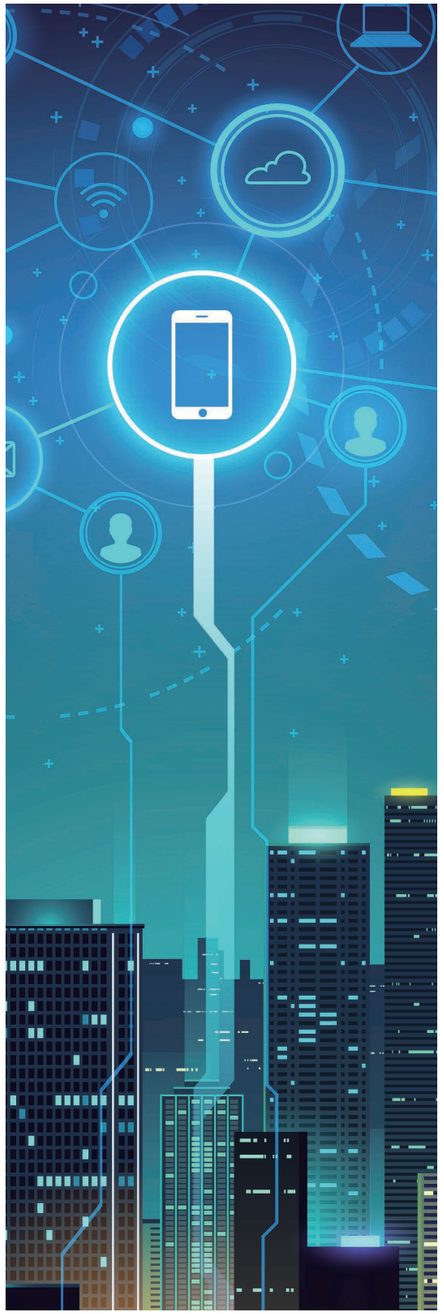
Increase access to information and services

ICT infrastructure 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 organisations in both developed and developing nations, which can underpin progress on almost all SDGs in some way. Uneven access resources, information, education, and services of all kinds exacerbates issues of inequality worldwide. Not being able to access health information or crop market data, for example, can deepen social inequalities and environmental problems. There are also challenges related to access to high quality ICT infrastructure and services, e.g. ensuring equal access to high quality computers, high speed and affordable connectivity, and ability to obtain technical support. Fortunately, some of the devices needed to access online information and services are becoming more affordable, expanding available options in developing and least developed countries. Increasing access information and services ultimately helps empower individuals and societies and close gaps of inequality; ICT tools can help do this.

Increase connectivity between people and organisations

Increased access leads to better connectivity and communication between every person, home, and organisation at an instantaneous or near-instantaneous level. 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.

The youth are at the forefront of rising connectivity worldwide. According to the **ITU**, 70 percent of the world's youth (15-24 year olds) are online – a total of 830 million people. This is significantly higher than that for general populations in all regions of the world. For instance, in Africa, more than 40 percent of youth are online compared to 22 percent for the general population. In Asia Pacific, 72 percent of youth are online compared to 44 percent.



Bridging the gender divide in connectivity will be key to progress on the SDGs. While the gender gap in internet use has been narrowing in most regions in recent years, the proportion of men using the Internet remains slightly higher than the proportion of women in two-thirds of countries worldwide. The ITU estimates that in 2017, the **global internet penetration rate** for men was 50.9 percent compared to 44.9 percent for women. In Africa, however, the gender divide has actually been increasing, with the proportion of women using the internet currently being 25 percent lower than that for men.

A major gap remains between the degree of progress on ICT infrastructure for developed and developing nations. According to **statistics by the ITU**, 84 percent of households in developed countries have internet access, compared to 43 percent in developing countries and 15 percent in the least developed countries. This gap is gradually closing, however, with mobile broadband becoming a promising and affordable solution to expand access to new populations.

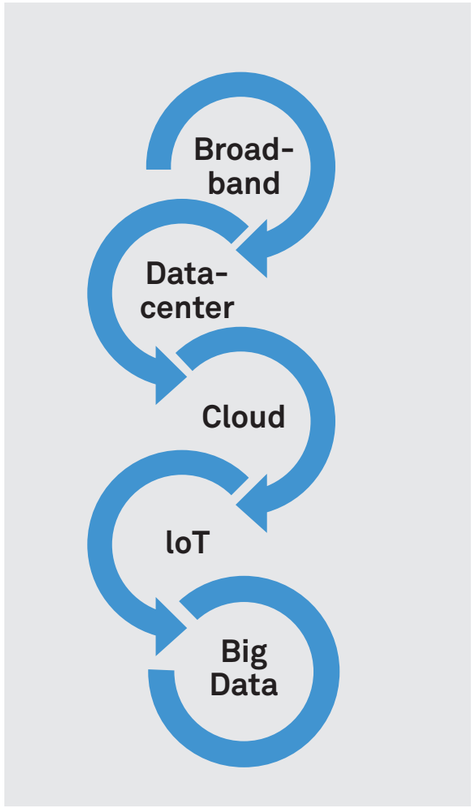
Increasing digital skills of people will be another major factor that will determine the pace of connectivity growth. It is mostly the least developed economies and most disadvantaged populations that lack advanced digital skills, which further exposes them to a growing risk of being left behind in a digitised economy. Increasing their level of digital literacy will result in major improvements to all aspects of their livelihoods, including in the economy, healthcare, education, and other areas.

Increase productivity and resource efficiency

ICTs hold immense potential to raise productivity through increased access to information and communication. Digital technologies provide solutions for more efficient ways to collect and analyse large sets of data with the help of big data analytical tools.

The private sector will be a major benefactor of these productivity gains; however, to achieve timely progress on the SDGs, these solutions will also have to be adopted and spearheaded by the public sector. According to some estimates, the public sector in the European Union **could save up to 1 billion euros** (US$1.25 billion) per year by switching to e-invoices from paper. The savings would be even more substantial if the countries fully implemented other e-Government aspirations. Not only would these initiatives improve the quality and effectiveness of public services, but they would also free up significant resources to invest in healthcare, education and other major areas key to societal well-being.

Digital infrastructure



Digital infrastructure can open these pathways and accelerate sustainable development

Digital technologies need to be deployed to open these pathways; however, Leaders, Up-and-Comers, and Pioneers each face different constraints on how they expand their ICT infrastructure. We offer insights below on broadband, cloud, IoT, big data, and data centres.

Broadband: The Internet has significantly transformed how people, homes, and organisations interact and acquire knowledge, allowing for new ways to collaborate and address sustainable development needs through access to information, financial services, healthcare, and education. In this way, broadband is the base upon which efficient digital solutions can be deployed at scale and speed; as such, it offers an important opportunity for Pioneer countries to close the gap with Up-and-Comers and Leaders.

In the last five years, the global number of fixed-broadband subscriptions has been **increasing by nine percent annually.** Most of this growth is taking place in China though. The gap between developing and developed nations remains significant, with the average number of subscriptions per 100 inhabitants in developed economies standing at 31, and only nine per hundred inhabitants in developing nations. Continued growth of fixed broadband in developing economies and especially in the poorest economies where fixed broadband infrastructure is nascent will be key to SDG progress.

Wireless broadband has been growing at a much faster pace than fixed broadband, at an annual global rate of 20 percent. Mobile broadband prices **dropped by half** between 2013 and 2016 and the prices of devices continue to fall as well. Mobile broadband provides opportunities to improve connections and decision-making, reduce isolation, and improve access to healthcare, education, and public services.

In addition to growing access to broadband, international Internet bandwidth is **growing significantly**, growing worldwide by 32 percent between 2015 and 2016, and Africa seeing the greatest increase of 72 percent during this period. Greater bandwidth can lead to increasing capabilities in the use of sophisticated ICT services.

Data Centres: Along with submarine and land-based communication cables, data centres are the infrastructure backbone of all ICT and support many of the technologies mentioned below. Data centre infrastructure enables the increased use and higher quality Cloud services as well as support the growth of IoT. Some technological advancements, like Artificial Intelligence (AI), Augmented Reality (AR) and the Cloud, are driving growth in large data centre construction, while other technologies are creating the need for smaller edge data centre deployments. For example, smaller (or micro) edge data centres are in demand for reasons ranging from caching content or web application data closer to users or collecting the massive amounts of data from the connected devices that make up the **IoT**

A new type of data centre that emerged within the last ten years are containerised data centres, which are built within one or multiple shipping containers. At first, containerised data centres were used for ruggedized application like military and remote oil and gas operations, though their uses have expanded to become rapidly deployable, energy efficient, cost effective methods for bringing connectivity and computing capabilities to remote areas.

Cloud: The Cloud enables the storage, management, and processing of data on a network of remote servers hosted on the internet and can offer vast benefits in many areas of sustainable development. Cloud computing enables much faster and more efficient data processing, greater productivity and flexibility. In developing countries, the Cloud offers vast opportunities for social innovation including for entrepreneurs to design tailored applications to solve the most pressing local social and environmental challenges.

The Cloud also offers major environmental benefits through increased energy efficiency and improved processes. According to some estimates, moving e-mail, productivity software, and customer relationship management software to the Cloud has the potential to **reduce primary energy footprint** by as much as 87%.

However, Cloud adoption requires a strong and stable broadband network to be in place first though, which for many Pioneer countries remains a major challenge. The potential benefits need to be measured against the investment costs, but as broadband coverage grows, it reaches a catalyst point at which Pioneers can begin to utilise the Cloud whilst at the same demand increases for cloud services across individuals, homes, and organisations. A second catalyst point exists for Up-and-Comer countries later that enables them to advance to more sophisticated cloud solutions on par with Leaders.

IoT: Cloud development opens up the way to The Internet of Things (IoT), which enables the gathering and processing of data through interconnection of computing devices embedded in everyday objects. IoT is expanding exponentially, and it is estimated that **20 to 50 billion devices** will be connected by 2020. IoT already has many applications to improve human lives and holds promise to offer many more solutions to address issues in healthcare (e.g. by monitoring patient data), water (e.g. by tracking water usage and levels), agriculture, natural resource management, and climate change resiliency, among other issues. Increasingly, unmanned aerial vehicles, also called drones, **are being used** to help with efficient delivery of development programs (e.g. by helping provide data from remote areas, places struck by natural disasters, etc.).

Big Data: Similarly, the cloud also leads the way to greater use and application of Big Data solutions, which refers to large volumes of information that require advanced data processing methods to interpret. As the amounts of data generated by various devices expands exponentially, it is becoming increasingly important to have the right tools and skills to analyse the data, draw out the insights, and visualise it. Making use of this data and using the insights to design effective programs will have a major impact in many sustainable development areas. Big data can help businesses and organisations understand their operations better and lead to efficiency improvements and reduced environmental impact, can help organisations assess and better understand environmental risks, and can offer solutions for governments to implement more effective regulations.

Telecommunication Industry Association (TIA)

Annual spending on information and communication technologies (ICT) has been forecast to reach $5.5 trillion by 2020 by research company IDC. This growth of new technologies, including 5G, cloud, analytics, and robotics, promises to revolutionize how we live and work by creating an integrated network of connected solutions and economies. This digital transformation will help address some of the world's toughest sustainable development challenges by providing access to information, overcoming remoteness, and creating new economic opportunities.

The Telecommunications Industry Association (TIA) is the leading trade association representing the global ICT industry and delivers assurance, quality, and assessment solutions that drive market leadership across the sector with its QuEST Sustainability Assessor Tool. TIA supports the Sustainable Development Goals (SDGs), and like Huawei, we believe they will all require the better use of digital technologies. In this way, we are working to address the critical trends of technological innovation and marketplace globalization by leading the development of voluntary, industry-led standards and benchmarks to improve the effectiveness of our members' sustainability programs and initiatives. We advance best practices and business performance solutions across the ICT industry and help companies around the world establish their strategies and goals for sustainability.

A common vision is vital and results in a multiplier effect. Connected by shared goals, ICT innovations will deliver outcomes that would be impossible to achieve within the intended timeframe of the 2030 Agenda for Sustainable Development. For this reason, TIA agrees with Huawei's analysis that ICT accelerates human progress.

Creating a Smarter and More Sustainable Future

Flex designs and builds Intelligent Products for a Connected World™. Huawei has a vision of a fully connected, intelligent world. Together, we power ICT to connect people, products and services to create a smarter, more sustainable future. Our strategy and global efforts are aligned with the United Nations' 2030 SDGs. Our primary focus is on Quality Education, Affordable and Clean Energy, Decent Work and Economic Growth, and Responsible Consumption and Production. Our commitment to these goals, individually and collectively, will benefit the environment, people and communities in which we live and work.

"Because sustainable living is central to who we are and how we operate, Flex is not only creating a smarter, more connected world, but each and every one of us is helping to create the conditions for a safer and healthier world, now and well into the future."

– Mike McNamara, CEO, Flex

Innovation at Flex powers the Intelligence of Things™, an evolving ecosystem of smart, connected devices, machines and systems that interact to help make our lives more efficient, healthier, safer, and more dynamic. Connected Agriculture will move to vertical and in-vitro food production, which will see higher yields from crops, lower inputs required to produce them, including a significantly reduced land footprint, and the return of unused farmland to increase biodiversity and carbon. Connected Healthcare will move from the current reactive model to more predictive healthcare, with sensors alerting of irregularities before any significant incident occurs, dramatically improving outcomes. Connected Manufacturing will enable the transition to manufacturing as a service, distributed manufacturing (3D printing) and mass customization; all with huge resource conservation possibilities. Connected Energy, with the ability to 'listen' to supply signals from generators, will move to a system where demand more closely matches supply (with cheaper storage, low carbon generation, and end to-end connectivity).

These are just a few examples of how we deliver Sketch-to-Scale™ solutions, with and for our customers, creating a better world through technology.

Only affordable communications infrastructure provides opportunity for all

Through our collaboration with Huawei, Hisense Broadband's optical access transceivers help individuals, homes, and companies communicate more easily and cheaply. By reducing the cost of internet access, we promote the rapid development of new business models, such as e-commerce and the "sharing economy". These methods not only enable easy access to goods and services, more importantly, they also create business opportunities for people living in remote and undeveloped areas. In this respect, Hisense Broadband's technologies contribute to the accomplishment of SDG 9 (Industry, Innovation and Infrastructure) and SDG 10 (Reduced Inequalities).

Looking ahead, we are developing optical transceivers for 5G wireless application, which will be critical for the deployment of 5G networks. We expect 5G wireless communication to be a key enabling technology for autonomous cars. The widespread use of autonomous cars will help reduce vehicle accidents and road traffic fatalities, and provide a safer, more energy-efficient transportation service. We therefore hope that our innovations will bring more benefit to society and that 5G technology will contribute to SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 3 (Good Health and Well-being).

Great progress starts with small connections

Shennan Circuit Company (SCC) designs and manufacturers printed circuit boards (PCBs) used by Huawei throughout its different products and solutions. We are one of the largest PCB manufacturers in China. Social responsibility is integrated into our business and we help lead our industry through the development of new standards and partnerships that promote environmental protection and eco-efficiency.

We share the same vision as Huawei: the power of connections – even the smallest ones – can help build a bright future for society. PCBs, PCBAs and Substrates are used in all but the simplest electronic products. Our objective is to create high quality products in a green and responsible way, and we take pride in the role they play bringing technological solutions to life. Our PCBs enable new digital and smart solutions that are increasingly being deployed in healthcare, transportation, aerospace, and business environments to name only a few. Whether it's smart devices for consumers and industry, or more complicated telecommunications equipment, we are helping to build a digital world that connects everyone and improves the world around us. Moreover, the high quality, reliability, and energy efficiency our of products means ICT solutions are kept stable, safe, and secure. In this way we are able to contribute to all of the SDGs.

Digital solutions that help drive human progress

Below we outline digital solutions that could be deployed through ICT infrastructure and support progress on the six SDGs in the Benchmark. We show how digital solutions open up the ICT pathways, described above.

Table 4 Role of ICT in achieving SDGs and examples of Digital Solutions

SDG	Examples of Digital Solutions	Key ICT Pathways
 Ensure healthy lives and promote well-being for all at all ages	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 Online or mobile learning and training solutions for medical professionals	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.
	Digitalised medical records and management Artificial Intelligence solutions and machine learning for diagnostic services and patient monitoring	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.
 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 Online learning programs for children and adults including live streaming and live chat capabilities	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 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 solutions to support efficiency and individualised 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. Analytics will enable the offering of more tailored learning curriculums (e.g., smart systems can analyse patterns of student learning and help prescribe learning plans to improve results).
 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, and markets. 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, discuss issues, tackle challenges, etc.	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.
	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.

SDG	Examples of Digital Solutions	Key ICT Pathways
 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 and households 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 Online and mobile platforms that can connect businesses or communities interested in pursuing a renewables project to sources of funding and potential partners	Connectivity: Connectivity between organisations 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 residential and commercial customers to access meter data and tools for managing energy use Big data analytics for modelling and scenario planning	Efficiency: Increased efficiency by improving ICT infrastructure can greatly reduce energy consumption, performing the same tasks better while saving energy and reducing costs.
 Build resilient infrastructure, promote inclusive and sustainable industrial-ization 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 labour 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. 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 organisations 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 Cloud computing and growth of "X as a service" offerings Smart building management systems 3D printing that drives innovation in manufacturing	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).
 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	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	Connectivity: ICT-enabled connectivity between individuals and organisations 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	Efficiency: ICT can support resource-efficient building and the management of sustainable cities through smart building applications, smart water and energy grids, and intelligent transport systems. Cities that have efficient resource and transport systems also improve the productivity of their residents.

Mobile technologies will change our world, for the better

By United Nations Environmental Program (UNEP), Mia Turner, Program Officer, and Jorge Laguna-Celis, Director

Every industrial sector is affected by mobile technology. And this technology is changing at a breathless pace. In every part of the world, consumers are racing to catch up with the latest in smartphones, computers, and other new digital technology. Over 5 billion people now have access to a mobile phone and nearly 4 billion people surf the net.

We are experiencing a dramatic technological revolution from intelligent robots and self-driving cars to gene editing and 3D printing. The boundaries between humans, the internet and the physical world are now converging. And the way we work and relate to one another is rapidly changing and impacting our industries, economies and lifestyles.

This is creating enormous problems and opportunities as well. We face a staggering 50 million tons of e-waste every year. At the same time, smart technology is connecting human beings as never before so that farmers in Kenya can share information on crop prices in China and geospatial monitoring systems can now be used on smartphones to warn of droughts and other natural disasters.

Indeed, thanks to the ease and use of the products and accessibility of the services, mobile technology has become one of the most powerful platforms for accelerating economic and social change and progress on the SDGs.

UN Environment Programme (UN Environment), the foremost authoritative advocate for the environment, and private sector groups like Huawei, who are at the forefront of the digital revolution, can lead the race to discover and scale up the transformation for the use of mobile technology for improving the quality of life while protecting the planet.

Three areas where partnerships are changing our world

There are at least three areas where the UN Environment can work with private sector to add value in using ICT to address the SDGs and these include smart utilities, big data for the environment, and an improved industry-policy dialogue.

Global champions for smart utilities

The United Nations has set the goal of connecting all the world's population to affordable internet by 2020. This will increase access to information, education and global marketplaces as never before, giving people access to knowledge and services that will empower them to improve their lifestyles and escape poverty.

A key positive outcome of this global connectivity will come through smart utilities, which are already changing the way we live. Mobile technology has been unlocking new and innovative models to improve access to energy, water, and sanitation for millions of people who live in areas where there is no traditional 'grid' but who are covered by mobile networks.

We now have to find the champions of our emerging smart utilities and scale them up. For example, the "pay-as-you-go" energy sector in emerging markets, has seen US$360 million of investment over the last four years, providing opportunities for the private sector and improving the lives of some 5 million people.

Mobile technology is also bringing change to health care systems so that smartphones can now keep track of stock levels of critical medications and vaccines, particularly in the developing world, and provide the digital infrastructure for collecting disease surveillance information or training programmes for healthcare workers.

Big data for a healthy planet

A combination of mobile phones, satellites, sensors and drones are also collecting planetary information in real time that can inform decision making on the sustainable development of natural resources and democratise access to data. Artificial intelligence and blockchain technologies can transform economic systems towards more sustainable models.

However, the sheer size and scale of the various data streams overwhelms the capacity of many stakeholders to use this wealth of information. Indeed, while the quantity of available data is doubling on an exponential basis every year, it is not yet structured in an actionable format. There is a global demand for tools to analyse, visualise and communicate the data to inform policies and decision making.

The Power of Collaboration

The time is ripe for the United Nations, which convenes decision-makers and companies leading on the fourth industrial revolution, to build on the power of collaboration and creative ideas for the regulatory frameworks that will inspire corporate responsibility in mobile technology.

Working together we can determine how we can connect across the planet though mobile technology and tackle our greatest environmental challenges, while aligning our material choices in smart technology to our planet's global quest for sustainability.

Digitalisation accelerates development process in emerging economies

By Mr. Kensuke Tanaka, Head of the Asia Desk, OECD Development Centre

The expansion of the digital economy – the convergence of fixed, mobile, and broadcast networks, the increasing connectivity of devices and objects, and the changes in social interactions and personal relationships that these developments bring about – is reshaping the manufacturing and services sectors in Emerging Asia. This process of digitalisation has brought about rapid change and presents further opportunities and challenges for the region. The spread of ICT can bridge the digital divide and develop knowledge societies. It has great potential to speed up progress in achieving the SDGs by providing access to education resources and health care, and services such as mobile banking, e-government and social media, among others.

In Emerging Asia, the increased use of ICT in manufacturing and services is affecting business activities, trade, and productivity. It has led to the expansion of existing industries and the emergence of new ones in the region, such as electronics manufacturing, software development, and ICT in Vietnam; business and knowledge process outsourcing in the Philippines; and mobile payments in China. ICT services embodied in manufacturing and services account for a considerable share of the value of exports from some of the region. Interestingly, it is primarily domestic digital added value that is being embodied in services exports. There is also evidence that improvements in aggregate and firm-level productivity are associated with the use of new technologies in many countries.

Despite the progress made, access to the digital economy is uneven across and within Emerging Asian countries. For example, rates of Internet use, a prerequisite for participation in most aspects of the digital economy, vary between 81% of the population in Singapore and 22% in Lao PDR. Policy makers in the region seeking to foster the continued responsible development of digitalisation should consider addressing the issue of trade restrictions, particularly those affecting trade in services; barriers to investment in the digital economy; the development and reform of physical and regulatory infrastructure; and ways of addressing labour market and social challenges. As digitalisation is influenced by a range of factors, policy strategies will need to be adapted to local needs. Continued regional co-operation is also needed in addressing shared and cross-border challenges in the digital economy.

The opinions expressed and arguments employed herein are solely those of the author(s) and do not necessarily reflect the official views of the OECD or of its member countries.

5G is a force for good

The fifth generation of mobile and digital networks, 5G, offers an unprecedented leap in bandwidth speeds (enhanced Mobile BroadBand (eMBB)), reliability and network response time *(uRLLC, ultra Reliable Low Latency Communication)*, and capacity (mMTC, massive Machine Type Communication). When this network capability is integrated with the Cloud, artificial intelligence (AI), big data, and IoT, future communication networks will be able to broaden their scope of services to potentially solve some of society's greatest challenges.

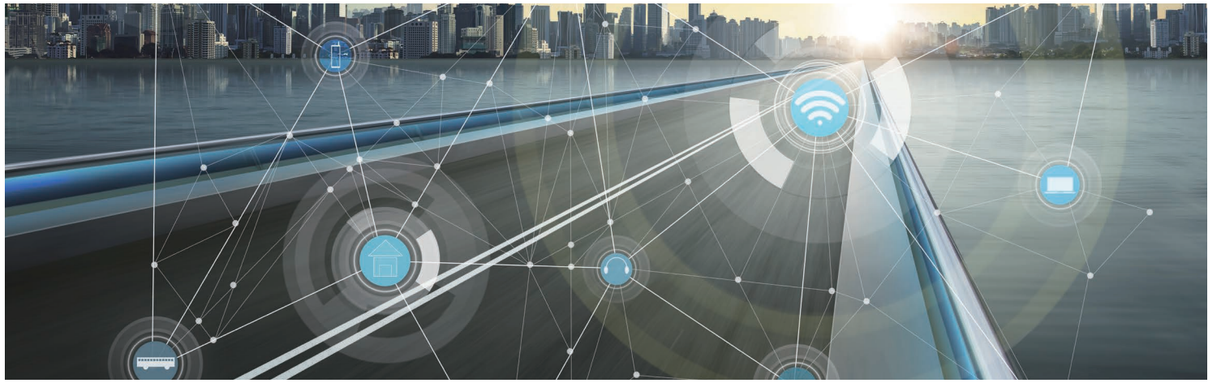
Forecasts show that 5G will open an important pathway to achieving the goals. According to IHS, 5G will **power the digital economy** and create more than US$12 trillion in goods and services by 2035. 5G will help accelerate economic growth and innovation to create more job opportunities. IHS estimates that, by 2035, the 5G value chain alone will drive US$3.5 trillion of economic output and support 22 million new jobs.

Some exciting 5G capabilities are highlighted below:

5G Attribute	Top ranking for SDG
5G enhanced Mobile Broadband (eMBB)	5G will improve mobile connectivity by connecting everything we can imagine, particularly helping to bridge the economic divide and ensure everyone has equal access to economic resources and opportunities, helping to reduce extreme poverty. 5G networks will increase access to high-quality multimedia education. 5G cloud architecture will introduce cloud-based virtual reality devices and enable virtual classrooms. It will enrich the learning experiences through interactive platforms.
Ultra Reliable Low Latency Communication (uRLLC)	5G aims to introduce nearly zero network response time. 5G connectivity and a nearly unperceivable response time will enable additional deployment of digital healthcare and smart medical solutions. This will help reduce health risks with better preventive and emergency medicine, remote diagnostics, and treatment that can extend beyond national borders. 5G-enhanced broadband and nearly zero network response time capabilities will provide mission critical communications that will improve the resilience of communities and reduce the impact of disasters on economies. 5G enables smart solutions, such as the mass-notification systems used in emergency situations will make cities safer and more sustainable for their citizens. 5G ultra reliable, intelligent, and low latency networks will enable fully automated driving and traffic management systems that will improve energy efficiency and safety, and reduce traffic and air pollution.
Massive Machine Type Communication (mMTC)	5G could play an important role in achieving zero hunger and improved nutrition. 5G enhances the capacity of networks to connect massive numbers of devices. This opens the door to a full range of smart solutions to automate and optimise sustainable food production intelligently. In addition, 5G's capability to serve large numbers of monitoring devices will enable the deployment of intelligent and sustainable water management solutions which, if used correctly, could increase water efficiency and protect freshwater resources. 5G connectivity will enable smarter and more sustainable grids and intelligent energy management. Through intelligent platforms, 5G will be able to facilitate access to affordable, reliable and sustainable energy for all. 5G connectivity and AI-based platforms will help industry improve production and consumption patterns, enabling the transition to the circular economy. Enhancing manufacturing and automation will be one of 5G's key capabilities, relying on zero network response time and high density wireless connection. 5G connectivity will help protect marine life and ecosystems through Machine-to-Machine (M2M) monitoring solutions, advanced mapping and data analytics, and real-time weather forecasting. 5G will help improve land use, biodiversity management, and combat desertification through the deployment of automated farm and irrigation systems, and improved monitoring and integrated weather information systems.

The Impact of Digital

How digital technologies energise and accelerate progress towards sustainable development in Argentina, Philippines, South Africa and United Arab Emirates



Argentina

Argentina has slightly above average ICT development compared to the Benchmark countries and is certainly a leader within Latin America. While Argentina has seen massive growth in mobile-cellular services over the past two decades and has high internet usage rates, it is still looking to make improvements in bringing access to more remote areas of the **country**. Argentina's telecommunications sector is regulated by the Ministerio de Modernización (created in 2015), which was tasked with executing the Plan País Digital that aims to further develop the country's ICT infrastructure, modernise public services, and close the digital divide. For example, Argentina has already made strides toward achieving a digital inclusion goal to provide public Wi-Fi access to more than 1,000 **municipalities**. Through a separate national plan run by the government called Argentina Conectada, the government intends to bring free digital television access to remote regions, and the Empresa Argentina de Soluciones Satelitales S.A. (state-owned infrastructure operator) will increase investments in broadband in rural **areas**.

Argentina is also making progress on the SDGs. In December 2015, the National Council for Social Policy Coordination was tasked with implementing the 2030 Agenda for Sustainable Development in **Argentina**. Since then, Argentina has incorporated the SDGs and priority targets into its national agenda, partly influenced by President Mauricio Macri's zero poverty goal and other national **priorities**. The Council has also made an effort to collaborate with civil society organisations, the private business sector and **universities**, which will be important if Argentina is to improve its score on SDG 9 (Industry, Innovation and Infrastructure), the only SDG on which it performs lower than the Benchmark average.

Argentina's ranking on the ICT SDG Benchmark: 22	
Argentina's ranking on SDG progress: 22	Argentina's ranking on ICT development: 22

Argentina ranks 22nd out of the 49countries on the ICT SDG Benchmark, scoring 69 out of a possible 100. Argentina is the highest ranking upper-middle-income country, scoring higher than four other high-income countries.

Figure 7 Argentina's SDG scores, each out of a possible 40 points

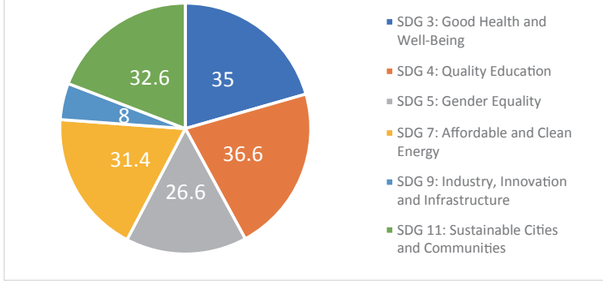
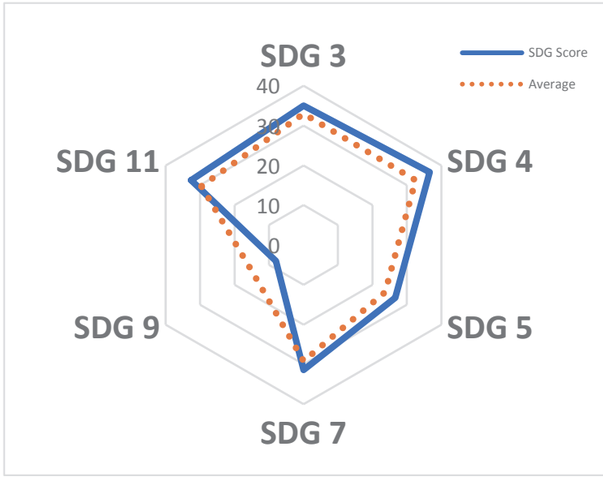


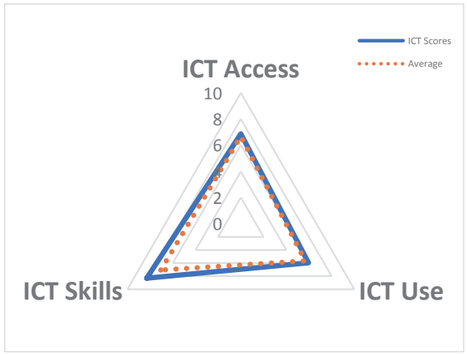
Figure 8 Argentina's SDG scores compared to the Benchmark average



Of the six SDGs analysed, Argentina performs best on SDG 4 (Quality Education) and SDG 3 (Good Health and Well-being), scoring above average on progress toward both goals Argentina scores above average on all education-related indicators for SDG 4, with its strongest scores in "expected years of schooling" and "literacy rate of 15-24-year-olds." SDG 3 progress is rated on indicators that involve various mortality rate metrics and incidence of tuberculosis, on which Argentina scores above average on three of the four. Argentina also scores above average on SDGs 5, 7, and 11.

Argentina's most notable area for improvement is in SDG 9 (Industry, Innovation and Infrastructure). This is the lowest of its SDG scores by a large margin, and even though many countries score quite low on SDG 9, Argentina is below average and well below most Leader and some Up-and-Comer countries. Argentina's SDG 9 scores highlight that not only is there potential for infrastructure improvements, there may also be opportunity for greater focus on innovation.

Figure 9 Argentina's ICT scores compared to the Benchmark average



Argentina does not perform as well on ICT as it does on the SDGs, though it scores slightly above average overall and on all three indicators - Access, Use, and Skills – and is certainly a leader in its region. Its strongest area is the category of ICT Skills. Other areas of strength are "mobile-cellular telephone subscriptions per 100 inhabitants" and "percentage of households with a computer" (both indicators for Access), as well as "percentage of individuals using the internet" (an indicator for Use). Areas for improvement include providing internet access to a higher percentage of households, increasing international internet bandwidth per internet user, and increasing fixed broadband penetration.

Key ICT Initiatives and that Support Progress on the SDGs

Hydro-meteorological monitoring system: Buenos Aires often suffers from flooding and intense storms that cause property damage, loss of income and threaten lives. In an effort to be more prepared and increase its resilience, Buenos Aires created a water and weather monitoring system made up of an interconnected sensor network that gathers data on meteorological, hydrological and other environmental **conditions**. The collected data is then used for flood prediction and mitigation, emergency planning and management efforts, and protecting water resources. The system can save lives in emergencies, conserve financial resources, protect infrastructure, protect the environment, and overall, help the city better manage these risks. These outcomes support both SDG 9 (Industry, Innovation and infrastructure) and SDG 11 (Sustainable Cities and Communities).

City Performance Tool: The city of Buenos Aires conducted research using a City Performance Tool, which compares the use of different technologies at various levels of implementation and **timeframes**. Using the City Performance Tool's data analytics, it analysed how implementing ten different technologies (across a range of sectors including buildings and infrastructure, transportation and energy) could impact both the economy and the environment, with specific focus on things like jobs created, air quality and emissions, electricity consumption, etc. The project resulted in recommendations catered to Buenos Aires, outlining which technologies will help it reach its 2030 goals around air quality, emissions, renewable energy, transportation infrastructure, and more. For example, one recommendation was to install an intelligent system for controlling the flow of traffic in a way that reduces emissions, which would likely include a network of cameras as well as more advanced controls on traffic lights. The tool supports Buenos Aires' sustainable city aspirations and can potentially contribute to SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and infrastructure), and SDG 11 (Sustainable Cities and Communities).

Tech-enabled schools: In order to help secondary school enrolment numbers and allow children in rural areas better access to secondary school, Argentina is building a network of tech-based high schools in rural parts of the **country**. Teachers located in urban headquarters live-stream classroom lessons to community centres in rural areas where local students gather to learn. Each urban headquarter can support ten rural classrooms, extending the reach of limited educational resources. The program connects students to higher quality educational opportunities and also to other students around the country through open chat forums, providing even deeper learning experiences. There are currently tech-enabled high schools in 3,000 community centres reaching 40,000 students, directly contributing to SDG 4 (Quality Education).

Examples of ICT solutions that can further Argentina's SDG progress

As one of the higher scoring Up-and-Comers, Argentina is poised to become a Leader, but is held back by a lack of progress on SDG 9. ICT could further enable Argentina's contributions to SDG 9 and its transition to a Leader in the following ways:

- Mobile banking solutions can enable more small and medium businesses, especially in remote areas, to have access to financial solutions.
- Ensuring that universities, independent research bodies, and research and development centres are equipped with proper ICT infrastructure can enable them to access, research, and develop the latest technologies, including machine learning, artificial intelligence (AI), and IoT applications. This fosters innovation and technological advancement.
- ICT solutions such as advanced monitoring and sensor networks can enable higher levels of resilience in new infrastructure.
- Additional ICT infrastructure and upgrades would allow Argentina to achieve a higher percentage of households with internet access and higher bandwidth per user.

Spotlight: Plan for Sustainable Mobility

Buenos Aires has a Plan for Sustainable Mobility that aims to improve transport efficiency and decrease its environmental **footprint**. There are a number of ways ICT enables this plan such as through the Bus Rapid Transit system, the EcoBici program, and a centralised command station.

Bus Rapid Transit

Part of the Plan involves expanding the Bus Rapid Transit service, known as the Metrobus, which launched in 2011. As commuter populations continue to increase in the city, the Metrobus system has been integral to reducing emissions from vehicles, reducing traffic congestion, and increasing safety. Just one of the Metrobus corridors has reduced CO2 emissions 5,612 tonnes per year and halved travel times for 200,000 commuters it serves.

In terms of ICT features, the Metrobus system has GPS-equipped bus stops and has a Priority Routes program which helps optimise traffic flow by directing buses to wide avenues and private vehicles to smaller side **streets**.

EcoBici

The EcoBici program provides free public bicycles to citizens through an automated bike sharing **system**. Citizens can use a mobile app to view the availability of bikes at a given station and to check bikes in and **out**. Users of the program can also go onto the EcoBici website and calculate their ecological footprint from transportation and the amount of CO2 emissions saved by using **EcoBici**.

Centralised Traffic Command Station

The command station can remotely control and synchronise traffic lights in real time to better manage traffic circulation and improve safety in congested areas. This is made possible by upgrades to traffic light junctions with high-performance ICT **equipment**.

United Arab Emirates

Over the past two decades, the United Arab Emirates (UAE) has rapidly developed and advanced its ICT sector, cities, and infrastructure, particularly in Abu Dhabi and Dubai. The creation of tax-incentivised zones Dubai Internet City in 1999 closely followed by **Dubai Media City** (2001), **Dubai Silicon Oasis** (2005), and **Masdar City** (2008) have been key milestones that have marked the UAE's push for technology, infrastructure, and economic **development**. In 2008, the Telecommunications Regulatory Authority (TRA), which manages all telecommunications and information technologies, set up an ICT fund - the **first of its kind in the Middle East** - to support research and development projects, and to provide education and training in order to stimulate further growth in the ICT sector. Between 2008 and 2014 the fund invested over AED 1.6 **billion** (US$418.7 million). The UAE's efforts are reflected in its above average score on ICT in the Benchmark.

With cities like Abu Dhabi and Dubai, the UAE excels in SDG 9 (Industry, Innovation and Infrastructure), an area where many of the other countries in the Benchmark perform poorly. The UAE's National Innovation Strategy draws direct ties between innovation and technology and SDG topics such as education, health, and renewable **energy**. Smart city initiatives in both Abu Dhabi and Dubai have supported progress on some of the SDGs as well. However, on the whole, the UAE performs better on ICT than on the SDGs, suggesting that there is opportunity to continue leveraging ICT to support the SDGs further, especially in the areas relating to SDG 11 (Sustainable Cities and Communities), and SDG 7 (Affordable and Clean energy).

UAE's ranking on the ICT SDG Benchmark: 24

UAE's ranking on SDG progress:	UAE's ranking on ICT development:
33	19

The UAE ranks 24th out of the 49 countries on the Benchmark, scoring 68 out of a possible 100. The UAE ranks higher than most middle- and lower-income countries, but lower than most of its high-income peers. Its total score is driven by its ICT score, which is significantly higher than its SDG score, a similar pattern to many of the Leaders in the Benchmark, though the UAE is categorised as an Up-and-Comer.

Figure 10 UAE's SDG scores, each out of a possible 40 points

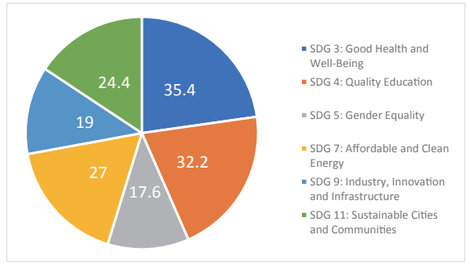
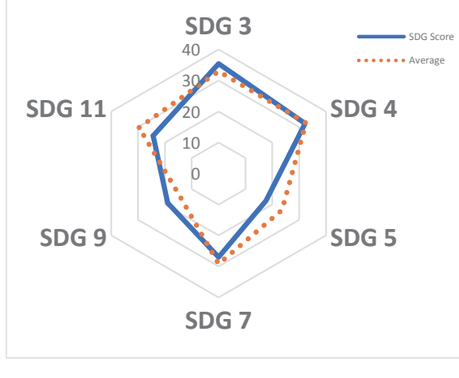


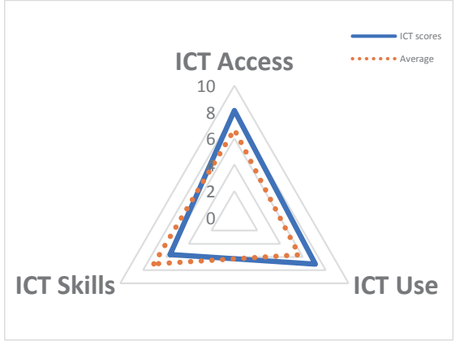
Figure 11 UAE's SDG scores compared to the Benchmark average



Of the six SDGs analysed, the UAE performs best on SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education). Though the UAE's score is lower for SDG 9 (Industry, Innovation and Infrastructure) than its other SDG scores, this score is actually above average, as many countries in the Benchmark score quite low on SDG 9. The UAE scores significantly above average on the two indicators for SDG 9 that involve trade and port infrastructure, which is a reflection of its strong energy export business.

This analysis also highlights opportunities for SDGs 11 (Sustainable Cities and Communities) and SDG 5 (Gender Equality). Using World Bank and International Labour Organization (ILO) statistics, the score for "female labour force participation rate" has increased significantly over the past few decades and is now 41%, but it currently remains below the global average of 49% affecting its score on SDG 5. Ratio statistics can be limiting however and may be influenced by the prevalence and scale of certain sectors, such as the large construction industry in the UAE. On SDG 11, the UAE scores below average on waste generation and air pollution, issues that are challenges for many developed economies.

Figure 12 UAE's ICT scores compared to the Benchmark average



The UAE is stronger in ICT development than SDG progress and scores higher than average on both Access and Use. For Access, the percentage of households with a computer and internet access are indicators on which it scores particularly well in addition to "international internet bandwidth per internet user (Bit/s)." For Use, the percentage of individuals using the internet and active mobile-broadband subscriptions per 100 inhabitants are both strong areas for the UAE. Skills is an area for improvement as the UAE scores slightly below average on all three indicators. However, tertiary gross enrolment ratio is the largest area for improvement. As of 2012, it is a legal **requirement** for children to remain in school until the completion of grade 12 or reaching the age of 18, so continued increases in mean years of schooling and secondary gross enrolment ratio are likely.

Key ICT Initiatives that support progress on the SDGs

Abu Dhabi Digital Government: To realize the social and economic objectives of the **Abu Dhabi Vision 2030**, which is to foster a sustainable, knowledge-based economy, an **eGovernment strategy** was launched to enable the digital transformation of government services. The service simplifies and centralises access to important government services, such as a virtual job market, an e-education platform, and online health services. This initiative shows how ICT can open government to its citizens, which is important because the achievement of the SDGs relies on government institutions and services being accessible to all.

Smart Patient portal: Providing world class healthcare is part of the UAE's Vision **2021**. To increase ease of access to health information and services, the Ministry of Health and Prevention offers Smart Patient, an online portal where patients can view and manage health profiles, medical records, test results, and medical appointments. The portal is also available as a mobile application that users can access directly from their **smartphones**. Additional initiatives such as the National Unified Database of Patients and the Electronic Medical Records project round out the UAE's e-health strategy, and its focus on efficiently getting patients and healthcare providers the information and tools they **need**. This highlights just one of many ways that the use of ICT can make health services more accessible in support of SDG 3 (Good Health and Well-being).

Online resources for women: In direct support of SDG 5 (Gender Equality) and SDG 3 (Good Health and Well-being), the UAE has introduced a wide range of services for women that are all available online. Women can access services like family consultation, financial assistance requests, health resources and housing benefits, among others. There are also places to anonymously report trafficking against women and children and human rights complaints.

Examples of how ICT solutions can further UAE's SDG progress

The UAE's ICT score is higher than its SDG score and indicates that there is opportunity to use its strong ICT capabilities, innovation resources, and ICT sector to make further progress on the SDGs:

- Reducing total energy consumption and increasing the percentage of renewable energy should be priorities for the UAE, given its heavy reliance on fossil fuels. The new **UAE Energy Plan 2050** demonstrates that it is continuing with initiatives to build renewable energy resources and enabling electrification with smart grid and smart metering infrastructure that will help the UAE progress on SDG 7. Smart metering projects and allowing residents and businesses to view their energy consumption can lead to better energy management and reductions in energy use.
- Waste generation per capita and air pollution are the two largest opportunities for the UAE to increase its contribution to SDG 11. Initiatives such as ICT-enabled campaigns to educate residents about proper waste diversion practices, sensor systems on public waste receptacles that make waste management and collection more efficient, and advanced air quality monitoring systems are possible solutions.
- Expanding the use of connected air quality monitoring equipment (like the mobile air quality monitoring **stations** in Dubai) across the country would allow for air pollution analysis and tracking at a national level. Such equipment can measure air pollution and particulates and send that information back to a central server for analysis. Expanding these monitoring systems could illuminate not only sources of air pollution, but how it travels.
- ICT solutions that make additional educational and job training resources even more readily available to women, like online education platforms or mobile-enabled solutions, could support the UAE's on-going achievements on SDG 5.

Spotlight: Masdar City

Masdar City is perhaps the world's best known sustainable city project. Its priority is to make Abu Dhabi the world's reference for knowledge and collaboration on the advancement of renewable energy, clean technologies and sustainable development. By pioneering new technologies and demonstrating commercial viability the city intends to become a key global hub for clean technology.

Its priorities include photovoltaic solar, concentrated solar, wind, and desalination technologies, but recent research has also included **smart transport** solutions that are enabled by mobile connectivity. New technologies to support smart transportation, including data processing power, sensors, batteries, blockchain, and artificial intelligence will accelerate the adoption of electric vehicles (EVs) and autonomous vehicles (AVs). Masdar City's clean technology vision and resources will contribute to achieving SDG 7 (Affordable and Clean energy) and SDG 13 (Climate action).

South Africa

South Africa has one of the most sophisticated networks of ICT infrastructure on the African continent and is the largest data centre market in Africa. The Department of Telecommunications and Postal Services is the central policy-making body, and one of the most recently adopted strategies is the National Integrated ICT Policy White Paper from 2016. It identifies gaps in South Africa's current ICT infrastructure and service offerings and proposes government and private sector investments that are needed to close those gaps. The country's broadband policy is called the 2013 South Africa Connect and aims to achieve average broadband speeds of 100 Mbit/s by 2030. Though it scores below average on ICT, a competitive market driven by private-sector telecommunications providers and its ability to invest in infrastructure (having one of the strongest GDPs in Africa) have enabled South Africa to achieve the level of ICT development it has thus far and create a strong foundation for future improvement.

South Africa's sustainable development aspirations are outlined in a number of strategies. The National Strategy for Sustainable Development and Action Plan was adopted first in 2011, with a second iteration in 2015 that presents the strategy through 2020. It outlines the country's plans for things like environmental stewardship, social equity, and economic health, all aligned with South Africa's values and vision. The National Development Plan, set in 2012, takes a longer-term approach and sets the country's vision for 2030, which includes goals to reduce inequality and eliminate poverty. Johannesburg and Cape Town both have numerous city-level initiatives supporting the SDGs as well, such as the Cape Town Global Action Plan for Sustainable Development Data that "provides strategic guidance for the design and implementation of country-led statistical capacity-building needed to achieve the 2030 Agenda."

South Africa's ranking on the ICT SDG Benchmark: 38

South Africa's ranking on SDG progress:	South Africa's ranking on ICT development:
39	37

South Africa ranks 37th out of the 49 countries on the Bench-mark, scoring 55 out of a possible 100. South Africa is on the higher-performing end of the Pioneer group. Of the countries in the upper-middle income bracket, it has the second lowest score. South Africa performs better on SDG progress than on ICT development, a pattern that is true for all Pioneer countries and some Up-and-Comers.

Figure 13 South Africa's SDG scores, each out of a possible 40 points

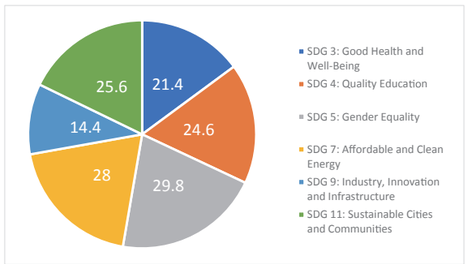
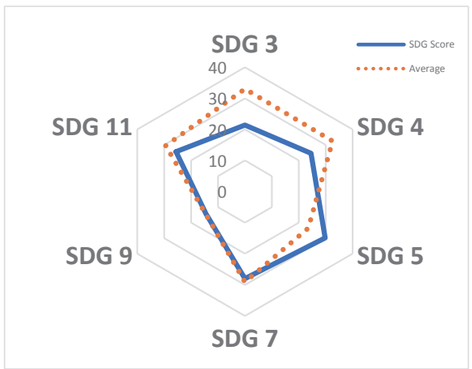


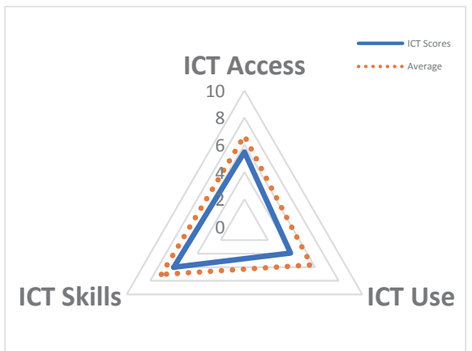
Figure 14 South Africa's SDG scores compared to the Benchmark average



Of the six SDGs analysed, South Africa performs best on SDG 5 (Gender Equality) and SDG 7 (Affordable and Clean Energy), and these are also the two SDGs on which its scores are average or above, SDG 7 being about average and SDG 5, above. For SDG 5, South Africa scores above average on all indicators, but performs particularly well on "proportion of seats held by women in national parliaments."

Though its performance on SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 11 (Sustainable Cities and Communities) are not far behind in score from its top SDGs, South Africa scores below average on all three of these, most significantly on SDGs 3 and 4, which are its biggest areas for improvement. This is common among Pioneer countries and lower scoring Up-and-Comers, and because SDGs 3 and 4 relate to basic needs, improving these SDGs in particular is critical to enabling South Africa to improve its overall Benchmark performance. Similar to many other countries in the Benchmark, the area where South Africa's SDG contributions are weakest is SDG 9 (Industry, Innovation and Infrastructure), but this score is approximately average.

Figure 15 South Africa's ICT scores compared to the Benchmark average



South Africa scores significantly lower on ICT compared to its SDG score, and scores slightly below average on all three areas - Access, Use, and Skills - with Use being its biggest area of opportunity. However, because Use is arguably dependent upon Access and Skills, South Africa will need a strong focus on all three if it is to improve ICT development in an impactful way.

South Africa's areas of success are specifically in "international internet bandwidth per internet user" and "mobile-cellular telephone subscriptions per 100 inhabitants," both of which are indicators for Access. It scores below average in almost all other ICT indicators; its most significant areas for improvement include increasing fixed telephone subscriptions, the percentage of households with a computer, fixed broadband subscriptions, and tertiary gross enrollment ratios.

Key ICT initiatives that support progress on the SDGs

Ekurhuleni smart city partnership: A large **municipality** in South Africa, Ekurhuleni, advanced its connectivity and digital services with investments in projects such as broadband connectivity, CCTV installation, smart meters, and fibre installation in city buildings, which has led to better monitoring, integration and efficiency of various services. The city anticipates that these improvements will also lead to a reduction in energy consumption and create better conditions for attracting start-ups and promoting entrepreneurship and job creation in previously disadvantaged areas, contributing to SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities).

C40's modeling tool, 'CURB': In 2006, the city of Johannesburg created its first strategy for long-term growth and development as a sustainable **city**, and in 2016, it developed a Climate Change Strategic Framework (CCSF) as a contribution to long-term **vision**. The CCSF aims to bring greater organisation to the city's climate change actions and requires joint effort between municipal departments, businesses, and the wider community. As part of this effort, Johannesburg will make use of a modelling tool from C40 called **CURB** (Climate action for URBan sustainability). CURB is a downloadable interactive scenario planning tool with a wide range of **functions**. The tool will help the city measure and track greenhouse gas emissions and enable the city to choose the best low-carbon actions based on the implications of each option. Overall, the use of the technology will help Johannesburg better plan and execute its climate change **strategy**, contributing to the achievement of SDG 7 (Affordable and Clean Energy).

Eduze: This media company based in South Africa is bringing educational digital content to clinics, hospitals, buses, universities, corporate offices, rural schools and other areas that may otherwise be unconnected through its "micro infrastructure device" called CLOX - Cloud in a **Box**. CLOX provides free high-speed downloading and streaming to a mobile device without requiring a mains electricity connection (it can be powered with solar panels), 3G or ADSL, overcoming two of the largest barriers to connectivity and use: expensive data costs and slow speeds. The devices are installed in private and public spaces and then loaded with videos, podcasts, music, books and other content by the Eduze team, in some cases tailored to the venue. For example, schools would be given content that complements their curriculum. Eduze aims to increase access to digital content and close the digital literacy gap in Africa, contributing to SDG 4 (Quality Education).

Open Medicine Project South Africa: Based in Cape Town, Open Medicine Project South Africa aims to improve the healthcare system by equipping healthcare workers with access to relevant information and support through mobile technology. The Project is a team of healthcare workers, mobile technology developers and application designers who are working to create innovative applications that tackle specific health system **problems**. For example, the Mobile Triage App helps prioritise patients in an emergency room and guides nurses through accurate **triage**. The HIV Clinical Guide App gives doctors on-the-go access to the most relevant and up-to-date HIV care information. The Project could ultimately improve the healthcare system in South Africa, elevate overall quality of care, and affect health-related metrics for the country, contributing to SDG 3 (Good Health and Well-being).

Examples of how ICT solutions can further South Africa's SDG progress

As a lower scoring Up-and-Comer, South Africa needs to focus on furthering SDGs 3 and 4 to improve its educational and health and well-being metrics in order to move up in the Benchmark. ICT could further enable its contributions to SDG 3 and 4 in the following ways:

- Continuing to digitise healthcare management, whether through e-government healthcare services or electronic medical record management can increase access to and use of medical resources and the healthcare system.
- Telemedicine and mobile health care solutions can increase access to information and services in rural, remote, or impoverished areas.
- Equipping teachers and classrooms with technology like tablets and other ICT equipment can enhance the learning environment and provide teachers with additional tools, which may be especially useful in South Africa since it scores quite low on the pupil-teacher ratio in primary schools.
- Online solutions as well as using advanced analytics to create individualised learning opportunities can increase both access to education and enrolment rates.
- Generally increasing access to and use of internet and mobile networks can further both SDGs 3 and 4 in various ways.

Spotlight: Mozilla Clubs

A partnership between UN Women and The Mozilla Foundation, Mozilla Clubs bring groups of women and girls together to learn web skills, coding, and other digital literacy **skills**. The project also aims to empower participants by also teaching them how to make use of opportunities for leadership.

Mozilla Clubs focus on women and girls because of the large digital literacy gap that exists between women and men in developing countries. According to research published by the Clinton Foundation and the Bill and Melinda Gates Foundation, there are 200 million fewer women online and 300 fewer women using mobile phones in developing **countries**.

As women in the initial Mozilla Clubs in Cape Town and Nairobi began to build their skills and sense of empowerment, new topics of discussion began to arise such as workplace discrimination and gender-based violence. As such, the clubs have evolved to integrate additional initiatives such as incorporating a curriculum on women-focused issues and providing an app on which members from different clubs and countries can engage with each other on these **topics**.

Philippines

While the Philippines has achieved pervasive levels of basic mobile access, its overall ICT score is well below the Benchmark average, and there are many opportunities for additional ICT development, especially outside of major **cities**. The Department of Information and Communications Technology (DICT) implements national ICT strategies, sets policies for the sector, aims to ensure sustainable growth of the ICT industry, and ultimately aspires to ensure all Filipinos have access to ICT **resources**. The DICT's policies and standards have been pivotal to the country's e-government efforts and the migration to the government's web hosting **service**. Most recently, in 2017, the DICT unveiled The National Cybersecurity Plan **2022**, which focuses on improving the government's ability to respond to threats proactively and, in the case of a cyber-attack, exhibit quick response and **recovery**. The Plan also provides systematic procedures for protecting the country's ICT infrastructure. In 2017, DICT also released the DICT **National Broadband Plan**, which outlines steps to improve its performance on affordability, availability, and speed of internet access. 2017 also saw President Rodrigo Duterte sign into law a measure establishing **free internet access in public spaces**, aiming to promote knowledge-building and participation of its citizens in information and communication.

The Philippines performs better on the SDGs than on ICT but still does not present strong performance relative to the Benchmark. The recent development of the Philippine Development Plan 2017-2022, approved by the National Economic and Development Authority Board, shows signs of increased focus on the SDGs ahead. The Plan was created in alignment with the Philippines' long-term vision, AmBisyon Natin **2040**, and takes into account how the country plans to contribute to international commitments such as the **SDGs**. The plan includes goals for reducing poverty and unemployment, increasing innovation efforts, and generally creating more inclusive, resilient **communities**.

Performance on the ICT SDG Benchmark

Philippine's ranking on the ICT SDG Benchmark: 43

Philippine's ranking on SDG progress:	Philippine's ranking on ICT development:
43	40

The Philippines ranks 43rd out of the 49 countries on the Benchmark, scoring 51 out of a possible 100. The Philippines is categorised as a Pioneer and has much room for growth on both its ICT development and SDG progress. Like its Pioneer peers, the Philippines scores significantly higher on SDG progress than on ICT development.

Figure 16 Philippines' SDG scores, each out of a possible 40 points

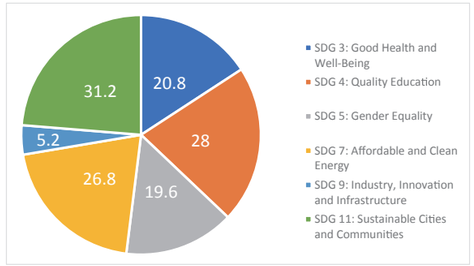
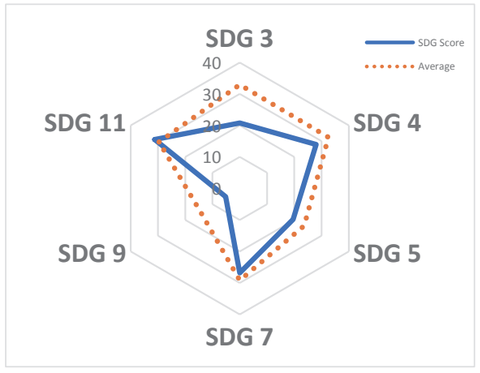


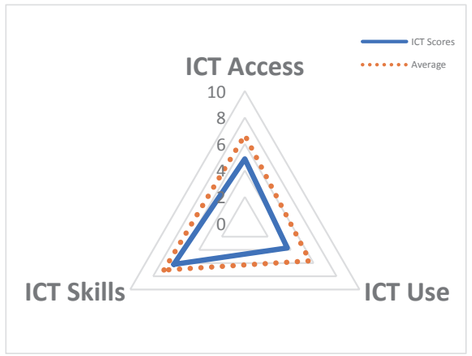
Figure 17 Philippines' SDG scores compared to the Benchmark average



Of the six SDGs analysed, the Philippines performs best on SDG 11 (Sustainable Cities and Communities) followed by SDG 4 (Quality Education), though SDG 11 is the only goal on which it scores above average. While it still scores below average in "access to improved sanitation facilities," Philippines scores above average on all other indicators for SDG 11, and performs best on "mean annual exposure to air pollution."

The Philippines' most notable areas for improvement are in SDG 9 (Industry, Innovation and Infrastructure) and SDG 5 (Gender Equality). However, addressing SDG 3 (Good Health and Well-being) and SDG 4 (Quality Education), as the goals that represent base needs, is crucial to building a strong foundation for performance for the country going forward.

Figure 18 Philippines' ICT scores compared to the Benchmark average



The Philippines scores below average on all of ICT Access, Use and Skills. Like South Africa, it is furthest below average on Use, making that a prime area for improvement, but that will likely require increasing performance on Access and Skills first, or at least simultaneously.

The Philippines performs below average on all eleven indicators for Access, Use and Skills but it is most behind on fixed telephone subscriptions (an indicator for Access) and fixed broadband subscriptions (an indicator for Use), followed closely by international internet bandwidth per internet user. This indicates that investments in ICT infrastructure are needed and will likely need to precede improvements in the other areas, such as percentage of households with internet access and percentage of individuals using the internet. It performs close to average on mobile cellular telephone subscriptions (as an indicator of Access) and mean years of schooling (as an indicator of Skills).

Key ICT initiatives that support progress on the SDGs

National Telehealth Center: Part of the University of Philippines in Manila, the National Telehealth Center focuses on how ICT can make quality healthcare accessible to more Filipinos, especially those in remote or disadvantaged **communities**. The Center identifies issues in the healthcare system and provides ICT-enabled solutions. For example, they provide training on eHealth, eMedicine solutions that allow patients in remote areas to access telemedicine services or find the specialists nearest them. The Center also developed the first electronic medical record system for government-based health facilities in the Philippines and is an active policy advocate. This contributes directly to the Philippines' performance on the SDG 3 (Good health and Well-being).

Ayannah: Based in Pasig City, Ayannah is a social enterprise bringing digital financial services to the "unbanked," workers in rural or remote areas and migrants with little access to traditional financial **services**. Access to digital commerce and payment services via online and mobile applications build users' digital and financial literacy and generally facilitates the financial inclusion of the emerging middle class. Ayannah was one of twenty-four startups recently chosen to participate in the two-week Google Launchpad Accelerator boot camp aimed at companies that have a good product that is ready to **scale**. Ayannah's model supports SDG 9 (Industry, Innovation and Infrastructure) by providing access to basic financial services.

Examples of how ICT solutions can further The Philippines' SDG progress

SDGs 3 and 5 are the Philippines' largest and most pressing areas of opportunity for improvement, especially if the country is to move toward the Up-and-Comer group. ICT could further enable its contributions to SDG 3 and 5 in the following ways:

- Mobile-based knowledge sharing and resources for medical professionals can bolster the quality of the healthcare system in the Philippines which struggles with high rates of tuberculosis and "mortality rates attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease."
- Social media, television, radio, and online platforms can all be used to increase the public's awareness of the facts around tuberculosis, reduce the stigma, and inform Filipinos of the vaccination programs and treatment options available. However, a higher number of Filipinos in remote or rural areas would need better access to internet and mobile networks as well as basic digital literacy in order to realise the full benefits of such efforts.
- Applications that allow women to access health information and resources online or from a mobile device as well as telemedicine solutions like being able to chat with a doctor over webcam, could make healthcare more accessible to a wider population.

Spotlight: Meralco's Advanced Metering Infrastructure Project

In 2017, Manila Electric Co. (Meralco) launched an Advanced Metering Infrastructure (AMI) project to deploy a system of smart meters controlled by advanced data management **systems**. The AMI system will allow the utility to have clearer vision into the state of the electric grid, respond to outages more quickly and improve efficiency. Customers will have access to energy consumption data and be able to set up alerts and notifications to better manage their energy use. As part of the project, Melarco will also be able to offer:

- Demand response programs
- Distributed energy resources management
- Electric vehicle supply equipment (EVSE) management
- Smart street lights

Such initiatives enable Manila to potentially lower energy usage and lay the foundation for increased use of renewable energy sources. Meralco aims to install smart meters throughout all of metro Manila by 2019 and expand to service areas beyond that by 2024.

Next Steps

The 2018 ICT SDG Benchmark confirms that ICT is linked to more rapid progress towards more sustainable and equitable development. The following is recommended:

Pioneers and Up-and-Comers

- Pioneer and Up-and-Comer countries should prioritise investing in ICT due to the potential for rapid returns on SDG progress, compared to Leader countries for which returns may be less pronounced. These countries should look to invest in ICT solutions that can simultaneously benefit multiple SDGs in pursuit of a balanced approach to SDG progress, as results indicate that to be a Leader country it is important to perform equally well across all six of the SDGs analysed.
- If countries must narrow their investments, a focus can be taken on ICT related to health and education, as there is a strong correlation between ICT and these SDGs, and it represents the largest gap between Leaders and Pioneers, signalling a promising opportunity to make strides in both areas. It should also be noted that health and education are issues that can be considered foundational and may be necessary to address before progressing on additional SDGs.

Leaders

- Leader countries should focus on using ICT to specifically improve performance on SDG 9 (Industry, Innovation and Infrastructure) and SDG 7 (Affordable and Clean Energy), two of the SDGs on which they score lowest, on average, compared to other SDGs. Leaders such as South Korea have also deployed ICT initiatives specifically targeted on providing greater access to social services (such as e-government), which demonstrates greater investments in driving progress on both ICT and the SDGs.
- Leaders can use the Benchmark to identify SDG areas on which their performance is low and focus ICT efforts in those areas. On the Benchmark, Leaders show the least progress on waste generation per capita (from SDG 11 (Sustainable Cities and Communities), proportion of renewable energy (from SDG 7 (Affordable and Clean Energy) and patent application (from SDG 9 (Industry, Innovation and Infrastructure). Harnessing ICT capabilities to develop solutions to these challenges can help Leader companies drive additional progress.

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 are all important for driving progress on sustainable development, Use emerges as a particular area of focus for most countries. 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 Pioneers, signalling this as an area where countries are falling behind.

Alongside these specific recommendations, we encourage national decision-makers to design and implement targeted policies that harness digital technologies to effectively address the most important social and environmental issues. The ICTs will continue on the track of exponential growth, but in order for digital technologies to deliver the most benefits to society, their deployment has to be targeted and thoughtful. Internet is core to most technologies; fixed broadband will continue to grow everywhere, but for leaders of developing economies, a particular focus on mobile broadband will be crucial, given that mobile broadband is becoming more affordable and accessible. It will be particularly important to have strategic policies for the fastest growing technologies: data centres, cloud, IoT, and Big Data. South Korea, a leader in e-government services worldwide, is a strong example of effective governmental policies. Not only is it a global leader in developing ICT infrastructure (e.g. 5G) but also is leading on the application of digital technologies (e.g. moving public organisations to cloud, customizing welfare services, etc.).

In addition to national decision-makers, business and other stakeholders will have a major role to play by partnering with policymakers to deliver the SDGs. Business should engage with policymakers regularly as private-public partnerships will play a major role. Business can play a more prominent leadership role in spearheading the application of ICTs for SDGs.

It is important to note that ICT is not the only contributor to achieving the SDGs. However, ICT shows great promise for quickening our progress on some of the world's most pressing global problems.

By strategically tapping into the power of ICT we can make great progress on the SDGs, faster, further and in more regions around the world.

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 2018 ICT Sustainable Development Goals Benchmark ranks 49 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 the countries included in Huawei's Global Connectivity Index (GCI). These 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 5) 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 5 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 2016
	Incidence of tuberculosis (per 100 000 population per year)	WHO 2016
	Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	WHO 2017
SDG 4: Quality Education	Literacy rate of 15-24 year olds, both sexes (%)	UNESCO 2010-2015
	Expected years of schooling	United Nations Development Programme's Human Development Report 2016 (2015 data)
	Pupil-teacher ratio, primary	The World Bank 2015
	Repeaters, primary, total (% of total enrolment)	The World Bank 2015
SDG 5: Gender Equality	Unmet demand for contraceptives (% of women married or in union, ages 15-49)	WHO 2015
	Proportion of seats held by women in national parliaments (%)	IPU 2017
	Labour force participation rate, female (% of female population ages 15+)	ILO 2016
	Mean years of schooling (females aged 25 years and above) (years)	UNESCO 2013
SDG 7: Affordable and Clean Energy	Access to electricity (% population)	World Bank, Sustainable Energy for All
	Renewable energy consumption (% of total final energy consumption)	World Bank, Sustainable Energy for All
	Proportion of population with primary reliance on clean fuels and technology	WHO Household energy database, 2016
	Electric power consumption (kWh per capita)	Electric power consumption (kWh per capita)
SDG 7: Affordable and Clean Energy	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 2016
	Patent applications, residents per million population	World Intellectual Property Organisation, 2015
	Automated teller machines (ATMs per 100,000 adults)	IMF Financial Access Survey 2015
SDG 11: Sustainable Cities and Communities	Waste Generation per capita (kg/yr)	Waste Atlas
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	Brauer, M. et al. 2016, for the Global Burden of Disease Study 2015
	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 6).

Table 6 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. Without access, individuals who want or need to use ICT services are not able to, and are cut off from benefits of connectivity	• 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 (WHO) 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 percent, 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 a proof of causation.

Changes between 2017 and 2018 Benchmarks

The 2018 Huawei ICT SDG Benchmark focuses on the same SDGs as previous years with one exception. This year SDG 13 (Climate Action) was removed and replaced with SDG 7 (Affordable and Clean Energy), retaining a total of 6 SDGs. This change was made due to the very low interaction between SDG 13 and ICT. SDG 7 was considered to have a stronger correlation with ICT given the relationship between ICT and energy management. While we believe all the Goals to be important for business and society to focus on to achieve a sustainable future, we highlighted these six SDGs as ones that can potentially benefit the most from strategic involvement of the ICT sector. We also based our selection on availability of data to help support our investigation.

A number of indicators have also been removed and replaced from those used last year (Table 7). The changes were made to avoid the use of 'input' indicators that would confuse the results of the analysis and prevent a clear understanding of the influence of ICT on the SDGs. In another case an indicator for SDG 9 was replaced with an alternative source because it did not cover all 49 countries. An alternative was found that did cover all the countries in the Benchmark. While these changes improves the methodology, a precise comparison with last year is not fully possible. In the long-term however the changes will enable a more robust year-on-year comparison.

Table 7 Indicator Changes

Previous Indicators	New Indicators
SDG 3: Good Health and Well-being • Physicians (per 1000 people)	**SDG 3: Good Health and Well-being** • Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease
SDG 4: Quality Education • Mean years of schooling for adults (years) • Gross enrolment ratio, primary, both sexes (%) • School enrolment, secondary, female (% gross)	**SDG 4: Quality Education** • Expected years of schooling • Pupil-teacher ratio, primary • Repeaters, primary, total (% of total enrolment)
SDG 13: Climate Action • CO2 emissions per capita (tCO2/capita) • Primary energy supply: renewable energy sources (% of total) • Climate Change Vulnerability Monitor (0-1) • Energy intensity level of primary energy (MJ/$2011 PPP GDP)	**SDG 7: Affordable and Clean Energy** • Access to electricity (% population) • Renewable energy consumption (% of total final energy consumption) • Proportion of population with primary reliance on clean fuels and technology • Electric power consumption (kWh per capita)
SDG 9: Infrastructure, Industrialization and Innovation • Patent applications, residents per million population (Source: OECD)	**SDG 9: Infrastructure, Industrialization and Innovation** • Patent applications, residents per million population (Source: World Intellectual Property Organisation)

Indicators for SDG 5 and 11 are unchanged between 2017 and 2018 Benchmarks

Data Charts

Correlation between ICT Sustainable Development Benchmark Scores and external indices

Figure 19 ICT Sustainable Development Goals Benchmark vs. GDP per Capita (measured as Purchasing Power Parity)

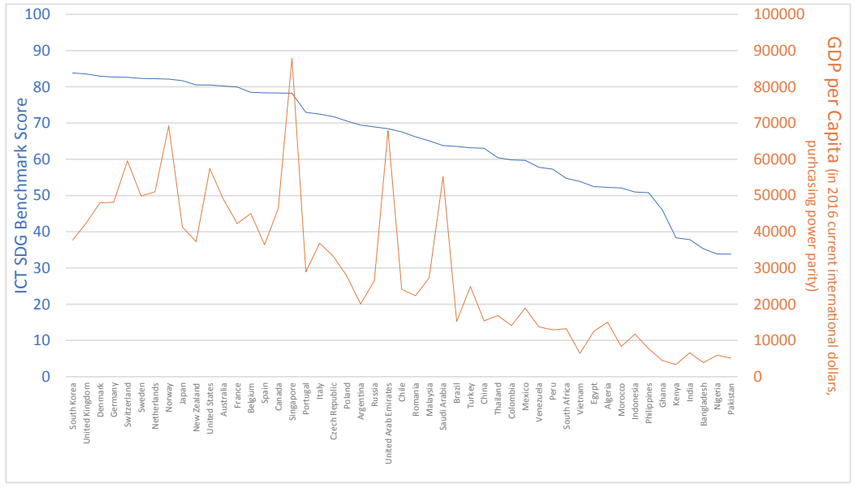


Figure 20 ICT Sustainable Development Goals Benchmark vs. Human Development Index (HDI)

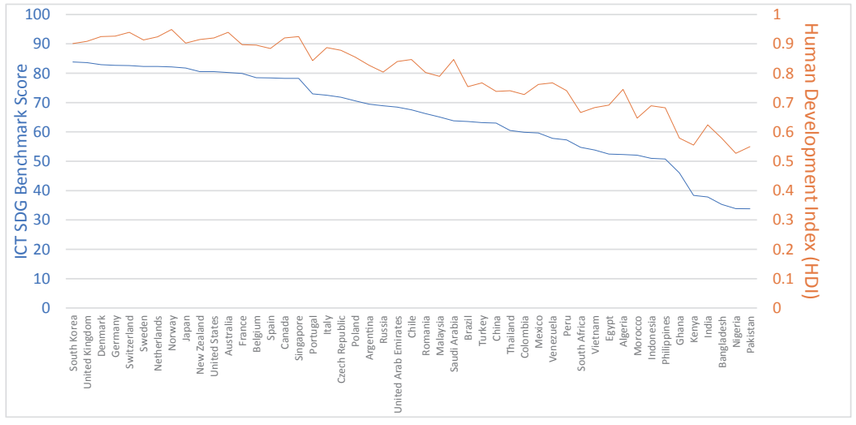


Figure 21 ICT Sustainable Development Goals Benchmark vs. Environmental Performance Index (EPI)

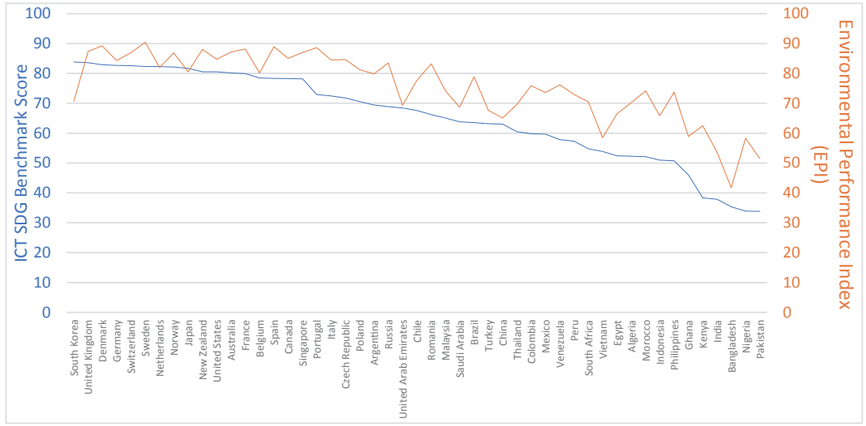
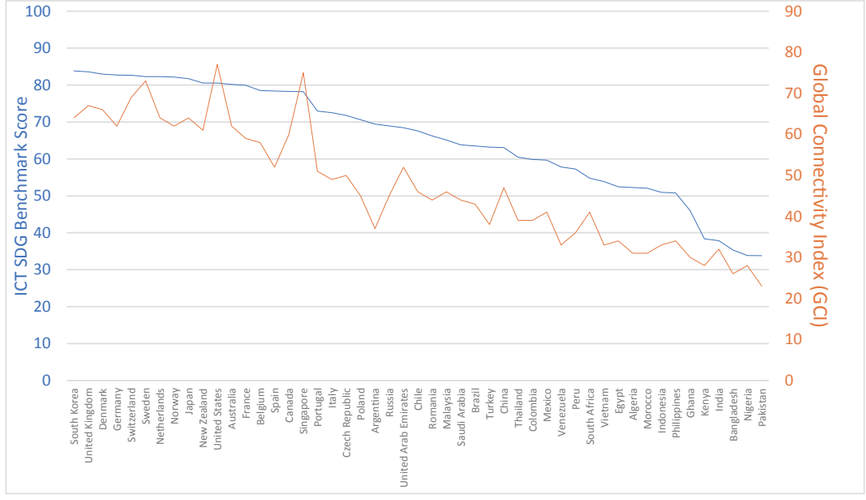
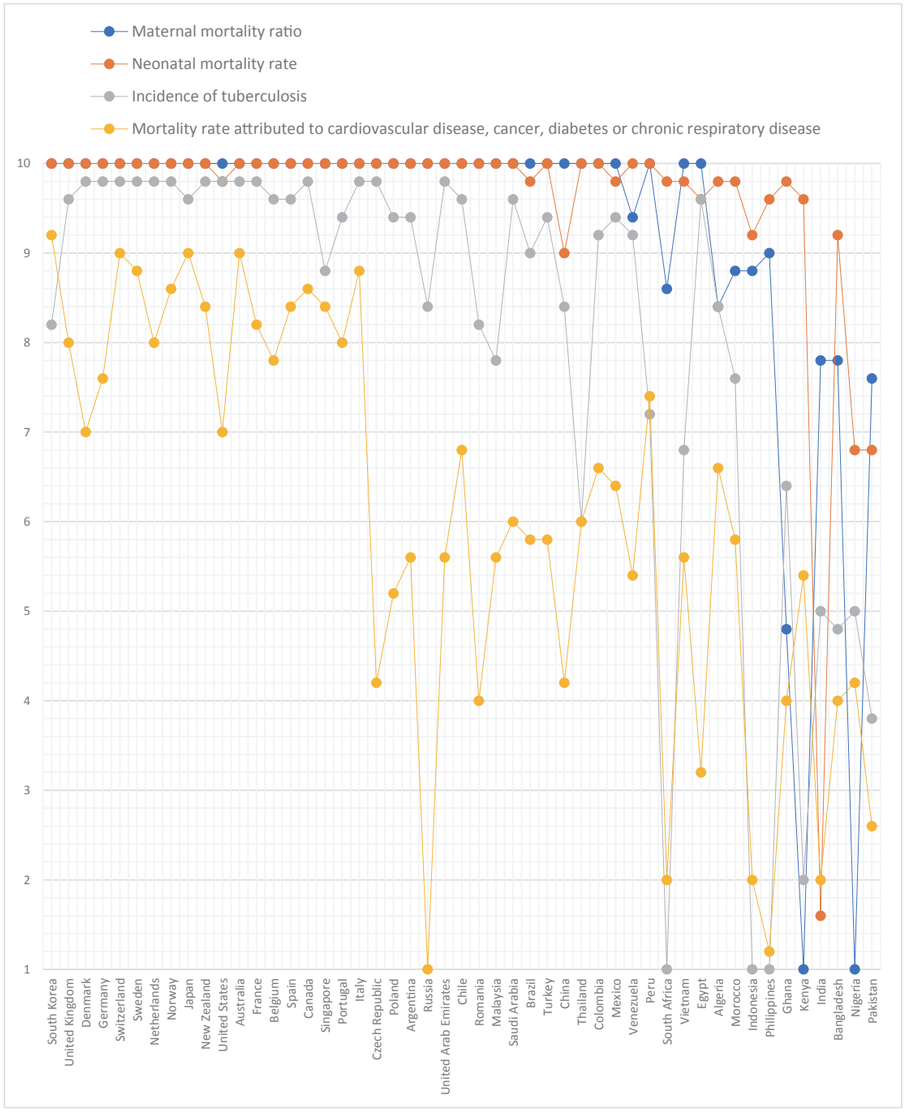


Figure 22 ICT Sustainable Development Goals Benchmark vs. Global Connectivity Index (GCI)



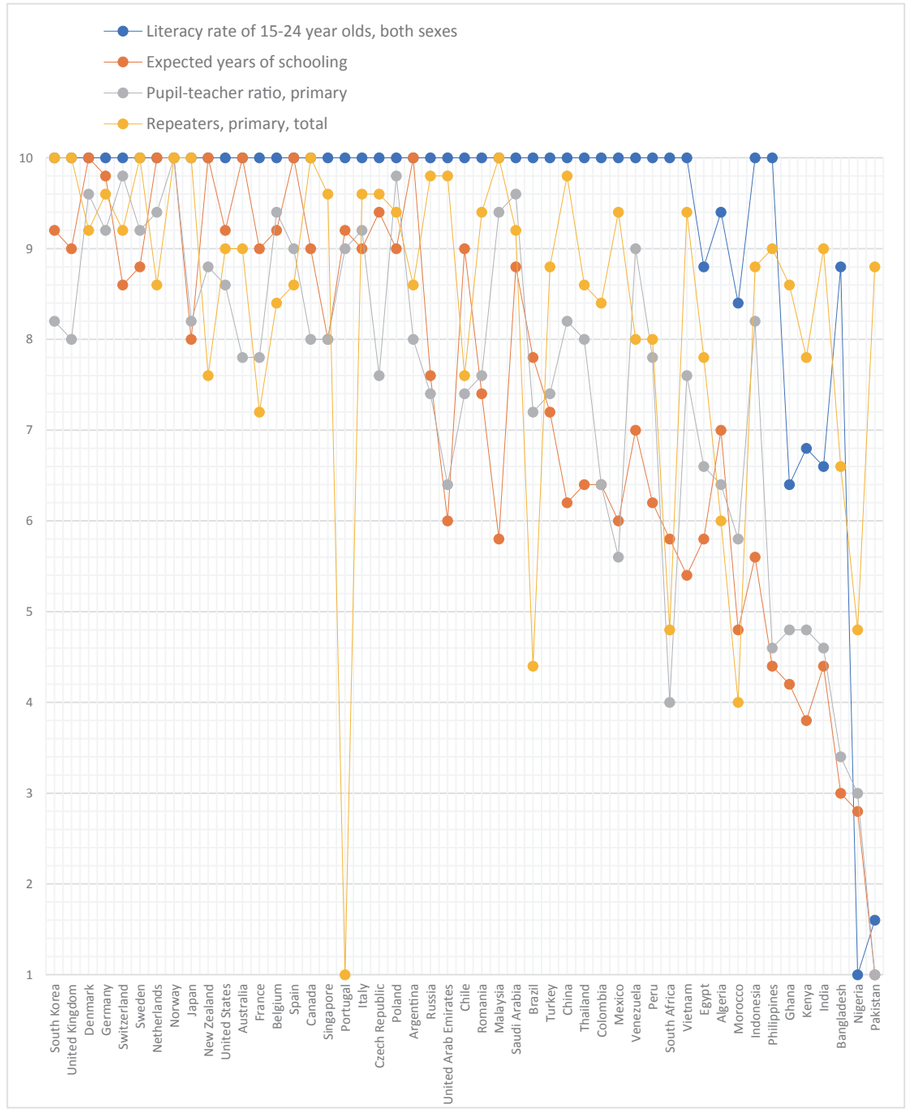
SDG 3 Indicator Scores

Figure 23 SDG 3 Indicators



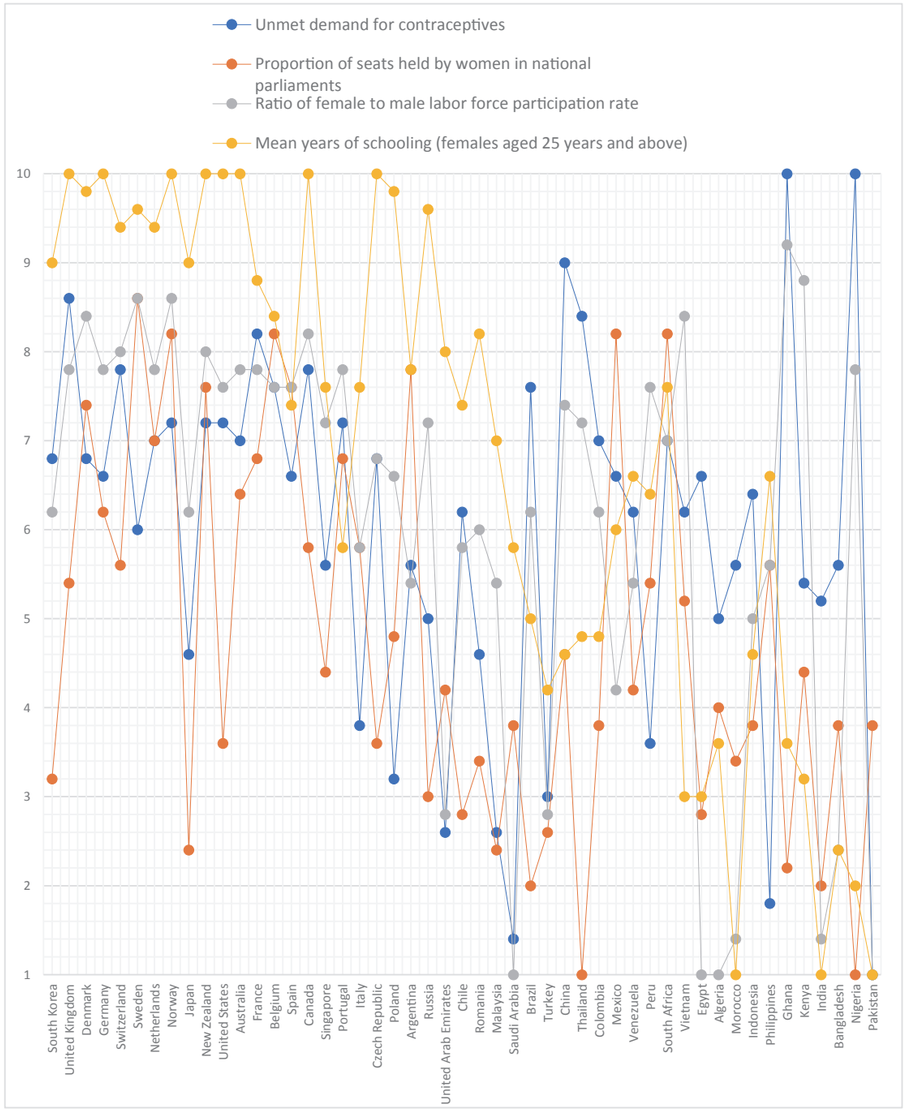
SDG 4 Indicator Scores

Figure 24 SDG 4 Indicators



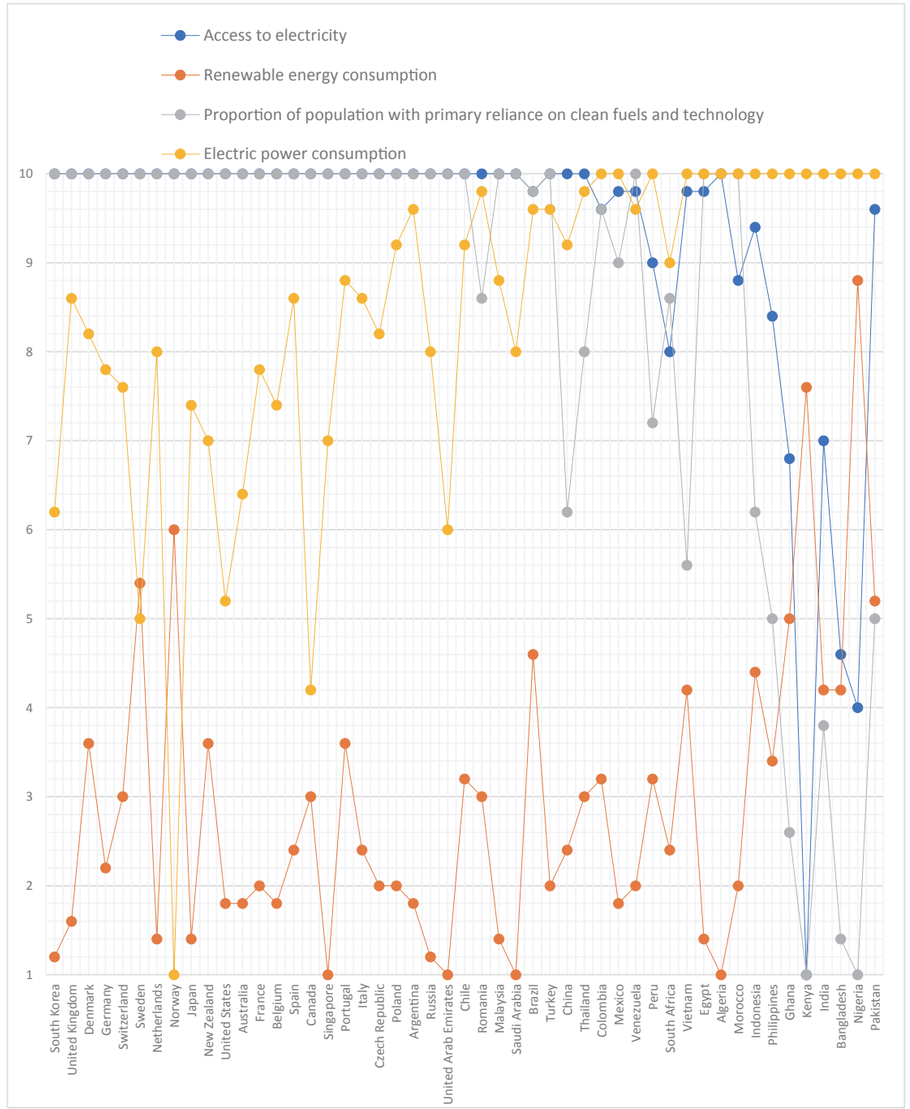
SDG 5 Indicator Scores

Figure 25 SDG 5 Indicators



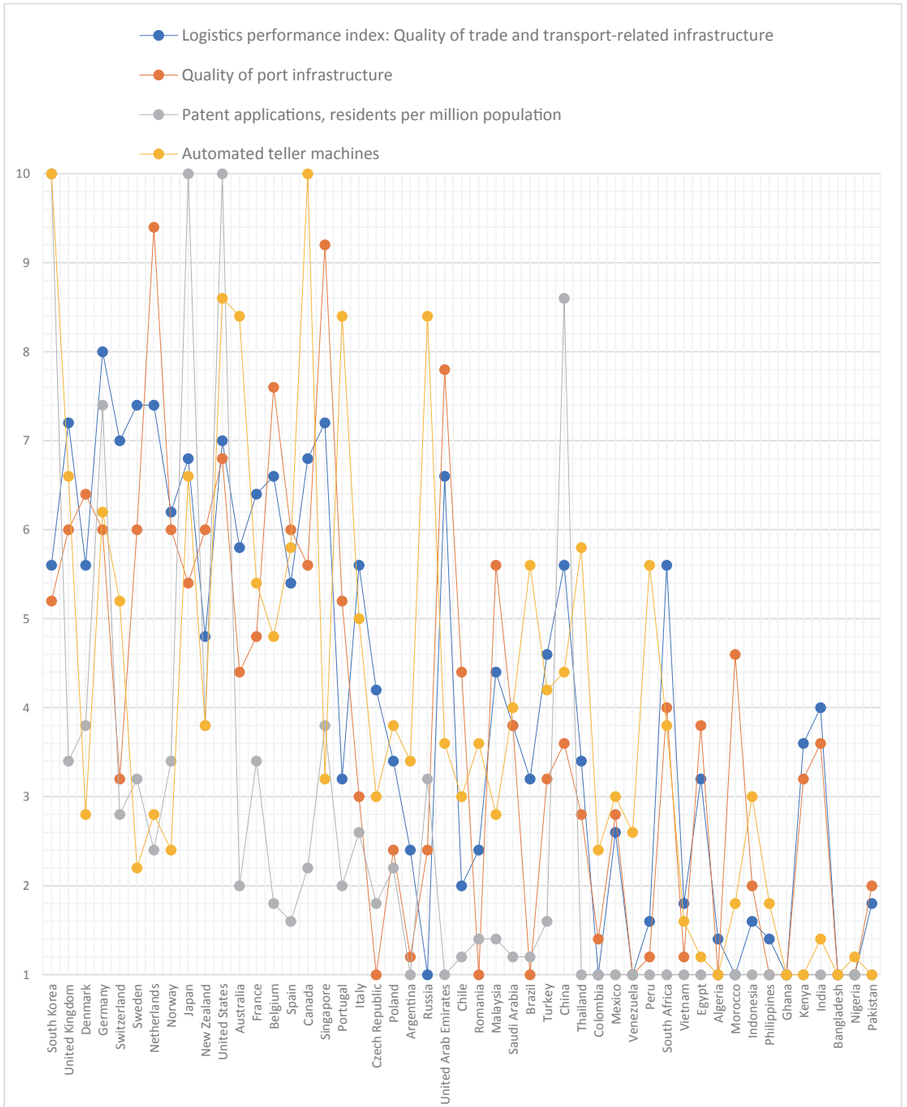
SDG 7 Indicator Scores

Figure 26 SDG 7 Indicators



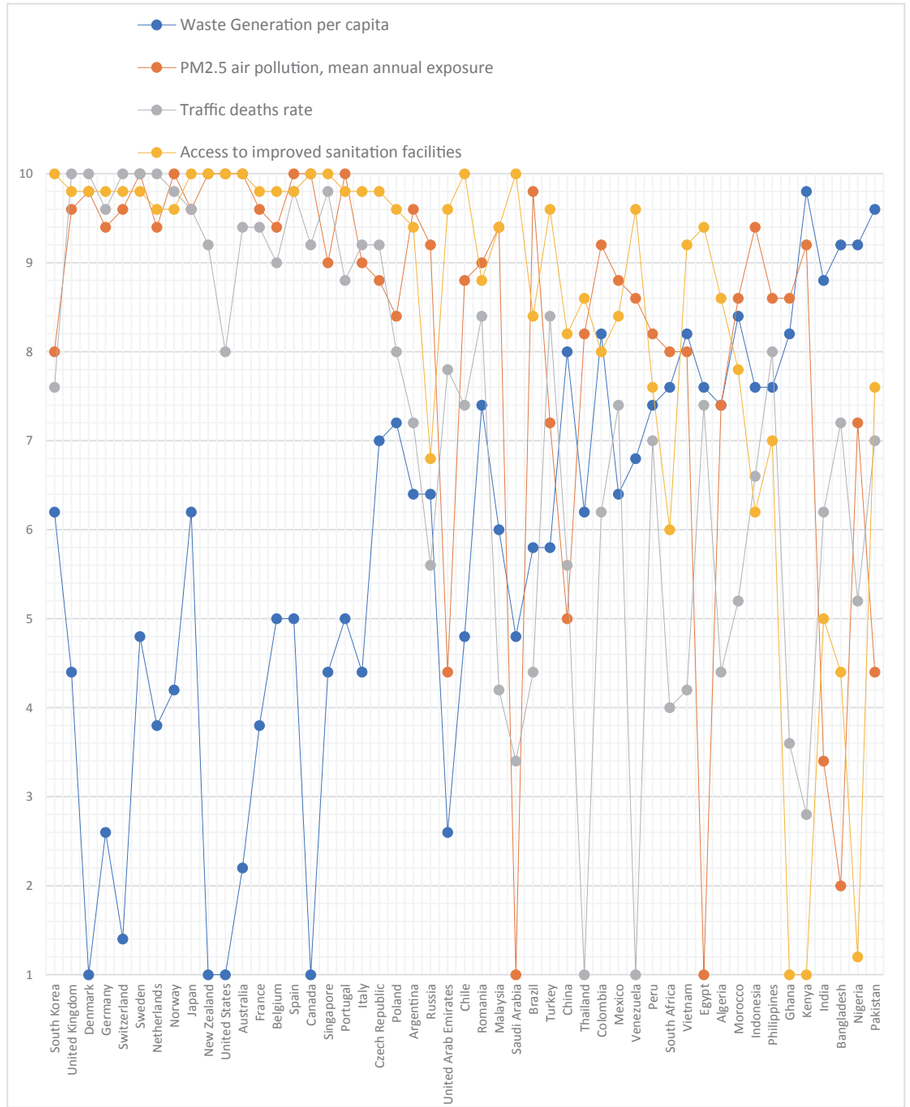
SDG 9 Indicator Scores

Figure 27 SDG 9 Indicators



SDG 11 Indicator Scores

Figure 28 SDG 11 Indicators



The 2018 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 12 years away. It shows that the digital pathway to achieving the SDGs is more rapid than business as normal.
