Enabling the Global Goals

Evidence of digital solutions' impact on achieving the Sustainable Development Goals (SDGs)

GeSI ENABLING DIGITAL SUSTAINABILITY

accenturestrategy

"GeSI is fully committed to steering the impact of digital solutions on SDG achievement. We will work with our members and partners to scale the positive impacts, flip the negative impacts and innovate for all SDGs."

James Gowen,
Chairman,
Global e-Sustainability Initiative (GeSI)

Contents

The purpose of this report

The UN Sustainable Development Goals (SDGs) represent the most ambitious global agenda ever formalized for the social, economic and environmental improvement of the world. If the SDGs become reality, the world will be transformed for good by 2030: no poverty, no hunger, gender equality, economic growth decoupled from environmental resource degradation – while ensuring no one is left behind.

Digital solutions, such as virtual learning and working, smart agriculture and e-health, are currently transforming the world and how people live. They can be a unique catalyst for the transformations needed to achieve the SDGs. The digital transformation is happening at unprecedented speed, reaching people nearly everywhere and in every income bracket, providing people-centric solutions and new business models that enable wealth and prosperity.

The purpose of this report is threefold:

- **Share fresh insights** about how digital solutions are already impacting the SDGs
- **Inform steering of digital industry action** on SDG achievement
- **Define an evidence-based and credible methodology** for measuring the digital industry's impact on the SDGs[1]

Building on our deep understanding of digital's impact potential

This report builds on GeSI's extensive work on quantifying the sustainability benefits of digitalization. GeSI's "#SMARTer"[2] series provided compelling data on digital solutions' potential to substantially reduce global CO_2 emissions. In 2016, GeSI made the SDGs its guiding framework for action, and published the "#SystemTransformation" report[3], which demonstrated that digital solutions can drive progress on achieving all 17 SDGs and deliver strong positive social, economic and environmental impacts, including

– saving 720,000 lives and preventing 30 million injuries on the world's roads (SDG 3)

– protecting 12% of GDP in developing countries and USD 9 trillion in enabled revenues and cost savings (SDG 8)

– reducing global CO_2 emissions by 20% and decoupling growth from oil consumption (SDG 13)

By fostering responsibility and engaging with stakeholders, GeSI and its members aim to unleash the full positive impact potential of digital solutions.

HIGHLIGHTS

Positive
65 % (11 SDGs)

Negative
6% (1 SDG)

?
Unclear
29 % (5 SDGs)

01

There is a strong and positive link between digital access and SDG achievement.

This report shares new, compelling evidence that the digital industry is positively linked to achieving most of the 17 UN Sustainable Development Goals (SDGs). For 65% of SDGs, there is a clear positive correlation with digital access at every level of analysis, across the world. Only 1 negative link – between digital access and the environmental SDG 12 – is apparent.

02

GeSI's new Digital Access Index allows the digital industry to track its contribution to the SDGs.

Debuting in this report, GeSI's new Digital Access Index is part of a robust methodology for measuring the digital industry's contribution to SDG achievement. The index is unique because it includes indicators relevant to the entire digital industry, and considers cross-cutting technologies and digital solutions.

03

Early indications suggest that causal relationships may exist between digital access and the SDGs.

This report goes well beyond observing a coincidental link between digital access and SDG achievement, and gets closer to causation. That's important because it allows for more confident estimates of the quantitative impact of digital access on SDG achievement, as the figures below demonstrate. Furthermore, it creates a solid foundation of evidence that can inform action.

+ 5 %
Digital access

would lead to

- 7.4%
neonatal mortality per 1,000 live births

=

+ 2
babies saved for every 1,000 live births in Least Developed Countries

+ 0.5%
years of schooling for girls and women compared to boys and men

=

+ 2
weeks of schooling for each female learner, globally

- 1.6%
consumption-based CO_2 emissions ($MtCO_2$)

=

~450
coal plants shut off

04

The digital industry needs to act in three ways: scale, flip and innovate.

This report suggests three action areas for the digital industry:

- **scale the positive impacts**
- **flip the negative impacts**
- **innovate for all SDGs**

GeSI is committed to working with its members and the wider digital industry to steer and maximize digital's positive impact.

01

A strong and positive link

This report shares new, compelling evidence that the digital industry is positively linked to achieving most of the 17 UN Sustainable Development Goals (SDGs). For 65 % of SDGs, there is a clear positive correlation with digital access across all levels of analysis. Only 1 negative link – between digital access and the environmental SDG 12 – is apparent.

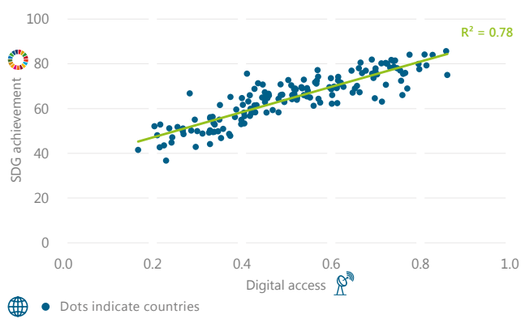
Overall results: strong positive link

Our research finds a strong and positive link between digital access and SDG achievement (see Exhibit 1). This means that an increase in digital access, such as more people and devices connected or higher network coverage (see Chapter 2), is linked with an increase in SDG achievement. With a coefficient of determination (R^2) of 0.78, this link is very strong.

These results are based on the most comprehensive correlation analysis of digital access and SDG achievement performed to date: data from 157 countries, on 81 SDG achievement indicators and 21 digital access indicators.

Strong positive link between digital access and SDGs

Exhibit 1: Correlation between the GeSI Digital Access Index and the SDSN SDG Index across 157 countries



Positive relationship dominant across all levels of analysis

The positive link between digital access and SDG achievement is dominant across every level of analysis (as Exhibit 2 illustrates):

- The SDG view: all levels of SDG achievement are mostly positively correlated with digital access across the world – at the index level, the level of the 17 SDGs and for the 81 individual SDG indicators analyzed
- The digital access view: all levels of digital access are mostly positively correlated with SDG achievement across the world – at the index level, the 4 Digital Access Index categories and the 21 individual digital access indicators analyzed
- The geographical view: the positive link holds true for all 3 development levels and 4 regions

Positive link dominant across perspectives and levels of analysis

Exhibit 2: Relationship patterns across perspectives and levels of analysis

How to interpret the correlation graphs

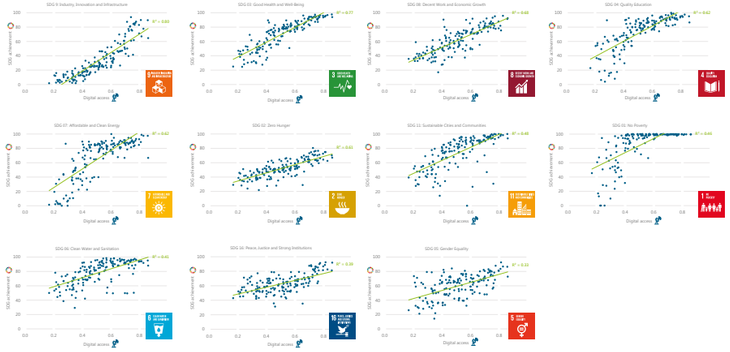
- The x-axis shows digital access as measured by GeSI's new Digital Access Index (DAI). The unique characteristics of the DAI are explained in Chapter 2 of this report and further details are provided in the methodological appendix.
- The y-axis illustrates SDG achievement measured by the SDG Index of the UN Sustainable Development Solutions Network (SDSN) and the Bertelsmann Foundation (hereafter referred to as the SDG or SDSN Index). More information about the SDG Index is provided in the methodological appendix.
- The correlation analysis uses DAI and SDG achievement data across 157 countries, represented by the dots on the correlation graphs.

For more detailed information about the methodology of the correlation analysis, please refer to the methodological appendix.

65% of SDGs with a positive link to digital access

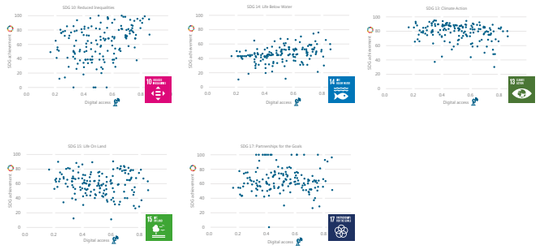
Exhibit 3: Correlations of GeSI's Digital Access Index with SDG Index for all 17 SDGs and 157 countries

Positive
65%
(11 SDGs)



Negative
6%
(1 SDG)

Unclear
29%
(5 SDGs)



Context:
The UN Sustainable Development Goals (SDGs)

The SDGs are 17 global goals for transforming the world for good in all impact areas of sustainability:

– **Social SDGs** – **improving people's quality of life,** with enough to eat (SDG 2), in good health (SDG 3), and with an open and trained mind (SDG 4), flourishing in a world without violence (SDG 16)

– **Economic SDGs – fostering equitable growth,** with no poverty (SDG 1), gender equality (SDG 5), a highly productive economy and employment (SDG 8), innovative infrastructure and environmentally-friendly industrialization (SDG 9), while leaving no one behind (SDG 10)

– **Environmental SDGs – protecting the environment,** ensuring that the other goals are achieved without destroying the planet's ability to regenerate for future generations, with fresh water supply (SDG 6), cleaner energy for everyone (SDG 7), better-functioning and cleaner cities (SDG 11), resource efficiency (SDG 12), combatting and adapting to climate change (SDG 13), as well as the need to protect aquatic and terrestrial ecosystems (SDG 14 and SDG 15)

Cross-cutting SDG 17 is about enabling the transformation needed to achieve all other goals, including digital technologies.

The SDG view: 65% positively linked to digital access

On the SDG level of analysis, 3 patterns of relationship between digital access and SDG achievement appear:

– 11 of 17 SDGs (65%) have a positive link with digital access

– 1 SDG (SDG 12) has a negative correlation with digital access (explored in the section about negative environmental aspects below)

– 5 SDGs have a yet unclear relationship to digital access

Strongest positive link with social and economic SDGs

Social SDGs that improve people's quality of life and economic SDGs that foster equitable growth have the strongest positive link with digital access (refer to Exhibit 4). This reflects the people-centric nature of digital technologies and their potential to increase participation and create new business models that drive new wealth and prosperity.[4]

The 3 SDGs with the strongest correlations are

– SDG 9 (industry, innovation and infrastructure): Logically, digital access has the highest correlation with the SDG that includes digital infrastructure indicators, such as internet use and mobile broadband subscriptions. It also positively correlates with the quality of infrastructure in general

– SDG 3 (health and well-being): 4 of the 10 most strongly correlated indicators with digital access come from SDG 3, with healthy life expectancy at birth and neo-natal mortality reduction being the strongest

– SDG 8 (decent work and economic growth): There is a very strong correlation between digital access and providing access to bank accounts (the third-strongest correlated indicator of all SDG indicators), which enables more economic participation. The analysis also finds that digital has a positive link with reducing child labor, an observation that could be further analyzed in the future.

Digital's strong positive relationships with social and economic SDGs; a mixed picture for environmental SDGs

Exhibit 4: Correlations for SDG impact areas of GeSI's Digital Access Index with SDG achievement globally (157 countries)

SDG impact area	Strength of relationship (R^2) with Digital Access Index (DAI)	SDG correlations with DAI (n=17)	Indicator correlations with DAI (n=81)
Social SDGs: Improving peoples's quality of life (2 Zero Hunger; 3 Good Health and Well-Being; 4 Quality Education; 16 Peace, Justice and Strong Institutions)	0.83	↗ 4 ↘ 0 ? 0	↗ 20 ↘ 1 ? 0
Economic SDGs: Fostering equitable growth (1 No Poverty; 5 Gender Equality; 8 Decent Work and Economic Growth; 9 Industry, Innovation and Infrastructure; 10 Reduced Inequalities)	0.79	↗ 4 ↘ 0 ? 1	↗ 13 ↘ 0 ? 11
Environmental SDGs: Protecting the environment (6 Clean Water and Sanitation; 7 Affordable and Clean Energy; 11 Sustainable Cities and Communities; 12 Responsible Consumption and Production; 13 Climate Action; 14 Life Below Water; 15 Life on Land)	0.37	↗ 3 ↘ 1 ? 3	↗ 6 ↘ 7 ? 16

↗ positive ↘ negative ? unclear

A mixed picture for environmental SDGs

For environmental SDGs, our analysis identifies 8 negative relationships, mostly related to environmental impacts (also compare Exhibit 4).

– The only SDG that has a negative link with digital access is SDG 12 on responsible consumption and production, which – among other things – promotes the efficient use of natural resources and waste reduction

– Of the 8 SDG indicators with negative links to digital access, 7 are about the environment, with e-waste generated (SDG 12) having the strongest negative link. There is also a negative correlation with CO_2 emissions from energy (SDG 13 on climate change), however, when we look at the impact of digital access on overall CO_2 emissions – not just energy – and remove other effects like GDP, this report finds a net positive impact (see Chapter 3)

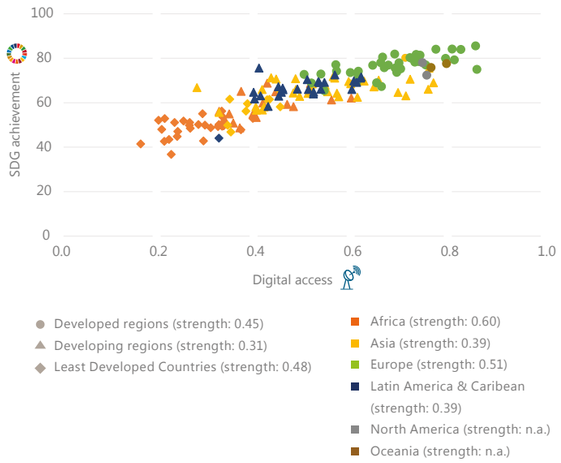
– The only non-environmental indicator with a negative link to digital access is about adult obesity

"We fully support this project that looks closely at how to achieve the UN's SDGs. Taiwan Mobile has just announced its Sustainability Vision 2030 Blueprint – a strategic map for establishing a clear consensus about sustainability KPIs at every level of the company. As an ICT company, we must not be absent from global sustainable development for a better future."

James Jeng,
President, Taiwan Mobile

The geographical view: positive links everywhere, strongest in Africa

Exhibit 5: Correlation between GeSI's Digital Access Index and SDG Index in 157 countries across development levels and regions, with strengths in brackets



The geographical view: Africa with the strongest link

The overall positive relationship between digital access and SDG achievement holds true for countries from all development levels (developed regions, developing regions and Least Developed Countries)[5] and all regions (Africa, Asia, Europe, Latin America and the Caribbean, North America and Oceania)[6] (see Exhibit 5).

Interestingly, the link between digital access and SDG achievement is strongest in Africa (with an R^2 of 0.60).

The digital access view: Connectivity use, infrastructure and technologies with a stronger link than affordability

Three sub-categories of GeSI's Digital Access Index (DAI) – described in the next chapter – have a very strong and positive relationship with SDG achievement (see Exhibit 6):

– Use of connectivity
– Technologies
– Infrastructure for connectivity

The link between affordability and SDG achievement appears to be weak, also across all geographic levels. This result does not necessarily demonstrate that affordability is irrelevant, but that the actual use and quality of connectivity infrastructure and technologies, such as social media, are more directly linked to SDG achievement. In Least Developed Countries, mobile-related indicators[7] are most strongly linked with SDG achievement, demonstrating the relevance of mobile penetration in environments with less resources.

Strong positive links of connectivity use, technologies and infrastructure with SDG achievement

Exhibit 6: Categories of GeSI's Digital Access Index (DAI) correlated with the SDG index on a global level

DAI category correlated with SDG index	Strength of relationship (R^2)	Relationship
Use (Connectivity)	0.74	↗
Technologies	0.71	↗
Infrastructure (Connectivity)	0.70	↗
Affordability (Connectivity)	0.24	?

↗ positive ↘ negative ? unclear

IoT's (mostly) positive links to SDG achievement

Exhibit 7: Correlation of DAI indicator "cellular M2M connections" with selected SDG indicators

Selected correlation results with SDG indicators	Strength of relationship (R^2)	Relationship
Infrastructure quality	0.61	↗
e-waste generated	0.59	↘
Wastewater treated	0.53	↗
Traffic deaths	0.35	↗
Cereal yield	0.30	↗

↗ positive ↘ negative ? unclear

Evidence of connected people's and IoT's positive links with SDG achievement

Connecting people is a core element of harnessing the power of digital access for SDG achievement. "Individuals using the internet" and "number of secure servers" are the two indicators most strongly and positively correlated with SDG achievement. This reflects the expected relevance of people actually accessing and using the internet to benefit from secure digital solutions.

The increasing relevance of intelligent machines and the rise of the Internet of Things (IoT) makes the indicator "cellular machine-to-machine (M2M) connections" particularly interesting. Our analysis reveals that M2M connections already have several positive and one negative correlation with SDG indicators (see Exhibit 7).

M2M connections are most strongly correlated with infrastructure quality (SDG 9). But our results also include positive links between connected machines/IoT and specific use cases, such as improving wastewater treatment (SDG 12), reducing traffic deaths (SDG 3) and increasing cereal yield (SDG 2). The negative correlation with e-waste (within SDG 12) is a reminder that increased digital access currently has some negative environmental impacts.

02

GeSI's new Digital Access Index

Debuting in this report, GeSI's new Digital Access Index is part of a robust methodology for measuring the digital industry's contribution to SDG achievement. The index is unique because it includes indicators relevant to the entire digital industry, and considers cross-cutting technologies and digital solutions.

"This report marks an exciting milestone: the launch of GeSI's new Digital Access Index. This is the first index that reflects the entire digital industry, allowing us to track and effectively steer how digital solutions impact SDG achievement."

Luis Neves,
Managing Director,
Global e-Sustainability Initiative (GeSI)

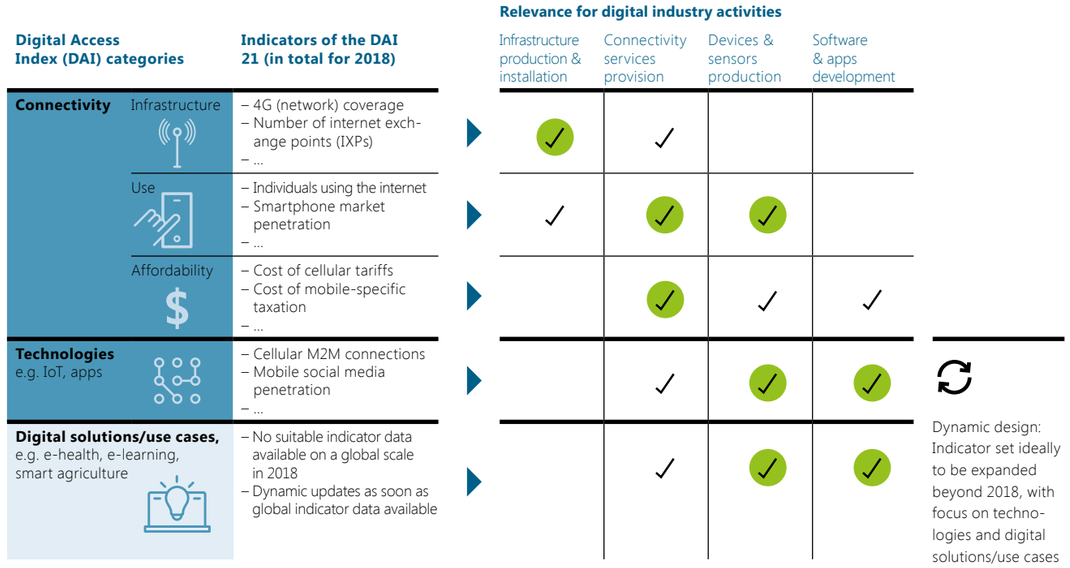
To best reflect digital access and digital industry activity, GeSI has developed the Digital Access Index (DAI). The DAI is unique in combining indicators relevant to the entire digital industry and being solely focused on digital and technology indicators, as opposed to other indices that focus on one aspect of the digital industry or include indicators on SDG impact, like education or economic progress.[8]

The DAI comprises indicators in the following categories (see Exhibit 8):

– Connectivity, divided into 3 sub-categories:
  - Infrastructure, with indicators such as 4G network coverage and number of internet exchange points
  - Use, with indicators such as fixed- and mobile broadband subscriptions and smartphone market penetration
  - Affordability, with indicators such as cost of cellular tariffs or cost of mobile-specific taxation

GeSI's new Digital Access Index – accurately reflecting digital industry activity

Exhibit 8: Overview of GeSI's Digital Access Index



– Technologies, with indicators such as cellular M2M connections or social media penetration

– Digital solutions and use cases – for example, e-health or e-learning; these will be included in the index as soon as global data becomes available about their spread and use

The index is dynamic and depends on globally available data. In 2018, the DAI comprises 21 indicators, but GeSI plans to update the index regularly to account for new data and industry developments. GeSI is particularly interested in updating and expanding the indicator set with a focus on technologies (IoT, 5G or 3D printing, for example) and emerging data on digital solutions and use cases, reflecting the full breadth of the digital industry's innovations.

The DAI is here to provide a relevant and reliable foundation of evidence to inform the digital industry's activities towards SDG achievement. If, for example, cellular M2M connections are key to achieving a certain SDG, this is particularly relevant to device and sensor production, as well as software and apps development.

03

Early indications of causation

This report goes well beyond observing a coincidental link between digital access and SDG achievement and gets closer to causation. That's important because it allows for more confident estimates of the quantitative impact of digital access on SDG achievement, as the figures in this chapter demonstrate. Furthermore, it creates a solid foundation of evidence that can inform action.

Why causation matters

Correlation analyses have a major limitation: even if we discover that two things are linked, this could be coincidental. Is digital access impacting SDG achievement, or is it actually the other way around? This is the classic "chicken and egg" problem. Only by proving causal – or close-to-causal[9] – relationships can we get a clearer picture of what aspects are causing others. This certainty provides a reliable foundation of evidence upon which action can be taken. In order to prove a close-to-causal relationship, different tests need to be applied, including checking consistency of data and consulting other related research. For more information, please refer to the methodological appendix.

More than a coincidental link

This report's global correlation analysis across all SDGs establishes more than a coincidental link between digital access and SDG achievement. Its large set of data, with consistent results over different levels of analysis, makes it more robust than, for example, correlations with smaller data samples. Additionally, our findings have been confirmed by outside research. However, the results are still far away from causality. More research is needed across all SDGs.

How significant is the impact?

Getting closer to causality increases certainty that digital access impacts SDG achievement. But how significant is the impact? Digital access is only one of several variables influencing SDG achievement. By analyzing digital access together with these other variables using multivariate regressions, a better prediction about the quantitative impact on certain SDG indicators can be made.

We now take a closer look at 3 SDGs – SDG 3 (good health and well-being), SDG 5 (gender equality) and SDG 13 (climate change). For each of these SDGs, we explore the correlation results, investigate other research to get closer to causation, and then run a multivariate regression analysis to identify the impact that an increase in digital access can have on SDG achievement compared to other variables. We selected these SDGs to provide a balanced view of the 3 impact areas, and for the following reasons: SDG 3 is the social SDG with the highest correlation with digital access. For SDG 5, there is already evidence of a close-to-causal relationship between digital access and economic participation. SDG 13, with a focus on CO_2 emissions, is highly relevant to the digital industry and global environmental protection.

"We simultaneously choose 'purpose, people and profit' and reject the idea that we have to choose one over the other. This report encourages us in this ambition: it demonstrates how our solutions deliver substantial and meaningful benefits to people and planet as well as value for our business."

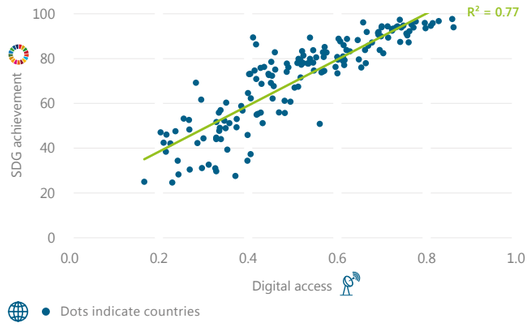
Bob Collymore,
CEO, Safaricom

For more detailed information about the methodology of the correlation, the causation testing, and the multivariate regressions for each of the following SDG deep dives, please refer to the methodological appendix.

SDG 3: Saving lives through e-health

Very strong positive relationship of digital access with SDG 3 on good health and well-being

Exhibit 9: Correlation between Digital Access Index and SDG 3



SDG 3 on health and well-being is the SDG with the second-strongest positive correlation with the GeSI Digital Access Index of all SDGs.

It includes targets to reduce maternal mortality rates (target 3.1), end deaths of children (target 3.2), achieve universal health coverage (target 3.8), foster a better-trained health workforce (target 3.c), reduce lifestyle diseases like diabetes (target 3.4) and halve deaths from road accidents (target 3.6).

SDSN measures progress towards SDG 3 achievement through 14 indicators on a global level. The detailed correlation results for 4 indicators are displayed in the table below.[10]

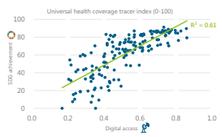
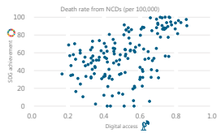
Multiple strong and positive relationships between digital access and SDG 3 indicators on good health and well-being

Exhibit 10: Selected SDG 3 indicator-level SDG achievement status and correlation results with digital access

↗ 9 ↘ 0 ? 5

Relationship patterns of SDG 3 indicators with Digital Access Index

3 GOOD HEALTH AND WELL-BEING

SDG 3 indicator	SDG achievement status highlights	Strength of relationship (R^2)	Relation-ship	Correlation scatterplot
Neonatal mortality (per 1,000 live births)	– Globally, 13 out of 1,000 newborn babies die before reaching 28 days of age – In Least Developed Countries, as many as 28 out of 1,000 newborn babies die before reaching 28 days of age, a rate over 9 times as high as in developed regions (3/1,000)	0.72	↗	
Traffic deaths (per 100,000)	– Globally, 17 out of 100,000 people die in a fatal traffic accident – In developed regions, the rate (7/100,000) is less than a third of the traffic death rate in Least Developed Countries (25/100,000)	0.62	↗	
Universal health coverage tracer index (0-100)	– Globally, the average score of the universal health coverage tracer index is 75/100 points – Developed regions reach a universal health coverage tracer index score of 87/100, 20 points higher than in Least Developed Countries and 10 points higher than in developing regions	0.61	↗	
Other positively correlated indicators (6) – Healthy life expectancy at birth (years) – Under-5 mortality (per 1,000 live births) – Subjective well-being (0-10) – Adolescent fertility (births per 1,000) – Maternal mortality (per 100,000 live births) – Births attended by skilled health personnel (%)		0.5 – 0.75	↗	
Death rate from NCDs (per 100,000)	– Globally, 18 out of 100,000 people die from noncommunicable diseases (NCDs) such as diabetes – The largest difference in NCDs death rate (alpha of 5/100,000) lies between developed regions (16/100,000) and Least Developed Countries (21/100,000)	0.24	?	
Other indicators with unclear correlation (4) – Incidence of tuberculosis (per 100,000) – Infants who receive 2 WHO-recommended vaccines (min % of DTP) – Death rate from household and ambient pollution (per 100,000) – HIV incidence (per 1,000)		0.07 – 0.29	?	

↗ positive ↘ negative ? unclear

Concrete digital solution beyond connectivity

E-health is the most powerful digital solution beyond connectivity that contributes to the achievement of SDG 3. It puts the doctor in patients' pockets, for example, through remote diagnostics or providing access to healthcare information from anywhere, anytime. E-health solutions also encompass electronic health data storage, big data health analytics, personalized medicine and artificial intelligence (AI). E-health hardware include sensors, wearables and user devices, e.g. to display augmented reality.

Currently, there is no indicator that tracks the adoption of e-health solutions that could be included in GeSI's Digital Access Index, beyond the connectivity, use and technologies aspects already considered.

5% increase in digital access = 2 babies saved for every 1,000 life births in Least Developed Countries

Exhibit 11: Impact potential of digital access (as per GeSI's Digital Access Index) on neonatal mortality per 1,000 live births[13]

Getting closer to causation

The consistency of positive correlations of digital access with several health effects are a first signal towards causality. Reviewing the research on digital access we find supporting evidence for digital's positive health impact, especially for e-health solutions that provide remote diagnostics and digital access to health information. This is powerfully illustrated by the reduction in neonatal mortality that can be enabled by digital access.

For wearables, such as fitness trackers, however, the research reviewed comes to an ambiguous result.

Quantifying the digital impact: 2 babies saved

Digital access, particularly health information and remote diagnostics, can help reduce deaths of babies in their first 28 days. Running a multivariate regression analysis[11], our research finds that a 5% increase in digital access would lead to a 7.4% decrease in neonatal mortality. This translates into a global average of 1 newborn life saved for every 1,000 live births. In the Least Developed Countries, 2 newborn babies for every 1,000 live births[12] would be saved, reducing neonatal mortality from 28 to 26 (per 1,000 live births). Of all variables analyzed, digital access (measured by the DAI) is the most relevant variable for predicting neonatal mortality. Other factors significantly influencing whether newborn babies survive their first 28 days are the share of the population with health coverage, the share of the population with access to improved sanitation facilities, GDP per capita and the density of medical professionals in the population.[14] Their impact share is removed when quantifying the impact potential of the DAI.

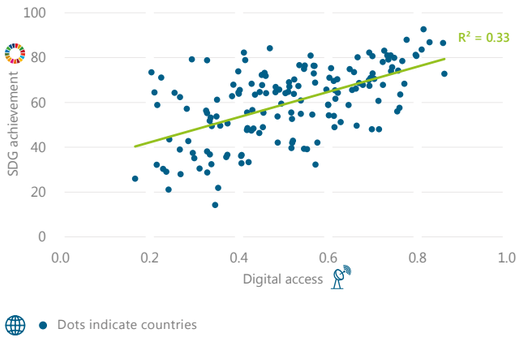
Ranking of the most important variables impacting neonatal mortality (per 1,000 live births) in model

1. Digital Access Index (DAI)
   – Most important indicators:
   - Individuals using the internet
   - Smartphone market penetration
   - Mobile social media penetration
2. Universal health coverage tracer index
3. Improved sanitation facilities per % of population
4. GDP per capita
5. Number of physicians, nurses and midwives per 1,000 people

SDG 5: Closing the gender gap through digital fluency

Positive relationship of digital access with SDG 5 on gender equality

Exhibit 12: Correlation between Digital Access Index and SDG 5



SDG 5 on gender equality has a clear, positive correlation with GeSI's Digital Access Index (DAI).

SDG 5 includes targets to ensure women's full and effective participation and equal opportunities for leadership (target 5.5), universal access to sexual and reproductive health and rights (target 5.6), equal rights to economic resources and property (target 5.a) and promote the use of enabling technology, in particular Information and Communications Technologies (target 5.b).

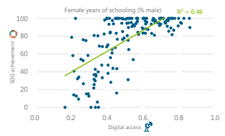
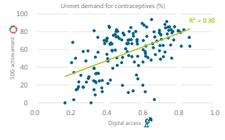
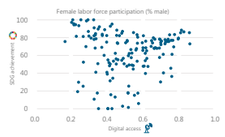
The SDG 5 indicators and achievement status

SDSN measures progress towards SDG 5 achievement through 4 indicators on a global level.
The correlation results these indicators are displayed in the table below.[15]

Positive and unclear links between digital access and SDG 5 indicators on gender equality

Exhibit 13: SDG 5 indicator-level SDG achievement status and correlation results with digital access

↗ 2 ↘ 0 ? 2 — Relationship patterns of SDG 5 indicators with Digital Access Index

SDG 5 indicator	SDG achievement status highlights	Strength of relationship (R^2)	Relationship	Correlation scatterplot
Female years of schooling (% male)	– Globally, the years of schooling that female students receive are only 87% of the years of schooling that males receive – In a Least Developed Country, a female student can expect to receive only 60% of the years of schooling her male peers obtain	0.46	↗	
Unmet demand for contraceptives (%)	– Globally, 2 out of 5 women between 15 and 49 who are either married or in a union find their demand for contraceptives unmet – In Least Developed Countries, <50% of women between the ages of 15 and 49 who are married or in a union find their demand for contraceptives unmet	0.30	↗	
Women in national parliaments (%)	– Globally, only 1 out of 5 parliamentary seats are occupied by women – In developed countries, 1 out of 4 parliamentary seats are occupied by women	0.03	?	
Female labor force participation (% male)	– Globally, female labor force participation is 30% below male participation – In developing countries, only 6 women participate in the labor force for every 10 men (participation 62% of male)	0.01	?	

↗ positive ↘ negative ? unclear

Concrete digital solutions beyond connectivity

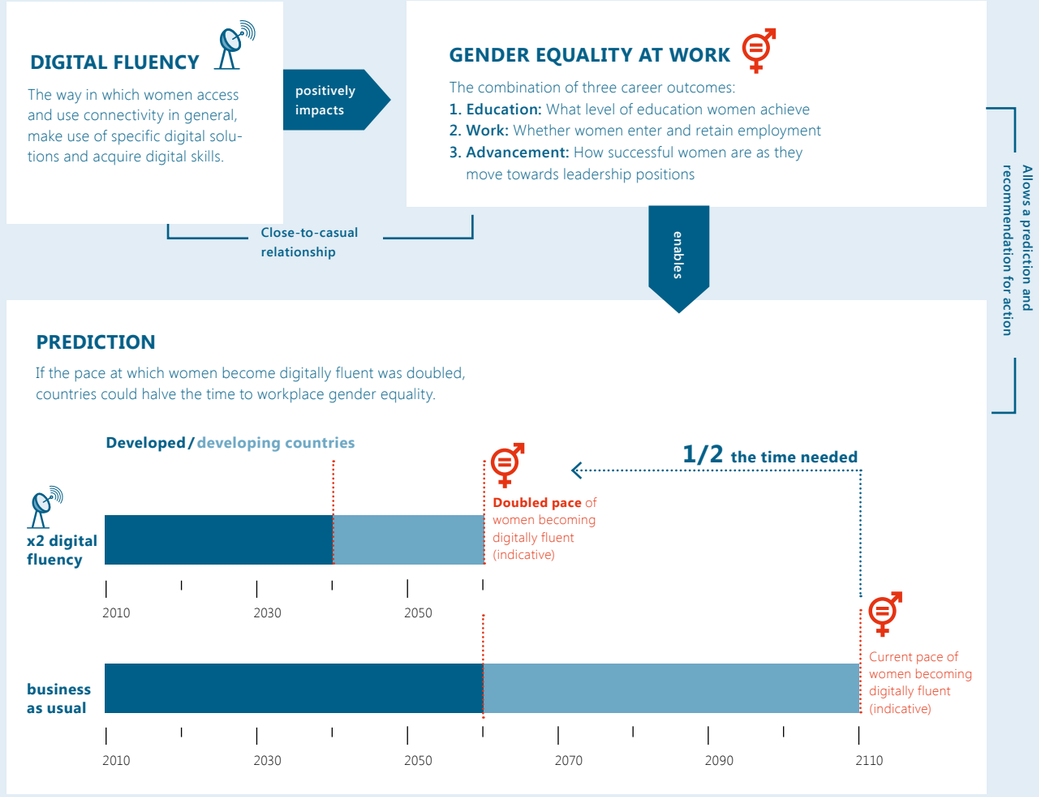
There is no gender-specific digital solution for improving gender equality. It is connectivity and technologies – and the way women use them – that shape how digital can help to learn, search for employment or develop relevant digital skills. This ability to use connectivity and technologies is referred to as "digital fluency" in Accenture's 2016 "Getting to Equal" study, which unveils a close-to-causal relationship between digital and SDG achievement.

Getting closer to causation

For SDG 5, research has identified a close-to-causal link between digital access and SDG achievement: the "Getting to Equal" study has run rigorous analyses providing evidence that digital fluency, the ability to access and use connectivity, positively impacts gender equality in the workplace[16] (Refer to the description in the exhibit below).

Digital fluency could halve the time needed to get to gender equality in the workplace

Exhibit 14: Overview of digital fluency driving gender equality in the workplace



Digital fluency positively impacts gender equality in the workplace

In its "Getting to Equal" study, GeSI member Accenture finds evidence of a close-to-causal[17] link between more digital fluency and a positive impact on gender equality at work. Digital fluency measures how women can access and use connectivity. It analyzes indicators such as the percentage of women using the internet, how women make use of specific digital solutions, such as e-banking, and how they acquire digital skills.[18] The study surveyed more than 4,900 people across 31 countries and 3 generations. For more information about the research, please refer to the methodological appendix.

The results show that digital fluency positively impacts three areas: the levels of education women achieve, whether women enter and retain employment and how successful women are as they move towards leadership positions.

Because an increase in digital access has a close-to-causal relationship to higher gender equality in the workplace, this provides a sound basis to suggest action: If businesses and governments were to double the speed at which women become digitally fluent, workplace gender equality could be reached in developed regions by 2040, and in developing regions by 2060.[19]

Quantifying the digital impact: 2 more weeks of schooling for girls and women

Digital access can help close the education duration gap between female learners and their male peers. Running a multivariate regression analysis[20] our research finds that a 5% increase in digital access would result in a 0.5% increase in years of schooling for girls and women compared to boys and men. This would mean that, on average, every female learner would receive 2 additional weeks (14.5 days) of schooling[21].

From the multiple variables analyzed, digital access (measured by the DAI) is the third-most relevant variable to explain changes in years of schooling for girls and women. Two other variables – female pupils in secondary education and the share of population with improved sanitation facilities – have a higher explanatory power than the DAI. Behind the DAI, the pre-primary school enrollment of girls is the fourth-most relevant variable[23]. The impact share of the non-digital variables is removed when quantifying the impact potential of the DAI.

Ranking of the most important variables impacting female years of schooling (% male) in model

1.Share of females in secondary education
2. Improved sanitation facilities per share of population
3. Digital Access Index - Most important indicators: – Individuals using the internet – Basic/feature phone + smartphone market penetration – Fixed telephone subscription
4. Share of girls in pre-primary school enrollment

Links to other SDGs

Digital access can also positively impact gender equality targets in other SDGs, specifically SDGs 4 and 10[24]:

Target 4.1: free, equitable and quality primary and secondary school education for all girls and boys
Target 4.3: equal access to vocational and tertiary education for all women and men
Target 4.4: substantially increase number of youth and adults with relevant skills
Target 4.5: eliminate gender disparities in education

Target 10.2: empower and promote inclusion of all irrespective of sex and other aspects

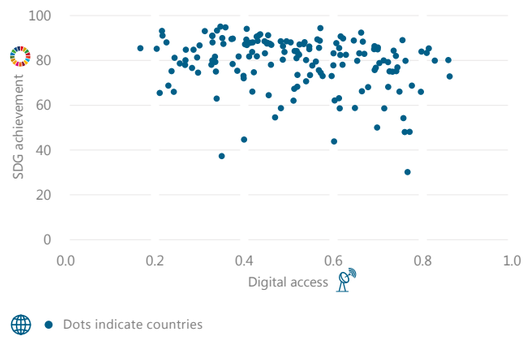
5% increase in digital access = two more weeks of schooling for female learners

Exhibit 15: Impact potential of digital access (as per GeSI's Digital Access Index) on female years of schooling (% male)[22]

SDG 13: Enabling CO_2 emissions savings through digital solutions

Unclear relationship between digital access and SDG 13 on climate change

Exhibit 16: Correlation between Digital Access Index and SDG 13



SDG 13 on climate action has an unclear correlation with GeSI's Digital Access Index (DAI) on an SDG level. To drill down and understand the actual impact of digital solutions on CO_2 emissions reduction, our multivariate regression analysis removed other effects, such as GDP, and could demonstrate a positive impact of digital access on reducing CO_2 emissions.

SDG 13 includes targets to strengthen resilience and adaptation to natural disasters (target 13.1), integrate climate change measures into policy making (target 13.2), improve capabilities on climate change mitigation and adaptation (target 13.3) and promote development aid mechanisms and capacity building for regions most severely affected by climate change (targets 13.a and 13.b).

The SDG 13 indicators and achievement status

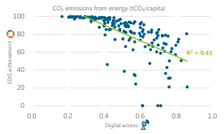
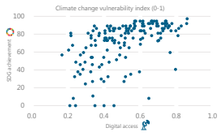
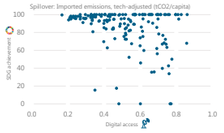
SDSN measures progress towards SDG 13 achievement through 3 indicators on a global level.[25] One indicator has a negative correlation and 2 indicators have an unclear correlation with digital access.

A mixed picture for SDG 13 indicators on climate change

Exhibit 17: SDG 13 indicator-level SDG achievement status and correlation results with digital access

0 ↗ 1 ↘ 2 ?

Relationship patterns of SDG 13 indicators with Digital Access Index

SDG 13 indicator	SDG achievement status highlights	Strength of relationship (R^2)	Relationship	Correlation scatterplot
CO_2 emissions from energy (tCO_2/capita)	– Globally, 4.8 tons of CO_2 per person are caused by energy consumption due to burning of petroleum, natural gas and coal – In developed regions over 20x as many tons of CO_2 per person are caused by energy consumption (7.4 tCO_2/capita) as in Least Developed Countries (0.36 tCO_2/capita)	0.43	↘	
Climate change vulnerability index (0-1)	– Global average climate change vulnerability is scored at 0.11/1 (1 indicating highest vulnerability) regarding weather-related disasters, sea level rise and loss of agricultural productivity – Least Developed Countries' average climate change vulnerability score stands at 0.19/1, almost 4x the score of developed regions	0.28	?	
Spillover: Imported emissions, tech-adjusted (tCO_2/capita)	– Developing regions have negative technology-adjusted CO_2 emission imports per person (-0.48 tCO_2/capita) – In Least Developed Countries, 0.12 t of technology-adjusted CO_2 emissions per person are imported	0.08	?	

↗ positive ↘ negative ? unclear

Concrete digital solutions beyond connectivity

GeSI's "Smarter2030" study identifies twelve digital solutions that have the potential to reduce CO_2 emissions. These include smart agriculture, smart building, smart energy, smart manufacturing and smart mobility, connecting machines and providing intelligent software and apps to capture efficiency gains and enable the transition to a renewables-based economy.

Getting closer to causation

A plethora of research and case studies, like those analyzed and presented in GeSI's "SMARTer2030" or on this report's website, provide evidence of efficiency gains and CO_2 emission reductions due to digital solutions. On the other hand, it is also clear that digital has a CO_2 footprint, for example, emissions from energy consumption. Taking both effects into account – the savings and the emissions – studies estimate a net positive effect for digital solutions on CO_2 emissions reduction.[26]

Quantifying the digital impact: cutting 450 coal plants' worth of CO_2 emissions

Digital access can have a net positive impact on CO_2 emissions reduction. GeSI's multivariate linear regression modelling removes other effects such as GDP and reveals that a 5% increase in digital access would reduce consumption-based CO_2 emissions[27] by 1.6%. This would mean that 530 Megatons ($MtCO_2$) could be avoided globally, equivalent to the annual emissions of 468 coal plants[28] (average plant with 300 Megawatts).

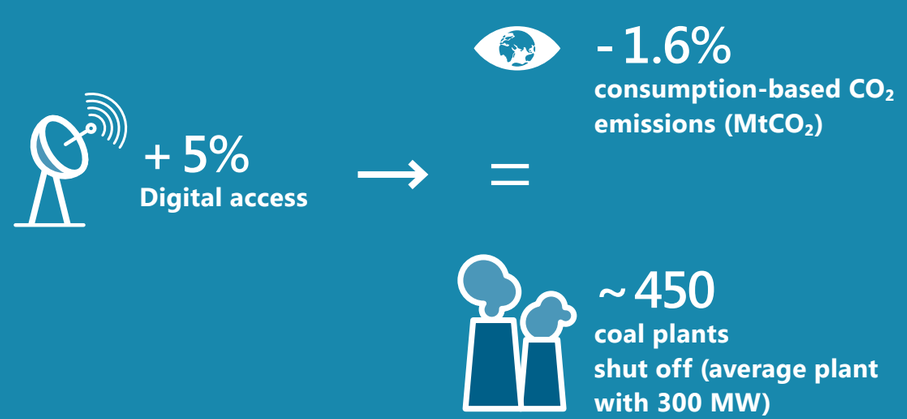
From the variables analyzed, digital access (measured by the DAI) is the fifth-most important variable to explain CO_2 emissions reduction. Four variables are more important: the total population, the share of renewable energy consumed, the total energy usage and the share of GDP caused by industry activity[30]. The impact share of the non-DAI variables on CO_2 emissions is removed when quantifying the impact potential of the DAI.

Ranking of the most important variables impacting consumption-based CO_2 emissions ($MtCO_2$) in model

1. Total population
2. Renewable energy consumption as a share of total energy consumption
3. Energy use per capita
4. Industry share of GDP
5. Digital Access Index - Most important DAI indicators:
   - Individuals using the internet
   - Mobile social media penetration
   - 3G network coverage

5% increase in digital access = CO_2 emissions reduced equivalent to ca. 450 coal plants shut off

Exhibit 18: Impact potential of digital access (as per GeSI's Digital Access Index) on consumption-based CO_2 emissions ($MtCO_2$)[29]

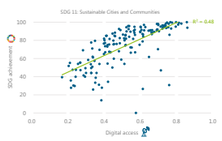


Digital's link with education, work, innovation and cities

In addition to the 3 SDGs analyzed in more detail above, this section looks at the correlation results of SDGs 4 (good education), 8 (decent work and economic growth), 9 (industry, innovation and infrastructure) and 11 (sustainable cities and communities). These SDGs have a high relevance for the digital industry,[31] and could be candidates for future analyses of close-to-causal impact.

Digital links with education, work, innovation and cities

Exhibit 19: Correlation results and digital solution for SDGs 4, 8, 9 and 11

SDG	SDG achievement status highlights	Correlation and strength (R^2)	DAI correlated with indicators	Concrete digital solutions beyond digital access and their benefits
4 QUALITY EDUCATION	– Globally, 90% of adolescents between 15 and 24 years of age can read and write. In Least Developed Countries, only 70% achieve this level of literacy – Globally, every tenth child at primary school age is not enrolled in primary school	 0.62	↗ 3 ↘ 0 ? 0	**e-learning:** e.g., videoconferencing, advanced data analytics, Massive Open Online Courses (MOOC), and gamification > can increase the reach of education and enable better learning outcomes
8 DECENT WORK AND ECONOMIC GROWTH	– Globally, 1 in 10 children between the ages of 11 and 15 years is involved in some form of child labor – Globally, only slightly over half of the adult population has access to a bank account or has used a mobile money service in the past 12 months	 0.68	↗ 2 ↘ 0 ? 2	**e-work:** e.g., augmented reality, cloud-based platforms ("platform as a service"), telecommuting and virtual business meetings > can improve access to work and help decouple growth from CO_2 emissions
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	– Globally, countries achieve a 3.95/7 score (7 indicating extensive and efficient standards) on infrastructure quality on aspects such as telephony, transport and energy – 0.77% of global GDP is spent by governments on research and development	 0.80	↗ 7 ↘ 0 ? 0	**Smart manufacturing:** e.g., industrial Internet of Things (IoT) and machine-to-machine (M2M) communication, robotics, 3D printing, cyber-physical systems (CPS), data analytics and drones > can deliver economic benefits to multiple stakeholders
11 SUSTAINABLE CITIES AND COMMUNITIES	– 76% of the global urban population has access to improved drinking water protected from outside contamination – Globally, urban air pollution (measured by the concentration of micrograms per cubic meter of air) is almost 3 times as high as the World Health Organization guideline	 0.48[32]	↗ 1 ↘ 0 ? 1	**Smart city mobility:** e.g., mobile ridesharing, e-mobility, driverless transportation, intermodal transport and connected infrastructure/IoT > can reduce accidents and improve air quality

↗ positive ↘ negative ? unclear

Dots indicate countries

04

Digital industry action and GeSI's commitment

This report suggests three action areas for the digital industry: to scale the positive impacts, flip the negative and innovate for all SDGs. GeSI is committed to working with its members and the wider digital industry to steer and maximize digital's positive impact.

"This report has an important message for businesses: using the positive force of digital transformation and integrating a sustainability lens into the innovation process can unlock business opportunities of USD 2.1 trillion for the digital industry."

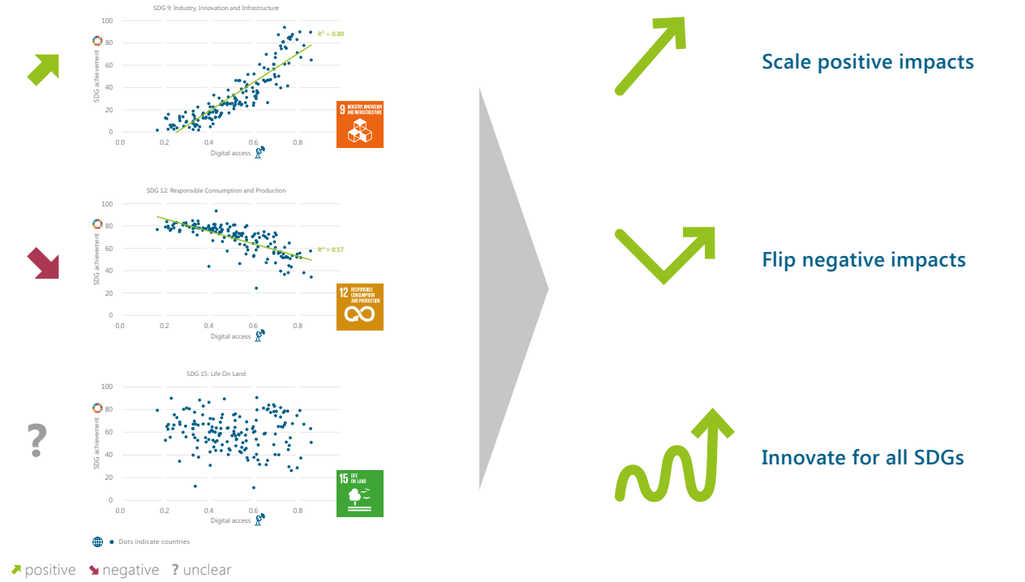
Mark Knickrehm,
Group Chief Executive,
Accenture Strategy

This report presents compelling evidence of a strong, positive link between digital access and most of the Sustainable Development Goals. A fair next question might be, "so what?"

We believe this evidence can be used as a foundation for digital industry action: to deliver benefits to society and create new business opportunities for the industry. Where we can now confidently say digital solutions are making a positive impact, let's look for ways to maximize these effects. And where digital solutions are negatively linked to SDG achievement, the digital industry can work to turn things around.

Three action areas for the digital industry: scale, flip and innovate

Exhibit 20: Three action areas for the digital industry



Three action areas for maximizing SDG impact and business value

Based on the different relationship patterns of digital access with SDG achievement, this report identifies three action areas for the digital industry to maximize its impact on SDG achievement:

1. scale the positive impacts
2. flip the negative impacts
3. innovate for all SDGs

These actions link positive impact with the prospect of new business opportunities.

Our research finds a $2.1 trillion revenue opportunity for the digital industry by 2030 from delivering solutions with positive SDG impacts – a 60% growth boost compared to today. Roughly $0.4 trillion come from increasing connectivity while the remaining $1.7 trillion result from deploying digital solutions, such as e-commerce, e-work, smart buildings, e-government and e-learning[33].

Innovating for SDG impact: A beneficial lens for companies

Innovating for SDG impact means applying a socially or environmentally inspired lens to the innovation process with the twofold objective of increasing the positive SDG impact of a company while capturing new business opportunities.

This report and the underlying analysis helps GeSI members understand which interventions and digital solutions would be most impactful. To act on these insights, digital companies can align their innovation process with the SDGs, for example, by conducting dedicated innovation sessions focused on addressing specific opportunities (like e-health and smart city solutions) or challenges (like e-waste or obesity). Additionally, companies can apply an SDG lens to innovation by considering aspects like the CO_2 impact of new products and solutions alongside traditional financial metrics.

Companies integrating an SDG lens into their innovation process benefit in four main ways. They can

– increase their revenues through new products and services and more future-proof business models

– reduce their cost of capital from better ratings (due to better sustainability performance)

– reduce their risks of paying fines (due to e-waste, for example) or losing their license to operate

– improve their reputation with governments and the wider public by actively contributing to positive societal progress while reducing negative impacts

GeSI's commitment: Steering industry impact for SDG achievement

With this report, GeSI reinforces its commitment to steering the digital industry's impact towards SDG achievement. It will do this in four ways:

1. **work with its members,** the wider digital industry and partners in other industries to scale positive impacts, flip negative impacts and innovate across all SDGs

2. **regularly update this impact analysis and enhance the Digital Access Index** with new indicators to better measure the spread of enabling technologies, such as the Internet of Things (IoT), and access to innovative digital solutions, like smart agriculture, e-health and e-learning

3. **support members in addressing concerns about the scale of digital transformation,** including concerns about energy consumption and e-waste, human rights in the supply chain, privacy issues, cybercrime, and the potentially negative impacts on employment

4) **engage with all partners** eager to unleash the full potential of digital solutions towards SDG achievement

Engaging with partners to unleash the full potential of digital solutions

This report shows how digital access, the spread of technologies and innovative digital solutions can enable the system transformation required to achieve the SDGs. But this can only happen through joint efforts. GeSI and its members from the digital industry have a strong desire to collaborate and communicate with many different stakeholders:

– **Policy makers** are the driving force behind setting the "rules of the game," both in terms of investment and cultivating the appropriate regulatory environment. They need to be fully aware of the potential of digital solutions to help achieve the SDG agenda nationally and globally. Strong evidence of a link between digital access and SDG achievement reinforces the need for policies that encourage investment in the roll-out of digital infrastructure. The regulatory environment should support innovation to achieve the SDGs, including ensuring a level playing field for competition and innovation in developing regions and avoiding overregulation of smart technologies in developed regions

– **Businesses from outside the digital industry** can be vital partners for innovating and applying digital solutions for SDGs that are sector-specific, for example, in SDG 2 on smart agriculture solutions, SDG 3 on e-health innovations, SDG 4 on e-learning solutions, SDG 11 on smart city applications, or SDG 13 on enabling the renewable energy transition

– **The SDG community**, including multilateral organizations like the UN, World Bank, SDSN, NGOs and donor organizations are key facilitators of SDG achievement on a global level and in tailoring solutions to local conditions. GeSI and its members are eager to share findings on the impacts of digital solutions and to learn from and partner with multi-stakeholder and civil society organizations to maximize benefits for local communities

– **All actors engaged in statistical evidence for SDG achievement and digital access** are invited to jointly develop new indicators to measure progress on digital access with a focus on the spread of technologies like IoT and innovative, SDG-relevant digital solutions

This report has taken us a big step closer to understanding the digital industry's social, economic and environmental impacts. We now have the evidence to take this impact to the next level.

Let's make it happen!

"Telenor Group places societal value at the center of how we run our business. To achieve the SDGs and the climate agenda, it is necessary to work across sectors and partner with a wide range of stakeholders. Businesses play a key role in driving this change, and we all have a responsibility to ensure that our activities drive equitable and inclusive growth in the markets we serve. Doing so in a sustainable way, leaders must become ambassadors of change. Now is the time to move from words to numbers to impact."

Sigve Brekke,
President & CEO, Telenor Group

Methodological appendix

This appendix provides further information about the suggested methodology to generate insights based on actual data and steer the digital industry's impact towards SDG achievement.

Correlation

GeSI commissioned Accenture Strategy to perform a correlation analysis to understand the relationship between digital access (on the x-axis) and SDG achievement (on the y-axis) in 157 countries. This statistical analysis identifies the direction and strength of the relationship between the 2 variables across the selected data sample:

Direction of relationship (also referred to as "relationship" in the executive summary)

Definition: The "direction" of the correlation indicates whether the correlation is positive or negative. A positive correlation means that an increase in the independent variable (digital access on the x-axis) happens in conjunction with an increase in the dependent variable (SDG achievement on the y-axis). In a negative correlation, an increase in digital access happens in conjunction with a decrease in SDG achievement.

$$R = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}}$$

x = DAI values y = SDG values n = sample size

Measurement: The direction of the correlation is measured with the R-value. It ranges between -1 and 1, with -1 indicating a perfect negative correlation, 1 indicating a perfect positive correlation and 0 indicating no correlation at all.

Strength of relationship

Definition: The strength of the correlation indicates how well the correlation explains the variability in the data of the 2 variables. The higher the strength of a correlation between digital access and SDG achievement, the safer it is to assume a linear relationship between the 2 variables.

$$R^2 = \left[\frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}}\right]^2$$

x = DAI values y = SDG values n = sample size

Measurement: The strength of the correlation is measured through the R^2-value. It ranges between 0 and 1, with 0 indicating no linear relationship between the two variables (very weak) and 1 indicating a perfectly linear relationship (extremely strong). On a scatterplot graph, the values get closer to a correlation trend line as R^2 approaches 1 and further away as R^2 approaches 0.

Relationship patterns

Three patterns of relationship emerge from the correlation analysis:

– **Positive:** When an increase in digital access correlates with an increase in SDG achievement. This is defined by a positive R-value and a robust strength of the correlation between the two variables, i.e. $R^2 \geq 0.3$[34] on a scale from 0 (indicating no linear relationship) to 1 (indicating perfect linear relationship)

– **Negative:** When an increase in digital access correlates with a decrease in SDG achievement. This is defined by a negative R-value and a robust strength of the correlation between the two variables, i.e. $R^2 \geq 0.3$

– **Unclear:** When there is no robust evidence for either a positive or a negative correlation between the 2 variables. This is defined by a low strength of correlation, i.e. $R^2 < 0.3$. On an aggregated SDG level, this can be due to different directions of correlations within the SDG caused by multidirectional indicator correlations within the SDG

R^2 values of 0.7 and above reflect a particularly strong relationship.

Levels of analysis

This report's correlation analysis systematically associates 2 variables to analyze their results for a large set of countries – 1 on digital access on the x-axis and 1 on SDG achievement on the y-axis. Correlations were run across all aggregation levels of the 3 perspectives:

– Digital access perspective: index-level (Digital Access Index (DAI) – see below), 4 DAI categories and 21 DAI indicators

– SDG achievement perspective: index-level (SDG Index – see below), 17 individual SDGs, 81 SDG indicators

– Geographical perspective: global (all 157 countries combined), 3 development levels and 4 regions

GeSI's Digital Access Index (DAI): x-axis of correlation

To measure digital access, GeSI commissioned Accenture Strategy to create a proprietary Digital Access Index (DAI) for GeSI in 5 steps:

1. Indicator selection: 21 indicators across 4 sub-categories (connectivity infrastructure, connectivity use, connectivity affordability and technologies) were selected for the DAI based on 6 criteria: the digital industry can influence them, they cover a large share of countries, stem from a reputable source (either listed in reputable index or provided by reputable source such as ITU, GSMA or World Bank), are regularly updated, can easily be accessed from a publicly available source and measure actual data (i.e., not based on expert surveys). Prior to this, existing indices had been analyzed for their suitability (see Endnote 8).

2. Data collection: Data for these indicators were collected for the 157 countries that are included in SDSN's SDG Index (see explanation of index below). The latest data points available were used.

3. Data cleansing: Outliers in the data were validated through research. A cutoff threshold for outliers was defined by three standard deviations above and below the mean of the indicator values. Outlier values were adjusted by trimming them to the cutoff threshold. Highly skewed indicators were logarithmically transformed. Where data for a country was missing, it was imputed based on the average available indicator value of similar countries based on region and development level.

4. Data normalization: All indicators were normalized, i.e. brought on the same scale from 0 (lowest) to 1 (highest), creating a relative scoring of countries for digital access indicators. The following formula was used for normalization:

$$x' = \frac{x - x_{\text{lowest value}}}{x_{\text{highest value}} - x_{\text{lowest value}}}$$

As part of the normalization, indicators for which a high value indicates low digital access, such as prepaid mobile cellular tariffs, were inverted.

5. Weighting and scaling: To create the DAI, a weighted average approach was taken. All DAI categories are equally weighted and, within each category, all indicators are also equally weighted. Like the DAI indicators, the DAI and its categories are scored from 0 (lowest) to 1 (highest).

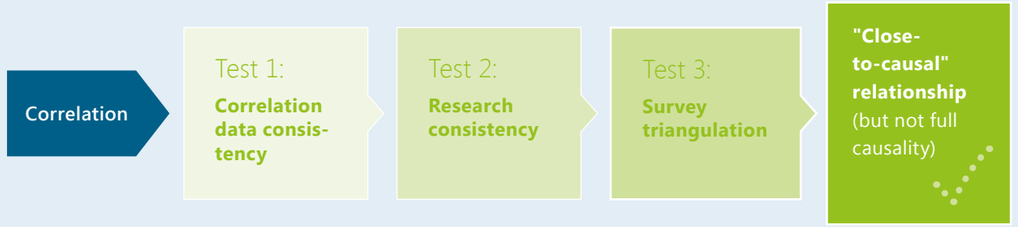
SDSN and Bertelsmann Foundation SDG Index: y-axis of correlation

To measure SDG achievement, this report uses the SDG Index of the Sustainable Development Solutions Network (SDSN) and the Bertelsmann Foundation[35], currently the most comprehensive indicator set on SDGs that is aggregated in an index, regularly updated and publicly shares the raw data. It provides SDG achievement scores across 157 countries, which have an average availability of 80% of the data across the 81 indicators applicable to all countries[36]. SDSN's SDG Index includes those indicators of the UN SDG indicators[37] that meet the data availability criteria to be included in the index and "fills gaps in data availability with variables published by reputable sources."[38]

On all SDG perspective levels (SDG index, SDGs, SDG indicators), SDSN normalizes achievement scores on a scale from 0 (lowest) to 100 (highest). As part of the normalization, indicators for which a high value indicates low SDG achievement, such as neonatal mortality, are inverted.[39] On the index level (all 17 SDGs combined), this report exclusively uses SDSN's SDG achievement for all countries. On the individual SDG and SDG indicator level, missing country scores were imputed based on the average available indicator score of similar countries based on region and development level.

Getting closer to causation

Exhibit 21: Three tests to get from correlation closer to causation



The three tests

The correlation analyses run for this report determine if a change (increase or decrease) in digital access and a change in SDG achievement coincide. The fact that both changes can be observed simultaneously proves a time-based link between the two variables, but does not signify a unidirectional cause-and-effect relationship (causation) between them.

This report is explicit about the fact that full causation can never be proven in the social sciences, the research area we are operating in. It is only possible to get closer to causation. We refer to "close-to-causal" relationships if there is a high level of certainty that digital access or solutions cause a change in SDG achievement. However, this does not imply fully proven causality.

To identify close-to-causal relationships[40], 3 decisive tests are required to confirm if digital access drives SDG achievement, or vice versa (also see Exhibit 21):

1. **Correlations data consistency test:** The correlation results are tested for consistency across a broad data sample.

2. **Research consistency test:** The correlation results are tested for logical consistency with research.

3. **Survey triangulation test:** A very important but time-consuming final test is the triangulation of the correlation results with surveys. Surveying individuals can verify which of the aspects analyzed is the cause, and which is the effect.

If these three tests have all shown the same impact direction, a close-to-causal relation between the correlated aspects can be assumed with high certainty. This report speaks about a close-to-causal relationship if the relationship passed these three tests with positive results. Where the tests are partially completed, we assume an impact potential.

Global correlation analysis: Applying the three tests

The global correlation analysis presented in this report addresses parts of the first and the second test, making it more thorough than correlations with smaller samples or without any other research confirming the hypothesis of impact direction. However, the results are still a long way away from confirming causality.

– **Test 1 on correlation data consistency:** First, a set of over 150 countries was analyzed, thereby providing a large sample of data. Second, the results are consistent across the levels of analysis: there is a high consistency of positive relationship patterns between the different levels of analysis, as well as some clear negative relationship patterns for selected environmental SDGs and indicators. In the future, this consistency can be further tested with emerging data over time, to additionally check for consistency in a time series.

– **Test 2 on research consistency:** Beyond the work done by GeSI and Accenture Strategy, many other studies and organizations, such as the ITU, UN and World Bank[41], suggest a positive impact potential of digital solutions on sustainable development. Research on the SDGs and/or SDG indicator level – which is more closely related to concrete measurable impacts – further confirm a positive impact direction, including research by GSMA and Huawei[42]. Additionally, several case studies from the digital industry demonstrate tangible positive impacts, and are available on this report's website.

– **Test 3 on survey triangulation:** No new survey triangulation was performed on the actual behavior of people, but existing survey results were analyzed in selected deep dives.

SDG 3: Impact of digital access/ solutions on health and well-being

In the context of SDG 3 on health and well-being, this research partially applied 2 of the 3 tests to get closer to causation (test 1 on data consistency and test 2 on research consistency). While outside research reviewed indicates a close-to-causal relationship for certain aspects of e-health, larger studies with survey triangulation could further validate causality.

– **Test 1 on correlation data consistency:** The positive correlation between digital access and SDG 3 achievement holds true across all development levels and regions (SDG 3 is consistently in the top-5 most strongly and positively correlated SDGs), as well as across the large majority of SDG 3 indicators: 9 out of 14 have a clear positive correlation with GeSI's DAI; 4 of the top-10 strongest correlated indicators with the DAI are SDG 3 indicators).

– **Test 2 on research consistency:** In sum, research suggests that there is a positive impact of e-health solutions[43] on health . This is particularly true for remote diagnostics and digital access to health information. For example, a meta-study by Hilty et al. (2013) finds that e-health solutions are effective for diagnosing and assessing mental disorders in many settings and across population segments.[44] Moreover the study confirms these e-health solutions do not only increase access to care, but that they are actually comparable to in-person care.[45] Similarly, an explorative study by Beratarrechea et al. (2014) claims e-health, specifically mobile health, to be a promising tool to address health access, coverage, and equity gaps in developing regions when dealing with chronic diseases.[46] Likewise, the World Economic Forum reports a 50% increase in safe hospital or clinic deliveries for pregnant women in Andhra Pradesh, India, through an internet-based video system that enables remote consultations with obstetricians and gynecologists in Hyderabad.[47]

With regard to digital access to health information, the study conducted by Nyamawe and Seif (2014)[48] and the solution review by Llevbare (no date)[49] find mobile access to pregnancy-related health information to have a positive impact on maternal and infant health in developing regions.

Evidence on the benefits of e-health solutions involving big data analytics and artificial intelligence (AI) includes reports on an AI application that leverages iris scans to predict a person's risk of heart attack or stroke within the next 5 years with 70% accuracy – a level of precision similar to that of blood tests that measure cholesterol levels.[50]

With regard to wearable-relevant indicators, the results are ambiguous. This report's correlation results reveal a negative correlation between digital access and adult obesity (SDSN tracks an indicator on obesity as part of SDG 2). Some studies, however, report a positive impact potential of wearables on obesity reduction. For example, Gualteri, Rosenbluth and Philipps (2016) find that the use of wearables increased well-being and supported weight loss in a test group analysis.[51] Similarly, Yang et al. (2017) discover positive impacts of a combined health app and wearable study on childhood obesity reduction.[52]

– **Test 3 on survey triangulation:** For this report, no primary survey research has been conducted. Also, a review of existing literature did not find any surveys that reconfirm the impact direction of the correlation between digital access and SDG achievement spanning a broad range of countries.

SDG 5: Close-to-causal relationship between digital fluency and workplace gender equality

A close-to-causal relationship between digital fluency and SDG 5, specifically workplace gender equality, has been identified by Accenture's "Getting to Equal"[53] study, based on conducting the 3 tests for getting closer to causation described above:

– **Test 1 on correlation data consistency:** The study analyzed data for digital fluency and workplace equality across 31 countries, finding consistent results across all countries studied for the positive correlation between digital fluency and workplace equality.

– **Test 2 on research consistency:** The results of the study were found to be consistent with leading research by reputable sources on the topic, such as the World Bank.[54]

– **Test 3 on survey triangulation:** The study surveyed more than 4,900 working men, working women and non-working women across 31 countries and 3 generations. The sample included people working in large, medium and small businesses. These surveys supported the study's hypothesis that digital fluency was causing improved workplace equality – not the other way around – based on respondents' views of how digital fluency positively impacts their ability to succeed in the workplace.

SDG 13: Impact of digital access/solutions on reducing CO_2 emissions

To qualify the impact of digital access and solutions on CO_2 emissions (SDG 13), this research applied tests 1 and 2 of the 3 tests to get closer to causation (test 1 on correlation data consistency and test 2 on research consistency). Research and a broad range of company case studies demonstrate the net-positive impact potential of digital access and solutions on CO_2 emissions. This indicates that the enabling potential of digital solutions across many areas of life, such as through e-work or smart building, can outweigh the emissions footprint of digital technologies, such as from data centers.

– **Test 1 on correlation data consistency:** For this report, the correlation data consistency test delivers unclear results for the two SDSN indicators related to CO_2 emissions. Higher digital access correlates with the indicator on higher CO_2 emissions from energy, but its correlation with the indicator on imported tech-adjusted emissions is unclear. Due to the conceptual limitations of these indicators to describe countries' actual CO_2 emissions, the multivariate regression analysis used the non-SDSN indicator consumption-adjusted CO_2 emissions (please refer to Endnote 26).

– **Test 2 on research consistency:** GeSI's "SMARTer2030" study finds a factor 9.7 emission reduction potential for digital solutions by 2030, indicating that the CO_2e avoided by the use of digital solutions is almost 10 times higher than the expected footprint from digital solutions in 2030 (1.25 $GtCO_2e$). Taking into account rebound effects worth 1.37 $GtCO_2e$, GeSI expects a net-positive impact of 9.46 $GtCO_2e$ avoided in 2030 across 12 digital use cases. There is ample research that provides evidence of the actual positive impact of digital access and solutions on CO_2 emissions reduction, for example, in the context of e-work and smart building. The Information Technology & Innovation Foundation finds that telecommuting reduces daily vehicle travel by 53 to 77%, cutting down CO_2 emissions from fossil fuels[55]. This is based on a meta-study by Walls and Safirova (2004) based on 20 empirical studies of telecommuting that confirm a reduction in number of trips, as well as distance travelled[56]. Similarly, Accenture's experience with smart building solutions finds an up to 40% reduction in CO_2 emissions from households' consumption and a 45% reduction from commercial buildings' consumption due to better energy management, automatic default settings, building supervision and control, as well as the implementation of operational guidelines.[57] These findings on the impact of digital access and solutions are further supported by a plethora of company case studies, for example, in the field of connected transportation. For instance, Verizon partners with IPS Group, a provider of smart parking in urban areas, to reduce the miles driven to find available parking. In 2017, this smart parking solution reports to have avoided over 34,000 metric tons of CO_2e emissions in the United States[58]. Likewise, Deutsche Telekom's Connected Car solution demonstrates a 15.9% CO_2 emissions reduction potential per car based on a coaching system for optimized driver behavior combined with a real-time traffic information and guiding system that anticipates traffic conditions.[59]

– **Test 3 on survey triangulation:** For this report, no primary survey research has been conducted. Surveys could address questions on verifying CO_2-friendly behavior changes through digital solutions. For future research in the context of CO_2 emissions, scientific measurements comparing settings with and without digital solutions could be another suitable way to confirm a close-to-causal relationship.

Estimating digital impact on SDG achievement: multivariate regression analysis

In addition to testing for causation, this study seeks to predictively estimate the impact that an increase in digital access can have on SDG achievement. To this end, 3 multivariate regression models on SDG achievement variables (within SDGs 3, 5 and 13) were run following a 7-step methodology:

1. SDG / control variable selection: Three dependent variables connected to achievement of SDG 3 (neonatal mortality), SDG 5 (female years of schooling) and SDG 13 (consumption-based CO_2 emissions) were chosen. For each of these, the most important explanatory independent variables beyond digital access were identified as control variables, based on literature research.

2. Data collection: Data on the non-digital control variables were collected from reputable sources, such as the CIA, Global Carbon Project, ILO, UNESCO, UNPD, WHO and World Bank. The latest available data points for the 157 countries that are included in SDSN's SDG Index were used.

3. Data cleansing: Variables with more than 40% of missing values were discarded. This applied to literacy rate in models for SDG 3 and SDG 5. Remaining missing country values were imputed based on the 3 countries most similar to the missing country in all other variables in the model. Data points with extraordinarily high influence on the model – the outliers – were searched for based on their Cook distance, but no such data points were identified.

Moreover, highly correlated variable pairs, as defined by R > |±0.9|, were discarded from the model to avoid redundant information.

4. Model selection: Multiple models were designed, based on different combinations of the selected variables. For all three models, the chosen model was a multivariate linear regression. The most suitable model for each of the independent variables was selected based on three criteria: Akaike Information Criterion (AIC)[60], interpretability[61] and inclusion of the DAI. An alternative modeling approach that did not force the inclusion of DAI in the selected model confirmed the relevance of DAI indicators for making predictions on the three independent SDG variables. Additionally, mandatory statistical requirements for the models were met, i.e., independent, normally distributed residuals with equal variance (homoscedasticity) and a mean of zero. Some indicators were transformed (log, quadratic terms) to meet these requirements.

5. Model calculation: In a first step, the model regressed the DAI and the control variables on the SDG variable to identify the impact that DAI can have on SDG achievement, considering the most important other aspects that influence each SDG variable. In a second step, the DAI indicators were regressed on the DAI.

6. Insight generation: The following insights were gained from the models:

– An impact prediction of a 5% increase in DAI on each SDG variable expresses the relative change in the SDG variable that is expected from a 5% change in the DAI. Predictions are made for a hypothetical country, calculated as the average of all countries, considering the impacts of the control variables. The prediction is provided together with a 95% confidence interval. This interval signifies that the real value for the SDG variable is expected to be within this range with a probability of 95% for the hypothetical average country.

– A ranking compares the importance of each explanatory variable in predicting the SDG variable across a broad range of possible models, providing additional evidence of the relevance of DAI in impacting SDG achievement.

7. Insight communication: To make the impact predictions easier to grasp and relate to, they were translated into tangible impacts on peoples' lives and the environment. The following calculation logic was applied to better communicate the impact of a 5% increase in DAI:

SDG indicator	Indicator impact	Tangible impact	Calculation logic
SDG 3: **Neonatal mortality (per 1,000 live births)**	**-7.4%** neonatal mortality (per 1,000 live births)	**+ 2 babies** saved for every 1,000 live births in Least Developed Countries	The 7.4% decrease in neonatal mortality (per 1,000 live births) is applied to the global average (of the 157 countries studied) of neonatal mortality (per 1,000 live births). Then the difference between neonatal mortality (per 1,000 live births) with and without the 7.4% decrease is calculated, resulting in the increased number of babies per 1,000 live births that survive their first 28 days.
SDG 5: **Female years of schooling (% male)**[62]	**+0.5%** female years of schooling (% male)	**+ 2 weeks** of schooling for each female learner	The 0.05% increase in female years of schooling (% male) is applied to the global average (of the 157 countries studied) of female years of schooling (% male). The difference between female years of schooling (% male) with and without the 0.05% increase is then multiplied by the global average (of the 157 countries studied) for male mean years of schooling (as per UNESCO). Since data is recorded in years, the figure is multiplied by the number of days in a year, providing the result of 14.5 days. Taking into account 2-day weekends, this is equivalent to two school weeks. School holidays are not considered in this calculation.
SDG 13: **Consumption-based CO_2 emissions ($MtCO_2$)** (indicator is not part of SDSN's SDG Index[63])	-**1.6%** consumption-based CO_2 emissions ($MtCO_2$)	**~450 coal plants** shut off (average plant with 300 MW)	The 1.6% decrease in consumption-based CO_2 emissions (Megatons (Mt) CO_2) is applied to the global total (of the 157 countries studied) of consumption-based CO_2 emissions ($MtCO_2$). The difference in consumption-based CO_2 emissions ($MtCO_2$) with and without the 1.6% reduction is then divided by the average annual CO_2 emissions of an average coal plant. The average annual CO_2 emissions of an average coal plant is calculated across 6,721 coal plant units (30 MW and larger, average of 300 MW) in 104 countries, as per CoalSwarm's Global Coal Plant Tracker (data as of January 2018). This provides the result of a reduction impact equivalent to the annual emissions of 468 coal plants.

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About GeSI: The Global e-Sustainability Initiative (GeSI) is a strategic partnership of the Information and Communication Technology (ICT) sector committed to creating and promoting digital technologies and practices that foster economic, environmental and social sustainability. Formed in 2001, GeSI's vision is a sustainable world through responsible, ICT-enabled transformation. GeSI fosters global and open cooperation, informs the public of its members' voluntary actions to improve their sustainability performance, and promotes technologies that foster sustainable development. GeSI enjoys a diverse and global membership, representing around 30 of the world's leading ICT companies and partners with over 30 global business and international organizations such as the International Telecommunications Union (ITU), the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Program (UNEP), the World Business Council for Sustainable Development (WBCSD), the World Resources Forum Association (WRFA), the Institute of Electrical and Electronics Engineers (IEEE), the Responsible Business Alliance (RBA), the Centre for Sustainable Consumption and Production (CSCP), The Institute for Sustainable Development and International Relations (IDDRI), the Global Climate Forum (GCF), the World Green Building Council (WGBC), the Flemish Institute for Technological Research (VITO), and the International Energy Agency (IEA) – as well as a range of international stakeholders committed to ICT sustainability objectives to share and develop ideas, launch joint initiatives, and collaborate on a broad range of sustainability projects. These partnerships help shape GeSI's global vision regarding the evolution of the ICT sector, and how it can best meet the challenges of sustainable development. For more information, see www.gesi.org.

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or visit www.accenture.com/strategy.

Endnotes

[1] Detailed information is provided in the methodological appendix

[2] GeSI and Accenture Strategy (2015). "SMARTer 2030: ICT Solutions for 21st Century Challenges"; GeSI and BCG (2012). "GeSI SMARTer2020: The Role of ICT in Driving a Sustainable Future"; GeSI and The Climate Group (2008). "SMART2020: Enabling the Low Carbon Economy in the Information Age"

[3] GeSI and Accenture Strategy (2016). "#SystemTransformation – How Digital Solutions Will Drive Progress Towards the Sustainable Development Goals"

[4] Our "#SystemTransformation" report reveals an economic opportunity of USD 11.1 trillion from digital solutions with sustainability benefits in 2030

[5] Clustering of countries into development levels based on UN classification: UNCTADSTAT (n.d). "Classifications - Economic Groups." http://unctadstat.unctad.org/EN/Classifications.html

[6] Due to the low number of countries in North America (n=2) and Oceania (n=2), those regions could only be analyzed when combined with neighboring regions, i.e. North America combined with Latin America & Caribbean, Oceania combined with Asia

[7] Top-5 most strongly correlated indicators in Least Developed Countries: individuals using the internet, mobile social media penetration, active mobile broadband subscriptions, smartphone market penetration and 3G coverage

[8] Why a new index? First, existing indices on digital access or adoption only cover parts of digital industry activity. For example, they only use and access of ICT or only a certain part of the digital industry. Second, they often include non-digital indicators that are part of SDG achievement – which would lead to a mix of the two axes that are analyzed. Twelve existing indices have been screened, including the ITU Digital Development Index, the GSMA Mobile Connectivity Index, the WEF Networked Readiness Index and the World Bank's Digital Adoption Index

[9] As our research is situated in the social sciences, one might argue that full causal relationships can never be proven. Hence, a "close-to-causal" relationship is possibly the highest level of causality attainable
Please refer to endnote 17 for more information on the use of the term "close-to-causal relationship" in this study

[10] Please note that a higher SDG achievement score in neonatal mortality, traffic deaths, under-five mortality, adolescent fertility, maternal mortality, death rate from non-communicable diseases, incidence of tuberculosis, death rate from household and ambient pollution and HIV incidence indicates a lower occurrence of these negative health events, such as neonatal mortality

[11] An overview of the methodology applied is provided in the methodological appendix

[12] Please refer to the methodological appendix for the calculation logic applied

[13] Please note that there is strong evidence supporting the prediction of the impact potential displayed. However, further research, including survey triangulation, is required to increase certainty on a close-to-causal relationship
Please refer to endnote 17 for more information on the use of the term "close-to-causal relationship" in this study

[14] Three other indicators that significantly influence whether newborn babies survive the first 28 days of their lives were identified (Improved water source (% of population with access), births attended by skilled health personnel (%) and total health expenditure (% of GDP)) and introduced into the modeling, but were excluded from the final model due to high correlation with other explanatory variables. Additionally, literacy rate, adult total (% of people ages 15 and above) was introduced into the modeling process to serve as a proxy for parental level of education, but was excluded from the final model due to low share of countries with data available

[15] Please note that a higher SDG achievement score in unmet demand for contraceptives indicates a lower share of unmet demand for contraceptives

[16] Accenture (2016). "Getting to Equal – How Digital is Helping Close the Gender Gap at Work"

[17] This report speaks about a close-to-causal relationship if the relationship underwent the three tests of data consistency, research consistency and survey triangulation with positive results

[18] The study measures digital fluency through a set of seven indicators, four of which were obtained from surveys and three from secondary research. Survey-based indicators include ownership of / easy access to digital solutions, usage of digital solutions in personal life, frequency of use of digital solutions in personal life, proactivity in learning new digital skills. Secondary research-based indicators include the percentage of individuals using the internet (by gender), usage of electronic payments to make payments, usage of the internet to pay bills or make purchases

[19] Accenture (2016). "Getting to Equal – How Digital is Helping Close the Gender Gap at Work"

[20] An overview of the methodology applied is provided in the methodological appendix

[21] Schooling is defined as education across all levels, i.e. the "average number of completed years of education of a country's population aged 25 years and older, excluding years spent repeating individual grades" as per UNESCO (n.d.): "Education: Mean Years of Schooling." http://data.uis.unesco.org/Index.aspx?queryid=242

[22] There is strong evidence supporting the prediction on the impact potential displayed. However, further research, including survey triangulation, is required to increase certainty on a close-to-causal relationship

[23] Two other indicators that significantly influence whether girls go to school were identified: adolescent fertility rate (births per 1,000 women ages 15-19) and GDP per capita, PPP (current international $). These were introduced into the modeling, but were excluded from the final model due to high correlation with other explanatory variables. Additionally, literacy rate, adult total (% of people ages 15 and above) was introduced into the modeling process to serve as a proxy for parental level of education, but was excluded from the final model due to low share of countries with data available

[24] Abbreviated target descriptions by Accenture Strategy

[25] Please note that a higher SDG achievement score in all three indicators indicates lower climate change vulnerability, imported emissions and CO_2 emissions from energy respectively

[26] For more information, refer to the methodological appendix. Removing other influencing effects on CO_2 emissions like GDP, our multivariate regression analysis could now demonstrate the net positive effect of digital access

[27] We use the indicator "consumption-based CO_2 emissions," sourced from the Global Carbon Project (2015), instead of one of the two CO_2-related indicators from SDSN's index. This has two main benefits: using a consumption-based CO_2 emissions indicator attributes emissions to the consumer countries of emissions-producing goods and services, rather than to the producer countries, avoiding the "outsourcing" of emissions from developed to less developed regions, as SDSN's indicator on imported emissions, tech-adjusted does. Our selected indicator additionally covers all key CO_2 emissions, and not only parts, as SDSN's indicator on CO_2 emissions from energy does. Considering this indicator allows more coherence with GeSI's "SMARTer" analyses on digital's potential to save total CO_2 emissions globally in all sectors

[28] Please refer to the methodological appendix for the calculation logic applied

[29] Please note that there is strong evidence supporting the prediction on the impact potential displayed. However, further research, including survey triangulation, is required to increase certainty on a close-to-causal relationship

[30] One other indicator that significantly influences CO_2 emissions – GDP per capita, PPP (current international $) – was identified and introduced into the modeling but was excluded from the final model due to high correlation with other explanatory variables

[31] Assessment of relevance based on GeSI member and Accenture Strategy analysis for "#SystemTransformation", taking into consideration SDG's industry transformation potential, business case for the digital industry and equal distribution between social, economic and environmental impact area

[32] We assume a very strong link between digital solutions and their impact on cities (SDG 11). However, the two indicators on SDG 11 currently included in the SDSN SDG Index might not reflect the entire sustainability impact potential in cities

[33] GeSI and Accenture Strategy (2016). "#SystemTransformation"

[34] In the social sciences, it is widely accepted that an R^2 value of 0.3 and higher signifies a robust correlation

[35] Bertelsmann Stiftung & SDSN (2017). "SDG Index and Dashboard Report 2017: Global Responsibilities – International Spillovers in Achieving the Goals"

[36] In total, SDSN tracks 83 indicators for their global SDG Index. However, 2 indicators for SDG 17 are only available for a subset of countries. Those were not considered in the indicator-level correlation analysis for this report because the robustness of a correlation for fewer countries would not be comparable to that of the other indicator-level correlations

[37] UN Statistical Commission (2016). "Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (E/CN.3/2016/2/Rev.1), Annex IV." Data availability for UN indicators is an issue. Over 60% of the UN indicators have no or only partial data. UN Statistical Commission (2017). "Tier Classification for Global SDG Indicators"

[38] Bertelsmann Stiftung & SDSN (2017). "SDG Index and Dashboard Report 2017"

[39] Further details on SDSN's methodology for calculating SDG achievement scores can be found in Bertelsmann Stiftung & SDSN (2017). "SDG Index and Dashboard Report 2017"

[40] As our research is situated in the social sciences, 100% causal relationships cannot be proven. We refer to "close-to-causal" relationships if we assume a high level of certainty for a causal relationship

[41] World Bank (2016). "World Development Report 2016: Digital Dividend."; GSMA (2016 and 2017) "Mobile Industry Impact"; ITU (n.d.). "ICTs for a Sustainable World #ICT4SDG." https://www.itu.int/en/sustainable-world/Pages/default.aspx; UN includes ICT indicators and targets in SDG achievement (e.g., SDG targets 9.c and 17.8), showing the assumed positive impact

[42] GSMA (2016 and 2017) "Mobile Industry Impact"; Huawei (2017) "ICT Sustainable Development Goals Benchmark"

[43] For example, Donald M. Hilty et al. (2013). "The Effectiveness of Telemental Health: A 2013 Review"; Beratarrechea et al. (2014). "The Impact of Mobile Health Interventions on Chronic Disease Outcomes in Developing Countries: A Systematic Review"; World Economic Forum (2017). "Global Healthcare: The $300 Billion Question"; Ally S. Nyamawe & Hassan Seif (2014). "The Role of ICT in Reducing Maternal and Neonatal Mortality Rate in Tanzania"; Justice Ilevbare (no date). "Safermom: Using Technology to Reduce Maternal and Infant Mortality"; Lisa Gualtieri, Sandra Rosenbluth & Jeffrey Philipps (2016). "Can a Free Wearable Activity Tracker Change Behavior? The Impact of Trackers on Adults in a Physician-Led Wellness Group"; Hye Jung Yang et al. (2017). "Interventions for Preventing Childhood Obesity with Smartphones and Wearable Device: A Protocol for a Non-Randomized Controlled Trial"

[44] Donald M. Hilty et al. (2013). "The Effectiveness of Telemental Health: A 2013 Review"

[45] Ibid

[46] Beratarrechea et al. (2014). "The Impact of Mobile Health Interventions on Chronic Disease Outcomes in Developing Countries: A Systematic Review."

[47] World Economic Forum (2017). "Global Healthcare: The $300 billion Question"

[48] Ally S. Nyamawe & Hassan Seif (2014). "The Role of ICT in Reducing Maternal and Neonatal Mortality Rate in Tanzania."

[49] Justice Ilevbare (n.d.). "Safermom: Using Technology to Reduce Maternal and Infant Mortality."

[50] Business Insider (2018). "Google Has Developed a Way to Predict Your Risk of a Heart Attack Just by Scanning Your Eye." http://www.businessinsider.com/google-verily-predicts-cardiovascular-disease-with-eye-scans-2018-2

[51] Lisa Gualtieri, Sandra Rosenbluth & Jeffrey Philipps (2016). "Can a Free Wearable Activity Tracker Change Behavior? The Impact of Trackers on Adults in a Physician-Led Wellness Group."

[52] Hye Jung Yang et al. (2017). "Interventions for Preventing Childhood Obesity with Smartphones and Wearable Device: A Protocol for a Non-Randomized Controlled Trial"

[53] Accenture (2016). "Getting to Equal – How Digital is Helping Close the Gender Gap at Work"

[54] World Bank (2016). "World Development Report 2016: Digital Dividend"

[55] The Information Technology & Innovation Foundation (2009). "Improving Quality of Life Through Telecommuting"

[56] Margaret Walls & Elena Safirova (2004). "A Review of the Literature on Telecommuting and its Implications for Vehicle Travel and Emissions"

[57] Accenture (n.d.). "Accenture Smart Building Solutions: Optimizing Building Management and Improving Energy Efficiency"

[58] Verizon (2018). "Building the Future: 2017 Corporate Responsibility Report"

[59] GeSI & Accenture Strategy (2015). "#SMARTer2030: ICT Solutions for 21st Century Challenges"

[60] AIC measures information provided by a model and its complexity. The model with the lowest AIC is considered the best model. Any model within an AIC distance of 5 is considered plausible, and was further analyzed

[61] Only linear models were considered interpretable in order to derive the required insight of impact prediction and variable ranking by importance

[62] Referred to as "years of schooling for girls and women compared to boys and men" in Chapter 3 for communication purposes

[63] Please refer to Endnote 27

Jeffrey D. Sachs,
University Professor at Columbia University
Special Advisor to UN Secretary General António Guterres on the Sustainable Development Goals

"As this important GeSI report underscores, digital solutions are essential tools for achieving the Sustainable Development Goals. Broadband connectivity combined with new cutting-edge applications are being adopted for every one of the SDGs, from fighting poverty (SDG 1), to raising the quality of education (SDG 4) and health (SDG 3) and to enabling the scale-up of renewable energy (SDG 7). The telecommunications providers, technology firms, academic centers of excellence, and others in the digital sectors should now step forward boldly to provide breakthrough digital solutions at global scale."

John Donovan,
CEO, AT&T Communications

"Technology from AI to 5G has the power to transform public safety, education, transportation, manufacturing, energy and more. We have an obligation to make sure innovation best serves the people and communities we serve. This report demonstrates the impact our industry is making and we couldn't be more optimistic about AT&T's contribution in what's to come."

Mr. Dong-Jin Koh,
CEO, Samsung

"We at Samsung, devote our talent and technology to creating innovative products and services. Our products and services are designed to help people connect, pursue their best and enrich their life more easily and seamlessly. As a global corporate citizen, we are pursuing opportunities to solve societal challenges with a vision for a sustainable future, in line with the UN SDGs."

Urs Schaeppi,
CEO, Swisscom

"Swisscom will play its part in achieving the UN Sustainability Goals, and will rely on this study to inform our efforts. GeSI's research clearly shows how innovative digital solutions can promote sustainable development."

Paul Polman,
CEO, Unilever

"At Unilever, we apply an SDG lens to every aspect of strategy, from innovating to create sustainable solutions to marketing products and services that inspire consumers to make sustainable choices. This report demonstrates the critical role of digital solutions, and I am thrilled about the prospects of using these solutions and working with the digital industry to help us deliver on our commitment towards the SDGs."

Lise Kingo,
CEO & Executive Director,
United Nations Global Compact

"At the UN Global Compact, we believe private sector engagement is critical to delivering the Sustainable Development Goals by 2030. And the global business community is stepping up to the challenge, with more and more industries working to measure their impact on supporting the achievement of these Global Goals. Therefore, we welcome initiatives such as GeSI that are taking important steps to help business be an impactful force for good."

GeSI ENABLING DIGITAL SUSTAINABILITY

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