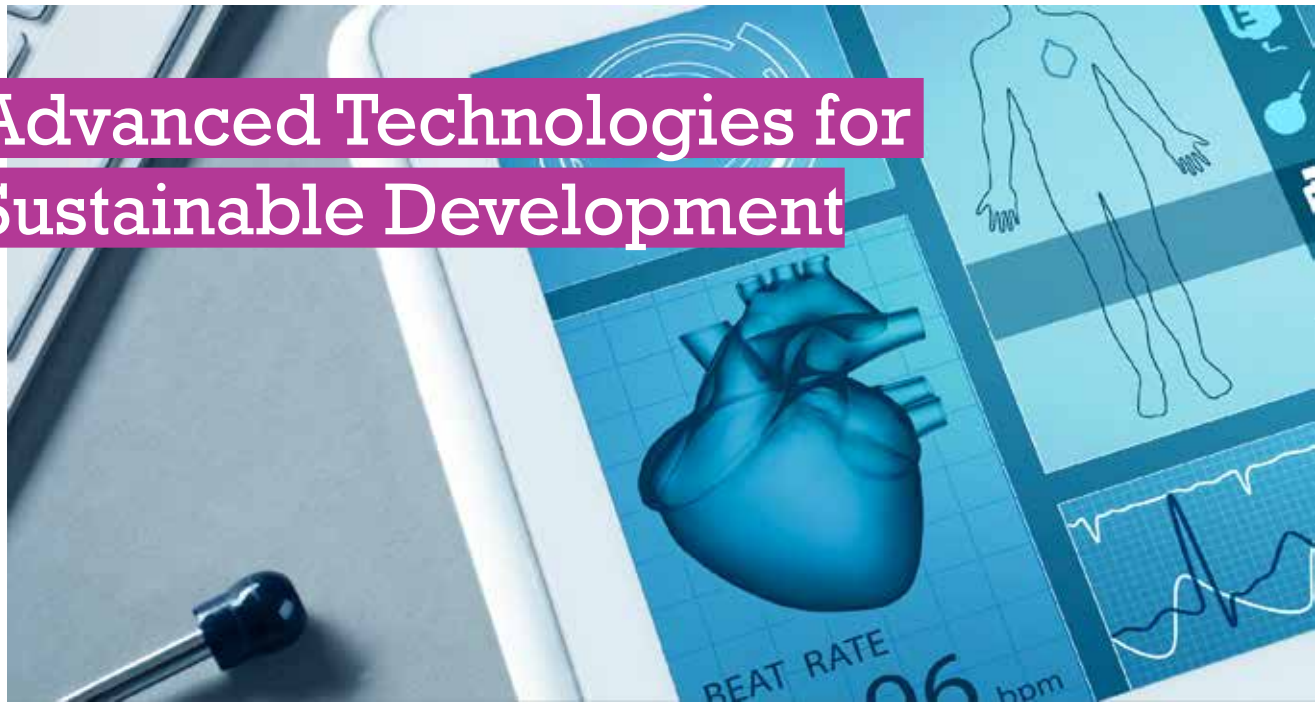
4 Advanced Technologies for Sustainable Development



It is clear that mere access to infrastructure is not enough, no matter how high-speed or sophisticated. How broadband applications and services and data are used – and for which purposes – is becoming vitally important for development, and for achieving the SDGs and the promise to "leave no one behind".

Technologies themselves are usually amoral – technology can be used for good or bad and is given moral purpose, depending on the uses and goals to which it is put. Undoubtedly, there are ethical issues and social dilemmas that can arise with poorly considered uses of these technologies. As Professor Yuval Noah Harari notes in his book, "*Homo Deus: A Brief History of Tomorrow*"[1], technologies and medicine almost always begin by "helping people and saving them from falling below the norm, but the same tools and know-how can then be used to surpass the norm" (Harari, 2017). "Once you achieve a momentous breakthrough, you cannot restrict its use to healing and completely forbid using it for upgrading" (Harari, 2017) and purposes other than those originally foreseen.

It is paramount to capitalize on the positive potential of broadband, ICTs and new technologies, to achieve the most extensive and far-reaching beneficial impact for as many people as possible. Indeed, the moral purpose of technologies is becoming ever more important, given the far-reaching scale and predictive power now made possible through new and emerging technologies, such as big data and AI.

There is no universally agreed definition of artificial intelligence. "AI" is a term of art that has been used for at least forty years, to apply to any number of processes. Historically, this term has been applied where machines imitate thinking or behavior that people associate with human intelligence (such as learning, speech and problem solving). AI refers to the theory and development of computer systems able to perform tasks that normally require human intelligence (such as visual perception or decision-making), and comprises a rich set of sub-disciplines and methods with different functions, including visual recognition, perception, speech recognition and dialogue, decisions, planning and robotics, among others.

New families of AI algorithms now make it possible to obtain actionable insights automatically and at scale. Accompanying these developments in AI is big data. According to Maaroof (2015), "big data is not just [about] data—no matter how big or different it is considered to be; big data is first and foremost 'about' the analytics, the tools and methods that are used to yield insights, the frameworks, standards, stakeholders involved and then, knowledge"[2]. Big data opens up opportunities towards a potential shift towards information-rich and more informed policy-making.

Table 4: Different Types of Data

Health	**Government**
• Medical history	• Identification numbers and identity
• Prescriptions & Vaccinations	• Address
• Fitness tracking	• Civil information (birth, marriage, etc.)
	• Legal records
Web	**Mobile phone**
• Email	• Number and contact network
• Browsing & searches	• Call records
• Content (social profiles, posts, photos, etc.)	• Location data (GPS)
• Contacts, followers, friends	• Activity and motion data
Financial	**Other**
• Accounts	• Home information
• Transactions	• Travel
• Debts	• Vehicle information
• Investments	
• Insurance	

Source: World Bank.

As discussed in Section 3.1 on NBPs, the Open Data Institute has suggested that public data should be recognized as an infrastructure asset[3]. Policies that discuss data infrastructure in the government typically focus on management of data assets (collection, access, reuse, sharing, preservation, security) and data governance (ownership, funding)[4] (World Bank, 2018). This implies that data is an asset, much like any other infrastructure asset. Table 4 from the World Bank depicts some of the different types of data collected by different players in the newly emerging data ecosystem, while Viewpoint 22 by UN Global Pulse explores how big – and better – data and AI can be used for sustainable development.

Viewpoint 22: Better Data for Doing Good – Using Big Data & AI for Sustainable Development

Advances in ICTs are driving global changes in our society – from the way we communicate with each other to the forces that shape our economy and

industrial processes. Big data sources and the rapidly-evolving capabilities of AI hold tremendous promise for social impact and are driving transformation across many domains. Location data from mobile phone networks reveal the extent of displacement after a disaster and predict the spread of infectious diseases, while mobile airtime purchases help track food consumption. Roofing materials visible from space serve as a proxy for poverty, changes in debit card usage indicate the impact of a crisis, and postal records have been used to estimate trade flows.

New families of AI algorithms are now making it possible to obtain such insights automatically, and at scale. Beyond Internet business or commercial applications, there are many examples of how big data and AI can be used to advance progress in each SDG. Every project represents a small, but significant innovation in learning about the world around us; taken together, they represent a new approach in our capacity to detect and respond to crises.

Key to achieving sustainable development is the responsible use of data, which presents both genuine opportunities and daunting challenges. Think of the digital ocean of big data as a new natural resource with the potential to accelerate the transformation of societies in ways that create a healthier, more equitable and more sustainable future for everyone. This isn't just about measuring progress – it's also about designing development programmes in ways that take advantage of access to real-time, empirical information. Even more exciting is the promise of predictive analytics, making it possible to spot emerging risks to outcomes and take corrective action.

However, this new resource has arguably fallen into the hands of a largely unregulated extractive industry, creating another digital divide. Too few organizations have the AI tools and expertise needed to turn big data into useful insights for good, and the potential benefits of the data currently do not reach everyone. To date, big data and AI – in domains such as targeted advertising and automation – have resulted in concentrations of wealth. They also have profound implications for privacy.

Many young people now grow up in a big data world in which their information has been collected, sold, and used without their knowledge by thousands of companies. It has become common to hear remarks such as "I have nothing to hide, why should I care about privacy" or "privacy is dead". We sometimes forget perhaps that big data isn't just being collected to let companies understand us better. Often, it is to make us desire things we didn't want before, and to buy them. As it has become evident that these capabilities may even be repurposed to affect political choices within democratic processes, there is renewed public interest in privacy protection, particularly online.

While it is clearly possible to misuse big data and AI, there is also growing recognition of their massive – and largely untapped – potential to do good. More companies recognize in the promise and peril of big data an ethical obligation to act, and are partnering with governments, researchers and communities to advance the field. The *mobile industry* is undoubtedly leading the way, with other industries catching up. Efforts such as the *EU's General Data Protection Regulation,* the *UN Guidance Note on Big Data for SDGs: Data Privacy, Data Protection and Ethics*, and the *IEEE guide* for ethical considerations in AI, are paving the way to using new technologies while mitigating potential risks.

Box Figure: Data Privacy, Ethics and Protection

Source: UNDG (2017), Data Privacy, Ethics and Protection: A Guidance Note on Big Data for Achievement of the 2030 Agenda. Available at: https://undg.org/wp-content/uploads/2017/11/UNDG_BigData_final_web.pdf.

Getting to scale in this data revolution for sustainable development will require an evolution in how data is regulated around the world in a way that is grounded in science, fully transparent, sensitive to context and puts human rights front and centre. Data ethics should be treated holistically using a consistent and inclusive framework that considers a diverse set of outcomes, instead of an ad hoc approach towards limited applications. Data ethics principles or codes of conduct, ethical impact assessments, ethical trainings for researchers and ethical review boards can help. Accountability and transparency are critical ethical principles that should accompany any and all innovation projects.

A key first step is to educate the public about the incredible ways the data they produce in their daily lives could be used to also help them. Second, we need to ensure we assess the privacy and ethical impacts of innovations at every stage of a project, to help mitigate harms, maximize benefits, and lead to better use of new technologies. At UN Global Pulse, we build ethical considerations into our data practices by conducting a 'risks, harms, and benefits assessment' to identify anticipated or actual ethical and human rights issues that may occur during a data innovation project. Lastly, we need to ensure that governments, public and private sector work together to put in place adequate data privacy and data protection frameworks that balance both the risks of misuse of data, and the risks of non-use.

In the end, fully harnessing the data revolution will require that we not only explore what can be done with data, but also that we understand the broader impacts of how any individual or organization's contribution affects the lives of others.

Source: Robert Kirkpatrick, Director, UN Global Pulse.

4.1 Digital Technologies for Education

Globalization, new technologies, migration, and environmental and political challenges are transforming labour markets and creating demand for new skills and knowledge for work, citizenship and managing personal lives. Digital skills are fast becoming vital, in addition to basic literacy and numeracy. Digital skills can themselves be further broken down into three categories – the basic digital literacy needed for all workers, consumers and citizens in a digital society; the advanced ICT skills (coding, computer science and engineering) which are needed to develop innovative ICT products and services; and e-business skills or the specific know-how needed for digital entrepreneurship[5]. According to GSMA, 29% of global mobile users use their phones to access information to support their education, or that of the children or relatives.

The report, "*Technologies & the future of learning and Education for All*" (UNICEF & UNESCO, 2018[6]) identifies various core functions enabled by new digital technologies, including: enhancing the role of teachers as facilitators; delivering engaging quality content; enabling learners to acquire new skills; assessment and certification; efficient delivery; improved administration; and effective learning. Viewpoint 23 describes the opportunities provided by digital technologies for enhanced learning and education. Indeed, digital technologies are most effective when they support teachers and accompany students in their learning processes. Online learning resources (such as language and translation platforms, for example) can help supplement and reinforce learning, as well as digital tutors, learning and language academies, curricular playlists and intelligent virtual reality. Digital technologies can and are being used to support in different needs individual students, classes, teachers and learning establishments (primary, secondary and higher education), as well as students with specific learning difficulties.

Viewpoint 23: The Opportunities Provided by Digital Technologies for Learning & Education

New technologies such as cloud computing, blockchain, big data analytics, gaming, robotics, 3D printing, machine learning, VR, AR and AI, all have significant relevance to the future of education. Technology-enabled trends and new capabilities (including the increase of remote interactions, mobility and portability and the rise of the personal cloud) will require, and enable, different pedagogies, curriculum and institutional arrangements.

These technologies can be used across all aspects of education and learning, but at their heart is the potential to deliver anything, anywhere, to anyone, in any format, at any time. Seven dimensions of educational transformation through innovative technologies are particularly important:

- **Enhancing the evolving role of teachers as facilitators**: technology is effective only when it supplements and supports teachers, rather than replacing them. However, the style and role of teaching will clearly need to change to take advantage of new technologies.
- **Delivery of content**: Numerous platforms now deliver a wealth of interactive content relevant to users' needs and the changing demands of curricula.
- **Enabling learners to gain new and personalized skills**: new technologies can be used to encourage learners to develop critical thinking, creative and collaborative skills.
- **Assessment and certification**: ICTs provide accurate, reliable, replicative and swift means of assessing and certifying pupils' and learners' work in many cases.

- **Efficiency of delivery**: existing software can perform and collate repetitive grading and evaluation, releasing teachers to other duties that computers or machines cannot undertake.

- **Administration, management and data**: the collection, dissemination and analysis of data can potentially reduce the administrative burden within education systems and help monitoring.

- **Inclusive learning**: ICTs can benefit the learning potential of marginalized people or those with special learning needs, including disabilities and isolated communities.

The overall effect of new technologies on employment levels remains to be seen. While technologies are likely to lead to a reduction in routine jobs, digitalization can also lead to the creation of new jobs, with a positive effect on economies. Four main elements are often identified as essential for learners to participate in the workplace of the future: ensuring digital literacy for all; teaching computer programming & coding; facilitating the development of digital skills; fostering soft skills. People need to become more flexible and adaptive to fast-changing labour markets. Work-based and online learning can be harnessed to improve learning opportunities and reinforce learning achievements.

To ensure technologies are used effectively and appropriately in learning, five enablers are important:

- The main focus should be on learning outcomes, rather than assumed benefits of news ICTs.

- Teachers need to be empowered, rather than disenfranchised.

- Integrated cross-government approaches should be in place to deliver technology-enhanced learning, involving all relevant Ministries.

- Such initiatives should be designed to be inclusive, so marginalized groups and communities, especially people with disabilities, refugees and/or those out of school or living in isolated communities, are able to access appropriate learning opportunities.

- Governments must be willing to ensure that sufficient funding is available for such initiatives to be delivered at scale and sustainably, and to ensure funding reaches desired target groups.

There are clearly challenges in using new technologies effectively and appropriately to enhance learning outcomes and equip the workforce for the changing needs of future labour markets, but education plays a fundamental role in empowering and inspiring individuals to take advantage of opportunities to enrich their lives, as well as the lives of others, in the world around them.

Source: UNESCO and UNICEF report, "Technologies & the Future of Learning & Education for All", with support from other UN agencies.

For example, according to some estimates, some 10% of the population at any time may have dyslexia, a neurological learning disability that affects reading and writing but does not affect general intelligence. Children with dyslexia can learn coping strategies to deal with its negative effects. Unfortunately, in many cases, dyslexia may be detected too late for effective intervention. Change Dyslexia is a Spanish project that uses AI cutting-edge scientifically based computer games, such as Dytective Test and DytectiveU, to screen and support dyslexic children at largescale[7].

"Indonesia Belajar" (Indonesia's Learning) is a digital education programme focusing on increasing digital literacy in Indonesia. It uses technology to make education more accessible for children across the country. In 2017, five major Indonesia Belajar programs

were launched which have supported some 2,500 teachers and 50,000 students to date. These programs leverage VR and AR to educate communities about digital literacy and improve community learning, with long-term benefits for remote areas across Indonesia. Viewpoint 24 describes the use of digital technologies for education in Africa

Viewpoint 24: Digital Technologies for Education in Africa

African countries are embracing ICT, broadband and digital education in national development, and are building ICT infrastructure in educational institutions to enhance digital learning. Schools and tertiary institutions are connecting to the Internet, enabling teachers and students to access online educational materials and the latest publications, broaden their knowledge and learn what is happening globally, as well as enable them to use social media to connect with other students.

A study by UNESCO reveals that digital literacy is two-way – both instructors and learners need to be digitally literate. Digital education is rewarding to students as they increase their knowledge through 'presentations, demonstrations, drilling, practice, interaction and collaboration'. The report further states that 'over 87% of students learn best through visual and tactile modalities'[8]. Several initiatives are ongoing in Africa towards development of digital materials, such as the Open Educational Resources (OERs) project and Teacher Education for Sub-Saharan Africa (TESSA), which are popular with students.

Other challenges to digital education in Africa cited by the World Bank include:

- The absence of comprehensive policies to enable and support interventions, supported by clearly defined and resourced strategies for implementation at both the national level as level of educational institutions;
- Lack of financing and prioritization of ICT investments;
- Limited infrastructure of the kind required to support the use of ICT in education;
- Lack of capacity at all levels to integrate and support the use of ICT in education effectively;
- Lack of necessary ICT skills among teachers, and specific training;
- Lack of appropriate content;
- Lack of accurate, comprehensive, up-to-date data on education;
- The tendency of ICT to accentuate social, cultural and economic disparities.

It is believed that ICT can empower teachers and learners, promote change, and foster the development of 21st century skills, but data to support these perceived benefits from ICT are limited and evidence of effective impact remains elusive.

By creating enabling policy environments, countries are addressing ICT in the education sector as well as helping to promote and drive the national ICT agenda, including bandwidth and connectivity. In Kenya, the Government is integrating ICTs into education to enhance teaching and learning. There is a laptop project for primary school pupils, while higher education institutions are developing and implementing e-Learning policies[9]. Students are encouraged to own smartphones and/or tablets or laptops for easy access of educational materials. In Kenyatta University, for instance, there are several free computer laboratories with Internet access, as well as Internet hotspots. Distance learning students are issued with a tablet pre-loaded with learning materials for the semester. Over half of all students own a laptop, smartphone or another digital gadgets.

In Ghana, teachers have been trained to change their attitudes towards digital education. The Ghana Reads Program aims to provide more 'interactive teaching methods, breaking the traditional instructor/student hierarchy'[10]. Teaching coaches are assigned two schools each and work with teachers to help them in planning lessons and recording videos of teachers delivering lessons.

In South Africa, embracing digital technology is seen as a means to transforming the economy. Despite there being many e-Education initiatives, however, few have been able to pave the way for the larger-scale uptake of e-Education, which may be partly due to insufficient budgets, lack of human readiness, or inadequate technology deployment. Programmes must address the different pillars of infrastructure, technology, the human factor, and policy and funding.

African countries can focus on the rural and remote areas to build digital villages or establish Internet hotspots where students and other digital literate people can have easy access to the Internet, as well as developing inclusive policies for digital education.

Source: Dr. Speranza Ndege, Kenyatta University.

4.2 Digital Technologies for Health

Digital technologies can be used for a range of purposes to promote positive health outcomes and to support health systems to cope with their growing disease and cost burdens[11]. Mobile-based products in health insurance and remittances can help expand coverage while reducing waste and inefficiencies in health system financing. They can enable organizations and health managers to collect data on dashboards, providing real-time evidence for decision-making. New technologies such as 5G and AI can provide new applications for the e-health applications (remote surgery, remote diagnostics etc.).

According to GSMA, 26% of global mobile users access services that help them to improve or monitor their health and/or the health of their family on a mobile phone.

The sources and quantities of health data from mobile devices, Internet searches and wearables are growing. Growth in computing power and predictive analytics is enabling the study and use of vast amounts of information that reveal patterns, trends and associations, thanks in part to big data. For example, mobile data records and big data have been used to track the migration of people with Ebola in Sierra Leone, the spread of dengue fever in Pakistan[12] and cholera in Haiti. With regards to AI, IBM has outfitted Watson, its "cognitive computing" platform, to tackle multiple challenges in healthcare[13].

Governments, health authorities and other stakeholders are moving to capitalize on these advantages. For example, the number of mHealth products and services has doubled in the past five years in LMICs[14], and there are now over 165,000 mobile applications for health services[15]. Fifty-nine percent of patients in the LMICs are using mHealth applications and services versus 35% in high-income countries[16]. Globally, 44% of mobile users have seen a medical professional using a mobile device during diagnosis or treatment[17], and 86% of clinicians believe that health applications can facilitate diagnosis[18]. There is clearly a need to meet growing demand through digital health solutions. Viewpoint 25 explores the impact of digital health on Non-Communicable Diseases (NCDs) for Universal Health Coverage (UHC). Viewpoint 26 explores mobile's role in driving behavioural change for underserved communities, while Viewpoint 27 explores the work of the Carlos Slim Foundation in Mexico.

Viewpoint 25: Promoting Digital Financial Inclusion

Tackling NCDs is essential to accelerating progress towards Universal Health Coverage (UHC) as more than 75% of Non-Communicable Disease (NCD) deaths (around 31 million) occur in LMICs. This situation is coupled to an ageing population worldwide and

shortages of health workers. Integrated primary health care is fundamental to address the needs of patients with NCDs but health systems in many LMICs are currently ill-equipped to face the rising burden of those chronic diseases. Digital health can become a game changer to revolutionize the way healthcare is delivered, strengthen primary health care and expand UHC, if (and only if) it helps to tackle the growing NCD epidemic. Although advocacy and attention has risen on NCDs, little awareness seems to prevail in many circles on the potential impact digital health could have on addressing this growing crisis.

Digital technologies can, for example:

- Increase quality of care by centralizing expertise to coach less skilled health workers with digital technologies;
- Optimize NCD screening and diagnosis opportunities by including and educating non-traditional health players and linking them to the health system through digital technologies;
- Accelerate health seeking behavior for (often asymptomatic) chronic conditions by raising awareness in the general population, on symptoms and signs, and the advantages of early diagnosis and treatment;
- Use real-time data for more efficient health planning, resource allocation, public health surveillance and research;
- Enable and accelerate the scale-up of prevention strategies;
- Improve supply chain management of critical health supplies and treatments;
- Offer digital continuous medical education to healthcare workers at different levels;
- Empower patients to take more responsibility in the management of their own health;
- Assure coordinated care pathways for chronic patients, across all levels of their healthcare including across multiple medical specialties;
- Provide opportunities for financing and reimbursement mechanisms to cover for chronic care.

In 2017, the Working Group published the report "Digital Health: A Call for Government Leadership and Cooperation between ICT and Health", which mapped the status of digital health and advocated for governments to take action on national digital health strategies to enable realizing the full potential of digital health. The Broadband Commission Working Group on Digital Health, chaired by the Novartis Foundation and Intel, will publish a new report in September 2018 on leveraging digital technology to strengthen Primary Health Care capacity to address policy and the needs of NCD patients in order to accelerate the achievement of UHC.

The report examines the promise of digital health for NCDs and UHC in LMICs. It presents the findings of scientific studies with examples, where impact of digital health has been demonstrated on a patient, provider and system-level, with examples of digital health solutions. Digital health services must be fully integrated into the existing health system, and scaled for enhanced customer access and financial sustainability for long-term provision. Strategy, leadership and governance of coordinated actions are essential to ensure an aligned vision, goals and roadmap for digital health. Clear and consistent regulatory frameworks are needed to ensure safety and build trust for digital health solutions.

ICT infrastructure and common platforms must be accessible and interoperable

to ensure connectivity of digital health stakeholders and prevent fragmentation. Partnerships with stakeholders from public, private and non-profit sectors can help ensure delivery of digital health solutions with maximum social impact. Financing and business models are needed which focus on revenue streams and cost containment measures for the infrastructure and provisioning of digital health services.

Source: Novartis Foundation.

Viewpoint 26: Mobile's role in driving behavioural change for underserved communities

With 75% of global mobile subscribers located in LMICs and regional penetration rates forecasted to range from 50% in Sub-Saharan Africa by 2020[19], mobile is uniquely positioned to distribute educational information to underserved communities that otherwise lack access to essential information, enabling them to make better and informed decisions. At the same time, Mobile Network Operators (MNOs) can increase their relevance in the market by providing such services. In particular, MNOs derive value from offering mobile health (mHealth) information services through indirect benefits of improved customer loyalty and brand perception as well as a growing customer base. Additionally, providing an mHealth service that can be leveraged by governments and other organisations is an emerging opportunity for MNOs and health tech providers that could then lead to business-to-government or business-to-business revenues.

Since 2013, the GSMA mHealth programme, funded by DFID, has been working with MNOs and mobile and health stakeholders to support the launch and scale of mHealth services in GSMA mNutrition Initiative. As of May 2018, these mHealth services have delivered lifesaving maternal and newborn child health and nutrition information to almost two million families across eight Sub-Saharan African countries: Malawi, Ghana, Tanzania, Kenya, Nigeria, Zambia, Uganda and Mozambique. The GSMA and its partners adopted a human-centred design and iterative product optimisation approach across all eight markets. The key findings from the implementation of the GSMA mNutrition Initiative were:

- **Mobile is bridging the gap in access to life-saving information.** For one in three mHealth service users, these services are the only source of nutrition information available.
- **mHealth service users are improving their nutrition knowledge.** Knowledge levels on the appropriate use of supplements were improved by 16 percentage points among users, in comparison to non-users. Similarly, knowledge on appropriate breastfeeding practices was improved by 11 percentage points among users compared to non-users.
- **Mobile information services drive behaviour change.** Across 8 implementing countries, 69% of users demonstrated appropriate nutrition behaviours in comparison to 56% of non-users.
- **Mobile information services have a strong impact with new or poorly understood concepts**. In Kenya, only 5% of non-users could correctly recall appropriate supplementation practices in comparison to 41% of mHealth service users.
- **Mobile information services improve knowledge, even when existing knowledge around certain nutrition topics is already reasonably high**. In Uganda, 90% of non-users correctly recalled breastfeeding should be initiated within one hour of birth. mHealth service users still demonstrated a seven percentage point improvement

on this, with an average of 97% of them correctly recalling this practice.

- **Repetition and reminders of key health practices reinforces the behaviour.** In Uganda, providing four messages on exclusive breastfeeding as opposed to just two, over a four-week period, increased adherence to this practice by eight percentage points. In Tanzania, 78% of users who recall receiving clinic appointment reminders declared that they went to the clinic in response to receiving the reminder.

- **Positive user experience results in widespread sharing of information.** 43% of users report sharing information from these services with at least four other people.

Although the proportion of the Sub-Saharan African population that is undernourished has decreased from 33% between 1990-1992 to 23% between 2014-2016, much progress still needs to be made to eradicate hunger. The findings from GSMA's mHealth programme suggest that mobile technology accelerates progress towards SDG 2 (Zero Hunger) and SDG 3 (Good Health & Well-Being).

Source: GSMA.

Viewpoint 27: Accelerating the Implementation of Digital Health as a Public Policy in Mexico

With 111.7 million subscribers to mobile phones and 80.2% of them using a smartphone, 79.1 million users of Internet and 76.9 million of subscriptions to mobile bandwidths in a country with 119 million people, Mexico has rapidly adopted mobile technologies into their daily lives. Digital Health will play a catalytic role in modifying the current paradigm of healthcare by strengthening health interventions that target the basis of the pyramid, thus democratizing effective access to health services. In addition, Digital Health will empower citizens to demand quality care services, and will transform the way health professionals, the health systems and patients interact.

Since 2007, the Fundación Carlos Slim (FCS) has devoted its work to structuring health models that strengthen primary care and support a reengineering process in prevention and disease management in two dimensions: enabling personalized public health with precision profiling, and its implementation throughout the care continuum. In particular, FCS has worked in the design, development and scale of models around non-communicable diseases (NCDs), maternal and child health and vaccination. By convening a strategic partnership with Mexico's Ministry of Health, these models have become a public policy with a national scale, securing sustainability:

- CASALUD is an innovative model that strives to reengineer primary healthcare services, centering its model on proactive prevention and systematic risk assessment of NCDs through MIDO™, a strategy that enables precision profiling through a series of algorithms. In addition, health professionals can perform systematic risk and disease management with SIC™. CASALUD currently operates in 12,000+ primary care clinics in the 32 states of Mexico, and is now seeking its expansion in other LMICs.

- AMANECE assures the continuum of care from the pre-conception at the community, to systematic risk assessment during prenatal care at the primary care clinic and the hospital, to obstetric care and monitoring of high-risk pregnancies, and is implemented in networks of care that connect the community with primary care clinics and the hospital. AMANECE today operates in 100+ municipalities with the greatest risk of maternal mortality, reaching 100,000+ pregnant women.

- **SIIVac strengthens the immunization program with the implementation of the Electronic Vaccination Schedule, enabling health professionals to register the application of vaccines in children and adults, creating a nominal registry, alongside the monitoring of cold chain and supply chain. It is implemented both at the clinic and at the community. SIIVac today operates in 20 states, and will reach 2.5 million children by December 2018.**

These three models incorporate effective management strategies to discuss best practices, monitor the operation of these solutions and assess their performance. Finally, health professionals, stakeholders and citizens can analyze the performance of these clinics, and thus enable accountable care through online integrated dashboards.

Source: Fundación Carlos Slim, Mexico.

4.3 Digital Technologies for the Environment

The evidence is mounting to suggest that considerable challenges are emerging with respect to our natural environment. The most common environmental threats are loss and degradation of natural habitat, but unsustainable exploitation, invasive species and pollution are also proving major threats[20]. Digital and sensor technologies offer opportunities to monitor the environment and wildlife populations accurately.

Big data analysis can be used to help update old-fashioned reporting of animal populations. For example, WWF and the Zoological Society of London (ZSL) have developed the Living Planet Index (LPI) and Database as a measure of the state of global biological diversity based on population trends of vertebrate species from around the world, with time-series data for over 19,500 populations of more than 4,000 mammal, bird, fish, reptile and amphibian species.

ICTs and sensor technologies can play a big role and offer huge potential for game-changing solutions. With big data and technologies, the time for companies and governments underplaying deforestation, wildlife trade, poaching or illegal fishing is over. AI can be used to help boost protection and resilience of natural systems.

Remote sensing plays an important role in planning, monitoring, and evaluating WWF's work on the ground and has enabled WWF to monitor the developments of extractive industries in socially and ecologically-sensitive areas, including World Heritage sites. The Natural Capital Project uses remote-sensing-based natural capital assessment to guide jurisdictional development planning, mapping supply risk for corporate sourcing decision, and helping conservation organizations target investments in forest restoration.

ICTs can be used extensively to observe, monitor, track and protect our terrestrial wildlife from poachers as well as other destructive activities. WWF is working with governments and enforcement agencies to explore, fund, and test a wide range of technologies becoming available for wildlife conservation – from drones and wildlife tracking to radar, thermal cameras and gunshot detectors. WWF has found that unmanned aerial vehicles or UAVs function best as 'reactionary eyes' in the sky. WWF is testing civilian-grade UAVs for conservation applications with plans to rigorously test the technology in protected areas in Malawi, Namibia and Zimbabwe.

Thermal imaging cameras have been used by anti-poaching teams in Lake Nakuru National Park and in the Maasai Mara Game Reserve to increase the chances of catching poachers hunting antelope and rhinos by over 60%. Anti-poaching teams have also been able to achieve all this with smaller numbers of patrol teams. Wildlife management using tracking collars can also help conservation efforts – for elephants and lions in Kenya.

However, the use of these new technologies is open to question – they can be used to protect the environment, as well as to enable humankind to exploit natural

resources more effectively. For example, the same tracking technologies can be used to monitor natural populations of tunafish in the oceans or lions on land, or they can be used to hunt the same animals or to stimulate and attract public interest[21].

Big data can help generate and analyze a greater number of on-the-ground observations. For example, the University of Minnesota's Lion Project has deployed 225 camera traps across 1,125 square kilometers in the Serengeti National Park in Tanzania to evaluate spatial and temporal dynamics since 2010 to produce 1.2 million sets of pictures by 2013. Members of the general public classified the images via a citizen-science website[22]. The project applies an algorithm to aggregate the classifications to investigate multi-species dynamics in an intact ecosystem[23].

With regards to marine life, the Republic of Indonesia has partnered with Global Fishing Watch (a partnership between Google, Oceana and SkyTruth) to deliver Vessel Monitoring System (VMS) data for Indonesian flagged fishing vessels in a publicly-available platform. The project aims to promote transparency in the fishing industry[24] as to which ocean areas are fished and for which species of fish.

Endnotes

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3 https://theodi.org/what-is-data-infrastructure

4 "*Data-Driven Development*", ICT4 Development Report 2018, World Bank (forthcoming).

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6 HLCP Discussion Paper, "Technologies and the Future of Learning & Education for All", prepared under the leadership of UNICEF and UNESCO, with support from other UN agencies.

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