MAY 2019

Beyond Technology

The Fourth Industrial Revolution in the Developing World

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CSIS | CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES

A Report of the
CSIS PROJECT ON PROSPERITY AND DEVELOPMENT

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Introduction

Evolution of Revolutions—The Human Element of Technological Change

By Daniel F. Runde and Aaron Milner

Technological Myopia

There are not going to be driverless Ubers in Lagos anytime soon. Robots are not going to steal millions of jobs from American miners or factory workers. Nor will our genes be spliced with technological enhancements to defeat diseases and to supercharge our neurons. Not yet, at least.

But we are beginning to see symptoms of the globally disruptive phenomenon known as the Fourth Industrial Revolution (4IR).[1] Rapid periods of past technological industrialization have created tectonic shifts in societies throughout human history. Diverse technologies have grown and scaled to knock off behemoths and traditions to become the next giants themselves.

Some of these technologies that will define next-generation human enterprise, connectivity, and lifestyles already are here, but they haven't been scaled to everyday utilization. For example, the vertical lift technology for flying cars has been around for years, but the regulatory environment, legal considerations, and other issues currently outweigh the benefit to innovate. Just because society has these technologies does not mean they will roll out. There are growing speed bumps to technology around privacy, competition, and equitable access. Technologies' dramatic impact on everyday life could take a long time, but just like previous revolutions, if we do not plan for these evolutions now, we won't benefit from them in the future.

The first industrial revolution, powered by the steam engine, dramatically spurred production and urbanization. New forms of energy such as electricity and oil defined

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1. The 4IR—first coined by Klaus Schwab of the World Economic Forum in 2015—refers to the newest technological revolution "changing the way we live, work, and relate to one another." Klaus Schwab, "The Fourth Industrial Revolution: What it Means, How to Respond," World Economic Forum, January 14, 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.

the second industrial revolution whereas the third industrial revolution saw the introduction of digital technologies such as computers, cell phones, and the internet, which in turn have revolutionized communications and trade. The Fourth Industrial Revolution also encompasses those digital technologies, but the phenomenon is defined more by next-generation innovations—such as artificial intelligence (AI), robotics, and nanotechnology—becoming more complex and irreplaceably ingrained in all aspects of human life, including our physiology.[2] Although the revolutions all were defined by innovation, their most important legacies are their impacts on humanity and society.

Will the Fourth Industrial Revolution Be Different?

The effects of the 4IR are only beginning to be felt, though we have little way of knowing how far these shockwaves will ripple into our lives and history. Some even are skeptical about defining these periods of technological change at all.[3] But these debates about future impacts should not result in myopic inaction or complacency. More important and immediate than robots replacing human labor is preparing for future trends that in one way or another will prove disruptive. Whether you agree that the 4IR is here or not, few can argue that societies stand to benefit from anticipating the impacts of innovation. Nevertheless, many institutions, including governments, would rather lean on industries of the past rather than lean into changes of the future.

> *Many institutions, including governments, would rather lean on industries of the past rather than lean into changes of the future.*

Past technological changes always have resulted in economic growth. But they also often have seen uneven growth and always have come with disruptive growing pains. Underserved members of society—like women and people of color—and developing countries have been excluded from the benefits of innovation-led economic growth. Lagging access to technological resources continually prevents billions of marginalized people from contributing to modern formal economies. If there is something we can learn from past technological revolutions, it is the need to properly manage change. In this regard, the 4IR will be no different, especially as more complex technologies affect more people in more regions in diversified ways.

A Developed Country Phenomenon

In the developed world, we already see reactions to the 4IR. Although mechanization, automation, new technology, and globalization have displaced humans from traditional labor, these trends also have created new types of labor and industries.

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2. "The 5th Industrial Revolution: When It Will Happen and How," DevOps.com, December 27, 2017, https://devops.com/5th-industrial-revolution-will-happen/.
3. Andrew Fursman and Georgia Frances King, "We're thinking about the fourth industrial revolution all wrong," Quartz, January 29, 2019, https://qz.com/1515869/were-thinking-about-the-fourth-industrial-revolution-all-wrong/.

But economic displacement has contributed to societal resentment of institutions, the rise of populist politics, and even retrenchment into isolationism. A growing portion of society—one that has been a prime beneficiary of past industrial revolutions—feels disconnected, disenchanted, and disempowered, even though technology was thought to have the opposite effect. Developed countries have benefitted immensely from every industrial revolution thus far, sometimes at the expense of developing countries.

These mainly Western countries, however, have rested on the laurels of technological dominance for too long, relying on technologies of the past rather than focusing on innovation for future leadership. Especially in the United States, dependence on industries of the past has sacrificed global leadership and its correspondent advantages. The attempt to continually rely on earlier innovation stifles the ability to get ahead of coming evolutions. The United States increasingly leaves global decision making to countries like China as it tries to preserve short-term gains and growth.

A Developing Country Phenomenon

Developing countries are experiencing the same 4IR, but in dramatically different ways. In fact, many countries are experiencing all the industrial revolutions at the same time. Countries from Africa to Asia and Latin America to Eastern Europe are simultaneously urbanizing and industrializing for the first time. They are building the infrastructure of the second and third industrial revolutions, powering emergent production and manufacturing with technology rather than people while also adopting the technologies of the 4IR quicker than developed countries.

> *Developing countries are experiencing the same 4IR, but in dramatically different ways. In fact, many countries are experiencing all the industrial revolutions at the same time.*

This confluence of revolutions sets developing countries on a new "leapfrogging" growth trajectory that may not reflect how the United States, Canada, Europe, and other developed regions emerged. Innovators in developing countries can—and do—incorporate their cultures, values, and needs into solutions to the needs of their own economies.[4] They target solutions at growing youth unemployment, high informality, new infrastructure, migration, conflict, resource constraints, and urbanization. Developed countries would stand to benefit from recognizing and ingraining these local needs into emerging market engagement.

Most important, whereas these developing economies used to be mainly consumers of technology, they now are becoming producers. Increasingly as technology is designed and built for developing countries and by developing countries, these regions will drive innovation out of necessity to realize the economic growth that has been promised for so long. Adoption rates for foreign technology like mobile money show the matured appetites for economic engagement in developing countries—with fragile countries like Somalia

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4. Lonny J Avi Brooks, "The 21st century belongs to China—but the 22nd will be Africa's," Quartz, February 21, 2009, https://qz.com/1550626/chinas-investment-will-allow-africa-to-lead-the-22nd-century/.

even surpassing U.S. usage—but local production can spur even greater heights through accounting for local needs and culture.[5]

ETHICS AND EMPOWERMENT

Of course, just because innovators can do something does not necessarily mean they are, particularly when it comes to weighing ethics with profit. Regions—and countries within regions—are following different trajectories that ultimately will affect the number of potential workers, the composition of the workforce, and the types of jobs created. Growth continues to be uneven, with many left behind. Many developing economies face wage stagnation, "jobless growth," and difficulty creating meaningful work opportunities for their citizens. Increased trade, environmental challenges, and migration are posing challenges and creating opportunities. Women and girls—who have been historically repressed and disenfranchised in developed and developing countries—could be empowered like never before through equitable access to technology and innovation. They could also be targeted and marginalized by people and groups using the same resources.

Therefore, there needs to be a shift from just enabling technological change to understanding what new technologies mean for people. People will either be empowered to contribute to world progress by technology or will be left to deal with issues we thought were exclusive to previous industrial revolutions. The inflection points of previous revolutions always have centered around humans: those who worked the mines, the factories and the mills, those who built the railroads and powered the power plants, and those who built networks and the internet.[6] The 4IR is no different. It is time to think about the types of jobs, skills, and safety nets that economies—especially those in the developing world —need to meet people's aspirations.

Thinking About the Fifth Industrial Revolution

Without thinking strategically about the implications for people of a future characterized by 4IR-related disruptions, we run the risk of suffering the dystopian outcomes while reaping few of the opportunities presented by innovation and technology. Technology companies already face significant legal and moral questions about their management of personal data. And from a regulatory perspective, the lack of policies protecting against abuse emboldens and empowers unethical behavior. A growing "techlash" against technology companies can be an outlet for societal frustration with institutions unable to handle the dark side of innovation.[7]

The goal of this anthology is to present these challenges alongside opportunities for rethinking how we approach the Fourth Industrial Revolution. The Project on Prosperity and Development at the Center for Strategic and International Studies compiled these essays to inspire, to anticipate, and to prepare policymakers and the public for technological change. This anthology features some of the world's foremost thinkers on the 4IR. Rather than predict when you'll get your package delivered by drone, they aim

5. Victor Odundo Owuor, "Mobile money transactions in Somalia are overtaking Kenya, but there are significant risks," Quartz, October 12, 2018, https://qz.com/africa/1422018/somalia-mobile-money-beats-kenya-mpsea/.
6. Fursman and King, "We're thinking about the fourth industrial revolution all wrong."
7. Kaveh Waddell, "Keeping AI away from the bad guys," Axios, February 21, 2019,   https://www.axios.com/keeping-ai-away-from-bad-guys-e0bee227-cdf9-4139-8bcf-dc15eedd0f37.html.

to spur debate on how to craft forward-thinking policies that provide for the worker displaced by that drone, that ensure the drone is manufactured sustainably and ethically, and that pursue regulations on the drone-producing industry. They aim to challenge your assumptions and broaden your understanding.

> *Without thinking strategically about the implications for people of a future characterized by 4IR-related disruptions, we run the risk of suffering the dystopian outcomes while reaping few of the opportunities presented by innovation and technology.*

In this anthology you will find discussion of how 4IR technologies might affect people, societies, various sectors and institutions, and governance systems. The first two chapters set the stage, describing the 4IR and the tensions new technologies pose in geopolitics, labor markets, privacy, and other issues. The following four chapters take a deeper dive into social, economic, and financial issues the 4IR represents; including the confluence of technology with gender and financial regulations, its impact on the future of work and labor in developing countries, and how technology can power a sustainable infrastructure. Finally, the anthology concludes with a call for countries to ensure that internet connectivity—without which the 4IR would not have happened—is realized for all.

The 4IR is limitless in its reach across every aspect of our lives. The technologies that make up this revolution are important; their impact on humans, on society, and on our institutions is more important. Future industrial revolutions are on the horizon, and we have learned incomplete lessons from the past. Although a driverless Uber may not pick you up tomorrow in Lagos and a robot may not deliver your next Amazon package, we need to prepare for those eventualities now, so when they do happen, we will reap the benefits and spend our time planning for the Fifth Industrial Revolution, whatever that may be.

1 | Technology and the New World Order

Risks and Opportunities

By Casper Klynge

I clearly remember my first meeting after arriving in Silicon Valley. It was a scorching hot day in the Bay Area with temperatures easily in the nineties. Together with my deputy, I had made my way to Mountain View, about 40 miles south of San Francisco, to meet with a leading engineer at Google headquarters. The engineer had been headhunted to work on speech recognition, a key ingredient in Google's emerging AI technology. I was dressed, as any government official, in a dark suit, dress shirt, and shiny office shoes. He greeted us in the lobby in shorts, sneakers, and a novelty t-shirt—a first valuable lesson in Silicon Valley attire for a career-diplomat out of his comfort zone.

More important, we spent the next hour talking about how Google drives machine learning and artificial intelligence across the organization; for example, these tools make it possible to convert audio to text in 120 languages by applying powerful neural network models. The meeting left no doubt in my mind that today, it's the Googles, Apples, Amazons, Alibabas, and Tencents of this world driving cutting-edge innovation with a pace and global impact unlike any time in history. Democratically elected governments, on the other hand, run the risk of being left behind in this digital reality where private companies make bigger global decisions. It was an eye-opener: welcome to the digital twenty-first century!

More than 18 months into the job as Denmark's (and the world's) first tech ambassador, I have seen the initial lesson from Google confirmed and reinforced in countless meetings. Yet we have only seen the tip of the iceberg in terms of how new technologies will reshape our societies. The impacts of the so-called Fourth Industrial Revolution truly will be transformational, with a pace and complexity that will challenge our governance structures at every level from local to global. For industrialized and developing countries alike, digitization holds enormous potential for driving sustainable economic growth, job creation and entrepreneurship, and homegrown innovative solutions to society's challenges.

Over the course of the last year, however, it has become increasingly evident that technology brings not only incredible opportunity, but also real risks and threats to democratic societies worldwide, for example, job loss, cyber security and privacy threats, and other assaults on society. The very technologies and platforms originating in liberal democracies can be hijacked and turned against us to exploit existing weaknesses and divides in our societies. As public perception of platforms and the tech industry has changed, the urgency of our mission has only increased. Balancing the inherent risks and opportunities in a human-centered approach to technology is one of the most crucial tasks of our time and one that will shape geopolitics for decades to come.

> *Balancing the inherent risks and opportunities in a human-centered approach to technology is one of the most crucial tasks of our time and one that will shape geopolitics for decades to come.*

The Digital Compass Is Turning

Two major global trends are driving this profound transformation: first, technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and the use of Big Data to develop new business models and services represent enormous potential for global prosperity and well-being at both the societal and individual level. Technology is reinventing global communication and business models and presents unprecedented opportunities for collaboration and innovation across the globe (i.e., precision medicine, remote education, safer and faster transportation, or cleaner energy sources). However, the growing influence of technology on society also is spurring the disruption of long-established institutions and creating new challenges for our democracies.

Second, a select number of highly successful multinational tech companies have grown extremely influential, to the point where their economic, political, and societal power match—or in some cases surpass—that of nation states. In economic terms, the world's largest tech companies would qualify as G20 members if they were actual countries, with average revenue targets easily outweighing the GDP of most countries, including my own. Some CEOs—not only of tech companies—have higher net worth than national GDPs, yet there still are questions about the persistence of inequality. In 2018, Apple became the first company to hit the $1 trillion market cap.[1] This equals roughly 5 percent of the yearly GDP of the United States and exceeds the GDP of more than 183 countries worldwide. Moreover, with hundreds of millions (or in Facebook's case, 2.5 billion) monthly users worldwide, today's digital platforms and tech giants enjoy an unprecedented global reach and influence.

The political—and geopolitical—ramifications of these interlinked trends are becoming increasingly evident. We are moving away from the unchallenged technological

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1. Sara Salinas, "Apple hangs onto its historic $1 trillion market cap," CNBC, August 2, 2018, https://www.cnbc.com/2018/08/02/apple-hits-1-trillion-in-market-value.html.

supremacy of the United States to a much more fragmented global landscape with a more unpredictable foreign policy reality, as state and non-state actors compete for influence, and digital capabilities become more important than ever. Political leaders, commentators, and technologists increasingly talk about a digital arms race in which not only China and the United States, but also their respective tech giants, will compete for predominance.

Geopolitics of AI

AI is likely to be the next battlefield in a shifting global balance of power. China has announced a large-scale plan to become the world's number-one AI hub by 2030, with a 1 trillion renminbi AI core industry. If China realizes this level of investment, it will outspend the European Union more than tenfold every year. We are starting to see these trends materialize. According to CB Insights, roughly half of the world's equity investments in AI startups in 2017 went to China, just under 40 percent to the United States, and the remaining 14 percent to other regions, including Europe.[2] China's entrepreneurial spirit can be seen through the emergence of tech giants like Alibaba and Baidu as well as some of the world's highest-valued AI startups like SenseTime, Face++, and ridesharing unicorn Didi.

> *AI is likely to be the next battlefield in a shifting global balance of power.*

In his recent book *AI Superpowers: China, Silicon Valley and the New World Order*, Kai-Fu Lee—author, investor, and former head of Google China—argues why China is likely to emerge as a global AI leader in the next decade: the combination of strong backing from the Communist Party, access to public and private capital, a thriving entrepreneurial ecosystem characterized by fierce gladiatorial style competition, and relatively unhindered access to almost endless amounts of data from its 1.4 billion population. In his book, however, Mr. Lee spends less time discussing the normative and ethical questions of AI, such as protection of privacy and fundamental human rights.

It seems clear that AI will be one of those technologies that will influence—and exacerbate—current trends in the global balance of power, especially between the United States and China. Meanwhile, the European Commission has responded by proposing a *European Approach to AI*—a sort of third approach to technology and regulation that emphasizes not only new investments in AI but also a stronger focus on its socioeconomic impacts and appropriate ethical and legal frameworks. By demonstrating a higher readiness to regulate the global tech industry, epitomized by the entry-into-force of the General Data Protection Regulation (GDPR) in 2018, the European Union has emerged as the de facto leader in crafting policies and regulations for the digital age. EU regulation is not without difficulties or challenges for users and companies alike, but it nonetheless is inspiring other parts of the world.

Powerful states competing for international influence through technological innovation

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2. Deepashri Varadharajan, "State of Artificial Intelligence in China," CB Insights, https://www.cbinsights.com/research/briefing/china-in-ai-trends/.

of course is not new; however, the quest for digital supremacy marks a new era in international politics. In the words of Russian President Vladimir Putin: "Whoever becomes the leader in artificial intelligence, will become the ruler of the world." [3] Given developments in recent years on the world stage, statements like this should attract attention in many capitals. In the twenty-first century, the keys to change are increasingly held by those who master new technologies; the local and global governance structures that we have relied on for decades increasingly are challenged by the pace, reach, and impact of technology.

This shifting paradigm raises several fundamental questions: How do we balance societal benefits and risks of technology? How should global governance adapt to new digital realities? Do we need to do more to safeguard our democratic institutions in a time of disinformation and cyber warfare? And how do we close the digital divide to ensure all regions and countries benefit from digitization?

International Cooperation

The international community is beginning to recognize the profound transformation and impact digital technology represents. At the global level, United Nation's Secretary-General António Guterres has set out a path to bring the UN into the digital twenty-first century. In 2019, his High-Level Panel on Digital Cooperation will deliver recommendations to strengthen international cooperation in the digital space "to ensure a safe and inclusive digital future for all taking into account relevant human rights norms."[4] The panel consists of twenty representatives from industry, civil society, and governments, chaired jointly by Melinda Gates and Jack Ma—co-founder of the Chinese conglomerate Alibaba.

The Office of the UN High Commissioner for Human Rights (OHCHR) also has increased its engagement with the technology sector, creating space for dialogue between human rights experts, tech companies, and others to address the growing challenges.[5]

And there are other examples. In Europe, Frederica Mogherini, the EU High Representative, has established a Global Tech Panel to promote new types of cooperation between diplomats and technology companies.[6] The World Bank has launched a Disruptive Technologies for Development Fund to pioneer innovative solutions in development finance.[7] The OECD is spearheading work to develop new approaches to digital taxation, among other things.[8] The World Economic Forum has established a Centre for the Fourth

3. "Putin: Leader in artificial intelligence will rule world," CNBC, September 4, 2017, https://www.cnbc.com/2017/09/04/putin-leader-in-artificial-intelligence-will-rule-world.html.
4. "United Nations Secretary-General Appoints High-level Panel on Digital Cooperation," United Nations, July 12, 2018, http://www.un.org/en/pdfs/HLP-on-Digital-Cooperation_Press-Release.pdf.
5. "Human rights in the world – today and tomorrow," Office of the High Commissioner for Human Rights, November 14, 2017, https://www.ohchr.org/en/NewsEvents/Pages/DisplayNews.aspx?NewsID=22395&LangID=E.
6. "About the Global Tech Panel," European Union, September 21, 2018, https://eeas.europa.eu/category/tags/global-tech-panel_en.
7. "World Bank Group and Credit Suisse Launch Disruptive Technologies for Development Fund," World Bank, May 1, 2018, https://www.worldbank.org/en/news/press-release/2018/05/01/world-bank-group-and-credit-suisse-launch-disruptive-technologies-for-development-fund.
8. "Tax Challenges Arising from Digitalisation: More than 110 countries agree to work towards a consensus-based solution," Organisation for Economic Co-operation and Development, http://www.oecd.org/tax/tax-challenges-arising-from-digitalisation-more-than-110-countries-agree-to-work-towards-a-consensus-basedsolu-

Industrial Revolution in San Francisco to promote agile governance and pilot digital solutions for maximum societal impact.[9]

Although such multilateral initiatives are by no means straightforward given the obvious differences in national positions and the complexity of the issues, they clearly illustrate a growing realization—within the UN and other multilateral and regional organizations—that we need both industry and governments around the table to find effective, global solutions.

The Rise of TechPlomacy

National governments worldwide also are stepping up domestic and foreign policy efforts to address technological disruption. Australia, France, Germany, Bulgaria, and the Netherlands all have appointed envoys dedicated to digital affairs, cyber security or entrepreneurship, and the UAE became the first country to appoint a minister for artificial intelligence. Over the past two years, 25 or so countries have developed national AI strategies and several more are developing strategies for adopting Internet of Things and Blockchain.[10]

Denmark responded in 2017 by elevating technology and digitization to a crosscutting foreign and security policy priority. The government's TechPlomacy Initiative established a diplomatic mission for technology and created the new position of tech ambassador. The initiative recognizes not only the important role technology plays today but also the global influence and reach of multinational tech companies in the twenty-first century.

The underlying argument is simple: with global influence comes global responsibility. We expect the global tech industry to engage with policymakers, civil society, and international organizations to identify adequate responses to some of the challenges brought about by data-driven technologies. With a mandate that bridges domestic sectors and foreign policy, and tech representation that spans Silicon Valley, Copenhagen, and Beijing, TechPlomacy aims to redefine the traditional notion of diplomacy by engaging the borderless tech industry, in much the same way we engage countries.

On behalf of Danish authorities, we engage in a frank dialogue with the technology sector, on issues where we agree and disagree, to make Danish and European viewpoints clear and find common ways forward. By bringing the big policy debates to the doorstep of the global tech companies, we aim to reinforce, not erode, the role of governance and nation states in the digital age. Not to replace but to augment our traditional bilateral and multilateral diplomatic efforts.

> *By bringing the big policy debates to the doorstep of the global tech companies, we aim to reinforce, not erode, the role of governance and nation states in the digital age.*

tion.htm.
9. See World Economic Forum Centre for the Fourth Industrial Revolution, https://www.weforum.org/centre-for-the-fourth-industrial-revolution.
10. Tim Dutton, "An Overview of National AI Strategies," Medium, June 28, 2018, https://medium.com/politics-ai/an-overview-of-national-ai-strategies-2a70ec6edfd.

The case for rebalancing the power relationship between industry and democratically-elected governments has become increasingly evident in the past two years. The Facebook-Cambridge Analytica data scandal, which affected more than 87 million users, is a prime example of how technology has also brought about new challenges.[11] Facebook is not alone. Over the last year, we have seen a number of large data breaches from leading tech companies to airlines and hotel chains affecting more than half a billion users worldwide. Undoubtedly, the public debate around technology and society has matured as a consequence. Social media and digital platforms no longer are viewed merely as convenient ways to connect people around the globe but as a potential means to affect the outcome of elections, polarize democratic dialogue, spread hate speech and undermine rights, and exploit personal data.

The risks are becoming increasingly tangible: cyberattacks by hostile actors are causing more damage than ever before, as we saw when WannaCry and NotPetya hit both public and private organizations, costing billions of dollars and preventing them from operating—even disrupting hospitals.[12] The world's cyber experts agree that the bar to participate in the cyber domain has become lower and that attacks will continue to grow in frequency, size, and complexity. On the positive side, cyber awareness among business executives and governments alike has risen proportionally to the threat level, and we are seeing a growing number of concerted initiatives to counter cyber threats.

Thus, we find ourselves in a time where technology drives profound changes in societies across the globe shaping economic, political, and geopolitical structures. In this reality, nations must pursue the opportunities provided by digitization, but be equally prepared to address its inherent risks.

Open, advanced, and highly digitized economies such as Denmark are among the first to feel both the benefits and risks of digitization. But as the Fourth Industrial Revolution sparks new technological innovation and adoption across the globe, it may very well be the billons of people living in developing and emerging economies that have the most to gain—and lose—from technology.

Bridging the Divide

DIGITAL OPPORTUNITIES AND RISKS IN DEVELOPING COUNTRIES

More than 50 percent of the global population is now online, according to some estimates. Smartphones and mobile payments are creating enormous potential for developing countries to alleviate poverty and create homegrown, sustainable, and innovative solutions for some of the most entrenched global challenges, such as access to healthcare and education.

The positive examples are plentiful. India, Thailand, and Mexico have seen a significant economic boost by developing thriving software industries. Two hundred thousand farmers in Ghana now use mobile devices to track weather conditions, and Rwanda

11. Issie Lapowsky, "Facebook Exposed 87 Million Users to Cambridge Analytica," *Wired*, April 4, 2018, https://www.wired.com/story/facebook-exposed-87-million-users-to-cambridge-analytica/.
12. Andy Greenberg, "The Untold Story of Notpetya, The Most Devastating Cyberattack in History," *Wired*, August 22, 2018, https://www.wired.com/story/notpetya-cyberattack-ukraine-russia-code-crashed-the-world/.

has become a leader in using drones to deliver life-saving medicine to remote regions. Moreover, the rise of mobile banking across the globe has meant that hundreds of millions of people living in developing countries now have access to finance for the first time ever, paving the way for financial inclusion and a crucial step in escaping poverty. Digitization is rightly considered essential to achieve full implementation of the UN Sustainable Development Goals (SDGs) by 2030. For example, countries are accessing better healthcare through drones or promoting youth learning through remote education via online courses.

Although digitization increasingly empowers emerging markets, there still is a lot of work to do from a long-term perspective to ensure that developments are equitable, sustainable, and inclusive. Nowhere are the stakes higher than in Africa. With nearly 60 percent of Africans under the age of 25, the continent is facing a huge task in ensuring economic growth and job creation as most of these young people enter the labor market in the coming decades.[13] African youth undoubtedly will be an immense source of innovation and entrepreneurship in tech and digital sectors. This could further boost Africa's digital ascent in the coming years, with some commentators now talking about Africa as the next "tech continent."[14] However, as the World Bank and others have argued, there is a risk that without the right governance and policy structures, the "digital dividend" could turn into a widening digital divide, leading to renewed social instability, conflict, and migratory flows.[15]

Three areas will be of paramount importance for unleashing the digital opportunities in development and addressing the risks: 1) enhanced internet access for all, 2) promotion of digital skills to compete in the global economy, and 3) protection of democratic values, human rights, and effective governance amid a data-driven revolution.

There is a risk that without the right governance and policy structures, the "digital dividend" could turn into a widening digital divide, leading to renewed social instability, conflict, and migratory flows.

EQUITABLE DIGITAL INFRASTRUCTURE
First, to participate in the twenty-first century's wave of digitization, an expanded digital infrastructure is needed in addition to traditional infrastructure such as roads, schools, and housing. Internet access continues to expand across Africa, with more than 450 million people or 35 percent of Africans online at the beginning of 2018.[16] Households in many sub-Saharan African countries, such as Congo-Brazzaville, Tanzania, Ivory Coast, Sierra Leone, and Uganda, are more likely to have access to mobile phones than to toilets, clean water, and even electricity. Connectivity, however, continues to vary greatly both within and between countries.

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13. Bill & Melinda Gates Foundation, *The Goalkeeper's Report: The Stories Behind the Data* (Bill & Melinda Gates Foundation, 2018), https://www.gatesfoundation.org/goalkeepers/report.

14. Bill & Melinda Gates Foundation, "The tech continent: Africa's digital renaissance," *Guardian*, https://www.theguardian.com/world/series/the-tech-continent-africas-digital-renaissance.

15. World Bank, *World Development Report 2016: Digital Dividends* (Washington, D.C.: World Bank, 2016), http://www.worldbank.org/en/publication/wdr2016 .

16. *Internet Users Statistics for Africa*, Internet World Stats, https://www.internetworldstats.com/stats1.htm.

East Africa is a good example of the regional dynamics at play. With Kenya emerging as a regional tech-hub, around 90 percent of Kenyans access the internet via their smartphones and enjoy internet speeds almost twice the global average (for example, faster than the United States). Nairobi is boasting a growing startup scene and has become a leader in mobile payments with the pioneering M-Pesa system. In neighboring Ethiopia, however, more than 80 percent of the population lives outside urban areas, only half own a mobile phone, and of these, only one-in-five are smartphones with internet access.

Technology companies such as Google and Facebook have launched initiatives to expand broadband and mobile internet access across Africa, some of which have received widespread global attention. Critical voices argue that such initiatives are driven by a quest for data and the next billion online users rather than philanthropy.[17] Whatever the motives, technology companies undoubtedly will be important players and partners in creating the future of an increasingly digital African continent.

EDUCATION AND SKILLS FOR THE NEW JOB MARKET
Automation of the future labor market, and the resulting shifting demands placed on education and skills, is another major challenge for developing countries, as many tasks in agriculture, manufacturing, and industrial production are being automated. This trend could result in widespread job loss if traditional employment sectors deploy more technology and education systems fail to adapt. South Africa, for example, is widely considered the African nation best prepared to succeed in the Fourth Industrial Revolution. However, according to the World Economic Forum, more than 40 percent of existing work activities in South Africa are susceptible to automation. Although this is slightly lower than countries such as Nigeria, Kenya, and Ethiopia, the impacts in South Africa may very well occur faster than in other sub-Saharan countries because of higher salary levels.[18]

The challenge of large-scale job displacement is not new; we have seen this in previous industrial revolutions. The most significant difference with the data-driven revolution is the scale, cross-sectoral, and cross-border nature of its societal impacts. One prediction is that automation and 3D printing will gradually disrupt global value chains. Although this risk should probably not be overstated in the short run, it is easy to imagine the longer-term potential negative impacts on employment and industrial manufacturing in large-scale production hubs such as Bangladesh, Cambodia, and Kenya.

In terms of the future of education, some predict that skills in science, technology, engineering, and math will be vital, whereas others find that skills in the humanities are necessary to succeed in a world increasingly driven by algorithms. Either way, there will be a skills gap in the developing world because the jobs of tomorrow will require more formal education than what is currently available to large parts of the developing world.

17. Jessi Hempel, "What Happened to Facebook's Grand Plan to Wire The World?," *Wired*, May 17, 2018, https://www.wired.com/story/what-happened-to-facebooks-grand-plan-to-wire-the-world/.; Maeve Shearlaw, "Facebook lures Africa with free internet - but what is the hidden cost?," *Guardian*, August 1, 2016, https://www.theguardian.com/world/2016/aug/01/facebook-free-basics-internet-africa-mark-zuckerberg.
18. World Economic Forum, *The Future of Jobs and Skills in Africa: Preparing the Region for the Fourth Industrial Revolution* (Geneva: World Economic Forum, 2017), http://www3.weforum.org/docs/WEF_EGW_FOJ_Africa.pdf.

As labor market demands change, ensuring that digital skills and literacy are spread across society, not least among young people, women, and girls, will be one of the key tasks in the coming years.

SAFEGUARDING DEMOCRATIC INSTITUTIONS

It is essential to continuously promote and safeguard democratic values and institutions in developed and developing countries alike. Maintaining trust in society and electoral processes is more challenging than ever, and the ethical questions tied to protection and usage of personal data have become a truly global issue. As an example, the Facebook data harvested by Cambridge Analytica was used not only in relation to the 2016 U.S. presidential election but also in Kenya's tumultuous presidential election in 2017, which was marred by both violence and misinformation.[19]

As African countries become more digitally connected, risk increases from cyberattacks and misuse of digital platforms to spread false information and propaganda for political purposes. The balance between safeguarding free and open internet access on the one hand and increased state censorship and control on the other will be one of the key tests in years to come, for Africa and globally.

Where Do We Go from Here? A Balanced and Human-Centered Approach to Technology

More than a year has passed since our first meeting with the Google engineer in Mountain View. It was a year that has confirmed the underlying hypothesis of the Danish TechPlomacy initiative: it is possible to have a structured foreign policy dialogue with the global tech industry on everything from data breaches and privacy to cyber security, online extremism, disinformation, regulation, and the larger geopolitical question of how to ensure an inclusive digital development.

Has it been easy? Not exactly, or rather, it has been a mixed picture. Some companies immediately recognized the value of this kind of policy dialogue with forward-leaning governments. Others have been much more reluctant to engage in conversations at headquarters level. It has demanded a great deal of diplomatic elbow grease (and patience) from me and my entire team.

Even so, I believe Denmark and other likeminded countries and institutions have helped set an important international agenda at a crucial point in time. The Fourth Industrial Revolution undoubtedly will bring huge opportunities for developed and emerging economies alike. We must do everything we can to unleash the potential benefit for all. But we also must address the inherent risks and challenges of technology. That changing dynamic requires policy makers and governments to step out of their comfort zones and the global tech industry to take on a level of responsibility that matches their size and global influence.

As you read through the different essays in this anthology—on technology, finance, gender, labor, infrastructure, and policy—I hope you will feel this sense of urgency and the

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19. "Here's how Cambridge Analytica played a dominant role in Kenya's chaotic 2017 elections," CNBC, March 23, 2018, https://www.cnbc.com/2018/03/23/cambridge-analytica-and-its-role-in-kenya-2017-elections.html.

need for a new generation of public-private partnerships. Neither states nor companies can tackle the opportunities and risks of new technologies alone, and we have no time to waste. As Henry Kissinger wrote in a recent thought-provoking article on AI: "If we do not start this effort soon, before long we shall discover that we started too late."

> *As Henry Kissinger wrote in a recent thought-provoking article on AI: "If we do not start this effort soon, before long we shall discover that we started too late."*

2 | Defining the Technologies of the Fourth Industrial Revolution

By William Carter

Global society is undergoing dramatic and transformative changes driven by the rapid evolution of technology in, what is sometimes called, the Fourth Industrial Revolution (4IR). The first Industrial Revolution began in the latter half of the eighteenth century with the rise of water and steam-powered mechanical machines; the second with the rise of electrical machines powering mass production after the American Civil War; and the third in the 1980s with digital machines and automation.

In contrast to its predecessors, the 4IR cannot be reduced to any single technology. The Fourth Industrial Revolution is driven by a wide range of technological trends building on each other to create an exponential economic, social, and political transformation. Soon, embedded sensors and distributed computing power—the so-called Internet of Things (IoT)—will be brought together by ubiquitous fifth-generation wireless networks (5G) to create an unprecedented volume of digital data, all stored conveniently in a global cloud. Artificial intelligence (AI), powered by high-performance computing (HPC), will allow us to analyze and interpret that data, deriving a wealth of previously unavailable insight and enabling new systems that can absorb, process, and respond to that information at machine speed.

The borders between physical and digital space also are blurring, and the way that we interact with data is changing. Augmented and virtual reality (AR/VR) are bringing digital data into physical space and bringing real-time human interactions into digital space. Next-generation robotics allow us to act on digital insights in physical space with unprecedented regularity, speed, and safety. The next wave of innovation could be even more dramatic, as gene editing, cybernetics, and nanotechnology could bring the digital world not just into our environment but into our very bodies.

Taken together, these technologies portend a revolution not just of industry but also of nearly every aspect of our world and our day-to-day lives. The convergence of so many tectonic shifts in technology will have dramatic ramifications for economic growth, inequality, competitiveness, politics, security, and social cohesion. It will transform the

balance of global power, and force us to reevaluate the economic models, governance structures, institutions, and social norms that have defined human civilization for centuries. Technology has always driven change, but never this quickly and never on such a global scale.

> *Technology has always driven change, but never this quickly and never on such a global scale.*

Risks and Opportunities: Mixed Lessons from History

There is much about the 4IR to be excited about, from the economic growth promised by data-driven improvements in productivity to the individual benefits of such innovations as self-driving cars, smart cities, and personalized consumer services. But at the same time, the sheer scale and pace of these changes has left many feeling overwhelmed and uneasy about what the future may bring.

To an extent, some growing pains are inevitable. Technological progress has always meant change, and with change comes uncertainty. When that uncertainty begins to cloud issues as fundamental as humans' basic utility within society—as AI is now doing for many workers—it is understandable that people demand answers from our leaders about where 4IR will lead. Similar fears have accompanied each of the previous three revolutions, and we should take both comfort and instruction from the way that societies successfully managed those past instances of technological disruption.

Perhaps the greatest fear for many is that 4IR, particularly AI, will eliminate jobs and lead to massive growth in inequality. Previous revolutions have ultimately led to greater wealth and opportunity, and this one will be no different, but this generalization glosses over the experiences of workers who lived through those transitions and offers little insight into how to manage the inevitable disruptions that accompany these changes.

In the first industrial revolution in Britain, for example, real wages doubled between 1760 and 1860, but this did not happen immediately or smoothly. In fact, although the economy grew rapidly throughout this period, virtually all the growth for the first 70 years was in corporate profits, not incomes for workers, the so-called Engels' Pause.[1] Eventually, the benefits of massive gains in productivity flowed down to workers, and in the final decades leading up to 1860 real wages exploded.

The Impact of 4IR on the Economy, Society, and National Power

What happens when you experience Engels' Pause in today's world? In modern democratic societies, workers are voters, and voters are unwilling to wait decades for the benefits of technological change to reach them. The ongoing debates around trade and globalization are a perfect example. Although there is ample evidence that free trade is beneficial to the global economy and leads to greater opportunity across the board in the long term, around the world trade agreements are being torn up because of their short-term disruptive

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1. Robert C. Allen, "Engels' pause: Technical change, capital accumulation, and inequality in the british industrial revolution," *Explorations in Economic History* (2009), https://www.nuff.ox.ac.uk/Users/Allen/engelspause.pdf.

impacts, further exacerbating the long-term challenges faced by workers whose incomes have stagnated.

In reality, the impact of the 4IR on workers will be far more nuanced than the current, simplistic narrative of "robot in, worker out." AI systems remain profoundly limited in the kinds of tasks they can perform. AI will automate tasks rather than entire positions, taking on the drudgery of many modern jobs and freeing workers to instead spend their time analyzing information and coming up with creative solutions to problems. And for many work roles, such as anything involving empathy, creativity, communication, or creative thinking, machines are still decades away—at a minimum—from being able to take over from a human.

> *In reality, the impact of the 4IR on workers will be far more nuanced than the current, simplistic narrative of "robot in, worker out."*

But some jobs will be eliminated, and for many, the new jobs created by 4IR will require new skills and experience. For a start, basic digital literacy will become an absolute requirement for all workers as jobs evolve to incorporate some measure of human-machine interaction. Soft skills will also grow in importance as the value of human labor shifts towards providing the kind of creativity and personal touch that machines cannot easily replicate.

The nature of work itself will also change. For those who stay in their jobs, remote and virtual work are already becoming increasingly prevalent, allowing workers to live where they want and work from the comfort of their own homes on their own schedules. The implications for work-life balance are exciting: eliminating commutes, allowing parents to spend time with their kids while also remaining engaged in the workforce, and making it easier for people to travel and pursue new hobbies and interests.

For others, 4IR will mean transitioning to new jobs and careers, sometimes presenting new and exciting opportunities. But for some, 4IR could spell more uncertainty and less opportunity to grow and advance. In San Francisco and New York, where technological change has led to an explosion of wealth, a class of "new artisans" has developed, with millions of workers forming small businesses to provide bespoke services like hairdressers, personal stylists, and private chefs to the increasingly wealthy tech elite.[2] Many displaced workers are also moving into the gig economy, driving for Uber or delivering for Postmates. Although these careers and contracting jobs provide flexibility and independence, many offer little opportunity for growth and advancement, and the lack of stable income and benefits will put strain on many workers.

Finally, as the pace of technological change continues to accelerate, workers will have to become lifelong learners capable of routinely adding new skills and abilities to keep pace

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2. Lawrence Katz, "Get a liberal arts B.A., not a business B.A., for the coming artisan economy," PBS Newshour, July 15, 2014, https://www.pbs.org/newshour/nation/get-a-liberal-arts-b-a-not-a-business-b-a-for-the-coming-artisan-economy.

with changes in the technologies underpinning their work. Managing these disruptions will require countries to make major investments in education and retraining to ensure that their current and future workers will be prepared to take advantage of the new opportunities created by the 4IR.

The Fourth Industrial Revolution also will create new social and political pressures as the proliferation of sensors and data challenge our concepts of privacy and our expectations of the people around us, including our leaders. As Andrew Moore, Dean of the School of Computer Science at Carnegie Mellon, put it, with IoT and AI, "everything will be knowable from anywhere," and that will change the nature of politics and social relationships. At the same time, nothing will be knowable anywhere, as increasingly sophisticated disinformation and misinformation, including AI-enabled "deep fakes"— seamless fake audio and video—cloud our political discourse and social interactions. And all of these narratives, particularly the negative ones, will be amplified on social media to circulate around the world nearly instantaneously.

In democracies, will elected officials be able to live up to the exacting standards of behavior expected of them, especially when everything that they do and say from early childhood will be recorded and accessible online for posterity? How will we adapt to a world in which malicious actors can make any public figure, or even any private citizen, appear to do or say anything they want?

Conflicts will also arise as governments wrestle with the question of how best to deal with emerging technology giants. On one hand, technology companies will continue to serve as critical engines of growth, and innovation and investment will continue to flock to areas with permissive regulatory environments and friendly governments, creating challenges for governments trying to govern emerging technologies. The increasingly global nature of these companies will further tax our concepts of sovereignty and the power of national governments to manage the impact of technology and innovation on society.

One of the biggest challenges will be mobilizing companies and innovators to think proactively about how technology can be abused by malicious actors and how to prevent malicious use of technology. From AI-enhanced cyber-attacks to armed drones and the threat of weaponized biotechnology, the 4IR will greatly enhance the scalability of malice, allowing terrorists, criminals, and other non-state actors to inflict large-scale havoc and harm over long distances, relatively easily, at low cost, and with little chance of being held accountable for their actions.

> *One of the biggest challenges will be mobilizing companies and innovators to think proactively about how technology can be abused by malicious actors and how to prevent malicious use of technology.*

National power also will come to be defined to a greater extent than ever before by a country's capacity for technological innovation. Already, countries around the world— particularly the United States and China—are engaged in an intense competition for

leadership in the next generation of technologies. Struggles over access to data, hardware, investments, and talent and resources will come to define the countries' relationships, as is already beginning to show in recent conflicts over IP theft, foreign investment, and supply chain security.

Developing Countries and the 4IR

Although nations like China and the United States often take the spotlight in news about the 4IR, new technologies also offer enormous opportunities for the developing world. Developing nations have an opportunity to adopt emerging technologies at a rapid pace because of the lack of institutional inertia slowing their deployment. The power of "leapfrogging," whereby emerging countries bypass previous generations of services to adopt the newest and most efficient technologies, already has been demonstrated in the developing world by the explosion of mobile banking and mobile payment systems. If emerging economies invest in things like smart infrastructure and technical education, for example, they could gain valuable competitive advantages over developed nations struggling with legacy infrastructure debt and entrenched vested interests.

> *If emerging economies invest in things like smart infrastructure and technical education, they could gain valuable competitive advantages over developed nations struggling with legacy infrastructure debt and entrenched vested interests.*

The developing world also faces significant obstacles as it works to adapt to 4IR. Deployment of new innovations could be hampered by the lack of a skilled workforce and the loss of low- and middle-skilled jobs that have historically served as a critical bridge out of poverty. Lack of ICT infrastructure and difficulties securing financing could also make it difficult for many to capture the benefits of emerging technologies. And new technologies like drones, facial recognition, and behavioral analytics could put untold arsenals of new and devastating tools in the hands of oppressive regimes and corrupt kleptocrats.

That said, many 4IR technologies promise new solutions to many of the developing world's most pressing challenges. 5G connectivity and VR/AR could make it easier for workers in developing economies to offer digital services to customers around the world. Cloud and platform services will make it easier for entrepreneurs to access capital and tools to build new businesses and innovate. And the Internet of Things, digital analytics, and perhaps even blockchain could offer new tools to hold governments accountable, reduce corruption, and strengthen the rule of law in the developing world, removing key impediments to investment and growth.

Defining the Future

The Fourth Industrial Revolution will create disruptions and displacements and greater prosperity and opportunity. The question is whether and how policymakers can act to

ensure the disruptions are mild and short-lived and the eventual benefits widely shared. This will require new institutions and new approaches to problem-solving. At every level, from the local to the global, we must create new systems for political and economic decision-making agile enough to adapt to the changes wrought by emerging technologies.

The challenges and opportunities presented by 4IR will vary around the world. Developed nations will struggle to overcome the stresses of economic disruption and job displacement, the loss of even a semblance of privacy, as well as the challenges of unprecedented transparency and pluralism in politics; but they also will be well placed to build and operate the advanced technologies that drive the post-4IR economy. Developing economies will continue to grapple with infrastructure, education, and rule of law deficits as they try to compete in the increasingly global economy, but technology also could offer new opportunities for people in developing economies to access capital and education, especially entrepreneurs looking to grow their businesses.

The Fourth Industrial Revolution is upon us, and our economy, society, and politics will change in dramatic ways, for better and for worse. How painful the transition is, and who benefits and how much, depend on choices that we have yet to make. And as in the previous industrial revolutions, understanding the technologies reshaping our world and building new policies and institutions for the future will be essential to maximize the benefits of technological change and minimize its risks and costs to the world.

3 | The Best Laid Plan . . . Fintech and Regulation

By Steven Zausner and Christina Campbell-Zausner[1]

Few people like talking—or reading—about regulation. It's boring. Yet, it is the primary tool through which nations build markets and protect investors and consumers. Without it, a sovereign cannot effectively connect Wall Street with Main Street, or New York with Nairobi. Regulation is the set of rules by which multiple stakeholders operate to achieve cross border flows, capital building, and savings preservation.

Although frequently mind numbing, or ignored, regulation often can lay waste to some of the best financial technologies (fintech) associated with the Fourth Industrial Revolution—including blockchain/distributed ledger, mobile money, and non-bank small and medium enterprise (SME) lending. One of the authors of this piece, a venture capitalist, often hears from fintech founders some form of the following value proposition:

> Hey, I went to (insert elite school here). I got (insert tier-one venture capitalist here) funding my seed. I got (insert large investment bank here) thinking about investing in or partnering with my product. When the regulators see just how great this is, and how it is going to solve all the problems associated with (access to finance or trade finance or SME lending or just plain making a boatload of dough), they are definitely going to change the regulations.

No. They are not.

In the wake of the 2008 financial crisis, regulators are, generally, an unaccommodating bunch—and we say this with both respect and firsthand knowledge (the other author is a former regulator). There are major policy challenges facing fintech firms, especially in areas on which the international development community focuses, such as increasing access to finance and SME lending. These regulations include Basel III capital requirements and Know Your Client (KYC)/Anti-money Laundering (AML) guidelines. Indeed, handling

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1. Research assistance provided by Andrew Haimes of Office: FMA/NYU and Anastasia Zausner of University of Miami.

regulations wrongly can threaten the ability of some emerging market economies to access the international financial system.

> *In the wake of the 2008 financial crisis, regulators are, generally, an unaccommodating bunch.*

The regulators won't stop regulating because a founder is wicked smart. Just ask the folks in the crypto- world about those sanctions over the past couple of years that have basically shut down the market.[2] That said, agencies around the globe are increasingly offering accommodative programs called regulatory sandboxes, which essentially allow for some level of co-development. Think of these sandboxes as safe spaces for growing fintechs to learn how to comply with the rules.[3]

Some Context

THE POST-CRISIS FINANCIAL SYSTEM, EMERGING MARKETS, AND FINTECHS
The term "fintech" can mean different things to different people. For the purposes of this article, we concentrate on fintech examples that fall into one, or both, of two categories: 1) extend access to finance banking, credit, or capital markets or 2) reimagine technological infrastructure.

After nearly a decade of international exploration of the fintech proposition, several trends have emerged.

First, the access-to-finance—or branchless/mobile money—model often is successful in emerging markets where there are few or no alternatives for low and unbanked individuals. Fintech has proven more popular in emerging markets because of the leapfrog phenomenon: since there often are few other routes for getting a bank account, mobile money can be the best. In a developed country, such as the United States, the cost of acquisition—the total costs incurred when gaining a new client—is high, and the preference for a physical presence is reemerging. [4] As a result, online depository and lending fintechs often partner with traditional financial institutions to marry the best of tech with the best of traditional banking and finance. Lack of a physical space does not equal lack of regulation: prudence, securities, and consumer protection rules still may apply, especially in a developed country.

Second, the value of redeveloping financial infrastructure through new technology is proving to be increasingly attractive for traditional finance institutions. As in other sectors, technology increases financial firms' productivity and, often, allays other costs. In response to the 2008 crisis, global regulatory pacts, such as the group that develops

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2. Beau Barnes and Jake Chervinsky, "Get Ready for Crypto Sanctions Enforcement," Coindesk, December 2, 2018, https://www.coindesk.com/get-ready-for-crypto-sanctions-enforcement.

3.   Jason Henrichs, "Fintech needs more regulatory 'sandboxes'," American Banker, April 26, 2018, https://www.americanbanker.com/opinion/fintech-needs-more-regulatory-sandboxes; "The Role Of Regulatory Sandboxes In Fintech Innovation," Finextra, September 10, 2018, https://www.finextra.com/blogposting/15759/the-role-of-regulatory-sandboxes-in-fintech-innovation.

4. Tanaya Macheel, "Why customer acquisition is so difficult for financial startups," TS, November 7, 2017, https://tearsheet.co/data/why-customer-acquisition-is-so-difficult-for-financial-startups/.

banking standards—the Basel Committee on Banking Supervision (BCBS)—required countries around the world to tighten capital and AML requirements. Adherence to these standards is a prerequisite for continued participation in the global financial system. That system is monolithic and, for more than a century, has supported even the most fundamental transactions at the backend of global trade, particularly for services through correspondent banking. These transactions, in large part, allow emerging markets to be exporters, to receive hard currency, to convert U.S. dollars into local currencies, and to support the local economy.

But those post-crisis regulations, most importantly Basel III (capital requirements) and KYC/AML, simultaneously made it more difficult for emerging economies to access developed market credit from private firms and to use the global infrastructure. As such, regulation drove many emerging markets largely outside of the perimeter of global access and created a greater need for them to replace that option with their own banking networks. International regulation and the limitations on access to finance in emerging markets drive interest and success at the local and regional levels while also blocking some of them from the jurisdictions that control most global wealth.

Basel III Capital Requirements

The Basel Committee on Banking Supervision developed Basel III as a result of the crash of 2008 (Basel I was implemented in 1988 and Basel II in the 2000's).[5] These even more stringent regulations include steep requirements and restrictions for lending to lower-rated countries and to small and medium enterprises (SMEs). The price of lending to an SME in an emerging market became prohibitive for larger banks in developed markets, which also have to absorb the cost of foreign exchange and higher risk management standards. In fact, even in G20 nations, SME lending has declined dramatically, because the credit costs, alone, are significantly higher.

The importance of these additional costs is appreciated when considering how central leverage is to a financial institution's economic viability. The greater the leverage (the ratio of a company's debt to equity), the better the institution's returns. So, the higher the capital requirements, the less leverage a financial institution can extract from their balance sheets. This dynamic leads to banks choosing between two ends of a spectrum: either holding more capital to sustain the same amount of lending or keeping the gross amount of capital and reducing risk. Most banks end up reducing risk by cutting loans to riskier assets. SMEs became an easy target: high risk, lots of person-power needed to process loans and, with a higher capital requirement, now an almost guaranteed lower return. SMEs in emerging markets? Well, that is just risk compounding risk. As such, they are almost the easiest to cut.

Unlike banks, fintechs can often avoid regulation by not accepting deposits. This practice, however, can put them at a funding deficit: by not accepting low-cost deposits, they remain dependent upon banks for their funding, which can mean:

1. Fintechs often start out less profitable because they have to pay higher fees for their funding.

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5. "The Basel Committee—overview," BIS, https://www.bis.org/bcbs/.

2. Sometimes, banks require borrowers (fintechs and others) to adopt certain high-cost reporting or other measures that lowers the bank lenders' regulatory burdens.

Unless a fintech is self-funded and exists in its own microcosm, policy incentives will filter through to them as well, even though they may not be regulated directly.

Know Your Client: Anti-Money Laundering Requirements

One of the success stories of the Fourth Industrial Revolution is mobile banking, where adoption is increasing across the unbanked and the banked alike. One of the most often cited examples of fintech fulfilling its monumental promise is Kenya's M-Pesa. Mobile banking does have amazing potential, but some of the biggest hurdles to a seamless mobile banking experience—issues around digital identity verification and KYC/AML requirements—also apply to fintechs. For example, most financial institutions in developed markets, and many in emerging markets, force consumers to conduct identity verification at a physical branch, or through time-consuming digital processes that can lead to abandonment, which somewhat negates the whole mobile money process.

KYC and AML regulations have even more dire, and important, ramifications for emerging market banks because of their criticality in correspondent banking relationships—banks that provide services on behalf of one another. Through correspondent banking relationships, usually smaller banks can access financial services in different jurisdictions from larger banks, facilitating cross-border payment services to their customers and supporting international trade and financial inclusion. Global banks have traditionally maintained broad networks of correspondent banking relationships, but this is changing rapidly.

KYC/AML compliance always was high stakes, but sanctions have become a key tool in combating terrorism (KYC/AML compliance is overseen by the Financial Crimes Enforcement Network [FINCEN], a joint venture between the U.S. treasury and the FBI). Roughly 90 percent of bank officers surveyed by the International Chamber of Commerce in 2016 cited the cost or complexity of compliance requirements relating to anti-money laundering/Know Your Client and sanctions as a chief barrier to the provision of trade finance.[6]

This sensitivity has particularly hurt SMEs, which encompassed 58 percent of rejected trade-finance proposals, even though they represented only 44 percent of submissions. For first time participants in the financial sector—like SMEs that are graduating from the "grey economy," a large segment of which are in emerging markets—the intrusive nature of expanded due diligence and regulations can be an insurmountable barrier. Most of these firms will not have ready—or will not have sufficiently-prepared access to—all of the financial information, historical data, or other sources required by their counterpart at a financial institution.

In worst case scenarios, requirements and regulations can essentially shut out whole countries from the correspondent banking system. As a result, the cross-border payment network has effectually fragmented, and the range of available partners may have

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6. Doina Buruiana, "Addressing The Global Shortage Of Trade Finance," International Banker, December 15, 2016, https://internationalbanker.com/finance/addressing-global-shortage-trade-finance/.

narrowed for some countries to only those trading partners that are essential to sovereign or sovereign-like entities. Bank of England Governor and Chairman of the G-20 Financial Stability Board (FSB) Mark Carney recently highlighted the risk: "So-called 'de-risking' in correspondent banking relationships has threatened the ability of some emerging market and developing economies to access the international financial system, and it risks driving flows underground."[7]

Regulatory Sandboxes

To facilitate innovation and provide a temporary time-out from regulations, more countries are establishing regulatory sandboxes: controlled environments that allow private firms small-scale testing in partnership with the regulators. Common areas of focus include payment systems, the tracking of physical as well as digital assets, customer databases, identity verification procedures, and transaction recording. About two dozen countries and several U.S. states are using regulatory sandboxes, speeding along the adoption of new tech.

To date, the efficacy of regulatory sandboxes is unproven. They are too new to be fully understood and evaluated. They also are not without controversy: some worry that fintechs are getting preferential treatments, which puts traditional brick-and-mortar banking at a competitive disadvantage.

Although their efficacy is unproven, the sandboxes have a pragmatic appeal: when an industry rapidly evolves, including the businesses and technologies in it, it can be unclear what regulations should be applied. More important, new tech may not sync up with old tech or other new applications being developed simultaneously. Regulatory sandboxes are great tools for industry and regulatory cooperation in that:

1. Experiments help regulators pinpoint areas where technology innovation may be outstripping current rules, signaling a need for clarifications or updates.

2. Tests provide regulators a practical opportunity to learn quickly about the technologies that are revolutionizing finance, "so that regulatory wisdom can keep pace."[8]

Continued coordination between the fintech and traditional finance and regulatory communities is essential for the adoption of new technologies not only in emerging markets but in all markets. Otherwise, regulations meant to protect and enrich the financial landscape may inhibit future potentially valuable technological innovations and stifle development in emerging markets.

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7. See Financial Stability Board, http://www.fsb.org/.
8. Jo Ann Barefoot,"BankThink: Banking Needs a Regtech Sandbox," American Banker, November 2, 2018, https://www.americanbanker.com/opinion/banking-needs-a-regtech-sandbox.

4 | Is Universal, Affordable Internet Just an Ambitious Goal? Overcoming the Digital Gender Gap

By Sonia Jorge and Maiko Nakagaki

The internet is one of the most important mediums of modern communication. We use the internet to connect with friends, to obtain information, to conduct business, to access products and services, and to engage politically and with our local communities. The 193 member states of the United Nations recognize the important role internet plays in today's digital world for social and economic development and have agreed to work toward achieving universal, affordable internet access by 2020 as part of the Sustainable Development Goals (SDGs).

Although this inclusion in the SDGs represents a significant step, the reality is that most countries have failed to implement clear plans or policies to achieve the universal access goals. Today, more than half the world is still offline.[1] The Alliance for Affordable Internet (A4AI) conducts research across 61 low- and middle-income countries to produce an annual report on affordability. According to A4AI's 2017 report, only 44 percent of the countries studied have public access policies that are backed by financial support for implementation. National broadband plans are necessary to achieve universal access yet in 41 percent of countries they have never been developed or are badly outdated.[2] Many countries lack concrete, time-bound targets for developing their Information and Communications Technology (ICT) sectors.[3] This failure to prioritize broadband development for all is resulting in a dramatic slowdown in the number of people coming

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1. Eleanor Sarpong, "Half of the world's people are still offline. How do we connect them as quickly as possible," Web Foundation, February 5, 2019, https://webfoundation.org/2019/02/half-of-the-worlds-people-are-still-offline-how-do-we-connect-them-as-quickly-as-possible/.
2. Alliance for Affordable Internet (A4AI), *2017 Affordability Report, Executive Summary*, https://a4ai.org/affordability-report/report/2017/.
3. Ibid.

online.[4] In fact, at the current rate of internet growth and adoption, universal affordable internet will not be achieved until 2043.[5]

Any policy or project aimed to get more people online will fail unless the gender gap is addressed by all actors. Although we may think of this as a task for only policymakers and governments, it also should concern companies that want to reach new consumers and markets and civil society organizations that want to ensure that everyone can use the internet to participate in civic and political life.

> *Any policy or project aimed to get more people online will fail unless the gender gap is addressed by all actors.*

Of the nearly four billion people still offline today, most are women.[6] Around the world, women face barriers to internet access, including inability to afford to connect, limited digital skills, and social and cultural barriers to using the web. Access to the internet is power, yet more than two billion women and girls are silenced, unable to access key resources, information, and opportunities that come with an internet connection.[7] Poor internet access can prevent women from socially, economically and politically engaging in even the most developed economies—restricting their communications, education, employment opportunities, civic participation, and accessing or managing finances. In turn, this prevents them from empowering themselves and contributing to their communities or families. This gender gap also directly correlates to democratic and human rights for women and girls. As outlined in the Universal Declaration of Human Rights, denying women and girls their freedom of expression, assembly, and association online goes against their rights as individuals.[8] More than ever, gender disparities in internet access and use are further marginalizing women and ultimately will undermine efforts and goals to foster a more gender-equitable world.

Closing the Digital Gender Gap

The digital divide falls along gender and income lines. Women are among the hardest hit by the high connection cost because women in the bottom of the income pyramid earn 30–50 percent less than their male counterparts, making internet access prices prohibitive.[9] Although international efforts to promote a gendered approach to ICT are increasing, there is more lip service than action: overall, policymakers across the globe are failing to take the necessary concrete steps for action. For example, A4AI's research

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4. Alliance for Affordable Internet (A4AI), *2018 Affordability Report*, https://a4ai.org/affordability-report/report/2018/.
5. Web Foundation, *The Case #ForTheWeb* (Washington, D.C.: Web Foundation, 2018) http://webfoundation.org/docs/2018/11/The-Case-For-The-Web-Report.pdf.
6. Emma Luxton, "4 billion people still don't have internet access. Here's how to connect them," World Economic Forum, May 11, 2016, https://www.weforum.org/agenda/2016/05/4-billion-people-still-don-t-have-internet-access-here-s-how-to-connect-them/.
7. International Telecommunication Union, *Measuring the Information Society Report 2017, Volume 1* (Geneva: International Telecommunication Union, 2017) , https://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2017.aspx.
8. "Universal Declaration of Human Rights," United Nations, http://www.un.org/en/universal-declaration-human-rights/.
9. Alliance for Affordable Internet (A4AI), *2015-2016 Affordability Report*, https://a4ai.org/affordability-report/report/2015/#gender_inequality:_exacerbating_affordability_challenges, 32.

of 58 low- and middle-income countries across Latin America and the Caribbean, Africa, and Asia revealed that fewer than 9 percent of countries have gender-responsive policies in place.[10] This means that only 5 of the 58 surveyed countries had developed gender-specific targets for internet access and digital skills training, with adequate budgets for policy implementation.[11]

Gaps must be closed by reducing the cost of internet access, which requires reducing overall cost structures while improving the internet infrastructure and ecosystem. Other gender-based challenges to coming online need to be confronted as well, from digital skills and overall education levels to social and cultural norms preventing women from exercising their rights. The unique barriers to connectivity faced by women and girls should be analyzed and gender-responsive steps to improve internet access should be developed. This effort could include designing broadband policies with women in mind by engaging gender advocates and experts in policy discussions and ensuring that gender-disaggregated analyses are integrated in policy developments and plans.[12]

Some global actors are leading the way. Through the GSMA's Connected Women Commitment Initiative, international mobile operators are attempting to close the gender gap in mobile internet by offering cost-efficient mobile plans and promoting safe web usage.[13] On the research and advocacy side, Data2X, a global multi-stakeholder alliance within the UN Foundation, is spearheading the gender data movement to highlight the lack of gendered data worldwide. In their mapping of the availability of gender data across key indicators, including access to mobile phones and the internet, Data2X found comprehensive gaps and limitations, including: limited coverage across countries, limited international standards to allow for comparability, limited complexity of information, and limited granularity in disaggregation of datasets.[14]

The Web Foundation is similarly promoting a women-centered approach to measuring the digital divide — calculating the gap as the difference between the internet penetration rate between men and women, as a proportion of internet penetration rate for women — so that policymakers can set a more ambitious, yet impactful, target for improving access and use for all through their policy goals.[15]

Some governments also are effectively implementing gender-responsive ICT policies. Costa Rica's Fondo Nacional de Telecomunicaciones (the country's Universal Service and Access Fund) administers a program that subsidizes low-income households to purchase

10. Dhanaraj Thakur et al., Reach with Gender-Responsive ICT Policy (World Wide Web Foundation and Alliance for Affordable Internet), http://webfoundation.org/docs/2017/09/REACT-with-Gender-Responsive-ICT-Policy.pdf.
11. Ibid.
12. Alliance for Affordable Internet (A4AI), *2015-2016 Affordability Report*.
13. See GSMA Connected Women Commitment Initiative, https://www.gsma.com/mobilefordevelopment/connected-women/the-commitment/.
14. Mayra Buvinic, Rebecca Furst-Nichols, and Gayatri Koolwal, *Mapping Gender Data Gaps*, (Data2x, 2014), https://www.data2x.org/wp-content/uploads/2017/11/Data2X_MappingGenderDataGaps_FullReport.pdf.; "Gender Data Gaps Table," Data2x, https://www.data2x.org/wp-content/uploads/2017/11/Data2X-Gender-Data-Gaps-Table.pdf.
15. "Measuring the digital divide: Why we should be using a women-centered analysis," Web Foundation, May 22, 2018, https://webfoundation.org/2018/05/measuring-the-digital-divide-why-we-should-be-using-a-women-centered-analysis/.

fixed internet service and a computer. Approximately 95 percent of the households qualifying for a subsidy under this program are headed by women. As a result, the initiative has been recognized internationally for supporting access for women and low-income groups.[16]

At the local and national levels, organizations such as those that make up the Web Foundation's Women's Rights Online (WRO) network are working to change the face of the digital divide. For example, the International Association of Women in Radio and Television in Kenya strategically convened forums with ICT and ministerial policy leaders to examine national launches of country digital gender divide audits and to deliberate policy actions by their governments.[17] WRO partners in Colombia, Cameroon, Ghana, and the Philippines held multiple consultations and dialogues with women's rights groups to get their input on national ICT and broadband strategies and subsequently shared their demands with ministries.[18]

Such aforementioned activities are laudable. Yet global stakeholders — civil society groups, governments, private sector, and multilateral organizations —must do more to challenge the status quo to enable affordable, quality connections for all.

Looking Forward: What's Next?

There are three steps that stakeholders can take to move towards digital inclusivity for all.

First, we must address the affordability barrier and drive down costs through good policymaking. Technology is not gender neutral, nor are the policies that guide its development and use. Policies must be developed with measures to keep the long-term benefits of promoting wider and targeted availability of—and access to—the internet for all, especially for today's unconnected populations. These long-term approaches will encourage and support job growth, spur greater innovation through a diversified ICT sector, and will ultimately contribute to economic growth.

> *Technology is not gender neutral, nor are the policies that guide its development and use.*

Investing in public access and digital skills education are good policy examples. Women are more likely to use public Wi-Fi spots because of gender wage gaps and the inability to pay for regular internet use. Public access solutions, such as low-cost connection for schools, public WiFi, and increased unlicensed spectrum options—to provide low-cost or free broadband in rural and remote areas—are critical to reach women.[19] Likewise, investment in digital skills education is important so that individuals can navigate the web more meaningfully once they have access and participate in the digital economy.

16. Alliance for Affordable Internet (A4AI), *2015–2016 Affordability Report*, 10.
17. John Walubengo, "Government ICT policy must address gender gaps," Daily Nation, March 7, 2017. https://www.nation.co.ke/oped/blogs/dot9/walubengo/2274560-3840232-77gbum/index.html.
18. "How the Women's Rights Online network is tackling the digital gender gap in 2017," Web Foundation, April 10, 2017, https://webfoundation.org/2017/04/how-the-womens-rights-online-network-is-tackling-the-digital-gender-gap-in-2017/.
19. Alliance for Affordable Internet(A4AI), *The Impacts of Emerging Mobile Data Services in Developing Countries*, (Washington, D.C.: 2016), 10. http://1e8q3q16vyc81g8l3h3md6q5f5e-wpengine.netdna-ssl.com/wp-content/uploads/2016/05/MeasuringImpactsofMobileDataServices_ResearchBrief2.pdf.

Digital skills are especially key for women and girls so that they have the agency to exercise their full rights and freedoms flexibly as active citizens once online.

Second, we must prioritize gender equality in our investments. Many countries have established sector development funds dedicated to expanding connectivity opportunities to unserved and underserved communities. Universal Service and Access Funds (USAFs) —which typically are financed through mandatory contributions by mobile network operators and other telecommunications providers —have tremendous potential for closing the digital divide.

However, research from A4AI and the Web Foundation shows that an estimated $408 million are sitting unused in Africa in Universal Service and Access Funds (USAF).[20] Only 3 of the 37 nations with USAFs have policies that explicitly aim to connect women and girls.[21] If fully utilized, USAFs in those countries could bring 6 million women online and could be used to provide digital skills training to nearly 16 million women and girls. Governments need to set up USAFs, to commit to investing these funds, and to have gender-responsive projects that specifically expand women and girls' internet access and use. Private sector and civil society leaders must work with governments to design policy frameworks that incentivize investment and put available resources where they are needed most.

Multilateral Development Banks (MDBs) should also increase their investments in ICT projects that specifically target the last-mile users, including women. Between 2012 and 2016, MDBs committed a cumulative of $525 billion to fund development projects in low- to middle-income countries worldwide. Yet, since 2012, only 1 percent of that funding has gone toward ICT sector projects — despite increasing global recognition of ICTs and wider digital access as critical to the realization of the SDGs. Moreover, nearly zero resources were dedicated in 2016 to supporting ICT regulation and policy projects.[22] Now, more than ever, is a critical time for MDBs to refocus their investment strategies and commit to supporting ICT development, and especially gender-responsive ICT projects, to bring billions online.

Third, we must pay attention to cultural and social gender norms. Addressing technological barriers is imperative, but social and cultural norms also hinder women and girls from accessing the internet. Women may not use technology in the household out of fear for safety and harassment, or simply because families may not be comfortable with it. These social and cultural norms often prevent wives, sisters, and daughters from using the internet.[23] To achieve full digital inclusion all stakeholders should engage social scientists or user-centered design to understand the local cultural and social norms and limitations of technological use by women and girls. Such insights should be used to design locally

20. "Why is US$400 million of funding to expand internet access sitting dormant?," Web Foundation, March 19, 2018, https://webfoundation.org/2018/03/why-is-us400-million-of-funding-to-expand-internet-access-sitting-dormant/.
21. Dhanaraj Thakur and Lauran Potter, *Universal Service and Access Funds: An Untapped Resource to Close the Gender Digital Divide* (Washington, DC: A4AI, Web Foundation, and UN Women, 2018), 3,9, https://webfoundation.org/docs/2018/03/Using-USAFs-to-Close-the-Gender-Digital-Divide-in-Africa.pdf.
22. Guy Zibi and the World Wide Web Foundation, *Closing the Investment Gap: How Multilateral Development Banks Can Contribute to Digital Inclusion* (Washington, DC: A4AI, Web Foundation, and Xalam Digital Analytics 2018), 5-6, http://a4ai.org/wp-content/uploads/2018/04/MDB-Investments-in-the-ICT-Sector.pdf
23. Shireen Santosham and , Dominica Lindsey, *Bridging the gender gap: Mobile access and usage in low- and middle-income countries. GSMA, Altai Consulting* (London: 2015), 40-42, https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/02/Connected-Women-Gender-Gap.pdf.

appropriate programs and policy solutions that are socially and culturally sensitive, yet also strive to increase gender equality.

Conclusion

What can we do to help achieve universal, affordable internet access? A4AI and the Web Foundation believe that if policymakers focus on REACT (rights, education, affordable access, content, and targets) to close the gender digital divide, rapid progress is possible.[24] This will also help to ensure that gender-responsive ICT policy becomes the norm, not the exception.

In the end, it is up to us to ensure that the digital revolution empowers us all, especially currently underserved women and girls. We know the policy steps needed to move the needle forward, and we need to start making the necessary efforts toward digital inclusion and to create an environment where everyone has equal access and the opportunity to use the internet meaningfully. Let us make the vision of digital inclusion and equality a reality for all.

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24. Read more about gender-responsive policy frameworks to achieve gender equality in the *REACT with Gender Responsive ICT Policy*.

5 | Making the Future Work for Us

Technological Impacts on Labor in the Developing World[1]

By Daniel F. Runde, Romina Bandura, and MacKenzie Hammond

Our world of work—both in rich and poor countries—is changing fast. Technology, globalization, environmental changes, and shifting demographics are impacting workplace environments and the types of jobs that will be available in the future. Everyone can relate to these issues since people depend on work for their livelihoods.

Much of the current discussion of the future of work centers on fast-paced technological disruptions and the perceived job losses and transformations in Western economies. The focus is on the pace of impact of the Fourth Industrial Revolution or 4IR, that is, how the interaction of automation, robotics, artificial intelligence (AI), and other technological drivers—unlike prior technological waves—will have an unprecedented and distinct disruption in terms of "velocity, scope and systems impact."[2],[3] Although past technological revolutions created and destroyed jobs—many believe this scale "is different": the combination of these technologies and the speed at which they are changing will lead to massive jobs losses across the board.[4] Yet there is a lot of uncertainty about future technological impacts and predictions about job losses are contested.[5] Moreover, estimates of job losses caused by automation have been revised downwards.[6]

1. This article largely draws on the CSIS publication, "The Future of Global Stability: The World of Work in Developing Countries," October 2018, https://www.csis.org/programs/project-prosperity-and-development/education-work-and-youth/future-global-stability-world.

2. OECD, "Future of Work," *OECD*, http://www.oecd.org/employment/future-of-work/; James Manyika, "Technology, Jobs, and the Future of Work," McKinsey & Company, May 2017, https://www.mckinsey.com/global-themes/employment-and-growth/technology-jobs-and-the-future-of-work; Felix Kwame Yeboah, "Youth for Growth: Transforming Economies Through Agriculture," Chicago Council on Global Affairs, March 2018, https://digital.thechicagocouncil.org/youth-for-growth; The World Bank Group, *World Development Report 2019: The Changing Nature of Work* (Washington, DC: 2019), http://www.worldbank.org/en/publication/wdr2019.

3. Klaus Schwab, "The Fourth Industrial Revolution: What it Means, How to Respond," World Economic Forum, January 14, 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.

4. Ibid.

5. Eva Paus, ed., *Confronting Dystopia: The New Technological Revolution and the Future of Work* (Ithaca, NY: Cornell University Press, 2018).

6. World Bank Group, *World Development Report 2019: The Changing Nature of Work* (Washington, D.C.: World

In developing countries, technological disruptions must be evaluated in a broader context of structural changes taking place in their economies. There are other forces that will impact labor markets in developing countries beyond technology. First, different regions of the world are following varied paths of demographic transitions. This will affect the number of potential workers, the composition of the workforce, and the types of jobs created. Many developing countries have completed their demographic transition (i.e., from high birth and death rates to lower birth and death rates) and are aging, that is, the proportion of elderly workers is increasing.[7] This requires thinking about elderly care and sustainable retirement systems. Other regions, such as the Middle East and Africa will experience growing youth populations, which will put pressure on economies to create jobs and on education systems to prepare future workers. In Africa, 60 percent of its population currently was below the age of 25 in 2017.[8] Africa will have the largest continental youth population increase with over 100 million youths (age 15–24) between 2015–2030.[9] By 2030, there will be nearly 1.3 billion youth between the ages of 15 and 24 years old globally with the majority living in Asia and Africa.[10] Demographic challenges, if not addressed, can lead to problems in terms of national security, social unrest, and political backlash, especially when the needs and aspirations of the youth are not met.

> *Demographic challenges, if not addressed, can lead to problems in terms of national security, social unrest, and political backlash, especially when the needs and aspirations of the youth are not met.*

Second, developing countries are rapidly urbanizing, creating challenges for cities in infrastructure provision, job creation, and access to basic social services. Africa's urban population alone is expected to increase from 40 percent in 2017 to 56 percent by 2050; whereas, in Asia it will increase from 48 percent in 2017 to 64 percent by 2050.[11] Cities that were bastions for jobs and economic opportunity now grapple with exploding population growth. Improving social inclusion will be an important aspect of handling rising urbanization. Adequate infrastructure and public services will be needed for citizens and to drive growth in businesses.

Third, increased trade, environmental challenges, and migration also will continue to create challenges and opportunities in labor markets around the world. Although

Bank Group, 2019), http://www.worldbank.org/en/publication/wdr2019.

7. United Nations, *World Population Ageing: 2015* (New York: United Nations, 2015), http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf.

8. United Nations, *World Population Prospects The 2017 Revision*, (New York: 2017), https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf.

9. United Nations, *Population 2030: Demographic challenges and opportunities for sustainable development planning* (New York: 2015), http://www.un.org/en/development/desa/population/publications/pdf/trends/Population2030.pdf.

10. United Nations Population Division, *Population Facts: Youth population trends and sustainable development* (UN Department of Economic and Social Affairs, 2015), https://www.un.org/en/development/desa/population/publications/pdf/popfacts/PopFacts_2015-1.pdf.

11. United Nations, *World Urbanization Prospects The 2014 Revision*, (New York: 2014), https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.pdf.

many developing countries benefited from the fragmentation of global supply chains and offshoring of production activities into their countries, automation, robotics, and 3D printing have shifted the discussion of the promise of "reshoring" activities back to developed countries. Reshoring refers to reintegration of global supply chain processes into developed countries rather than exporting it to developing countries.[12] Yet the impacts of reshoring remain uncertain.

World of Work Trends in Developing Countries

Beyond technological impacts, developing countries have unresolved problems in the quantity and quality of jobs created. Many economies are facing "jobless growth"—grappling to create meaningful work opportunities for their citizens. Even if economies produce jobs, these tend to be of low quality: people work in low productivity jobs unable to make ends meet. As it currently stands, 60 percent of workers globally (or 2 billion people) are employed in the informal sector. Informality, working poverty, and underemployment remain the main labor market challenges in many developing countries.[13]

> *Even if economies produce jobs, these tend to be of low quality: people work in low productivity jobs unable to make ends meet.*

Employment in developing countries has also changed over the last 25 years. Agriculture has historically been the largest supplier of jobs, but it accounted for almost 34 percent of employment in developing countries in 2018.[14] Much of the agriculture employment was absorbed by the services sector which has been steadily growing from 38 percent in 2010 to 43 percent in 2018.[15] In contrast, employment in industry has remained relatively stable at 23 percent.[16]

In what has been called "premature deindustrialization," developing country economies are relying on service industry jobs without first undergoing a broad-based industrialization stage.[17] This trend is denoted as "premature" because these countries have not yet reached high economic growth through industrialization. Manufacturing historically has been associated with development. In the past, economies that focused their strategies on manufacturing exports have undergone high levels of prosperity.

12. Barbara Ocicka, "Reshoring: Implementation Issues and Research Opportunities," *Management* 20, no.2 (2016), https://www.degruyter.com/downloadpdf/j/manment.2016.20.issue-2/manment-2015-0053/manment-2015-0053.pdf.
13. "Addressing Labour Market Challenges and Unlocking Private Sector Growth Are Key to Gainful and Quality Employment for All," The World Bank Group, November 16, 2016, http://www.worldbank.org/en/news/press-release/2016/11/17/addressing-labor-market-challenges-unlocking-private-sector-growth.
14. World Development Indicators, "Employment in agriculture (% of total employment) (modeled ILO estimate)," Data, https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=XO.
15. World Development Indicators, "Employment in services (% of total employment) (modeled ILO estimate), Datahttps://data.worldbank.org/indicator/SL.SRV.EMPL.ZS?locations=XO.
16. World Development Indicators, "Employment in industry (% of total employment) (modeled ILO estimate), Data, https://data.worldbank.org/indicator/SL.IND.EMPL.ZS?locations=XO.
17. Dani Rodrik, "Premature deindustrialization in the developing world," Rodrik's weblog, February 12, 2015, http://rodrik.typepad.com/dani_rodriks_weblog/2015/02/premature-deindustrialization-in-the-developing-world.html.

Manufacturing absorbed a large amount of low-skilled labor and led to productivity gains especially for those economies open to trade.[18]

The worry is that technological shifts, along with a retrenchment in trade, will make it even harder for developing countries to adopt manufacturing as a pathway for development.[19] In some regions of the developing world (particularly in Latin America, the Caribbean, and Sub-Saharan Africa) both the value-added of manufacturing and employment in the sector have shrunk. Employment has been moving to the service sector, despite generating low productivity jobs. Countries in East Asia have been able to weather the storm better.[20]

At the heart of this premature deindustrialization debate is an underlying "jobs deficit" challenge: the world needs to create around 600 million jobs over the next 15 years to absorb the number of youth projected to enter the labor market.[21] Today, approximately 64 million youth are unemployed and another 145 million working youth live in poverty.[22] At the same time, improving the quality of jobs is an imperative: developing countries have large informal sectors and many do not earn enough to lift themselves and their families above the poverty threshold.[23],[24] Informal workers lack legal and social protections, work in hazardous conditions, have low productivity jobs and do not contribute to the tax base for any given country. Many of the informal workers are women. Moreover, 30 to 45 percent of the working-age population globally is underutilized; that is, they are either inactive or work less than they would like to (i.e., underemployed).[25] These are some of the major challenges that labor markets in developing countries must address.

Technological Disruption, Availability of Jobs, and Quality of Work

The Fourth Industrial Revolution will affect all countries but not everyone in the same way.[26] Many predict that technology will destroy jobs, increase income inequalities, and create higher shares of contingent workers.[27] Technology also is expected to disproportionately reward owners of capital and highly skilled individuals. However, technology also can be a force for good, just like in past industrial revolutions. This technological revolution can bring about improvements in productivity allowing for goods and services to be delivered cheaper, and increased savings that free up people to

18. Mary Hallward-Driemeier and Gaurav Nayyar, *Trouble in the Making? The Future of Manufacturing-Led Development*," The World Bank Group (Washington, D.C.: 2018), https://openknowledge.worldbank.org/bitstream/handle/10986/27946/9781464811746.pdf .
19. Ibid.
20. Rodrik, "Premature deindustrialization in the developing world."
21. "Jobs and Development Overview," The World Bank Group, April 10, 2018, http://www.worldbank.org/en/topic/jobsanddevelopment/overview.; "Wanted: 600 million jobs," United Nations, March 26, 2015, http://www.un.org/en/development/desa/news/ecosoc/600_million_jobs.html.
22. "Youth Employment," International Labour Organization, https://www.ilo.org/global/topics/youth-employment/lang--en/index.htm.
23. International Labor Office, *Women and Men in the Informal Economy: A Statistical Picture*, (Geneva: International Labor Office, 2018), http://www.ilo.org/global/publications/books/WCMS_626831/lang--en/index.htm.
24. "Wanted: 600 million jobs," United Nations.
25. Lydia Dishman, "This Is The Hidden Challenge In The Future Of Work," Fast Company, December 7, 2016, https://www.fastcompany.com/3066281/this-is-the-hidden-challenge-in-the-future-of-work.
26. Manyika, "Technology."
27. African Development Bank (AfDB), Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), and the Inter-American Development Bank (IDB), *The Future of Work: Regional Perspectives* (2018), https://publications.iadb.org/handle/11319/8840.

pursue paths of entrepreneurship.[28] Innovative technology can generate new employment opportunities via digital platforms and more flexible work arrangements.

However, there is fear that this new technological revolution is different than the past because of its speed (i.e., leaving less time for workers and societies to adjust and leading to job losses as well as massive redefinition of skills needed for existing jobs) and impact (i.e., increased inequality).[29] Skills learned today, for example, may be obsolete by the time someone can apply them because of, for example, machine learning abilities. The most intense debate of the 4IR is the potential for robots or algorithms to replace humans in the labor market—to replace not just physical work but cognitive work through AI. Although this is a concern, there also will be new industries created by these new technologies which, if channeled correctly, could modernize societal equity.

Most occupations will be affected by the 4IR to some degree. Jobs that require a substantial portion of physical and repetitive tasks have a higher likelihood of being automated and therefore could be replaced by cheap labor in the form of robots or AI.[30],[31] Tasks that require specialization, like research and development, design and creativity, and managing people are less likely to be negatively impacted by the 4IR. Additionally, the "human touch" in many services cannot be overstated. Although many of the tasks performed by service industry workers can be automated, many consumers prefer human-to-human interaction that a machine cannot replicate, and therefore that preference will determine the extent to which services become automated.

However, for developing countries, absorbing these new technologies will not be a straightforward process. The Economist Intelligence Unit (EIU) has sampled 25 countries' ability to automate and found that developed countries are better prepared for automation than their developing countries counterparts.[32] Factors such as wage levels, availability of skilled workers, cost of technology, broadband access, regulatory barriers, and others affect the pace of technology adoption.[33]

Jobs in developing countries will not disappear overnight since the costs and benefits of adopting these technologies need to be factored in. In these places, the infrastructure may not yet support radical technological adoption of some of these evolutionary industries, despite the social readiness or willingness a country may project. Yet jobs will evolve, as technology is used by workers in all industries.

What developing countries can expect in terms of technology adoption can be summed up in four interrelated trends:

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28. Schwab, "Fourth Industrial Revolution."

29. "The Future of Work We Want: A Global Dialogue," International Labour Organization, April 2017, http://www.ilo.org/global/topics/future-of-work/dialogue/lang--en/index.htm.

30. "Technology, Jobs, and the Future of Work," McKinsey & Company, February 2017, https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Employment%20and%20Growth/Technology%20jobs%20and%20the%20future%20of%20work/MGI-Future-of-Work-Briefing-note-May-2017.ashx.

31. Michael Chui, James Manyika, and Mehdi Miremadi, "Where machines could replace humans—and where they can't (yet)," *McKinsey Quarterly*, July 2016, https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/Where-machines-could-replace-humans-and-where-they-cant-yet .

32. The Economist Intelligence Unit, *The Automation Readiness Index: Who is Ready for the Coming Wave of Automation* (The Economist Intelligence Unit, 2018), http://www.automationreadiness.eiu.com/static/download/PDF.pdf.

33. Chui, Manyika, and Miremadi, "Where machines could replace humans—and where they can't (yet)."

- The pace of technological adoption overall will be slow in the short run.

- Governments of developing countries and the private sector are aware of future disruptions and are not blocking technological change.

- For the most part, governments do not have a strategy for the future of work and education systems lag in preparing the workforce of the future.

- The private sector is taking the lead, by providing training to its workforce.

Globalization and the Future of Work

Closely related to technology, globalization also will continue to affect workplace environments. Technology and openness to trade have allowed the fragmentation of the value chain between production and service delivery in a variety of sectors such as textiles, footwear, food, and tourism, among others.[34] Companies have been able to divide the stages of production across various countries, thereby expanding their supply chain to a global reach. Since the early 1990s, global supply chain-related jobs in emerging markets have increased from 19 percent of total employment to 25 percent of total employment in 2013.[35] They have been responsible for the creation of 450 million jobs worldwide.[36] Additionally, services have also been subject to this offshoring wave. For example, the call centers for customer service established in countries like the Philippines or India where labor is cheap, and English is spoken, or Business Process Outsourcing (BPO) services in Central America and other Western Hemisphere countries, to take advantage of the time zone and geographic proximity to the United States.

The recent wave of automation, robotics and 3D printing has shifted the discussion on the promise of "reshoring" activities back to developed countries. There is still little actual evidence on large scale reshoring but benefits could include reduced transportation costs, just-in-time production, which reduces the surplus inventory sold at a discount, product quality improvement, and reduced corporate social responsibility risks that come with companies working in developing countries with poor labor law regulations or environmental protection enforcement.[37] However, those who do "reshore" will have to adjust to high real estate prices, wages, taxes, organized labor, and other facets of work in the developed world that prompted offshoring in the first place.

Nearshoring is another term used to describe a trend of cutting the geographic length of supply chains without returning them all the way to the home country; for example, U.S. companies are moving parts of their supply chains from East Asian countries to Mexico, saving on transportation costs. There is still uncertainty around the trends of offshoring, nearshoring, or reshoring, but they will have implications for the future of work and

34. International Labour Office, "Technological changes and Work in the Future," *The Future of Work Centenary Initiative*, 4, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_534201.pdf.

35. International Labour Organization, *Inception Report for the Global Commission on the Future of Work,* (Geneva: International Labour Organization, 2017), 10, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_591502.pdf.

36. Ibid., 31.

37. International Labour Organization, Global Value Chains for an Inclusive and Sustainable Future, Issue Brief 10 (February 2018): 2, https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/publication/wcms_618173.pdf.

global production. Although the future of these initiatives is complex, it is certain that that developed countries returning to an economic model with 80 percent of their growth based on manufacturing production is not a sustainable future.

The role of trade networks will continue to be important for developing countries and will impact their labor markets. As the ILO puts it, evolving trade and technology asks whether manufacturing-led growth can still be a viable strategy for developing countries or whether countries should focus on highly productive segments of the services sector.[38]

Conclusion

MAKING THE FUTURE WORK FOR US

The traditional workplace is changing; the way we work is undergoing a transformation. In developing countries, employers like the government or the manufacturing sector have been in retreat for some time. For many workers in developing countries, a conventional employer-employee relationship never has existed since many workers are in the informal economy. They may be self-employed or do several "gigs" to make a living. In this regard, the "gig economy" that is being debated in Western economies has been present in developing countries for some time.[39]

Moreover, jobs with routine and repetitive tasks likely will become automated and people will be pressured to move about, both occupationally and geographically. To remain employed, people will have to incorporate training and skills development throughout their lives, learning will be ongoing and in different settings beyond school or university—what experts call "lifelong learning." There will be more blurred lines between "work" and "training and learning;" these will not be distinct stages like in the past—they will be interconnected.[40]

Future generations of workers will bring new ideas and aspirations, and they will require diverse skills. Economies will have to create more and better work opportunities, even with the disruptions taking place. Education ecosystems, companies, and governments should help citizens adapt to the many forces affecting the workforce. Citizens will have to approach education and work through a "lifelong" learning lens.

Although it is not easy to predict future trends in the world of work, stakeholders will need to partner to create strategies to create good jobs and increase country resilience to workforce transformations. Countries will need to shape the future of work to make the future work for us.

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38. Ibid., 4.
39. World Bank, *Risk Sharing Policy for a Diverse and Diversifying World of Work*, Social Protection and Jobs Global Practice White Paper (mimeo), presented at the First Meeting of the G20 Employment Working Group in Buenos Aires, Argentina in February 2018 (Washington DC: 2018), http://www.g20.utoronto.ca/2018/risk_sharing_policy_-_fow_world_bank.pdf
40. "Forging the Future of Jobs: A Conversation with Guy Ryder, Director General of the ILO," CSIS, July 19, 2018, https://www.csis.org/events/forging-future-jobs-conversation-guy-ryder-director-general-ilo.

6 | The Fourth Industrial Revolution and Infrastructure

Implications and Impacts

By Peter Raymond

Much has been written about infrastructure's ability to deliver economic development benefits. In a widely cited study, the IMF found that a 1 percent GDP increase in infrastructure investment for any country would yield a 1.5 percent overall GDP increase within four years for that country and a 0.4 percent GDP increase for that country in the year of investment.[1] Infrastructure's economic development benefits are evident. China is probably the best example, demonstrating the power of infrastructure to connect people, goods, and services, and drive economic growth.[2] Indeed, the promise and the lure of infrastructure-led development is one of the rationales behind China's Belt and Road Initiative—a massive infrastructure investment program covering more than 69 developed and emerging countries globally.[3]

And there is no doubt that infrastructure is needed, particularly in emerging economies around the world. In "developing Asia" alone, the Asian Development Bank estimates that some $1.7 trillion per year would be needed through 2030 to continue current economic growth momentum.[4] Much more would be needed if Africa, parts of Eastern Europe, and Latin America were included in these estimates.

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1. International Monetary Fund, *World Economic Outlook: Legacy, Clouds, Uncertainties* (Washington, D.C.: October 2014), https://www.imf.org/external/pubs/ft/weo/2014/02/. An important point in this study is that projects have to be selected properly (for greatest economic benefit) and executed well to achieve these outcomes.
2. Not all infrastructure is equally value-adding; there are studies that suggest that China has "over-invested" in infrastructure. See Atif Ansar, Bent Flyvbjerg, Alexander Budzier, and Daniel Lunn, "Does infrastructure investment lead to economic growth or economic fragility? Evidence from China," *Oxford Review of Economic Policy* 32, no. 3 (2016), 360-390, https://arxiv.org/ftp/arxiv/papers/1609/1609.00415.pdf. ; "Is China investing too much in infrastructure?", Economist, June 1, 2018, http://country.eiu.com/article.aspx?articleid=866788670&Country=China&topic=Economy
3. The State Council, People's Republic of China, The Belt and Road Initiative, http://english.gov.cn/beltAndRoad/.
4. Asian Development Bank, *Meeting Asia's Infrastructure Needs* (Manila: Asian Development Bank, 2017), https://www.adb.org/sites/default/files/publication/227496/special-report-infrastructure.pdf.

Infrastructure's catalytic relationship to economic development and the large financial deficits needing to be filled in emerging economies has made infrastructure an increasingly important focus for development institutions and governments worldwide. New institutions have been founded to mobilize or facilitate finance for infrastructure, such as the Asian Infrastructure Investment Bank (AIIB), the New Development Bank, the Global Infrastructure Facility, and the Global Infrastructure Hub. Considerable hope also has been placed on tapping the $100 trillion that exists in pension, insurance, sovereign wealth, and other institutional investment funds to help finance infrastructure in emerging economies.

But infrastructure is a notoriously difficult sector, plagued by charges of corruption, poorly planned projects, and even more poorly executed projects. Money alone will not solve the infrastructure problem, and money is unlikely to flow to the sector in the volumes needed unless and until some of the sector's core challenges are addressed.

> *Money alone will not solve the infrastructure problem, and money is unlikely to flow to the sector in the volumes needed unless and until some of the sector's core challenges are addressed.*

New technologies will be a big part of the answer to these infrastructure challenges, improving transparency and efficiency, and creating new, often more sustainable, business models. But as in every industry it touches, technology also will be a disruptive force, displacing traditional ways of doing business and creating distinctions between new and old ways of planning, financing, executing, and maintaining infrastructure.

To understand the potential of technology to impact infrastructure, it's useful to consider four dimensions of projects: (1) project selection, (2) project procurement, delivery and operations, (3) project financing, and (4) emerging, new technology-based infrastructure.

Project Selection

One of the most challenging issues governments (and businesses) face is selecting the right projects to build and finance. Project selection often is justifiably criticized as being politically motivated or "uneconomic" and based on unclear criteria. Almost everyone can cite a "white elephant" infrastructure project that yielded limited benefits but cost a fortune.

New technologies are starting to make a difference. In the past several years, project selection software tools have emerged that enable project sponsors (public or private) to evaluate a portfolio of potential projects against defined economic, social, and environmental criteria and select the optimum project(s) to achieve the stated benefits. These tools not only provide transparency in project selection and a rigorous methodology for doing so, but they can be used throughout the lifecycle of a project—from design through operations—to measure the projects' ability to achieve its stated goals (and this data can be fed back into the models to further improve project selection in the

future). Governments and private businesses properly deploying these models not only have avoided injecting millions of dollars into less beneficial investments but have built capabilities to manage their projects much more rigorously and with much greater public or shareholder disclosure.[5]

Project Procurement, Delivery, and Operations

Once the right project or projects are selected, getting them procured and delivered effectively (on time, on budget, and to specification) has been an historic challenge. By some estimates, more than 50 percent of projects are delivered over-budget, late or short of specifications.[6] Technologies are rapidly being deployed to help address these issues.

In a survey conducted by PwC in 2016, construction industry executives expected project cost savings of some $78 billion per year from the application of new technologies for design and construction.[7] The World Economic Forum reports that a 1 percent productivity improvement in the industry, driven largely by technology adoption, would yield $100 billion in savings.[8] But many engineering and construction firms are already realizing project level savings greater than these macro numbers suggest.

Contractors using some of the following technologies report savings of 10–50 percent or more on some project costs:[9]

- augmented and virtual reality to facilitate design and construction
- building information modeling (BIM) systems to design, track, and record performance
- drones to survey, monitor, measure, and report progress
- worksite sensors to track materials, trades, and safety
- advanced software and data analytics to aggregate and analyze these findings

Used effectively, these technologies allow end-to-end design, contracting, construction, and operations oversight, and reduce expensive cost over-runs, delays, and performance failures. Moreover, the integrated use of these tools can dramatically improve transparency around the construction contracting and payments processes—major areas of corruption concern.

For developing economies, savings of this magnitude on construction could make a major difference in whether a project goes forward or not, or whether resources can be dedicated to construction techniques yielding a longer, lower-cost asset life. Although perhaps perceived as more expensive in the short term, technology, when properly deployed, offers the potential to deliver higher quality projects with lower life-cycle costs, a benefit that governments, lenders, and infrastructure users all would welcome.

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5. "Project Portfolio Optimization," PwC, https://www.pwc.com/us/en/services/audit-assurance/valuation/fund-portfolio-capital-projects.html.
6. Bent Flyvbjerg, *Mega Projects: Over Budget, Over Time, Over and Over,* Cato Institute (January/February 2017), https://www.cato.org/policy-report/januaryfebruary-2017/megaprojects-over-budget-over-time-over-over.
7. *"Industry 4.0: Building the Digital Enterprise,"* PwC, 2016, https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf.
8. *"Shaping the Future of Construction; a Breakthrough in Mindset and Technology,"* World Economic Forum, 2016, https://www.weforum.org/projects/future-of-construction.
9. Ibid., stakeholder interviews.

But there are challenges to applying these technologies in developing economies. Many rely on experienced users (contractors, subcontractors, and owners/sponsors) and require reliable wireless internet connectivity. Moreover, government procurement processes must be amended to enable and incorporate bidding that emphasizes technology application, real time cost and schedule reporting, and rapid issue resolution.

Technology therefore is expected to deliver significant benefits in the selection, procurement, design, and construction of infrastructure projects. But at the same time, other new technologies are rapidly emerging that are beginning to disrupt long-standing infrastructure finance business models, creating both opportunity and uncertainty in the feasibility and financing of projects.

Project Financing

For years, infrastructure has been built and financed on the principle that major capital expenditures are repaid overtime from the direct cash flows from that asset, or from the economic benefits a project produces for the country. Power, water, transport, and other infrastructure projects often can be financed through the private sector if they produce revenues to repay lenders and investors. This is the classic public private partnership model, which appropriately focuses on attracting new, private-sector monies.

But technology is rapidly disrupting these business models with potentially serious consequences for current assets and project financing for of infrastructure. The most stark and visible example of this kind of disruption comes from the power sector in Europe. A recent report by Material Economics/SEI shows that between 2010 and 2015, European power utilities lost 129 billion euros in market value because of significant shifts in the energy sector.[10] In essence, European utilities "over-invested" in major power generation, transmission, and distribution assets, particularly as renewables and energy efficiency efforts gained momentum in Europe. Material Economics/SEI goes on to forecast that the total value destruction from these trends and the further adoption of next generation energy systems (battery storage, distributed generation, and smart grid technologies, foremost) could exceed $650 billion.[11] At the same time, utilities are investing in new types of services, such as grid management and home energy services, where 4IR technologies underpin these businesses. The power utilities of the future will look very different than those of today because of these technological advances.

The technology disruption and lessons from the European power sector are not limited to Europe or to the power sector. Every infrastructure sector from water to transportation to urban services and many others will be affected, with significant secondary market impacts on suppliers and service providers and broader industry. Considerable uncertainty exists with respect to the impact of autonomous vehicles on the demand for cars or public transit or toll roads, as just one example.[12]

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10. Material Economics/Stockholm Environmental Institute, *Framing Stranded Asset Risks in an Age of Disruption* (2018), https://www.sei.org/wp-content/uploads/2018/03/stranded-assets-age-disruption.pdf.
11. Ibid.
12. See the analysis by RethinkX: "*Rethinking Transportation 2020–2030,*" May 2017, which projects that within 10 years of the approval and adoption of Autonomous Vehicle regulation in the United States, 70 percent fewer au-

For developing economies, these changes are exciting, offering countries the ability to adapt new technologies and new infrastructure delivery practices without the significant disruptions likely in more developed economies, but there are challenges, too. To work, these new systems need advanced telecommunications, internet technologies, and enabling regulatory frameworks. For many countries working to build core power, transport, water, and urban infrastructure, the old financing models (large capital investments repaid over long periods of time) are still attractive. But what happens to those investments (and repayment obligations) when new technologies are introduced, undermining the original investment thesis by reducing demand or requiring new services? Will countries be compelled to sustain uneconomic business structures to service long-term debt obligations? Will investors continue to finance long-lived assets subject to such disruptions?

Emerging, New Technology-Based Infrastructure

Perhaps the most dynamic and value adding potential of 4IR is its creation of new services and new ways of delivering, using, and paying for infrastructure. As seen above, this will impact every sector, but it is perhaps most clearly seen in the concept of the "smart city."

Although a range of definitions exist for "smart cities," most involve the principle of using digital technologies to provide enhanced services for citizens, businesses, tourists, and public officials. These range from smart mobility options (such as transportation as a service) to energy and water management to health, education, entertainment, mobile payments, wayfinding, governance, and other services. 4IR technologies are at the heart of all these systems. And the smart cities market is growing rapidly. Although market projections vary significantly, many are predicting that annual investment in enabling technologies and infrastructure for smart cities will be between $1.2 trillion and $2.5 trillion by 2025, with projections through 2030 showing continued strong growth.[13]

Street lighting provides a simple example of how base infrastructure can become a platform for new digital services and business models. Only a few years ago, governments were entering into public-private partnership contracts where the private sector replaced, refurbished, operated, and maintained the street lighting for a share in the savings that governments achieved from the installation and operation of lower-cost lighting. Today, companies are close to offering the street lighting for free to secure the contract to operate and maintain the street light infrastructure. This is because sensors, wireless transmitters, electric vehicle charging stations, 5G transmitters, and other digital technologies can be built into the street lighting infrastructure and create whole new services, revenue streams, and business models for the operators and the city.

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tomobiles will be manufactured for U.S. use and the number of automobiles on the road will decline from some 247 million to 44 million. https://www.rethinkx.com/.

13. Grandview Research, *Smart Cities Market Size Worth $2.57 Trillion by 2025 | CAGR:18.4%* (San Francisco: Grandview Research, 2018), https://www.grandviewresearch.com/press-release/global-smart-cities-market; Prescient & Strategic Intelligence, *Global Smart Cities Market Size, Share, Development, Growth and Demand Forecast to 2023—Industry Insights by Component (Hardware and Software), by Application (Smart Governance, Smart Utility, Smart Infrastructure, Smart Healthcare, Smart Security & Threat, Smart Education, Smart Building, Smart Transportation, and Others)* projects a $2.57 trillion market by 2023; Orbis Research, *Global Smart Cities Market-Analysis of Growth, Trends and Forecasts (2018–2023)* (Orbis Research, 2018) forecasts a $1.94 trillion market by 2023.

Other necessary infrastructure and operations in cities, such as water systems, subways, and payment cards offer similar opportunities. Fourth Industrial Revolution technologies are generating whole new businesses, and with them, whole new cash flow, citizen services, and technology opportunities (and challenges) for governments. Done right, smart cities can spark an innovation ecosystem where private and public sector entrepreneurs leverage city-wide data services and sensors to create new businesses and more efficient public services.

Like all other 4IR opportunities, this aspect of the infrastructure digital revolution requires strong telecommunications infrastructure, an enabling regulatory and business environment, and knowledgeable public sector officials to plan, manage, and procure infrastructure and services that are complementary and conform to a digital masterplan or framework.

The Fourth Industrial Revolution will bring sweeping changes to much of the world. No industry is immune. The opportunities for infrastructure are significant: better project selection and improved delivery will reduce costs by at the least $78 billion per year.[14] Technology also will be disruptive, displacing existing business models and stranding existing assets. Europe's potential $650 billion write-off in the power sector alone tells that story.[15] But the opportunity to develop and deliver better, cheaper, and more holistic services is also within reach, and that is at least a $1.2 trillion market that is growing fast.[16] For developing economies, these advances offer significant opportunities to improve country infrastructure at lower costs and higher performance standards than in the past. But these gains will be difficult to capture without supporting technology infrastructure, regulatory frameworks, governance structures, procurement processes, and in-country skills. In an industry already complex by nature, infrastructure is about to get much more interesting and even more complex.

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14. "Industry 4.0: Building the Digital Enterprise."
15. Material Economics/Stockholm Environmental Institute, *Framing Stranded Asset Risks in an Age of Disruption.*
16. Ibid.

7 | Unlocking the Fourth Industrial Revolution Requires Internet Access and U.S. Support

By Nilmini Rubin

Each previous essay has described a way in which the technologies of the Fourth Industrial Revolution will forever alter life in the developing and developed world alike. But there is one preeminent concern that the United States must focus on now to ensure that these technologies empower good and sustainable development, rather than be used to foster authoritarianism: universal internet access.

Technological breakthroughs are being achieved at rapid rates in artificial intelligence (AI), biotechnology, blockchain, energy storage, nanotechnology, robotics, quantum computing, 3-D printing, and other diverse areas. These innovations of the 4IR are transforming much of the world. But currently, a vast swath of the global population cannot access these technologies. One unifying goal could help people better access technologies to empower their own development: Internet access enables people to know that these innovations exist, to access the innovations—since many will be distributed through the internet—and to shape these innovations.

More than 50 percent of the world's population now has access to the internet. That's a 30 percent increase in a little more than ten years.[1] Yet, half of all people on our planet remain offline, unable to connect to critical information on the internet that could improve their lives right now. That half is arguably the half that could stand to gain the most from being connected: marginalized groups—particularly, women, youth, and rural populations—living in developing countries where infrastructure, investment, and regulation around connectivity remain inadequate at best, or simply nonexistent.

Aiding connectivity and access for marginalized populations is not just a feel-good exercise. Increased internet access around the world advances U.S. economic interests. When 95 percent of the world's consumers are outside of U.S. borders, the internet is

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1. Alliance for Affordable Internet (A4AI), *2017 Affordability Report*, https://a4ai.org/affordability-report/report/2017/#affordability_in_2017:_slow_progress_means_billions_are_still_excluded.

the easiest way to reach them.[2] Emerging market opportunities spur growth for U.S. businesses within the tech (via direct products) and non-tech (using internet as a conduit) sectors. That's good news for U.S. economic growth.

> *Half of all people on our planet remain offline, unable to connect to critical information on the internet that could improve their lives right now.*

The United States also better serves and advances its own national security interests by supporting and facilitating global internet connectivity. For one thing, China has emerged as a major technological force and is heavily investing in developing countries as part of its nebulous Digital Silk Road initiative. If we don't reach other countries first, China—as it has demonstrated in the past—is more than willing to take up the cause. Some experts even think that in the future, there will be two internets for the world: one Chinese, and the existing one.[3] China's growing influence in the digital domain should be especially concerning given that it has no qualms restricting access and surveilling its own citizens and seeks to replicate this model to governments around the world.[4]

Additionally, given the rise in global hacking, including recent efforts by Russia, Iran, and China, the United States cannot afford to turn a blind eye to how the internet is being developed. Cybersecurity cuts across borders. Hacking in one country has repercussions in another. Indeed, hackers increasingly see developing countries' nascent internet systems as rich testing ground to test their skills in an environment with limited detection before moving on to a state or company with more robust defenses.[5]

Strategic efforts by the U.S. government over the last 20 years also have been instrumental in bridging access and connectivity gaps between wealthier nations and their developing country counterparts. But more is needed if we are to fulfill our promise of connecting vulnerable populations to the modern world.

Reaching Marginalized Populations

Investing in developing country internet systems—and ensuring connectivity among the most marginalized populations in particular—makes sense on several fronts, from improving lives and interrupting the cycle of poverty to advancing U.S. economic and national security interests. Key to the U.S. government's success in developing internet for marginalized populations are: (1) setting up the internet using sustainable business models and (2) ensuring that internet access is developed within the structure of a competitive marketplace and not a monopoly.

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2. Greater Des Moines Partnership, *Global DSM: Trade and Investment Strategy*, https://www.brookings.edu/wp-content/uploads/2017/04/2016_global-dsm_tradeandinvestmentstrategy.pdf.
3. Dan Robitzski, "The World of the Future Will Have Two Separate Internets, Former Google CEO Predicts," Google, September 24, 2018, https://futurism.com/google-future-china-internet.
4. "RSF opposes spread of China's Internet surveillance model," Reporters Without Borders, December 9, 2017, https://rsf.org/en/news/rsf-opposes-spread-chinas-internet-surveillance-model.
5. Sheera Frenkel, "Hackers Find "Ideal Testing Ground" for Attacks: Developing Countries," *New York Times*, July 2, 2017, https://www.nytimes.com/2017/07/02/technology/hackers-find-ideal-testing-ground-for-attacks-developing-countries.html.

Sustainable business models support the development of interventions that are commercially successful, or market-driven; adaptable and forward-facing in their approach; and, developed within a sustainable framework that limits or mitigates harmful environmental and social effects. Healthy competition also lays the groundwork for functioning, democratic societies. An uncensored and competitive internet allows the best ideas to rise to the forefront and encourages innovation for the benefit of consumers. That process simply does not happen when goods and services are developed in a vacuum, with limited producer input.

Marginalized populations do not just need access to the internet; they need access to online technology that improves and enhances their lives in a range of areas, from healthcare to education and economic development. This has been reflected in more recent programming by the U.S. government. Early broadband projects focused on developing the infrastructure to get the internet up and running in poorer countries. This is a necessary first step and these programs still exist. However, they have evolved into cross-cutting initiatives that apply technology across a range of sectors:

- In India, USAID partnered with the Consortium of Affordable Medical Technologies (CAMTech) to support the development of innovative health-related technologies to improve the country's maternal and child death rate.[6]

- In Ghana, USAID partnered with local communications service provider, Esoko, to provide mobile agricultural extension services to farmers on topics ranging from post-harvest handling to the use of pesticides and fertilizers.[7]

> *Marginalized populations do not just need access to the internet; they need access to online technology that improves and enhances their lives in a range of areas, from healthcare to education and economic development.*

Employing a Market-Based Approach

Here are a few overall goals to keep in mind for achieving internet access for all:

Creating Opportunities for Multi-Stakeholder Engagement. Convening spaces provide stakeholders with opportunities to discuss, debate, and exchange ideas, best practices, and lessons learned. They ensure that goods and services aren't created in a void and ideally engage a range of interested and invested participants so that multiple viewpoints are captured. The Internet Governance Forum (IGF), which brings together stakeholders to discuss public policy issues around the internet, is one such forum. IGF gives equal voice to all participants and is particularly vital for bridging the access gap for developing nations because it provides stakeholders from those countries with opportunities to engage with and learn from countries with more advanced technological systems.

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6. "Technologies Impacting Mothers/Children Effectively (Time)," USAID, https://partnerships.usaid.gov/part-nership/technologies-impacting-motherschildren-effectively-time.
7. "Farmer First Program," USAID, https://partnerships.usaid.gov/partnership/farmer-first-program.

Approaching Multi-Stakeholder Markets. One of the most powerful examples of this is reflected in the success of the U.S. government-led Power Africa initiative, which brings together a range of stakeholders in the private and public sectors to facilitate access to electricity across the continent. Through Power Africa, the U.S. government and its partners provide technical assistance that focuses on the expansion of market opportunities for energy development. Since 2013, these interventions have brought electricity to more than 50 million people across the continent.[8] Power Africa's market-oriented approach should serve as a blue print for how the U.S. government can work to increase access to technology in developing countries.

In March, internet pioneer Vint Cerf spoke with *Forbes* magazine and championed this kind of international collaboration as necessary to making the internet more secure. "It is not easy to do," Cert acknowledged. "Different countries have different views on the internet. Some authoritarian regimes see freedom of expression as a danger and a harmful side effect of this kind of infrastructure as opposed to a beneficial and constructive one. So, finding a way to achieve common views … is a non-trivial exercise."[9]

Cerf is right—creating opportunities for engagement with a range of stakeholders is important and immensely difficult. It's also worth it.

Passing Legislation to Frame U.S. Internet Access Policy. In 2017, Foreign Affairs Committee Chairman Ed Royce introduced a bill that sought to reduce the digital divide between rich and poor countries by promoting private sector partnerships, a favorable investment climate, and the implementation of so-called build-once policies that streamline IT infrastructure and reduce redundancies.[10] The bill—known as the Digital Global Access Policy Act (H.R. 600), or Digital Gap Act—passed in the House but was not considered in the Senate. Given that the bill was not passed in 2018, it will need to be reintroduced in the current Congress. The Digital Gap Act represents the type of legislation that's needed to support the development of a free and open internet across developing countries where marginalized populations stand to benefit.

The U.S. government is taking the right steps in other areas to improve access to technology. The administration's recent Digital Connectivity and Cybersecurity Partnership (DCCP), announced during the Indo-Pacific Business Forum in July 2018, promises to improve digital connectivity and expand U.S. technology export opportunities within the Indo-Pacific region. The partnership will also focus on improving partner countries' regulatory policies and cybersecurity and is part of a suite of new U.S. economic initiatives (with $113.5 million set aside for funding) to be implemented in the region.[11] DCCP paints an encouraging portrait of U.S. involvement on several fronts, from improving connectivity to strengthening cybersecurity. Replicating this model across other regions would be a good next step.

8. "Power Africa Fact Sheet," USAID, December 2017, https://www.usaid.gov/documents/1860/power-africa-fact-sheet-122017.
9. Peter High, "The Father of the Internet, Vint Cerf, Continues to Influence Its Growth," *Forbes*, March 26, 2018, https://www.forbes.com/sites/peterhigh/2018/03/26/the-father-of-the-internet-vint-cerf-continues-to-influence-its-growth/#5c5690c949e5.
10. U.S. Congress, House, *Digital Global Access Policy Act of 2018*, HR 600, 115th Cong. Introduced in House January 23, 2017, https://www.congress.gov/bill/115th-congress/house-bill/600.
11. "Advancing a Free and Open Indo-Pacific", Department of State, https://www.state.gov/r/pa/prs/ps/2018/07/284829.htm

The United States must put in place policies that keep it at the technological forefront on the global stage or risk losing opportunities to remain influential. When the European Union saw a gap around laws on data protection and privacy, it stepped up to create the General Data Protection Regulation (GDPR). The GDPR has implications, including compliance requirements, for companies and countries beyond its borders. Its creation and implementation should serve as a reminder for the U.S. government that strong internal policies provide the framework within which a country can position itself to be at the front of global discussions on the adoption of emerging practices.

Strengthening Cybersecurity. The United States should adopt more rigorous policies around cybersecurity, which is a critical aspect of connectivity. What good is it to support developing countries' access to technology if that access is vulnerable to hacking by China, Russia, or Iran? Neglecting cybersecurity would be like building a house on sand—an internet without secure underpinnings will be vulnerable to control, corruption, and surveillance. The DCCP proposes to strengthen cybersecurity with its partner countries, but given that hacking is a borderless crime, the list of countries needs to be expanded to allies and nations outside of the partnership.

All these recommendations build on the continued work of the U.S. government. Since its early days, USAID has sought to open dialogue with stakeholders to determine the best course of action in an international context. More specifically, the United States, through USAID, has a long history of implementing programs aimed at increasing internet access to developing countries. From the 1990s Leland Initiative, which sought and successfully established internet connectivity across 20 African countries, to more recent efforts like the 2013 partnership between USAID and the Kenyan startup, Mawingu—a collaboration that merged wireless technology with solar power to provide remote Kenyan communities with affordable broadband access—U.S. efforts to expand access to the internet are long-established and ongoing.[12]

Conclusion

Internet connectivity is part of modernity. Like the discovery of electricity before it, the internet transforms lives in profound ways. The reality is, we live in a world where there is access to an unprecedented amount of information and data that informs decision-making, connects us, and facilitates innovations in a range of fields, from health and education to agriculture and science. But these advancements ring hollow when marginalized groups, trapped by the cycle of poverty, remain on the sidelines.

We, right now, have the opportunity to lay the foundation for a future that is connected and prospers together.

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12. USAID, Caribou Digital, and Digital Impact Alliance, *Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption* (USAID, Caribou Digital, and Digital Impact Alliance, 2017)https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf.

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Daniel F. Runde is senior vice president, director of the Project on Prosperity and Development, and holds the William A. Schreyer Chair in Global Analysis at CSIS. His work centers on leveraging American soft power instruments and the central roles of the private sector and good governance in creating a more free and prosperous world. Previously, he led the Foundations Unit for the Department of Partnerships & Advisory Service Operations at the International Finance Corporation. His work facilitated and supported over $20 million in new funding through partnerships with the Bill and Melinda Gates Foundation, Rockefeller Foundation, Kauffman Foundation, and Visa International, among other global private and corporate foundations.

Earlier, Mr. Runde was director of the Office of Global Development Alliances at the U.S. Agency for International Development (USAID). He led the initiative by providing training, networks, staff, funds, and advice to establish and strengthen alliances, while personally consulting to 15 USAID missions in Latin America, the Middle East, and Africa. His efforts leveraged $4.8 billion through 100 direct alliances and 300 others through training and technical assistance. Mr. Runde began his career in financial services at Alex. Brown & Sons, Inc., in Baltimore and worked for both CitiBank and BankBoston in Buenos Aires, Argentina. He received an MPP from the Kennedy School of Government at Harvard University and holds a BA, cum laude, from Dartmouth College.

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